SCIENCE: A RACE WITHOUT A FINISH. THE POSITION OF EUROPE

Peter Nijkamp[1]

Abstract. This paper addresses the fundamentals of our knowledge-based society, with a particular view to the emerging knowledge initiatives in the European Union. After a discussion on the current R&D investment trends in Europe, several flaws in the European knowledge system and in the European Research Area (ERA) are highlighted. The need for a drastic improvement of frontier research (i.e. excellence-driven research) and for a better coordination of the great many research initiatives in the widening European Union is emphasized. A drastic change is needed in order to cope with the fragmentation and the sometimes low R&D intensity in the ERA. The paper concludes with a presentation of a recent meta-analysis which demonstrates the importance of public expenditures for education and research, based on a comparative analysis of 123 applied studies on the impact of government expenditures for knowledge investments on economic growth.

1. Europe and the Knowledge Revolution

For the past centuries the socio-economic history of Europe has been characterized by drastic transformations in its production structure, starting from the Industrial Revolution (mid nineteenth century) and followed by the Service Revolution (in the period after World War II) and the Information Revolution (as of the 1980s). Very recently, from the beginning of the twenty-first century onward, a new concept has become ´en vogue´, namely the Knowledge Revolution. The latter concept refers to the emerging awareness that a knowledge-based economy is a critical condition for achieving a strategic and leading position in a competitive, globalizing world where innovation is the key to success.

The European Union (EU) has recognized the importance of a strong R&D support to the evolving knowledge society in Europe, witness the acceptance of the Lisbon objectives (2000) for Europe as a global knowledge leader and of the Barcelona targets (2002) on the commitment of a drastic increase of R&D intensity (toward 3 percent of GNP in Europe). Such ambitious policy statements and plans were needed, since most countries in Europe do not have a strong R&D system[2]. The following weaknesses have been recently noticed in particular[3].

[1] *Peter Nijkamp is Professor in regional and urban economics and in economic geography at the Free University, Amsterdam. His main research interests cover plan evaluation, multicriteria analysis, regional and urban planning, transport systems analysis, mathematical modelling, technological innovation, and resource management. In the past years he has focused his research in particular on quantitative methods for policy analysis, as well as on behavioural analysis of economic agents. He has a broad expertise in the area of public policy, services planning, infrastructure management and environmental protection. In all these fields he has published many books and numerous articles. He is member of editorial boards of more than 20 journals. He has been Visiting Professor in many universities all over the world. He is past president of the European Regional Science Association and of the Regional Science Association International. He is also Fellow of the Royal Netherlands Academy of Sciences, and is immediate past vice-president of this organisation. Since June 2002 he serves as president of the Governing Board of the Netherlands Research Council (NWO).*
President NOW, President EuroHORCs

[2] *Gronbaek, D.J.V.H., A European Research Council: an idea whose time has come?, Science and Public Policy, December 2003, pp. 1-14; Ministry of Economic Affairs, Science, Technology and Innovation in the Netherlands, The Hague, 2004*

[3] *Why Investing More in R&D at the European Union Level?, Mimeographed Note, EC, Brussels, 2005; OECD, Basic Science and Technology Statistics, Paris, 2001; LERU, Growth, Research-intensive Universities and the European Research Council, February 2005 (http://www.leru.org)*

- Compared to other world regions, Europe is lagging behind in terms of its investments in R&D (for example, the average annual gap in R&D expenditures between the EU and the USA amounts at present to more than 100 bln euro); thus, the knowledge investment rate has to be increased drastically.
- On average, Europe has a low researcher density (or knowledge worker density); the share of researchers in the total labour force in the EU-25 is only 5.3 per 1000, in contrast to 9 per 1000 in the USA and 9.7 in Japan. A significant boost has to be given to increase drastically Europe´s knowledge capacity.
- Europe has a relatively feeble interface between academic research and industrial/societal applications (the so-called European knowledge paradox), so that its innovation system is not sufficiently developed to cope with competition on a worldwide basis. The number of patents granted in Europe is much lower than that in the USA or Japan. Consequently, Europe has to experiment more with open science and innovation systems.
- Europe is not a strong export region of knowledge-intensive or high-tech products (for instance, the share of high-tech goods in Europe's total export is approx. 18 percent, compared to 29 percent in the USA and 25 percent in Japan). More R&D investments to support innovativeness in Europe and to reinforce its high-tech trade performance are needed.
- In the past years, Europe has even been losing a significant part of its young talent to the USA (400.000 knowledge workers in the USA originate from Europe and approx. 75 percent of European Ph.D. recipients wants to stay in the USA after their US doctoral degree)[4]. Consequently, the EU has to develop a much stronger brain gain policy, in order to support return migration of young talent elsewhere in the world.
- The research policy in the EU-25 is fragmented and largely uncoordinated, so that we observe both the presence of duplication in research and the emergence of gaps in new research in Europe. Thus, the research resources in Europe are not efficiently used; they do not lead to scale and scope to create the basis for scientific breakthroughs on the global science platform.

