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International Science Policy of Hungary at the Beginning of the 21st Century

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Magyar nemzetközi tudománypolitika a 21. század első évtizedeiben

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I. Introduction

Global challenges of the 21st century range from issues pertaining to climate change, food security and healthy ageing to energy production, industrial innovation, social welfare, and inclusive societies. Scientists and other members of the scientific community often work beyond national boundaries, beyond the traditional borders of their scientific disciplines, and beyond the sector of academia itself in their attempts to respond to such challenges. The nature of these challenges is such that they cannot be resolved by single countries or single disciplines working in splendid isolation. These extended, non-traditional networks of scientists are intrinsic elements of world-wide coalitions trying to resolve the global challenges, and they attempt to do so in the broader context of wider political and economic conflicts. More often than not, science and scientific cooperation, as an inherently apolitical activity, can go a considerable way to build advantageous alliances precisely in contexts fraught with political issues and other conflicts (Krige, 2003, p. 904).

Science Policy is often considered as the choice between two mutually exclusive positions when it comes to the production of scientific knowledge. The one horn of this dilemma represents scientific progress as an autonomous, bottom-up process driven by the unhampered curiosity of autonomous individuals working on topics of their own choice whilst the other horn views scientific progress as primarily driven by national governments in a top-down fashion, substantially hedging in the autonomy of curiosity-driven science. These governments make goal-oriented interventions, steer and manage scientific progress in predetermined directions, and usually do so by civil servants employing the tools of limited national funds dedicated to a limited set of goals. However, in actual practice these two approaches are likely to complement rather than mutually exclude each other. Scientists typically enjoy more autonomy in the area of fundamental and pre-competitive research, both in terms of research priorities and research methodology, whereas governments in general primarily set policy priorities and clearly defined output targets for applied competitive research and technological development. In doing this, governmental institutions try to support and facilitate the interaction between science and industry, as well as the establishment of innovative small and medium size enterprises. Within this wider context of a non-exclusive approach to fundamental and applied science, the task of national science policy seems to consist of providing robust and consistent but at the same time flexible framework conditions for setting research priorities, enhancing output and impact, and allocating budgets, funding instruments and bodies accordingly.

Nation states are increasingly more often not only inclined to compete for power by trying to extend their physical territory, but they also compete for the means to create more wealth and social well-being within their territory (Stopford & Strange, 1991, p. 1). In this specific area of competition, science and technological innovation is seen as one of the most prominent and effective means to increase the competitive edge of a nation in their endeavours to become a respected player in a more globalized world (Brandin & Harrison, 1987, p. V.). The global production of knowledge is also reflected in a strong increase both in the number of international co-publications and in the international mobility of researchers. When it comes to international mobility of top-researchers, being an attractive location to conduct scientific research is another pivotal competitive factor for national governments to take into consideration. A clear national policy on brain drain versus brain gain issues is important for any government to stay in the front of the queue in the competition to attract globally mobile human capital.

Open Innovation, Open Science, Open to the World, the Three Os set out by the EU Commissioner for Science and Technology, Carlos Moedas, also emphasise the importance of breaking down national barriers, cooperation and global competition (EC, 2016a). Openness in this context entails being open for knowledge produced by other stakeholders in the knowledge-innovation chain, producing knowledge in joint multidisciplinary teams, and co-creating and sharing knowledge with citizens for the benefit of society and the world at large.

Studies on international science policy in Hungary in the last decades are thin on the ground. Most existing research in Hungary is focussed on blending in with European Research programmes. Working in the field of S&T policy over the last 15 years I have been in close contact with the interactions between bilateral and multilateral schemes, programmes and policies. I stopped collecting data in June 2018, just after the last reorganisation of the Hungarian science policy landscape, so this thesis does not analyse institutional and policy changes after this date.

After a turbulent political history and the changes this history inflicted on science policy issues, described in detail in this thesis, Hungary's accession to the European Union has had a substantive impact on its bilateral international scientific cooperation and policy. Even Hungary's national science policy has been adjusted to EU schemes: both competition-based participation in European framework programmes as well as nationally available funds on the back of European Structural

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Funds are managed with European priorities in mind. The remaining national funds, outside of the EU remit, are often allocated to priorities and stakeholders not eligible for EU funding.

Hungary's EU membership also changed its cooperation with its traditional partners in bilateral alliances. Since its accession, Hungary has no longer been considered as a country in transition in need of additional support, but instead it has been viewed as a partner on an equal footing with the rest of the EU Member States. Most EU Member States supplement their existing bilateral cooperation agreements with European schemes, which can effectively be used for networking and cooperating within Europe. Furthermore, the European Research Area offers the guarantee of free movement for researchers. One of the consequences of all these and similar developments is that Hungary, in line with most of the other EU Member States, allocate most of their non-EU resources to bilateral activities with third countries outside of the European Union. Nevertheless, there are still existing good examples for bilateral cooperation inside of the European Union, too.

In this thesis, I will illustrate the various ways in which Hungary continues its bilateral relations in three typical examples, one with Austria – mobility funding, another with Germany – European programmes, and a third one with Turkey – joint research projects. I will discuss why these bilateral relations remain important even after Hungary's accession to the European Union. I have chosen these three countries for a number of reasons. My first example is Austria, Hungary's neighbouring country with a comparable size and population, because of its above-average performance and success-rate in European Union programmes. In this, Austria has the potential to serve as a role model for Hungary. My second example is Germany, because it has the highest GERD in the European Union, and the largest number of successful applications in European framework programmes together with Hungarian scientists. And finally, I have taken Turkey as an example because it has not yet achieved the status of full membership of the European Union, and because of its associated member status it can be regarded both as a European country and a third country at the same time.

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Research questions

In this thesis, I would like to formulate answers to the following three research questions:

(1) Which institutions, actors and mechanisms are involved in and responsible for setting the agenda of international science policy both in Hungary and in Europe at large, and in what way do such institutions, actors and mechanisms interact?

(2) How do international political events have an impact on national science policy in terms of adaptation to new framework conditions with special regard to Hungary's accession to the European Union?

(3) How do the main forms of bilateral scientific cooperation adapt to or are resilient to the new European framework? What are the forms and benefits of bilateral relations with Austria, Germany, and Turkey, and how is the cooperation with these countries affected by Hungary's membership in the European Union?

Methodology

In this thesis, I have used a mixed approach of quantitative and qualitative research methods. I have started my work by studying primary and secondary literature. I have given succinct definitions of key terms, and I have covered contemporary science policy strategies. I also briefly describe the history of science policy in Hungary based on some standard works of reference.

My main contribution to the current debate is to be found in the chapter about international science policy in Hungary in the 21st century, in which I use various analytical methods. I have analysed policy documents, agreements, and international strategy agendas. I have compiled two research questionnaires on relevant science policy issues: one for current and former Hungarian science attachés, another for Hungarian scientists who have submitted mobility projects with Austria. The questionnaire sent to science attachés was followed up by semi-structured interviews with current and former attachés, and with the Head of the Department for Science Diplomacy of the Ministry of Foreign Affairs and Trade. I give an analysis of OECD and eCORDA statistics so as to compare basic STI indicators and the participation of Hungary, Austria, Germany and Turkey in European framework programmes. I have set out three case studies of the history and current forms of bilateral cooperation between Hungary and three partner countries, *viz.* Austria, Germany and Turkey.

Chapters

After this introductory chapter, in the second chapter I set out the theoretical background by defining science policy and related concepts, which is followed by a brief analysis of primary and secondary literature relevant to the topic at hand.

In the third and fourth chapter I give a historical overview of Hungarian science policy starting from the beginning of the 20th century. I put special emphasis on the impact of decisive political events on Hungary's STI system. The fourth chapter is devoted to the developments after the systemic change in 1990.

In the fifth, and main, chapter, I discuss the international science policy of Hungary at the beginning of the 21st century from various perspectives. I describe the content of bilateral S&T agreements Hungary signed with Austria, Germany and Turkey, and provide a short overview of the science attaché network of Hungary. I then discuss the main features of Hungary's participation in European framework programmes. Finally, I set out three different forms of bilateral cooperation between Hungary and the three selected partner countries.

In the sixth, and concluding, chapter I attempt to give answers to the three research questions formulated above.

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II. Theory and Literature Overview

Science policy, or more precisely, international science policy forms the core concept of my thesis. Therefore, in this chapter, I will set out brief and general definitions of notions such as science, research, technological development, and international cooperation. In the first part, I will introduce the concept of a national science policy system, give a historical overview, describe its actors and management issues, and the institutions involved. In the second part I will elaborate on the significance of international cooperation in research, and the role of the European Commission as a policy entrepreneur.

II.1. Science Policy

In the following chapters I will unwrap the most important concepts pertinent to science, research and innovation, and I will give an overview of the historical evolution of science policy, and related issues such as the recently emerging theories like Science, Technology and Innovation (STI) policy research or Innovation Studies. Next, I will list the main stakeholders in this field and the connections between them. Lastly, I will introduce possible institutional systems involved in managing science.

II.1.1. National Science Policy

The idea of national science policy refers to national rules, regulations, methods, practices, and guidelines, in line with which scientific research is to be conducted. It also refers to the dynamic, complex and interactive processes and procedures – both inside and outside government – that have an impact on how these rules, regulations, methods, practices, and guidelines are designed and implemented. In this sense, national science policy can be defined as public policy governing all matters related to science, including research, development, regulation, and overall support of the national scientific community.

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Science can both influence and be influenced by government policy. Policy for science can be characterized as the process of decision making about how to fund or structure the pursuit of knowledge, while science for policy is concerned with the use of knowledge in assisting or improving decision making (Brooks, 1964, pp. 76-77).[1]

Science policy as such has not always been particularly well articulated. The professionalization of research took off in the nineteenth century, with the establishment of research laboratories in public and private sectors in multiple domains, supported by business and governments. These laboratories, in sectors such as agriculture and health, expanded in number and size in the first half of the twentieth century, and included new laboratories for cooperative research. Research councils emerged at the same time to sponsor research in addition to private, non-profit and government support. They were public and semi-public organisations, governed autonomously by the scientists themselves.

National S&T policies were a creation of the 1960s. While public interventions supporting science were in existence at this time, they were not constituted as a national public policy in ways similar to policies formulated for areas such as defence, public utilities, agriculture, or industry (Henriques & Larédo, 2013). Nowadays, the science and technology policy of a country is an integral part of general national politics, because it is one of the sectors of national politics. However, in reality it is not a separate branch or sector, since it pervades all the spheres of economy and society. As S&T policy is not a separate branch on its own, its governance should be decentralised, and the governance of all the sectors involved should be harmonized amongst each other (Darvas, Juristovszky, Mosoniné Fried, & Vas-Zoltán, 1982, pp. 22-24).