Science and research underpin an advanced knowledge-based society[5]. New knowledge is not only a prerequisite for technological innovation, but is also a critical success factor in coping with complex societal questions.[6] Thus, progress in scientific research is a cultural, economic and technological factor of paramount importance. It is driven by inspiration of scholars seeking to explore the frontiers of our knowledge, but it has spin-offs that are drivers of welfare in a modern society. This is inter alia confirmed in a recent Irish study, which claimed that "…with between 70 and 80 percent of economic growth now estimated to be due to new and better knowledge, a future prosperity is critically dependent on policies that foster the

[4] *Kelo, M., and B. Wächter, Brain Drain and Brain Gain, Nuffic, The Hague, 2004*
[5] *EIROforum, Towards a Europe of Knowledge and Innovation, Brussels, 2005*
[6] *European Commission, Frontier Research: The European Challenge, High-Level Expert Group Report, Brussels, February 2005*

continuous generation of knowledge and pursuit of learning"[7].

The EU has rightly recognized the key position of R&D in a competitive knowledge-based economy. It has also observed several weak elements in the European R&D system (such as lack of talent policy or the compartmentalized nature of European research). And it has also developed new initiatives to stimulate the scientific and technological competence of the research community in Europe. In the next section we will present and interpret some recent findings on the European knowledge system.

2. Diversity in the European R&D System

The ambitious Lisbon objectives and Barcelona targets prompt a question on the current R&D investment levels and their trends in the EU-25 countries. The European Research Area (ERA) aims to be more than just a collection of individual national R&D systems. Progress has to be sought through synergy and coordination of research activities. As mentioned above, largely overlapping research systems in the EU-25 are inefficient and sometimes even waste of scarce resources. The achievement of a focussed mass will be a major challenge for the ERA and a necessary condition to cope with the European knowledge paradox. The slow economic growth and the declining competitiveness on the international market symbolize the fact that the EU-25 is not reaping the full benefits from its knowledge system. A fact is that the ERA does not reach its maximum potential in terms of scientific performance, economic growth and innovation.

Some empirical figures may illustrate the above points. Figure 1 maps out the R&D intensity (or knowledge investment rate) of the EU-25 countries, with the USA and Japan as reference cases. These figures are illuminating and lead to two observations:

- there is an enormous variety in R&D intensity among European countries (the max/min ratio between the country with the highest and the lowest R&D intensity amounts to a factor 13!).
- almost all EU-25 countries (except two) have an R&D intensity below the Barcelona targets of 3 percent.

The next question is whether the R&D expenditures in the EU-25 countries have shown an accelerated pace of growth in the past years, so that by the year 2010 still the Barcelona targets might be reached. Figure 2 presents the growth rates in R&D intensity in both the period 1997-2000 and the period 2000-2003. This information gives rise to the following observations:

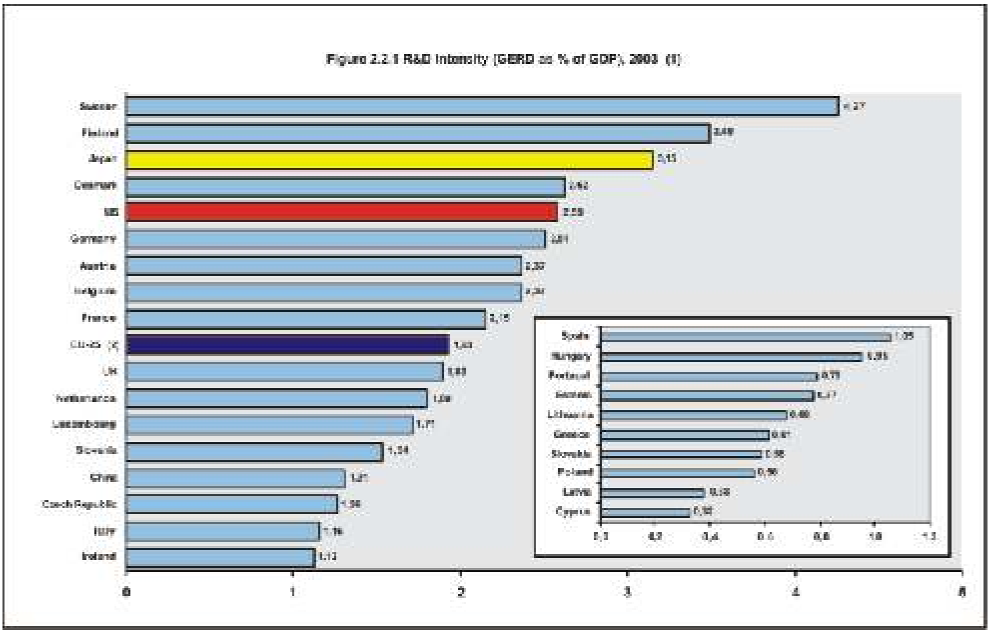
- some new member states seem to be in a catch-up phase and have accelerated the growth in R&D intensity.
- several EU-25 countries cluster more or less around the European average.
- a smaller group of EU-25 countries even has a negative growth rate.
- the EU-25 average growth in R&D intensity is disappointingly low and will be insufficient to reach the policy targets implied by the Barcelona declaration.
- the US figures are below the EU-25 average, whereas Japan has higher growth figures.

The above figures are indeed alarming. If the tides do not change, Europe will lose its opportunity to become a world leader in the global knowledge-based

[7] *D. O´ Hare, Building the Knowledge Society Report to the Government, The Information Society Commission, Department of the Taoiseach, Dublin, 2002.*

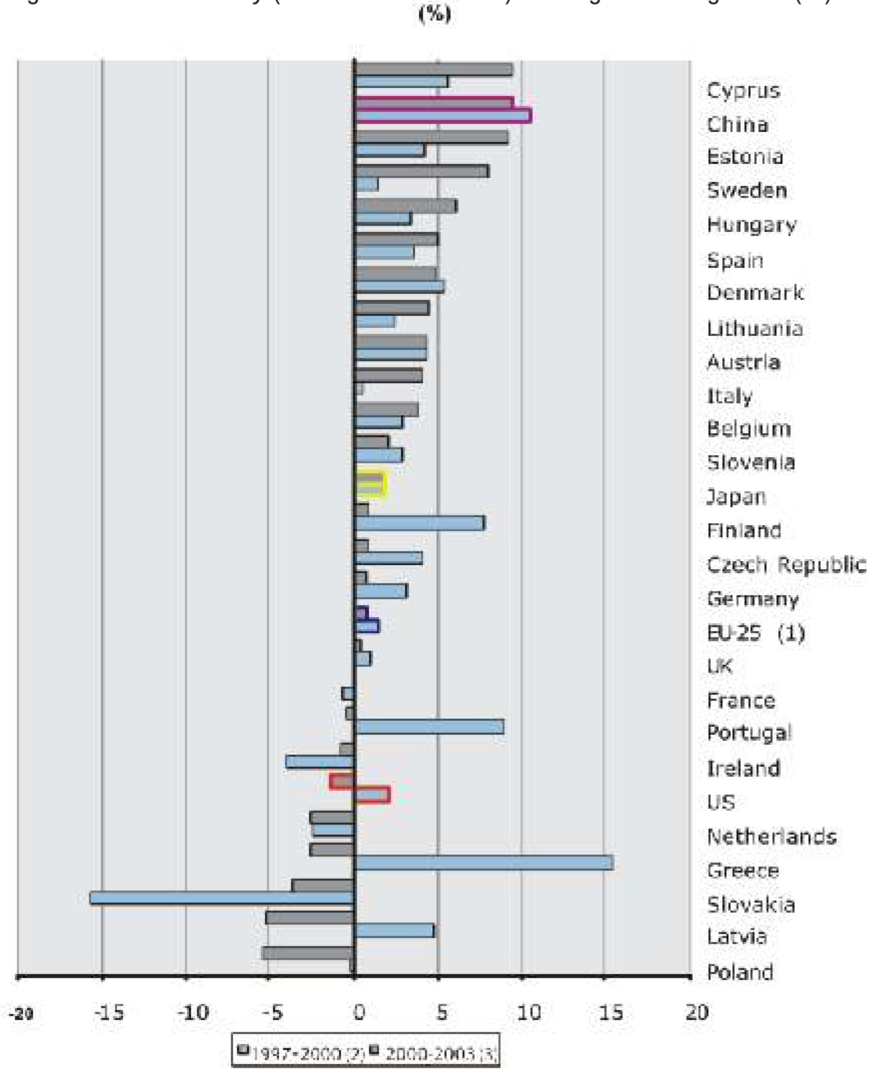
economy. The turn of the century has not meant a new boost and has shown only a very modest and almost negligible growth in R&D intensity in the past years. It ought to be recognized here that especially business funding of R&D has stayed behind the expectations. This worrying situation calls for a closer anatomy of the European R&D system. This will be offered in the next section.