As the development of science and technology is strongly related to economic growth, technology transfer and societal needs, governance of science and technological development is closely connected both to the governance of economy and society. Some authors argue that science has to be conducted in such a way as to enhance the public good (Neal, Smith, & McCormick, 2008, pp. 9-12), while others highlight the importance of regulating technological innovation (Barke, 1986, p. 11). Dodgson and Bessant have set out a clear distinction between science, technology and innovation policy. According to their view, science policy is concerned with the development of

[1] A relevant theory is set out by Hoppe, which claims that the politicisation of science is twofold: the increasing influence of politics on science and the increasing influence of science on politics (Hoppe, 1999).

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science and training of researchers, while technology policy has the aim to support, enhance and develop new technologies. Innovation policy, however, takes into account the complexities of the innovation process and focuses more on interactions within the national science policy system (Dodgson & Bessant, 1996, p. 38).

Ideally, science policy supports the scientific community, takes into consideration the needs of citizens, and boosts economic growth all at the same time. General politics should only make interventions in the actual conduct of science if such interventions benefit the public good or protect society from possible dangers of scientific research. It should not interfere, however, when doing so would limit the progress of science. In reality science politicians rarely live up to such high standards, partly because most of them are non-scientists with no research experience. Another reason for the failure to comply with appropriate standards is that while science is typically value free and objective, science policy is highly visible, value-laden, and open to public debate (Griffiths, 1993, p. 4). Both science policy and its outcomes are often subjective in itself, driven by personal interest or ideology, instead of being underpinned by objective facts. As a result, actively practising scientists are rarely inclined to play a role in policymaking, and so the scientific community shows a fair degree of reluctance to get bogged down in the science policy process. As a consequence, the opinion of scientists themselves are often to a large degree absent from debates over major policies affecting the scientific community and its work, which makes the assessment of positive and negative consequences of research activities even more fraught with difficulties. A further difference between scientists and policy makers is one of purpose: while new scientific knowledge often raises more questions than it answers, policymaking is aimed at concrete solutions (Neal, Smith, & McCormick, 2008, p. 13). As a result, policymakers often feel a sense of frustration because of the inability of science to provide clear, concrete and timely solutions to problems high on their political agenda. It is obvious that for more effective and adequate science policy regulations to come into existence, an improved dialogue and a better understanding between scientists and policymakers has to be encouraged.

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II.1.2. Science of Science

Short working definitions of concepts such as science, basic and applied research, experimental development and innovation are needed for an adequate understanding of the various activities science policy is engaged in. The precise definition and interrelatedness of these concepts have been changing over time, and this in its turn has had an influence on governmental strategies and funding decisions. It has also given rise to a number of emerging research fields focusing on science, technology and innovation. Working definitions and short descriptions of these relatively new research fields will also be set out in this sub-chapter.

Science refers to knowledge, a readily available stock of facts. Knowledge is both the process of discovering new things and the understanding itself, the outcome of this process. Science can be defined as the composition of collected facts, theories and methods (Kuhn, 1996, p. 1).[2] Science can be also described as the search for these facts. And facts should be observed and collected in an objective and systematic manner, by using standardised models and methods, by analysing statistical data, and carrying out controlled and replicable experiments. So science may be thought of as the objective pursuit of knowledge and understanding through the scientific method (Neal, Smith, & McCormick, 2008, p. 6). The main aim of carrying out scientific activities is to better understand the world in which we live and to create models that explain how it functions.

Research and development (R&D) refers to the systematic work to increase the stock of knowledge (*research*) and to develop new applications based on this stock of available knowledge (*development*) (NSF, 2015, p. 2). R&D activities are based on unique, original ideas, concepts or hypotheses. They aim at new findings, which increase the stock of knowledge. The final outcome of completely new research is quite uncertain and unpredictable, the reason why it is excruciatingly difficult to plan time and money needed for achieving these outcomes. It takes only a moment's reflection to see why these main features of research and development activities turn it into a major challenge for policy makers. However, regardless of these characteristics, planning and budgeting of R&D is necessary, simply because available funds are not unlimited, and without budget no results of R&D would materialize at all. (OECD, 2015, pp. 45-49).

[2] Based on another definition "Science is more than a body of knowledge; it is a way of thinking" (Sagan, 1996, p. 25).

Research and development cover three main fields: basic research, applied research, and (experimental) development. *Basic research* is theoretical and experimental work undertaken to acquire new knowledge with no particular application in mind.[3] Basic research also consists of two main categories: pure basic research and oriented basic research. Pure or fundamental research[4] is about acquiring new knowledge without making efforts to turn this knowledge into economic or social results. Oriented basic research is also not carried out with a concrete application in mind, but this type of research is more likely to produce knowledge, which is potentially capable of solving current or future concrete problems.

Applied research can be defined as the creation of knowledge that evolves into a specific application or commercial objective relating to products, processes or services. It still explicitly belongs to the realm of research activity, but it already bears the prospect of economic valorisation in mind.

Experimental development is in between research and economic utilisation. It uses the knowledge obtained from research to produce new or improve existing materials, devices, systems or methods, or to develop prototypes. Product development is an even wider concept that covers a wide range of activities from the formulation of ideas to commercialisation.

The concept of *innovation* is often related both to science and to economy and profitability. More recently, innovation is conceived of as an element that boosts economic growth. In its turn, science and technology is often considered to be the primary underpinning of innovation. This naturally gives raise to the expectation, embraced by many governments, that supporting research activities and thus innovation directly leads to economic growth. However, innovation entails more than just R&D. R&D is merely one of a range of elements that make up the innovation process. Other elements consist of activities such as training, marketing, design, all targeted at the development and the introduction of new or improved products or services into the market. Moreover, innovation itself is also a more complex and systemic phenomenon than was initially thought (OECD & Eurostat, 2005, p. 6). In its wider sense, innovation consists of anything novel, the production and

[3] The definitions of basic and applied research as well as development are based on (OECD, 2015, p. 45) and (NSF, 2015, p. 2).
[4] Research with no immediate real world applications is also called blue skies research or curiosity-driven research.

change in knowledge (Arrow, 1962), the ability and techniques required to produce goods and services of higher and better quality (Narula, 2003).

The idea of innovation as a major factor contributing to the increase of economic growth was introduced by Schumpeter. Schumpeter combined insights from economics, sociology and history to study economic and social change in the long run, focusing in particular on the crucial role played by innovation. Schumpeter characterized innovation as the process of "creative destruction", in which new economic structures continuously destroy the old ones by replacing them (Schumpeter, 1950, p. 83). He described the entrepreneur as the creator of innovation. (Schumpeter, 1934). The ideal, successfully innovating enterprise is characterized by strong R&D, marketing abilities, understanding of user needs, and management strength (Freeman, 1974) complemented by international dimensions like presence in international trade and globalized competition (Freeman & Soete, 1997).

On top of these other factors involved in innovation, another line of thought in the secondary literature suggests that it is only in the case of science-based enterprises that the main source of technology is R&D. And even in the case of suchlike companies, most technological knowledge applied in innovations turns out neither to be generally applicable nor easily reproducible, but very specific and targeted to a particular innovation. What they in realistic terms can do when it comes to technical innovation in the future is strongly conditioned by what they have been able to do in the past. (Pavitt, 1984) The upshot of this is that innovation on the level of a single organisation will not automatically lead to results in overall economic growth and prosperity. At the same time, however, technological change is also affected by the process of learning. The speed of technology transfer can therefore be enhanced by governments' technology policies that increase the pace of learning processes. (Rosenberg, 1982).

In the concept of the National Innovation System (NIS), which emerged in the 1980s, emphasis was put on the interconnectedness between all the actors involved in innovation (Freeman, 1987), (Lundvall, 1992), (Nelson, 1993), (Patel & Pavitt, 1994). Those advocating the concept of a NIS attempted to understand the connections between private enterprises, universities and public research institutes, parties which they considered key to improve technological performance. They proposed to see innovation and technological progress as the result of a complex set of connections between actors producing, distributing and applying various kinds of knowledge. In the concept of

NIS there is not as yet any emphasis on the regulating role of the state. The key actors in the NIS are rather the set of institutions which generate the framework within which governments form and implement policies to influence the innovation process. (Metcalfe, 1995). Other authors, however, put the emphasis exactly on the impact that science policy has on innovation, national competitiveness and economic security (Partha & David, 1994).

There are a number of emerging research fields focusing on science and technology, which began to form distinct dedicated areas of study in the 1960s.[5] What they share is the interdisciplinary character of their methodology. These areas of study are the result of discussions among natural scientists, philosophers and social scientists about the impact on society of science and technology, and about the steadily increasing need by governments for data that could underpin policy decisions for the organisation and finance of science and technology.

Rather than being theory-driven or paradigm-driven, these emerging disciplines are problem-oriented, and focus on practical issues pertaining to specific policies for science, technology and innovation (Bell, et al., 2009). In this, they differ from mainstream social science disciplines where theory is dominant and empirical work is used to test theoretical frameworks. Instead, they are devoted to analysing, understanding and finding responses to challenges posed by economy, policy, management and organisations for innovation, technology, and R&D (Martin B. , 2012, p. 1220).

As decision-makers are keen to prove that investment in STI is worthwhile and has impact, the need for and acceptance of STI-indicators has increased over time. The production of statistical data and instruments to measure the value and impact of science, technology and innovation – such as R&D expenditures, personnel statistics, patent statistics, and bibliometric (i.e. publication and

[5] *Science, technology and innovation (STI) policy research* or *Science Policy and Innovation Studies (SPIS)* can be defined as the application of social sciences to the study of policy for science, technology and innovation. STI policy research is mainly based on economics, it usually analyses the role of firms and the industry on a national level, it is focusing on the interaction between the market and the state, the role of the government in regulating or supporting market interactions. Sociology is the main discipline behind *Science and Technology Studies (STS)*, which is focusing on scientific and technical knowledge production, the notion of „social construction", accountability for society; it is analysing how social, political, and cultural values affect scientific research and how research, in turn, affects society, politics and culture. Finally, *Innovation Studies* is a popular new concept, which is concerned specifically with the economics, policy and management of technological innovation. Reference works were published by Spiegel-Rösing and de Solla Price (Spiegel-Rösing & de Solla Price, 1977), Van Raan (Van Raan, 1988), Jasanoff (Jasanoff, Markle, Peterson, & Pinch, 1995), Moed (Moed & Glänzel, 2004) and Hackett (Hackett, Amsterdamska, Lynch, & Wajcman, 2007). Well-known peer-reviewed journals in these fields are Research Policy, Social Studies of Science, Science & Technology Studies, Science and Public Policy and Scientometrics.

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citation) indicators[6] – have had a considerable impact on the process of science policy making in recent decades. As the same statistical data and indicators can be put to use to reach different results when it comes to policy decisions, it is recommended to combine these quantitative methodologies with non-quantitative ones.

Collection and analyses of data have been produced by a number of actors within the policy research community, including international organisations such as the Organisation for Economic Co-operation and Development (OECD)[7], the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the European Commission[8], research consultancy organisations, in-house research groups within government agencies and academic research centres. After 1960 the number of centres and departments involved in suchlike STI studies started to increase. This Science of Science movement was also enthusiastically embraced in Eastern Europe, in the former Soviet Union and in China. In Hungary a separate group of the Hungarian Academy of Sciences was dedicated to the organisation of science. This group has carried out scientific work of the highest quality, especially in the field of scientometrics. The academic journal Scientometrics has been edited in Budapest since 1978.

The objectivity of STI policy research is endangered by the consistent demand of policy makers to fit science-based evidence to their arguments supporting their policy decisions. They tend to find policy research useful only when it legitimizes solutions that have already been formulated ahead

[6] We can differentiate between input indicators like R&D funding, number of researchers and output indicators and impact like publications, trademarks or patents. Gross domestic expenditure on R&D (GERD) is the main aggregate statistic used to describe a country's R&D activities and covers all expenditures for R&D performed in the economy. Business expenditure on R&D (BERD) is the main aggregate statistic used to describe R&D performance within the business enterprise sector. R&D expenditures can be analysed according to the size of expenditure, the expenditure related to GDP, based on the source of expenditures (government, business enterprises, other sources) and share of expenditures (among sectors, among types of research).
The full time equivalent number of researchers employed in a country is another main STI indicator signifying the science base of the given country. Additional R&D personnel related indicators are the following: size/total number of the personnel in absolute numbers/headcounts (HC); size/number and R&D activities of the personnel measured in full-time equivalent (FTE) or person-years; researchers and engineers vs. technicians and support staff in absolute numbers and the ratio between them; dynamics and trends: change of the above indicators over time. Statistics can be compared to the country's total employment, total labour force or can be calculated per thousand employment or per thousand labour force.

[7] Beginning with the late 1970s, OECD played an important role in making national statistics comparable by developing STI scoreboards, which bring together the latest internationally comparable data.

[8] In the 1990s, the European Commission also started to play an important role in the field especially by promoting the use of so-called composite indicators that are able to summarise the big picture in relation to a complex issue with many dimensions (Grupp & Mogee, 2004, p. 1377) (e.g. the European Innovation Scoreboard).

of science-based evidence and its analysis. In other words, they tend to prefer „policy-based evidence" over „evidence-based policy" (Marmot, 2004).

The history of science policy and science policy research on the one hand, and the major political events that have an impact on science and the emerging new STI policy research theories on the other, are two sides of the same coin. In the period between 1945 and 1970 the presumption that basic research proceeds independently of, but often drives technological developments, in general strengthened policy makers' commitment to public. These years were characterized by trust of science on the part of politicians and citizens. Science enjoyed both full autonomy and generous funding. Most governments substantially invested in the development of research infrastructures, as a result of which new laboratories and research institutions have been built. The main task of research was knowledge creation, and scientists enjoyed a large degree of independence in selecting their research topics and carrying out research activities. The main role of the government was restricted to provide funding, whereas society was motivated to put scientific novelties to good use, that is to learn how to enjoy the benefits of science.

In the 1960s politics started to insist on having an impact on research, as a consequence of which the independent position of science started to collapse. This period was characterized by a double mechanism of financing research, since basic and applied research were financed in distinct ways. Basic research continued to enjoy its full academic freedom, whereas in other areas the criteria of applicability, valorisation and societal impact developed into necessary conditions for financial support. Important institutions of science policy making (e.g. OECD was formed in 1963) as well as university faculties devoted to science policy were established. This period was also called the golden age of science.

These golden years of science were hallmarked by the work of Vannevar Bush, who in his emblematic book „Science: The Endless Frontier" described science as the precondition for national welfare. According to him, health, prosperity and security of a nation can only be achieved by scientific progress. (Bush, 1945, p. 11). Bush introduced the „linear model" of science in his book. In this „science-push" innovation model, basic research was always the first step, which was carried out by academic research institutions. In a second step the results of basic research were applied in order to solve practical problems, and this in its turn was followed by technological development, and finally innovation. In Bush's line of thought a clear line of progression existed between basic research, applied research, technological development and innovation. Most importantly, for him basic research always was the very foundation of any applications. His model provided the basis for almost unlimited government expenditure on basic science after WWII. As against this linear conception of the production of scientific knowledge, Schmookler challenged precisely the fundamental assumption of „science-push" innovation, and introduced his „demand-pull" model, implying that innovation is primarily determined by market demand (Schmookler, 1966).

In the 1970s two significant events determined the predicament of research. To begin with, the economic crisis resulted in substantial budget-squeezes for research. Governments, facing increasing competition and tighter financial constraints, started to expect more specific benefits in return for their continued investments in scientific research and in universities. Secondly, in the wake of the emergence of environment protection and civil movements, society and politics started to be sceptical about the beneficiary character of scientific results, which prior to this had always been taken for granted. These doubts then gave rise to a distrust of science itself. The upshot of these developments was a tighter supervision on the part of governments over limited national funds, and the creation of science policy institutions to measure and monitor scientific performance and output. New fields of science emerged driven by societal needs. Transparency became a new element in science policy, going hand in hand with the demand for more control on the part of society. Policy makers encouraged the establishment of a new contract with the scientific community based not on the desirability of scientific autonomy and the ever increasing quest for funds, but on the implementation of a research agenda explicitly rooted in societal needs (Guston & Keniston, 1994, p. 6).

In the next decade, the leading role of Japan in technology kept other countries on their toes to remain in a position to compete with Japan in technological innovation. Industrial innovation, the need for cooperation between industry, research institutions, higher education and the government, planning and foresight activities, all these items have become central elements of science policy: government experts, scientists, and industrial experts as a group tried to make predictions and have an impact on future developments. Governments financed projects which could point to concrete and measurable targets, and they closely monitored the implementation of these targets so as to increase the impact of science and its utilization. In a parallel development with the increasing

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importance of innovation, science policy started to merge with innovation policy. Application of scientific results, industrialization of science, technology transfer were the key concepts of this new era.

These changes were reflected in the introduction of new theories like the Mode 1, Mode 2 concept or the Triple Helix model. Mode 2 knowledge creation blurred the clear distinction between basic and applied research (Gibbons, et al., 1994). According to the Mode 1, Mode 2 concept academic, discipline-based fundamental research, which was mainly carried out at universities was labelled Mode 1. Mode 1 research was looking for verifiable facts about nature, human beings, and societies, and was only aimed at acquiring scientific knowledge. There was little if any direct connection to societal needs, and the results of research were transferred at the end of the project to users who may or may not take up the results. There was also limited accountability on the part of researchers, they enjoyed almost full freedom to identify the problems on which to work. By contrast, Mode 2 research was targeted at problem solving, its tasks were derived from the problem-oriented assignments, given by a principal actor. It generally involved multi- or trans-disciplinary research carried out in an extending variety of institutions and sectors, also beyond the realms of universities and academic research institutes. The linear model of Vannevar Bush was no longer relevant for Mode 2, a series of consecutive steps or phases were no longer in place, basic and applied research were to be present simultaneously, and were to work alongside each other. Knowledge was increasingly produced in the context of application, where societal needs had a direct impact from the outset. At the same time, a relatively explicit societal accountability for funding received from government was put into place. Mode 2 research was also called relevant research, which always was interdisciplinary, interactive and targeted at a social problem. Mode 1 and Mode 2 research often coexist, coevolve and are interconnected (Llerena & Meyer-Krahmer, 2003, p. 74).

The theory of the linear model and Mode 2 research was subsequently changed to the Triple Helix model (Etzkowitz & Leydesdorff, 2000), a model that was based on the developing relationship between universities, industry and government. In the Triple Helix model, the distance between university and science-based industry has been decreased in that universities took up roles traditionally carried out by industry, whilst private enterprises started to carry out research, and the government, as an instigator and consumer of science, took up the role of supporting successful innovation. New networks and institutions came into existence, such as business incubators, whose task it was to facilitate knowledge transfer between the three actors of the Triple Helix Model. Universities with an entrepreneurial signature started to play a more pivotal role in the knowledge economy in that they started to contribute to economic development and to solve societal challenges, all this in addition to the two traditional roles of education and fundamental research. The Triple Helix model is characterized by a sense of permanent transition, of endless changing of roles and constant adaptation. The Quadruple Helix Model added a fourth layer to the university-industry-government triad: the component of civil society, which was to emphasize the needs and expectations of society in the innovation process overall (Carayannis & Campbell, 2009). The new model brought to the fore that emerging technologies do not always fit the demands and needs of society, a realization that put limits on the alleged impact of these emerging technologies.

In the 1990s society was facing an increasing number of scientific dilemmas, which were characterized by a high-level of uncertainty and social-political risks (Funtowitz & Ravetz, 1993). Due to the growing level of uncertainty, governments were more and more prone to share the responsibility with other actors. Globalisation has developed into the most decisive factor influencing science policy. Decision makers in science policy tried to harmonize national Research, Development and Innovation (RDI) programmes with global developments. Societal challenges had to be addressed by international approaches, coordinated by international intergovernmental institutions. Science has morphed into a strategically competitive resource that nations intended to use to maximum advantage. Governments therefore insisted on having more explicitly formulated science policies (Martin B. R., 2003, p. 10).

In recent years, representatives of STI research have concluded that the relationship between science, technology and innovation is an interactive relationship that works in both directions, rather than linear process that works in a single direction. The process of technological development and innovation is an evolutionary process, and the innovative capacity of a nation not only depends on the strength of individual players, but also on the connections between them. Governmental regulation can stimulate but can also constrain innovation (Bell, et al., 2009, p. 578), so in current research systems innovative research is increasingly steered by national strategic research programmes, university–industry cooperations and public-private-partnerships, to a considerable extent beyond the realm of direct government control. There has also been a shift from institutional financing towards project financing. Calls for proposals for particular projects are launched in fields of research priorities set by national governments and international organisations. Resources are allocated through research councils and other national funding agencies based on a transparent peer-review process. At the same time, a wide range of other stakeholders are also involved in research funding and research performance.