Figure 1 R&D intensity (GERD as % of GDP), 2003 (1)



Source: Key Figures 2005 on Science, Technology and Innovation, Towards a European Knowledge Area, EC, July 2005

Figure 2 R&D intensity (GERD as % of GDP) average annual growth (%)



Source: Key Figures 2005 on Science, Technology and Innovation, Towards a European Knowledge Area, EC, July 2005

3. Anatomy of the European Knowledge System

Advanced scientific research, new technological developments and creative innovations are decisive factors for the achievement of the ambitious Lisbon and Barcelona goals. It is broadly recognised in both scientific and policy circles - that the ERA calls for a scientific revitalisation based on competition, cooperation and coordination in order to cope with the drawbacks of current nationally and sectorally fragmented research and innovation funding mechanisms. Partnership and networking are key elements of a road map to proper knowledge discovery and usage in Europe.

Modern science is increasingly characterised by a strong internationalisation process, as is, for instance, witnessed by a multiplicity of cooperative agreements between research institutions in various countries or by a rising number of multi-country authorships of scientific publications. The rising cross-border orientation of scientific research prompts various challenging questions: Is Europe able to keep pace with the unprecedented dynamics in scientific development in our globalising world? Are the national and European research (funding) systems sufficiently and effectively addressing the far-reaching challenges of the emerging European knowledge economy? Is the result of national funding mechanisms for science-driven research in Europe comparable to that of competing regions like the USA and emerging economies like China or India? And is Europe able to translate its scientific performance into welfare and prosperity?

These challenges call for a critical review of European achievements. Whilst Europe has moved in the past decades to a common market for goods, services, people and capital, the market for scientific research is still mainly nationally oriented[8]. Despite the plethora of advances in the European knowledge-based society, two significant concerns have to be recognised. In the first place, the demand and user side of R&D is often insufficiently addressed in Europe. As a consequence, excellent knowledge does not always lead to the best entrepreneurship, the highest innovation rate or the most favourable growth path of the economy. Secondly, several national efforts outside the Framework Programme (FP) of the European Commission (EC) to invest in science-driven research in European countries lack focus and critical mass in many cases, with the consequence that the existing fragmented national funding schemes in Europe do not generate the maximum possible revenues and the high-quality knowledge intensity that is required to keep European industry internationally competitive. The plans to create a European Research Council (ERC) aiming at favouring scientific excellence - are an important step forward, but there is still an urgent need to cope with fragmented science systems in Europe[9].