The post-modern research system (Rip & Van der Meulen, 1997) is based on a dialogue between government and scientists. General objectives and research priorities are to be set by governments, but politicians should always do so in consultation with research organisations and scientists so as to co-create the strategy to be implemented. Less intervention and more flexibility is expected from governments, who are expected to only provide the necessary conditions for cooperation. Researchers themselves should be allowed to find the best solutions and to learn during the process. Cooperation, learning, and adaptation are key elements of such a system. Detailed rules and regulations as well as strict control should be substituted by reasonable supervision, monitoring and regular evaluation. Principles of contract-based systems like efficiency, interest, controllability should be substituted by new concepts such as social capital, trust, and cooperation. Networking between stakeholders should be built on partnerships. Vertical relations in hierarchical structures should be turned into horizontal ones in network-like partnerships. Dividing lines between scientific functions and research phases should blur, so all the actors across disciplines and across the stakeholder chain are in a position to harmonize their efforts to successfully carry out research. The role of politics evolves from a strict controlling supervisor into a negotiating, coordinating partner, a partner upon who it is nevertheless still incumbent to take decisions about the distribution of considerable funds to finance research.

In all this, the role of a proper STI strategy is also a very important one: targeted networking and communication can contribute to creating the preconditions of co-operation and to channel financial and intellectual resources to achieve jointly set goals. The strategy can show the main objectives, priorities and commitments of the government, it provides a general framework to enhance economic competitiveness and improve the quality of life. It combines education, research and development activities, legal regulations, organisational, knowledge and physical infrastructures and coordinates them in an efficient way (Havas, 2002).

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II.1.3. Actors in Science Policy

As we have seen in the description of the National Innovation System, enterprises, universities and public research institutes are the main actors producing and applying knowledge. The research, development and innovation activities of these actors are managed and funded by governments. R&D performing actors are also often involved in R&D funding. In order to see the complex set of connections between these actors, a short summary of the main research performing and funding sectors is provided in this chapter, followed by the characterization of principle-agent relations relevant for science policy. In my opinion, the principal-agent theory can well describe the differences between various national science policy systems in general, and also the Hungarian science policy systems in particular. I will therefore often refer to the principal-agent theory to analyse and to compare STI policy systems developed in Hungary over time.

The sector that is most active in both R&D performing and R&D funding is the *business enterprise* sector. This sector's primary activity is the development, production and selling of goods or services. As private enterprises are responsible for their own profitability, introducing innovative applications and processes is essential for them. They often subcontract their research to external research institutes, research universities with concrete tasks, or, as an alternative, they operate in-house research units to carry out the research activities locally. The competitiveness of the business sector is a factor contributing to the wellbeing of citizens, so enterprises also often receive R&D investments, mainly provided by the government sector.

The *higher education* sector[9] hardly plays any role in funding research outside of their own boundaries, but at the same time they are significant players in performing R&D. University departments are often subcontractors for external companies carrying out research activities for them, and spin-off companies are established to commercialise scientific results. The interaction between universities and the industry is also referred to as the third mission of universities, a mission that connects the activities of higher education institutes to their own socio-economic context, and engages the universities in interaction with societal needs and market demands.[10] The

[9] Public research organisations belong to this category in many countries.
[10] The other two missions of universities are education and research.

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private non-profit sector plays a less significant role both in research funding and in carrying out research.

The *rest of the world* sector – e.g. international organisations – plays an increasingly important role in research funding. Faced with the increased number of global challenges, international organisations invest more and more in science. The *government* sector's engagement in R&D can be described as funding rather than performing R&D, but some governmental bodies may have in house research departments and laboratories that perform some types of R&D activities.[11]

The relationship between the sectors described above can take different shapes. One extreme shape occurs when the government guarantees the freedom of research for scientists. The other extreme is when the government strongly intervenes by setting priorities and allocating funds. In most of the cases a middle way between these two extremes is taken. There is a limited amount of government intervention, which is often implemented by a funding agency that is itself established by the government, but that at the same time has some degree of protection from direct government intervention in its procedures. The government, to some extent, delegates both priority setting and allocation of funds to the funding agency.

When tasks such as these are delegated to funding organisations, civil servants working in these organisations ask for help from the scientists themselves to help them with issues they are not in a position to resolve themselves, because of their lack of scientific knowledge or other relevant skills. We can describe this kind of relationship as a principal-agent game. (Van der Meulen, 1998)

Principal–agent relations are basically relations between actors in which one actor, the principal, transfers resources to other actors, the agents, which the agents are expected to use to achieve those objectives of the principal which the principal himself cannot realize. In exchange for the transfer of resources, the principal acquires the right to monitor the process and the outcome.

In a classical principal-agent game, agents have their own professional objectives and interests, which might conflict or overlap with those of the principal. The resources of the principal is the main driving force for an agent to engage in a principal-agent relation. The principal usually lacks the relevant competence to judge what is appropriate to do to achieve its objectives, and so gives

[11] In Hungary the institutions and centers of the Hungarian Academy of Sciences are financed by the government so they are statistically considered as government institutions.

over this responsibility to the agents. To compensate for this lack of independence, governments have attracted outside advisers, as well as people with scientific backgrounds to give scientific advice and to monitor the agents. So the principal has the right to monitor, which entails additional costs. These additional costs are unavoidable because self-reporting or self-evaluation by the agents themselves would not be transparent and reliable.

Principals can monitor or trust, agents can comply or defect. In the case of monitoring, compliance will be rewarded, defection will be penalized. If we assume monitoring to be effective, but costly, the principal will prefer trusting the agent if he conforms, but monitoring the agent if he defects. Similarly, the agent will be more likely to defect if he is trusted and to conform if he is monitored. If both actors act rationally and try to maximize their utility, the game is an unstable game. The indeterminacy of the results of research efforts renders the government–science relation even more fragile, because sound science can result in negative or no results, and can thus, from the principal's utilitarian point of view, simply be disappointing results, failing to achieve any of the desired ends.

An important function of policy is to stabilize unstable games, especially if instability is societally undesirable. It can do so by designing intermediate structures that change the actor's preferences, rational strategies and thus, the game. The game can be stabilised by setting up a funding agency. Most of the agencies have been set up in cooperation between governments and scientists, so they can serve the interests of both parties. They represent the scientific community and governmental bureaucracy, and so agencies can be responsive to bottom-up and top-down pressures and policies.

It also commonly happens that there is a double principal-agent game between the government, the funding agency and the scientific community (Rip, 1994). In the first part of this double game, the government is the principal and the funding agency acts as an agent, in the second part the funding agency becomes the principal and the scientists act as agents. Governments prefer delegating their tasks to an intermediary government agency, because such funding agencies are much easier to influence and to monitor.

In addition to setting up government agencies, using peer-review as a way of monitoring also facilitates stabilising the game. Scientists are not only professional colleagues in the production of knowledge, but also consumers of produced knowledge by other scientists. So mutual control between scientists is both professional control and consumer control and will result in judgements affecting each other's reputation. As a consequence, the cooperation of scientists in peer review processes is in the self-interest of the scientific community. Peer review serves the interests of the scientific community because they themselves can keep control over the monitoring process and over allocation of funds. At the same time, principals use the outcomes of peer review to decide on allocation and new strategies. The result can be a stable game, but with a certain level of risk that the principal will get dissatisfied with the outcomes, monitored by the agents.

The game can be also stabilised via negotiations about the proper objectives between the agent and the principal. If agents accept the objectives they will prefer compliance over defection. In this case both actors realize maximum utility and costs of monitoring will accordingly decrease. As we can see, parties should invest in negotiations if they want to stabilise the game and institutionalize consensus-making. The main uncertainty of the game lies within the nature of the consensus that is reached – this consensus can either reflect a real meeting of minds with benefits on both sides, or a more fragile compromise.

The principal might possess a set of very concrete and detailed preferences and might set up a competition for achieving these preferences. In such a game scientists will compete for available resources. Principals can induce competition over their resources if they can develop a proper monitoring system: if the agents comply, the principal has to pay a maximum amount of rewarding fee, if they defect a minimum or nothing at all. In this case the principal prefers competition above trust and compliance above defection.

If any of these stable contracts institutionalize, this will results in the path dependency of science policies. Costs for structural changes are often too high to change existing institutional and organisational structures so most of the attempts to change, the success of which is a responsibility of both parties, are in the end absorbed by the existing institutional practices.

II.1.4. Management of Science Policy

The management of science policy can be influenced by various factors such as the social system, historical traditions, economic structure, development level, geographical characteristics, executive traditions, national interests and aims of the state, and so forth. These various factors result in a country-specific management system, tools and institutions. At the end of this chapter an OECD model of science policy management will be introduced in more detail because I will repeatedly use this model in comparing institutional S&T structures in Hungary in my thesis.

The management system of S&T policy can be divided into two subsystems (Darvas, Juristovszky, Mosoniné Fried, & Vas-Zoltán, 1982): the first one, the *institutional system* of S&T policy typically consists of one top-level institution and further down the line horizontal and vertical management bodies. Horizontal management institutions are coordinating bodies ensuring the implementation of R&D policy, such as ministries, committees, academies, scientific foundations. Such horizontal institutions coordinate research activities, prepare research plans, distribute financial resources and coordinate the activities of other institutions. Vertical institutions usually operate, supervise and finance their own network of research organisations. Such institutions can be sectorial ministries, public bodies or academies with their own institutional network.

The second subsystem consists of *tools of S&T policy management,* which include research planning, R&D programmes, priority setting, implementation, financing, regulation and monitoring (Darvas, Juristovszky, Mosoniné Fried, & Vas-Zoltán, 1982, pp. 29-82). Research plans set an R&D action plan for a given period of time based on political and economic aspects, taking into account current and future development trends, social needs and available S&T potential and resources. R&D programmes allocate and concentrate financial resources to some selected R&D priorities. Priority setting will result in certain R&D fields enjoying preference over others in a given period of time. Most resources will be allocated to these selected fields to ensure that an action plan prioritizing the selected field will be a success.

Scientific fields can be classified in five main categories: natural sciences, engineering and technology, medical and health sciences, agricultural and veterinary sciences, social sciences, humanities and arts (OECD, 2015, p. 59).[12] Social sciences – usually together with humanities – are periodically attacked by policy makers as not eligible for government support because they hardly ever result in concrete marketable applications. On the other hand, there is a tendency to devote more attention to societal needs, involvement of the society, citizen science and the demand

[12] Arts are not always considered as part of humanities, especially in the context of science planning and funding. Arts are usually financed and supported by other dedicated programmes.

side of innovation. Such contradictory tendencies have to be taken into account by policy makers when setting research priorities.

But how to set research priorities? Over the years numerous methods and procedures have been developed to identify research areas that require additional support, and how this support can be managed in the most effective manner. Priority-setting is essentially a problem of choice in which several sorts of criteria can be used. Setting the right priorities has turned out to be a more or less insolvable problem (Vos & Balfoort, 1989) because no single, unique criterium can be identified that covers all the widely diverging aspects of all the various fields of science, expectations of the scientific community, and expectations of the public at large. As a result, the process of accepting these choices as well as implementing selected priorities, are as important as the priority-setting process itself.

The institutional systems set up to manage science policy in a given country can be analysed and compared by a model developed by OECD (Henriques & Larédo, 2013). This model focuses on the institutional setting required for agenda-setting and policy formulation. It does so by identifying the policy structures and functions to set up an effective policy on the governmental level. In addition to the institutional setting it also indicates the most essential management tools for science policy. The model mentions seven main functions of science policy making and connects those to possible institutional forms.

The first function is *horizontal coordination*, which presumes the creation of a central governmental authority responsible for coordination and decision-making of S&T policy. Such a central body – which might take the form of an inter-ministerial commission, a ministry for science, etc. – decides about scientific planning, priority setting and budgeting.

The second function is *giving advice*. A national science office composed of recognised scientists from various disciplines and of key representatives from industry, trade unions and civil society might play this role in an efficient way by providing evidence and advice to the policymaking process. It might either be a committee (science policy council) or an individual (advisor).

The third function is *planning*. It simultaneously responds to the needs of knowledge production, its application to societal challenges, and to the requirement of a constantly improving economic performance. The OECD model has given preference to flexible approaches over deterministic ones, to bottom-up initiatives on scientific matters over top-down ones and to medium or long-term planning over short-term strategies. Planning can be implemented by the technical secretariat or body associated with administration of science policy, supporting governmental coordination. Planning might be substituted or enhanced by foresight activities.

Budgeting is the fourth essential function of science policy making. Science budget is the aggregation of the earmarked budgets of ministries for direct and indirect funding, annually allocated in the national budget. It follows both the government expenditures on research and the policy choices on resource allocations to realise national objectives.

The fifth, *priority-setting* function is related to the choices that need to be made by governments between fields of sciences and policy options.

Allocation of resources, the sixth function is the process of deployment and use of scientific potential – people, money, and institutions – while implementing national science policy objectives set in the planning, priority-setting and budgeting phases. The ideal implementation structure associated with the allocation of resources is a body without research laboratories, covering a wide range of fields and types of research.

Last but not least, the seventh function in the model is *administration*. OECD proposes the setting up of a new public body devoted to the administration of research policies and management of national programmes. Such a body could act as the focal point for priority-setting, planning, coordination and budgeting. The ideal form for this function is a specialised agency without laboratories, responsible for the administration of the policymaking cycle, reporting to the Prime Minister to ensure effective inter-ministerial coordination. The agency would be composed of professionals who are either senior civil servants or researchers trained to implement plans and to prepare decision-making processes at political level. It should have budget to launch and manage national programmes.[13]

In order to set up a well-functioning institutional framework, the effects of globalisation on science and technology policy also have to be taken into account. On the one hand, concepts and strategies guiding public policies have recently become more and more complex, whereas on the other hand – mainly due to the specific logic of economy that does not follow the logic of the nation states (Ohmae, 1990, p. 183) – state capacities to implement such complex and ambitious strategies

[13] This OECD model is not the most recent and single model for describing the ideal institutional setting for science-policy making. I use it as it is suitable for describing and comaring the various Hungarian systems over time.

successfully have been eroding. Existing policy strategies and institutional structures often turned out to be under-complex, while more adequate, comprehensive strategies tended to be over-complex as they overstrain the state's institutional capability. The state either tried to centralize the institutional setting to become more efficient, or to decentralize technology-policy by developing regional innovation policies. STI policies on the local and regional level are as a rule less complex, because local and regional governments are better equipped with soft, trust-based instruments of political intervention. Nevertheless, the heterogeneity of institutions on the local level makes the process of policy implementation difficult (Grande, 2001). As a result, these two tendencies, centralisation and decentralisation, are often co-existing phenomena. At the same time R&D activities have also often been decentralised, internationalized and integrated into global networks. (Grande, 2001).

Inter-organisational networks linking science, industry and politics have been created on the regional and national level in order to increase the effectiveness of science and technology policy making and implementation (OECD, 1999, p. 9). Such institutionalized networks mainly integrate public officials, scientists and industrial managers, representing various sub-systems of the R&D landscape. These networks, also called hybrid communities (Rip, 1981), decisively shape the formulation and implementation of national R&D programmes by communicating and intermediating the different rationalities and divergent interests, thus linking theory and practice, politics and truth (Grande & Peschke, 1999). Although the structure and function of hybrid communities and their contribution to the performance of the national S&T policy may vary, the necessity of institutionalized links between science, politics and industry is generally accepted.

II.2. International Science and Technology Cooperation

II.2.1. International Research Cooperation

Modern research is increasingly complex and demands an ever widening range of skills. It is obvious that no single individual can possess all the knowledge, skills and techniques required to resolve such complex problems the modern world is faced with. If two or more researchers

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collaborate, the likelihood of their possessing the necessary range of knowledge increases.[14] Research collaborators might be individuals, research groups or institutions, whole sectors, regions or countries.

The importance and necessity of international S&T cooperation have already been acknowledged by various international documents and organisations like the Charter of the United Nations[15], the Constitution of UNESCO[16] or the Helsinki Declaration[17] of the Conference on Security and Co-operation in Europe.

International S&T cooperation can be justified by various reasons (Darvas, Juristovszky, Mosoniné Fried, & Vas-Zoltán, 1982, pp. 173-192). Global problems, like the scarcity of raw materials, difficulties in providing sufficient and good quality food for everybody, energy production and consumption, or environment protection, has an impact on each and every country in the world, and can only be approached by international cooperation. Some scientific fields cover wider territories that cross national borders. Research in meteorology, oceanography or seismology can only be conducted by the cooperation between multiple countries. Planning, distribution and optimization of extended transport, telecommunication and energy networks have already crossed national borders a long time ago and they are still expanding.

Global R&D expenditure is constantly increasing both in absolute terms and in relation to GDP. The growth in expenditure is partly the result of the necessity of building large research infrastructures. On the one hand such infrastructures enable scientists to achieve new scientific output, whilst on the other hand the costs of such infrastructures cannot be paid by single countries. Large-scale research infrastructures need international cooperation both in funding and in using available capacities.

[14] The dictionary definition of cooperation suggests the working together of individuals to achieve a common goal. Thus, „research cooperation" could be defined as the working together of researchers to achieve the common goal of producing new scientific knowledge (Katz & Martin, 1997).

[15] The Charter of the United Nations was signed on 26 June 1945 in San Francisco. Its chapter IX on economic and social cooperation discusses international S&T cooperation (UN, 1945, pp. 11-12).

[16] Constitution of the United Nations Educational, Scientific and Cultural Organization was signed on 16 November 1946 in London (UNESCO, 2002, pp. 7-23).

[17] The Helsinki Declaration of the Conference on Security and Co-operation in Europe was signed on 1 August 1975 (OSCE, 1975, pp. 23-26).

Cooperation is also needed for international legislation, because international legislation provides the basis for the coordination of large multinational programmes, for standardization or for the regulation of IPR issues. Global standards also postulate international cooperation.
Research cooperation has various benefits: the most obvious one is the efficient sharing or transfer of existing knowledge, skills and techniques. This not only means scientific and technical expertise, but also the social and management skills needed to work as part of a team. Cooperation is also a source of stimulation and creativity because it brings together different views, which may generate novel ideas, hitherto un-thought of. A further advantage is that cooperation can enhance the potential visibility of the scientific work, co-authored articles are more likely to be cited and to have greater impact. Internationally co-authored papers are cited up to twice as frequently as single-country papers (Katz & Martin, 1997). As a consequence, the rate of co-authored articles is increasing. Co-authorship has been widely used to measure collaborative activity because it is a cheap and practical method to assess the level of cooperation.

Physical proximity and social distance are factors influencing cooperation, but they are not the most decisive ones. The choice of scientists to cooperate with others is primarily based on reputations and rewards. Scientists collaborate to gain visibility, reputation, complementary capabilities or access to resources. Co-authorships, increase of citations and other forms of professional recognition lead to further cooperation and reputation in a self-enhancing process (Wagner & Leydesdorff, 2005). Cooperation with highly productive scientists also tends to increase personal productivity.

International S&T cooperation has more advantages. It is an efficient tool to boost economic growth, concentrate human and material resources, and allows better use of S&T potential. It provides an excellent possibility, especially for smaller countries, to have their scientists be trained abroad, which is likely to result in increasing capacities and the adoption of new technologies. International networking facilitates the collection of STI information on an international level. Scientists can receive information about new discoveries in their own scientific fields, they can build upon already existing results while carrying out their own research activities. Being internationally well-informed and well-connected also helps to avoid unnecessary overlap of efforts and activities, which in turn leads to an optimization of processes. Building on already existing results also helps researchers to save time and shift their research to a higher level.

In spite of all these obvious benefits, governments sometimes struggle to comply with the preconditions for international scientific cooperation. Above all, the political will to cooperate is a genuine *condition sine qua non*. Cooperating partners should be informed about each other's plans, objectives, possibilities and each other's scientific potential. In an ideal case the technological development level of cooperating partners is similar, if not scientific cooperation is likely to turn into technology transfer or development aid.

Research cooperation also has certain costs. Even if the costs of travel are decreasing, for many countries travel and subsistence costs are still detrimental factors. For scientists time is the most valuable resource they have to spend on scientific cooperation. Writing proposals, attending meetings, reporting on progress of funded projects, are all administrative procedures that decreases precious amount of the time that could be spent on conducting research. Working in an unfamiliar environment, facing different management styles, financial systems, rules on intellectual property rights, can all cause problems and waste time. Whilst funding for collaborative projects have increased, so compulsory reporting and evaluation requirements have increased, thus creating favourable conditions for greater bureaucratization and increasing the costs of cooperation for researchers. This has further heightened the tension between the need for better management and the academic culture of intellectual autonomy (Chompalov, Genuth, & Shrum, 2002).