It is recognised that 'fragmentation´ is one of the important elements of the ERA that needs to be coped with urgently, alongside the need to favour excellence. Fragmentation refers to insufficient scale and scope in research compared to its full potential - in European countries, caused by the lack of critical mass in competences and resources in individual national research programmes in our countries. National

[8] *European Commission, Facing the Challenge, Report from the High Level Group Chaired by Wim Kok, Brussels, November 2004*
[9] *Forfas, Europe´s Search for Excellence in Basic Research, Dublin, 2004*

research organisations (both funding agencies and research performing bodies) are critical agents in improving the current sub-optimal functioning of research systems in the ERA. There is a need for more coordination in establishing clear focus and sufficient mass in research systems, in particular in those areas where large resources - often in a multidisciplinary context - are required in order to reach a forefront position on the international stage. Examples of such areas are global research challenges, such as the human genome project, infectious diseases, or climate change. But also the social sciences and humanities are faced with similar challenges for frontier research, such as social cohesion (at the interface of integration, migration and ethnicity) or cognitive research (at the interface of molecular and neurosciences, psychology, philosophy and computer science). There is hardly any individual country which has the resources to acquire a world leading position on its own in any of such new fields.

The European knowledge society is indeed suffering from several flaws which preclude an optimal use of its resources and its scientific talents. In summary, the most prominent weaknesses of the knowledge system in Europe which need to be coped with urgently are:

- a systematic and structural under investment in scientific research (including R&D), in both the private and the public sector
- a lack of focus and mass in world-class research, caused by fragmented research strategies and funding mechanisms in Europe and by uncoordinated investment plans in large-scale research infrastructure facilities
- the diversity in R&D mechanisms among European countries, which may lead to 'cannibalism' in research and innovation policy while neglecting the global battle field where the future is shaped
- the co-existence of various research funding mechanisms (both private and public), which lead to overlap and duplication in research efforts (leaving aside financial inefficiencies)
- the absence of benchmarking systems through which real European top quality of scientific research can be identified.

Such weaknesses are a source of deep concern among the research community in Europe (including the research councils) and they ought to be addressed with priority. A drastic intensification of science cooperation at the European level is a necessity.

The consequences of the current fragmented national research systems in Europe (i.e., the costs of non-Europe) are clear:

- a national focus on research spending is likely to lead to unnecessary or undesirable duplication;
- lack of coordination may also lead to a neglect of important new research domains in Europe, as purely national competences may be too insufficient to start a new large research domain (e.g., orphan diseases);
- a strategy of favouring only national research champions may hamper a full added value from a European perspective and may be an impediment to a break-through of new technologies of global importance;
- lack of cooperation among national research programmes may create conditions for structurally disadvantaged positions in countries

with weaker developed research systems (like in some of the recently acceded countries);

- an exclusive orientation towards national research programmes weakens Europe's position in the external world, due to lack of image, visibility, focus and mass, a joint profile and a common voice, and hence may lead to lost opportunities.

An effective policy for coping with compartmentalisation in the ERA as a consequence of disciplinary, national or segmented approaches calls for win-win bottom-up strategies leading to synergy revenues from collaboration among separate European knowledge systems. Scientific cooperation among European countries already has a long history; it has over the years adopted different forms ranging from bilateral covenants and intergovernmental agreements to EU-instigated framework programmes.

With the advent of the ERA a recent much discussed issue has been whether the national markets for science-driven research should be opened up for all European countries. An open research market would have great advantages for scientific achievements, notably:

- Significant enhancement of the quality of scientific research (e.g., through more competitive bids and strict benchmarks of evaluation standards and procedures).
- Stimulation of research mobility in all academic ranks within the EU countries.
- More efficient use of large-scale research infrastructures among EU countries.
- High international research standards resulting from trans-national scientific cooperation and networking and from open access to research programmes.
- A visible and appealing research profile of EU countries on a worldwide scale.

The widely accepted policy goal to establish a European knowledge society which would be internationally competitive and even at the forefront of science development in our world has prompted a vivid debate on the necessary investments in our knowledge society. Do public expenditures on knowledge creation and dissemination matter? This question has intrigued many policy-workers and researchers. They often refer to Silicon Valley types of development, to North Carolina, to Finland, to Taiwan or Singapore, where research has created an avalanche of spin-offs in the form of innovations, new start-ups, licenses and patents, and so forth. Europe will soon be facing a severe competition at the global level. How should we respond when we know that China will already need 4 million knowledge workers only in its 53 Science & Technology Parks? And what to do if already now India has a serious shortage of R&D personnel and is planning a rigorous brain gain policy?