Another challenge is to ensure balance within the innovation system. There often is pressure to fund scientific excellence in elite research centres, but, at the same time, there is also pressure to address political goals of equitable distribution and capacity-building. It is also a problem that although the overall, global system may benefit through the increased efficiency of connected networks, the national systems may lose out, at least in the short term. The question of where the knowledge is created and exploited becomes a key factor of the process. The challenge is to "tie down" the knowledge created at the global level and apply it to specific local needs (Wagner & Leydesdorff, 2005).

This brings us to the question of competition. Countries are competing for knowledge and the producers of knowledge, scientists. National programmes and schemes are set up, grants are provided, in order to attract the best scientists and to enjoy the benefits of knowledge production on the local level. This can result in the emigration of highly skilled labour, brain drain, which is a global phenomenon to which even highly developed countries on the regional level fall victim.

In order to avoid the loss of skilled labour force and promote mobility and the free flow and exchange of knowledge at the same time, incentives are provided to facilitate the return of scientists (brain regain) or to establish a constant balanced gain-and-loss of skills (brain circulation) (Cavallini, Soldi, Di Matteo, Utma, & Errico, 2018, p. 6).

At the same time, scientists are competing for scarce resources both on the national and on the global level. Governments and international organisations try to attract the appropriate skills and competencies they need to solve challenges by offering funding for relevant fields and types of research activities. Strategic planning and dedicated budgeting plays an important role here. It is hardly possible to set concrete objectives for fundamental research. This type of research can only thrive under stable funding conditions and the freedom to choose a research topic within a broader set of national priorities. Market-oriented applied research should respond to the existing needs of the society and economic institutions, which leads to more competitive forms of funding.

One also has to differentiate between R&I internationalisation in the business-enterprise sector and the R&I internationalisation of public R&D organisations and non-for-profit R&D organisations. The former rather has a competitive, while the latter a cooperative character. The closer the research activity is to market, the higher the level of competition is because of the profit generating potential of applied research and innovation activities.

Science policy makers, programme managers, and scientific leaders have to take into consideration both the costs and the benefits of cooperation when deciding about the size and allocation of support for research cooperation. If a country wants to benefit from global knowledge creation it needs coordinated domestic efforts to build research capabilities and make the country an attractive choice for cooperation-seeking researchers. Links should be strengthened among government and research institutions, and individual researchers should be considered "stakeholders" in the decision-making process on R&D investments.

II.2.2. Scientific and Technological Cooperation in Europe

A significant part of international cooperation of Hungarian scientists is carried out with European partners. This type of international cooperation either occurs on a bilateral basis or within the

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framework of European R&D programmes. Priority setting and funding opportunities on the European level obviously has an impact on the science policies of all European member states. For a proper understanding of these impacts, this subchapter will briefly sketch the role of the European Commission as a policy entrepreneur [18], and the importance of joint cooperation in the European research programmes.

In order to enhance the problem-solving capacity of nation states and to approach complex challenges in a more effective way, new institutional bodies setting out technology policy beyond the national level have emerged. In recent decades, the European Commission in particular has been playing an important role in setting the agenda of science policy in Europe. A direct result of the interaction between developing stakeholder networks and senior-level commissioners has been the instigation of the main tool for financing research and development activities on the European level, the EU framework programmes (Peterson, 1995). However, the literature reveals a lack of consensus as to the role of the European Commission as a policy entrepreneur: its role is either considered to be a reactive policy actor not actively involved in initiating and specifying policy initiatives (Citi, 2014), or its role is conceived of as one of an active policy entrepreneur (Edler & James, 2015, p. 1253). An active policy entrepreneur is an actor who is active in selecting, budgeting and putting sufficiently important scientific challenges on the policy agenda. The European Union and its complex institutional system offers a high number of entry points for policy ideas, and a high number of potential venues within which policy can be formulated and decided upon. The EU has acquired competencies in a multitude of areas, which are of importance for the regulation of technological developments and the improvement of industrial competitiveness.

However, the main institutional problem of European technology policy is that such a policy has to be developed and implemented in a multi-level framework of governance with complicated interactions among national and European stakeholders and institutions (Grande, 1999). Not only cultural differences among EU member states play a role in this, but also a number of fundamental conflicts pertaining to economic, regional or socio-political interests. As a result, European

[18] Policy entrepreneurs are organisations, individuals or teams who initiate dynamic policy change and invest resources in the hope of a future return (Kingdon, 1984, p. 122). Entrepreneurs play an important role in identifying opportunities for new policy initiatives, creating new policy venues and framing policy debates, mobilising and linking interests, forging coalitions and making others learn in the process. Their key functions thus relate to the process of agenda setting, policy formulation and decision making (Edler & James, 2015, p. 1254).

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technology policy often makes the political and institutional setting of technology policy-making even more complex without actually increasing the problem-solving capacity of the nation state. It seems fair to say that policy-making and programmes on the European level would primarily be justified either when global challenges require international cooperation, or when working on the European level has a proven added value. Along these lines a series of European framework programmes for supporting research and development cooperation has been created.

I will give a short overview of the history of science policy in the European Union. In 1951, the Treaty of Paris established the European Coal and Steel Community. This treaty allowed its members support for technical and economic research related to the production of coal and steel. The Treaty of Rome in 1957, which established the European Atomic Energy Community (EAEC or Euratom), broadened and deepened the European Coal and Steel Community's involvement in research. It promoted and facilitated nuclear research in Member States and made provisions for the Community to carry out its own research programme. In the mid-1960s, a lack of commitment to cooperate grew on the part of the members of the Community framework. If any cooperation was engaged in, it tended to be outside of the established frameworks (Sharp & Shearman, 1987). In the 1970s, the creation of a single market and further economic integration sparked a new momentum to cooperate in the field of science and technology. Four resolutions pertaining to science and technology were adopted by the Council of the European Communities in 1974: (1) the co-ordination of national science and technology policies; (2) the participation of the European Communities in the European Science Foundation[19]; (3) an action programme in the field of science and technology; (4) an action programme on foresight, assessment and methodology.

Based on these resolutions sectorial programmes to handle the European Paradox[20] were launched, on the assumption that the gulf between basic science and its application was responsible for the decrease in competitiveness of the EU at the global level (Grande & Peschke, 1999, p. 45).

[19] European Science Foundation is a non-profit organisation that promotes high quality science in Europe.

[20] Problems of competitiveness in European industry were caused not so much by technology "gaps" or lack of funds for research, but rather by severe deficiencies in the diffusion and application of generally well-known technologies and their integration into complex technical systems. The European Commission repeatedly emphasized that the main problem of European firms is not mainly the amount of their R&D expenditures, but rather their limited ability to turn their research and technology results into inventions and to turn their inventions into marketable products and profit. The result was a gap between Europe's results in basic research and R&D investments on the one hand and the results in the area of innovation and competitiveness on the other hand (EC, 1992, p. 10). This phenomenon is called the European Paradox. (EC, 1995, p. 5).

Sandholtz (Sandholtz, 1992). Papon (Papon, 2004), and other authors held that such sectorial programmes predominantly had an impact on the competitiveness of specific sectors, a policy that was well in line with international trends of science policy such as focusing on innovation and the application of research output. However, these European initiatives, ambitious though they were, still lacked the momentum to develop into a broader research base in Europe. In the following years, both the EC R&D budget and the legal framework for scientific cooperation were significantly increased and enhanced.

Further progress in the development of EU-wide research policy was made with formulating the European Framework Programmes. The First Framework Programme (FP1) was built around the so called Reisenhuber criteria, stating that European support was in order when the scale or cost of cooperation was beyond the level a single country could afford, when cooperative work could achieve results for the whole Community, and when research contributed to developing the common market, common laws and standards, or the unification of European science and technology. FP1 lasted for four years, from 1984 to 1987. In order to establish a Europe-wide scientific platform for the cooperation of national research institutes and universities it mainly supported cooperative research projects on key scientific areas of mutual interest. Even today, collaborative research is the most common form of scientific cooperation on European level. The First and Second Framework Programmes were mainly focusing on energy and information and communication technologies in order to establish a solid technology base for industry. Later, the share of energy research diminished, while the importance of new areas like life sciences has increased. The table below shows how the budget and number of priority areas in the various framework programmes have changed over time.

Table 1: Share of budget among priority areas of the first four framework programmes (in %)

Lines of activities	**FP 1** 1984-1987	**FP 2** 1987-1991	**FP 3** 1990-1994	**FP 4** 1994-1998
ICT	25	43	38	28
Industrial research and new materials	11	16	15	16
Environment protection	7	6	9	9
Life sciences	5	6	10	13
Energy	50	22	16	18
Transport	0	0	0	2
Social sciences	0	0	0	1

International cooperation	0	2	2	4
Dissemination of results	0	1	1	3
Human resources development and mobility	2	4	9	6
Total	100	100	100	100

Source*:* (Hargita, Izikné Hedri, & Palánkai, 1999, p. 203)

It was only with the passing of the Single European Act (SEA) in 1987 that EU policy in research and technological development was established in a full-fledged form. The Act held the declaration that science policy of the European Communities should be implemented via framework programmes for research and development. This declaration set the legal basis for R&D activities on the level of the European Community (EC, 1987, pp. 335-343). The Third Framework Programme (1990-1994) was aimed at the objectives to improve industrial competitiveness, to encourage transnational industrial initiatives, to introduce a European dimension into training of R&D staff, and to increase economic and social cohesion while ensuring scientific excellence. Protection of the natural environment and the improvement of the quality of life were overarching fields of priority.

The 1992 Treaty on the European Union (Maastricht Treaty) continued with the ideas of co-ordination and co-operation and strengthened the Framework Programmes by turning them into the umbrella structure for all RTD actions of the Community. Another turning point in science policy was the acceptance of the White Paper on Growth, Competitiveness and Employment (EC, 1993), and the Green Paper on Innovation (EC, 1995). The strategies set out in these papers had the aim to increase the competitiveness by investing in innovation, based on scientific research in the European Union, and hence to increase employment and to coordinate national research policies. A special focus was given to innovation as well as to the efficient valorisation of scientific results in developing products or services.

The Fourth Framework Programme (1994-1998) was built on its predecessor programme, to which it added a number of new strategic goals, such as the creation of large-scale research infrastructures, greater competitiveness of industrial technologies, dissemination of research results, and the coordination of Member States' national policies by a Community research policy.

A large-scale assessment of the implementation of the last five years of the framework programmes was carried out in 1997 (EC, 1997). The report has concluded that the next (5^{th}) framework

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programme should be built around scientific excellence, social-economical relevance and European added value. At the same time, stronger focus was to be put on technology dissemination, commercial exploitation and on supporting SMEs. The aim was to strike a balance between basic and applied research funding. The report also highlighted the importance of strategic approach on the European Union level, which was to be underpinned by a stable legal framework and effective implementation. The Fifth Framework Programme (1998-2002) was built on the results and conclusions of this assessment. It emphasized the importance of competitiveness, relevance as well as the significance of European added value in project proposals, which not only meant wide participation but also European-level impact.