It is undoubtedly true that knowledge-intensive regions with a research-benign climate tend to grow faster than others. Clearly, public expenditures in science and technology are not the only critical success factors for accelerated economic development. Other factors, such as the development of timely niche markets (e.g., ICT, biotechnology) are important as well. For example, Roller and Waverman[10] demonstrate that there is a significant positive causal link between

[10] *Roller, L. & L. Waverman, Telecommunications Infrastructure and Economic Development, American Economic Review, vol. 91, 2001, pp. 909-923*

telecommunications infrastructure and economic growth for 21 OECD countries over 20 years. Responsive governments may see it as their task to orient their R&D expenditures towards promising new market niches.

This message is also reflected in the new growth theory in economics which stipulates that public policy is not only driven by demand stimuli, but also by endogenously determined factors such as infrastructure, education, innovation and the like[11]. The diversity in explanatory frameworks has one element in common, namely, the importance of knowledge availability and access. Knowledge creation and diffusion is to a large extent a mission of academic research and educational institutions (universities, research laboratories, colleges, high schools etc.), so that governments are not a neutral actor in this context. The size and direction of public expenditures on science and education may exert a decisive impact on the prosperity and well being of nations or regions. The European knowledge society has an important and challenging mission to fulfil.

4. Public Expenditures, Knowledge and Growth

Innovation, entrepreneurship and economic growth are not 'manna from heaven' or the result of the forces of nature, but endogenously determined by deliberate choices of public actors and private business, in the context of a proper and supportive institutional setting[12]. Government policy (e.g., taxation policy, educational policy, R&D policy or location policy) is thus not neutral, but may exert a significant impact on the economic performance of regions or countries. In the light of the present paper on the knowledge-based economy, it is of course an intriguing question whether and if so, which category of knowledge policy has a demonstrable positive influence on the outcomes of a market system[13]. To answer this question, we will first offer some lessons from economic growth theory.

Growth theory is a standard element in economics. It addresses not only the question on the drivers of economic growth, but also the causes of differences in growth rates between different countries or regions. In the neoclassical world, the efficient combination of input factors such as capital or labour was supposed to be the key for the explanation of (differences in) growth, given the standard assumptions on perfect competition and constant returns to scale. In recent years, we have witnessed a considerable enrichment of growth theory by the inclusion of additional assumptions on increasing returns to scale and monopolistic competition. This new growth theory - largely based on micro-economic thinking was also able to encapsulate endogenous growth mechanisms related to education, R&D and learning-by-doing strategies in a competitive world where innovation and entrepreneurship are prominent factors[14]. In the same vein we have seen the rise of the so-called new trade

[11] Dixit, A.K., & J.E. Stiglitz, Monopolistic Competition and Optimum Product Diversity, American Economic Review, vol. 67, 1977, pp. 297-308; Lucas, R.E. , On the Mechanics of Economic Development, Journal of Monetary Economics, vol. 22, no. 1, 1988, pp. 3-42; Romer, P.M., The Origins of Endogenous Growth, Jounal of Economic Perspectives, vol. 8, no. 1, 1994, pp. 3-22.

[12] North, D., Institutions, Institutional Change and Economic Performance, Cambridge University Press, Cambridge, 1991.

[13] "What is the main thing governments must do to spur economic growth? Ah, well, that remains a mystery" (The Economist, March 6, 1999).

[14] See inter alia: Romer, P.M., Endogenous Technological Change, Journal of Political Economy, vol. 98, nr. 5.2, 1990, pp. S71-S102; Lucas, R.E., Why Doesn't Capital Flow from Rich to Poor Countries?, American Economic Review,, vol. 80, no. 2, 1990, pp. 92-96; Aghion, P. & P. Howitt, Endogenous Growth Theory, MiT Press, Cambridge, 1998; Sala-i-Martin, X., Regional Cohesion, European Economic Review, vol. 40, 1996, pp. 1325-1352; Groot, H. de, Growth, Unemployment and De-industrialisation, Edward Elgar, Cheltenham, UK, 2000; Nijkamp, P.& J. Poot, Spatial Perspectives on New Theories of Economic growth, Annals of Regional Science , vol. 32, 1998, pp. 7-27.

theory (on the endogenous influence of institutional environments) and the new economic geography (on the importance of agglomeration advantages and other spatial externalities). Although some economists complain that "*Cross-country growth regressions seem hopelessly naïve to longtime observers of the growth process*"[15], there are other statistically verified findings that stipulate a positive correlation between growth and educational level, or between growth and public expenditures for education[16]. It is now generally accepted that education, training, learning-by-doing, and R&D increase the efficient usage of human capital and hence favour economic growth. Thus, knowledge investments may be seen as a critical success factor for economic growth, innovativeness and competitiveness.