The Sixth Framework Programme (2002-2006) was based on the conclusions of two meetings of the European Council and the results of another assessment, carried out in 2000. The first European Council meeting was held in Lisbon in 2000. The meeting resulted in a strategy with the goal to turn the EU by 2010 into the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion (Council, 2000, p. 3). At the beginning of 2000, by a Communication of the Commission, the European Research Area[21] was created, to ensure the free circulation of researchers, scientific knowledge and technology (EC, 2000a). The creation of the ERA has had a considerably impact on the structure of FP6, which was built around three pillars: (1) focusing and integrating European research (including thematic priorities); (2) structuring the ERA and (3) strengthening the foundations of the ERA. The five-year assessments of 2000 also highlighted the importance of an overall R&D strategy for Europe in order to meet the objectives of the Lisbon summit. It also formulated a number of recommendations for the Sixth Framework Programme, based on the experience with previous framework programmes. The assessment panel advised to maintain the emphasis on social relevance, scientific excellence and on collaborative RTD projects. They recommended to further increase the risk-taking attitude of applicants, the possibilities for

[21] The European Research Area builds around six priorities: (1) more effective national research systems, (2) optimal transnational cooperation and competition, including optimal transnational cooperation and competition and research infrastructures, (3) an open labour market for researchers, (4) gender equality and gender mainstreaming in research, (5) optimal circulation, access to and transfer of scientific knowledge including knowledge circulation and open access, (6) international cooperation. The ERA roadmap 2015-2020 should be implemented via National Action Plans. The whole ERA framework is being renewed at the moment. The new concept would be built around a dynamic knowledge circle, stronger commitment both on the political and on the scientific level, a stronger focus on implementation, inclusion and impact.

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researchers' mobility, competence building, and the mutual support between science policy and other EU policies (EC, 2000b).

Two years later, in 2002, back to back with the launching of the Sixth Framework Programme, the Barcelona European Council, which reviewed progress towards the Lisbon goals, agreed that national investment in European research and development must be increased with the aim of approaching 3 % of GDP by 2010. It also called for an increase of the level of business funding to two-thirds of total R&D investment (Council, 2002, p. 20). As chances became increasingly slimmer nearer 2010 for this ambitious figure to be reached, they became part of the Europe 2020 strategy, which is a 10-year strategy proposed by the European Union in 2010 for the advancement of economic growth.

The final assessment of FP6 was published in 2010 (EC, 2010b). The report has concluded that FP6, especially its core thematic priorities, had created clear European added value, increased economic competitiveness, generated scientific networks and strengthened European knowledge infrastructures. Although its two main new instruments, Networks of Excellence and Integrated Projects were not as successful as originally hoped for, its ERA-NETs and European Technology Platforms had performed very well. The main drawback of the programme was the decrease in participation of industrial partners, which was partly attributed to the confusing and complex regulatory framework and application process, which needed to be simplified. The report has also concluded that framework programmes should not turn into a substitute for national RTD policies, but should be rather synchronised with national research efforts in order to strengthen the ERA.

The assessment report has also compared the number of participants and related EU contribution between FP5 and FP6. The below table also shows relevant data for FP7. As we can see, although the number of participants has decreased from FP5 to FP6, the average funding/participant has been going up.

Table 2: Main results of FP5, FP6 and FP7

	FP5	**FP6**	**FP7**
Number of contracts	16 553	10 058	
Number of participants	84 267	74 400	133 611
Average number of participants per contract	5.1	7.4	
EC financial contribution (million €)	13 065	16 669	44 917
Average EC financial contribution per participant (million €)	0.16	0.22	0.34

Source: (EC, 2010b, p. 14), (Fresco, 2015, p. 55)

The Seventh Framework Programme (2007-2013) reflected the growth and employment targets of the EU. FP7 consisted of four separate programmes: “Cooperation”, “Ideas”, “People” and “Capacities”. The “Cooperation” programme has broadened the thematic focus compared to FP6. It was the core of FP7, representing two thirds of its overall budget. Its aim was to foster collaborative research across Europe and with third countries through projects carried out by transnational consortia in 10 different thematic fields. The “Ideas” programme supported frontier research solely on the basis of scientific excellence. It was implemented via the newly established European Research Council (ERC). The “People” programme provided support for researchers’ mobility via the Marie Skłodowska-Curie actions.[22] The “Capacities” programme strengthened the research capacities of Europe. It supported *inter alia* SMEs, the establishment and operation of research infrastructures, and activities relating to international cooperation. As a new instrument, Joint Technology Initiatives (JTI) were established in order to facilitate business-academia cooperation and foster European competitiveness. All in all, 25 289 grants were signed under FP7, 15 612 projects have been finalised, 207 501 articles were published, out of which 64.7% were open access publications. FP7 funded publications were cited 21.4 times on average, which is much higher than the number of citations on the European level (9.4). 2 669 patent applications have been submitted under the seven year programme, research results were extensively used by the industry (EC, 2017).

The mid-term evaluation of FP7 (Fresco, 2015) has made some recommendations that were partly addressed by FP7 itself, partly taken into consideration in planning the next FP, Horizon 2020. These recommendations were to advance ERA and the Innovation Union[23], to develop high quality research infrastructures, to develop an innovation strategy, to further simplify the programme, to introduce more open calls, to increase the participation of underrepresented Member States, to open FP7 to international cooperation as well as to maintain the level of funding.

[22] The Marie Skłodowska-Curie actions support researchers at all stages of their careers, irrespective of their nationality and scientific field.

[23] The Innovation Union is a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

Table 3: Duration and budget of framework programmes

Framework Programme	Duration	Budget (billion ECU[24]/ euro)
First	1984-1987	3.8
Second	1987-1991	5.4
Third	1990-1994	6.6
Fourth	1994-1998	13.2
Fifth	1998-2002	15
Sixth	2002-2006	17.9
Seventh	2007-2013	50.5
Horizon 2020	2014-2020	80

Sources: (Council, 1983, p. 1), (Council, 1987, pp. 1-23), (Council, 1990, pp. 28-43), (Parliament & Council, 1994, pp. 1-33), (Parliament & Council, 1999, pp. 1-32), (Parliament & Council, 2002, pp. 1-33), (Parliament & Council, EUR-Lex, 2006), (Parliament & Council, EUR-Lex, 2013)

As the above table shows, the last recommendation has materialised, the budget of framework programmes has constantly grown and reached its highest point in the current, 8th Framework Programme. With a budget of almost 80 billion euro for 7 years (2014-2020), Horizon 2020 has the largest budget dedicated to science and technology in the history of the European Union. By coupling research and innovation, Horizon 2020 puts emphasis on excellent science, industrial leadership and tackling societal challenges. Compared to previous framework programmes it offers a unified framework of R&D funding on EU level: Horizon 2020 is also the financial instrument implementing the Innovation Union.

Horizon 2020 has a three-pillar structure. The first pillar supports frontier research (ERC grants), radically new lines of technology (FET programmes), researchers' mobility via the Marie Skłodowska-Curie Actions (MSCA), as well as the development of research infrastructures. The second pillar, "Industrial Leadership" aims to increase the pace of development of the technologies and innovations that will foster European economic growth. The third pillar consists of seven multidisciplinary "Societal Challenges" in the scientific areas of (1) health, (2) food security, sustainable agriculture, (3) energy, (4) transport, (5) environment, (6) social sciences and (7) secure societies.

[24] European Currency Unit, a basket of the currencies of the European Community member states between 1979 and 1999, used as the unit of account of the European Community before being replaced by the euro.

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The mid-term evaluation of Horizon 2020 has assessed the programme based on its relevance, efficiency, effectiveness, coherence and European added value (EC, 2017). The evaluation panel has found the programme relevant, addressing stakeholders' needs, but they have recommended a more impact-focused, mission-oriented approach, stronger involvement of citizens and further simplification. They have concluded that over-subscription is one of the main pitfalls of the programme, which should be tackled by a higher budget for the next FP. Although Horizon 2020 is already very effective in knowledge production, further efforts should be made to support SMEs, market-creating disruptive innovation and the open access of publications. Coherence and synergies with other EU programmes should be encouraged and facilitated. A separate monitoring flash report was published about international cooperation under Horizon 2020 (EC, 2019). Based on the findings of the report, 4700 participants out of 124 non-EU member state countries have participated in Horizon 2020 (including associated countries), with a success rate of 18%, which is above the success rate of member states (15%) (EC, 2019, p. 1). In spite of this impressive data, the share of non-associated third countries in collaborative projects has decreased from 4.2% in FP7 to 2.6% in Horizon 2020. (EC, 2019, p. 5)

The preparation of the next, 9th Framework Programme, which will be called Horizon Europe, has already started. Based on the results of the mid-term review, innovation and scientific missions will play decisive roles, on top of scientific excellence. According to the recommendation of the European Commission, Horizon Europe would dispose of a budget of 100 billion euro, so the increase of budget dedicated to framework programmes would continue. Horizon Europe would keep the current three-pillar structure of Horizon 2020 with pillars around (1) Excellent Science, (2) Global Challenges and Competitiveness of European Industry as well as (3) Innovative Europe. As the last pillar suggests, supporting innovation and R&D performing enterprises, in line with global trends, will play a more prominent role in the new framework programme than in previous ones.

When looking at the evolution of framework programmes we can see some recurring patterns: fostering industrial competitiveness, better alignment between national and EU policies, and more involvement of citizens in the planning process are common to most recommendations, where new framework programmes seem to fail to yield sufficiently real impact. At the same time, they seem to be successful in supporting scientific excellence, researchers' mobility and network-building.

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III. History of Science Policy in Hungary Before 1990

In this chapter, I will set out the role of main policy actors in regulating and shaping science policy of the country against the background of the political events that have turned out most decisive for setting the national agenda. I will compare the impact of these crucial political shifts on national and international science policy before the systemic change in 1990.

I will give special attention to two policy documents concerning two decisive historical periods. One is the *Basics of Hungarian Science Policy* by Zoltán Magyary from 1927, and the second is the *Science Policy Directives* from 1978. Both documents represent milestones in the history of Hungarian science policy. My intention is to show to what extent the range of decision-making power of national science-policy makers was determined by external historical events in these periods, and to what degree science policy could have successfully been adjusted to political frameworks that changed accordingly. These two documents and the two periods deserve special attention in the light of the fact that most of the organisations, players and structures in Hungarian science policy had already been established in these years before 1990. A short description and analysis of the institutional setting in the selected periods will be given at the end of the subchapters based on the principal-agent theory and the OECD model for science policy making.