The question is not anymore whether it helps, but how much does it contribute?

To answer this question, two steps have to be undertaken, namely (i) an analysis of the impact of knowledge on socio-economic performance and (ii) an analysis of the impact of public research and education (RE) expenditures on economic growth.

In the first step of our analysis we will now address the impact of schooling and related indicators. In the economics literature we find several empirical estimates that suggest a positive relationship. Examples are inter alia the following empirical statements:

"*An extra year of male average upper-level schooling is estimated to raise the growth rate by a substantial 1.2 percentage points per year*" [17]

"*The elasticity of gross private non-agricultural output with respect to current educational services is about 0.04 with a standard error of 0.02*"[18]

"*For low-income and medium-income countries, the average output elasticity of human resource-development capital is 0.62, more than twice as much as that of the private capital stocks*"[19]

"*An increase in the share of educational expenditure in GDP by one percentage point would increase the rate of total factor productivity growth by 0.28 percent per annum*"[20]

The above quotations suggest indeed a positive relationship between economic growth and investments in knowledge infrastructure or human capital. Using cross-sectional/pooled time-series regression analysis, Brons et al. [21] have tried to find a more solid empirical evidence on the basis of extensive data from 14 countries over the period 1960 1990. Their main results are summarized in the following table (see Table 1).

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[15] *Harberger, A.C., A Vision of the Growth Process, American Economic Review, vol. 88, no. 1, 1998, pp. 1-32.*

[16] *Easterly, W., and S. Rebelo, Fiscal Policy and Economic Growth, Journal of Monetary Economics, vol. 32, 1993, pp. 417-158.*

[17] *Barro, R.J., Determinants of Economic Growth: A Cross-Country Empirical Study, MiT Press, Cambridge, 1997*

[18] *Evans, P., & G. Karras, Are Government Activities Productive? Evidence from a Panel of US States, Review of Economics and Statistics, vol. 32, no. 3, 1994, pp. 291-303 <*

[19] *Baffes, J., & A. Shah, Productivity of Public Spending, Sectorial Allocation Choices and Economic Growth, Economic Development and Cultural Change, vol. 46, no.2, 1998, pp. 291-303*

[20] *Hansson, P., and M. Henrekson, A New Framework for Testing the Effect of Government Spending on Growth and Productivity, Public Choice, vol. 81, nrs 3-4, 1994, pp. 381-401.*

[21] *Brons, M., H.L.F. de Groot, & P.Nijkamp, Growth Effects of Fiscal Policies, - A Comparative Analysis in a Multi-Country Context, Growth and Change, vol. 31, 40-41, 2000, pp. 547-573.*

Table 1. Regression results of determinants of economic growth.

	Coefficient	T-value
Intercept	-0.0209	-2.636
Rate of initial GDP per capita to USA	-0.1770	-8.623
Ratio of real private investment to real GDP	0.1190	4.814
Effective tax rates on labour income	-0.0630	-5.599
Terms of trade shock	0.1890	3.988
Index of political rights	0.0088	3.415
Percentage of 'no schooling' in the total population	-0.0024	-7.718
Total gross enrolment ratio for higher education	0.0585	4.575
Finland	-0.0240	-4.962
Japan	-0.0120	-2.420
Sweden	0.0126	3.278
70-74	-0.0082	-3.450
80-84	-0.0199	-4.823
$R^2 = 0.84$		

Bron: Brons et al. (2000)

This table demonstrates clearly that schooling has a significant impact on economic growth. This is clear from both the negative sign of the 'no schooling' variable and the positive sign of the 'enrolment ratio for higher education'. Clearly, also other variables such as private investments and taxation have a significant impact, so that we observe a compound effect of several factors. But what is the role of the government? Is it now possible to derive a more conclusive statement on the expected impact of government RE expenditures on growth, based on empirical evidence?. This will be dealt with in the second step.

Step 2 of our approach deploys meta-analysis as a tool to draw conclusions from several quantitative case studies. We will first start with a short selection of some empirical findings from the literature on the relationship between public expenditures, government consumption and economic growth, which demonstrate quite some variety in results:

- Glomm and Ravikumar[22] find that public expenditures on education have a significantly positive impact on economic growth, provided such expenditures are conceived of as productive investments
- Kormendt and Meguire[23] claim that the growth of government

[22] *Glomm, G., & B. Ravikamar, Productive Government Expenditures and Long Run Growth, Journal of Economic Dynamics and Control, vol. 21, no.1, 1997, pp. 183-204.*

[23] *Kormendt, R., & P. Meguire, Macroeconomic Determinants of Growth, Journal of Monetary Economics, vol. 16, 1985, pp. 141-163*

consumption has a negative effect on economic growth.

- Hansson and Henrekson[24] state, on the other hand, that public expenditures aimed at eliminating market distortions will have a positive impact on growth.

There is indeed an avalanche of empirical studies addressing the above-mentioned relationship. In a recent study[25] a collection of empirical studies on growth and government spending policy has been assembled and analysed, with the aim of finding empirical evidence for the question whether and to which extent economic growth is significantly explained by five factors: government consumption, taxation rate, public expenditures for education and R&D, defence expenditures and physical infrastructure. A total of 123 studies was collected, and classified according to year of publication, the number of observations, the year of first observation, and the year of the most recent observation.

The numerical outcomes of these studies were used in a meta-analysis, that served as a comparative statistical method to treat quantitative findings from different case study analyses in order to generate an overall synthesis of various empirical findings. More details on the meta-analysis can be found in Nijkamp and Poot (2003)[26]. Using a meta-regression analysis, the following statistically significant results were found for the relationship between economic growth and government policy, in particular public expenditures. These results demonstrate convincingly a positive causal relationship between economic growth and public expenditures in education and R&D. The lessons for government policy in Europe are clear, in the light of the achievement of Lisbon objectives.

Table 2. Impact of government policy on economic growth

Policy categories	Sign and size of impact
Education and R&D	++
Physical infrastructure	++
Taxation rate	-
Defence expenditures	-
Government consumption	?

5. Retrospect and Prospect

Our modern economy is decisively determined by the efficient and effective acquisition and usage of knowledge. Hence, investments for improving and enlarging our knowledge capacity are sine qua non for competitiveness and economic growth. The

[24] *Hansson, P., & M. Henrekson, A New Framework for Testing the Effect of Government Spending on Growth and Productivity, Public Choice, vol. 81, no. 3 / 4, 1994, pp. 381-401.*

[25] *Nijkamp, P., & J. Poot, Meta-Analytic Perspectives on the Impact of Fiscal Policies on Long-Run Growth, European Journal of Political Economy, vol. 20, nr 1, 2004, pp. 91-124; Nijkamp, P., J.Poot, & G. Vindigni, Spatial Dynamics and the Government: An Artificial Intelligence Approach to Comparing Complex Systems, Knowledge Complexity and Innovation Systems (M.M. Fischer & J. Fröhlich, eds.), Springer-Verlag, Heidelberg, 2001, pp. 369-401.*

[26] *Nijkamp, P., & J. Poot (2003), ibid.*

arguments put forward in the previous sections both strategically and empirically highlight the importance of sufficient and tailor-made expenditures in education and R&D. Our meta-analytical results confirm the strategic importance of government expenditures for our knowledge-based society.

Investments in RE infrastructure form the Achilles heel of the ERA. The slow growth of the European economies runs parallel to a stagnating development of R&D intensity in Europe. The average R&D intensity (as a percentage of GDP) in Europe is approx. 1.93%, as compared to 2.59% in the US and 3.15% in Japan. Especially the low business funding of R&D is a source of concern and a threat for European competitiveness. Not only should R&D investments be increased in both the public and private sector, but also its effectiveness in terms of added value and synergy should be enhanced. This calls for an integrated initiative to make the ERA a success in the years to come, in terms of both scientific progress and innovativeness.