III.1. From the Beginnings Until the End of the First World War

Hungary has a long tradition in science. Prior to the foundation of the first universities in Hungary, students were simply obliged to leave the country to find a university abroad to continue their studies. They mainly attended Western European universities, at first Italian and French, later German, Dutch and Swiss universities (Ujváry, 2013, p. 11). The first university in Hungary was established in 1367 in Pécs, and its foundation coincided with that of other Central European universities like the universities of Prague (1348), Cracow (1364), and Vienna (1365). The widespread use of Latin in Europe in this period of time was a major factor conducive to the integration of Hungarian science and scientists in the wider academic community.

Unfortunately Pécs and other universities founded in the 14^{th} and 15^{th} century, such as the ones in Óbuda in 1395 and Pozsony in 1467, had a lifespan of only one or two generations (Löppönen &

Tamás, 1985). As a result, the number of Hungarian students attending universities abroad steadily grew. Hungarian students increasingly moved to the recently founded universities, which catered to the region, *viz.* the university of Vienna. In Hungary, the first university which has continued operation until today was founded in 1635. This university is the predecessor of today's Eötvös Loránd University of Sciences and Humanities (Budapest), and it was previously located in Nagyszombat. Around the time of its foundation, this catholic university consisted of only a philosophical and theological faculty, and was only later expanded to include law and medical faculties. The consequence of this was that its capacity to take up students in other subjects was restricted.

From the early 19th century onwards, science became the main tool for alleviating intellectual backwardness in the Austro-Hungarian Empire. The Habsburg administration played an important role in fostering and managing higher education. The first scientific policy decision-making body was the "General Commission for the Supervision of Science" set up in 1795, and operated under the supervision of the Royal Council of Deputies.

Until the establishment of the Hungarian Academy of Sciences the main problem in Hungary was the lack of a specific vocabulary in Hungarian language to express the nature of Hungarian, let alone international, scientific results. (Kornis, 1927). The Hungarian Association of Scientists, the predecessor of the Hungarian Academy of Sciences (HAS), was founded on 3 November 1825, and as such, it is among the oldest Science Academies in Europe.[25] Since its establishment, the Academy has always been one of the most influential actors in Hungarian science policy. However much of its role and function has changed over time, it has always been one of the foremost centres of scientific excellence. The original objective of the Academy was the propagation of the proper use of the Hungarian language in both scientific and literary works. Translating foreign works and building up a library of Hungarian publications was an important part of the Academy's activities. (Balogh, 1927)

[25] The first law on the functioning of the Academy was passed on 18 August 1827 – Article XI of the statutes is about the forming of a scientific association for the standardization of the Hungarian language. Based on this law the Academy started its work in 1831.

Table 4: Number of original scientific works published in Hungarian (1861-1900)

	1861-1870	**1871-1880**	**1881-1890**	**1891-1900**
Literary history	260	457	753	608
Law, politics, statistics	986	1595	1439	1786
Medicine	232	257	305	452
Natural sciences	226	646	615	411
Philosophy	73	64	114	86
History	538	848	960	959
Geography, ethnography, cartography	126	346	554	642
Mathematics, astronomy, technology	154	369	447	402
Linguistics	206	429	831	905
Total	2811	4989	6068	6251

Source: (Magyary, 1927, p. 11)

The table above shows that scientific productivity in terms of the number of published scientific works has been increasing in the second half of the 19th century. In almost all scientific fields the number of publications has at least doubled in forty years. We can also see the dominance of social sciences and humanities over natural sciences, which might also be related to the increased use of the national language in areas such as history or linguistics.

In addition to the task of spreading Hungarian as the national scientific language, the Academy set itself another important task: the management of international scientific relations of Hungary. The Academy joined the International Federation of Academies in 1900, and was a member until the dissolution of the federation caused by the outbreak of the First World War.

After the compromise between Austria and Hungary in 1867, the number of university faculties and scientific institutions started to grow quickly. In these years before WWI universities carried out the twin tasks of education and research. Research institutions did not have a teaching curriculum at all, so they were in a position to exclusively devote themselves to scientific research. Universities were established much earlier than research institutions. The formation of classical research institutions only commenced in the 19th century, in tandem with the trend of universities to increasingly concentrate on education. Back to back with international trends, in the period of rapid modernization between 1870 and 1920, a number of autonomous state research laboratories and institutes were set up in Hungary. This process was quite haphazard, and structural planning only started after 1920.

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III.2. Between the Two World Wars

After the First World War, as a consequence of the Treaty of Trianon[26], both the territory and the population of Hungary were decreased dramatically: it left Hungary a landlocked state covering only 28% of the pre-war territory of Hungary. Its population was decreased to 7.6 million, only 36% of the pre-war kingdom's population of 20.9 million. Having lost a large parts of the territory, infrastructure and population of the country had a detrimental effect on Hungary's economic and scientific performance. The decimated country was in dire need of a focused policy strategy to achieve the best possible results in science with the remaining resources. The Treaty of Trianon, however, had some salutary effects as well: Hungary became a country politically independent from Austria, and a country that was determined to hold its own in the field of science and technology. The completely new situation cried out for persons in positions that allowed them to turn the new circumstances in a positive direction.

As a result of the successful education and science policy of Kuno Klebelsberg[27] and Zoltán Magyary[28], the founding fathers of Hungarian science policy, the basis for a new R&D system was created. Until the end of WWI the administration of science policy was the exclusive responsibility of the Ministry of Religion and Education. This monopolistic hegemony was altered under the watch of Kuno Klebersberg in his position as a minister. Klebersberg considered freedom a necessary requirement both for scientific research and for science administration. He declared that the government should not monopolise science policy, but that its role should be limited to setting public goals, finding proper tools, and setting up the institutional framework to achieve these goals.

In addition to setting science policy goals, another important task of the government was to provide the necessary framework conditions for education in such a way that general curiosity was supported and that talent could find its way to outstanding achievements. On the back of a good

[26] The Treaty of Trianon was the peace agreement of 1920 between the Kingdom of Hungary and the Allies after World War I.

[27] Count Kuno von Klebelsberg was a Hungarian politician, who served as Minister of the Interior (1921-1922) and Minister of Religion and Education (1922-1931) in the István Bethlen government of the Kingdom of Hungary between the two world wars. He introduced many educational reforms throughout Hungary.

[28] Zoltán Magyary worked for the Ministry of Religion and Education between 1910 and 1930. After 1925 he was leading the Department of Science Policy, he was also responsible for higher education in the years between 1927 and 1930. He can be considered as the founder of science policy in Hungary.

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education policy the number of educated citizens was steadily growing, which proved salutary both for economic and societal wellbeing of Hungary.

Based on his conviction that decentralisation was the right way forward, count Klebelsberg decided to establish scientific councils. The National Council for Natural Sciences was responsible for the development of natural sciences, which included the representation of Hungary in international organisations in the field and the management of the National Fund for Natural Sciences. The National Council for Scholarships was not only responsible for scholarship programmes, but also for the proper functioning of Hungarian institutes abroad. The aims of both councils were similar, to find and support talented young people, to educate the future generation of scientists and to increase the number of well-educated citizens.

Minister Klebelsberg also stated that, because of budgetary constraints, it was advantageous for a small nation such as Hungary to only form scientific institutions in areas where they have a special interest or where they had a competitive edge over other countries. Only institutions that complied with these criteria are in a position to compete with research conducted abroad. As a consequence of this policy a limnological and a geophysical institutions were formed during his ministership.

As we can see in the table below, in spite of the severe losses in the size of the population after WWI the number of scientists both inside and outside universities increased in Hungary. Especially the increase at universities between 1913 and 1926/27 stands out: the already significant growth rate between 1880 and 1913 has continued in the years immediately following the war.

Table 5: Number of scientists between 1880 and 1927

	1880	**1900**	**1913**	**1926/27**
Outside of universities[29]	74	181	369	422
At universities	219	340	470	722
Total	293	521	839	1144

Source: (Magyary, 1927, pp. 8-10)

[29] This line shows the number of employees at ministerial research organisations, museums, libraries and at the Hungarian Statistical Office. Magyary refers to science policy as part of cultural policy, so cultural and science policy statistics are summarised in the table in a combined way.

Table 6. shows the budget allocated to science and education between 1880 and 1927. The increasing share of budget for science and education reflects the growing importance of these fields in national policies.

Table 6: State budget for science and education between 1880 and 1927

	1880	1900	1913	1922/23	1926/27
Share of Ministry of Religion and Education's budget from State budget (%)	1.59	3.54	5.54	4.54	9.3

Source: (Magyary, 1927, p. 13)

III.2.1. International Scientific Cooperation Between the Two World Wars

International cooperation in science was supported in various ways. A number of scholarship schemes have been developed, especially for young Hungarian scientists to learn as many foreign languages as possible. The Hungarian Academy of Sciences started its cooperation with the League of Nations in 1922, and in doing so, it started to become well-connected in international circles. After 1924, the Academy encouraged authors with ground-breaking results to attract the attention of the research communities of other nations by adding an abstract in French, English or German to their Hungarian articles.

The most large-scale novelty in supporting international science policy of this period consisted in setting up science-for-diplomacy institutions, the Collegium Hungaricum network.[30] The main aim of these Collegiums was to support the education, research activities and networking of talented, young Hungarians who were allowed to spend longer periods at the premises of the Collegiums and carry out research locally. All Collegiums were financed by the Hungarian government. Each Collegium Hungaricum has become a centre of scientific and cultural connections between the

[30] There were four Collegium Hungaricum-type institutions established around this time. The Hungarian Scientific Institution in Constantinople only existed between 1917 and 1918. In addition to the already established Pazmaneum (1623) and Theresianum (1746) a Hungarian Historical Institute and a so called Collegium Hungaricum were formed in 1924 in Vienna (Magyary, 1927, pp. 454-472). A Faculty of Hungarian language and history was opened at the University of Berlin in 1916. The faculty was primarily financed by Germany and was turned into a Hungarian Institute of the university in 1917 (Ujváry, 2013, pp. 136-137). In addition to the Hungarian Institute another Collegium Hungaricum opened its doors for Hungarian scientists in 1924. As long as the Institute was mainly open for German students interested in Hungarian language and history, the Collegium provided scholarships for young talented Hungarian researchers. The Institute of Hungarian History in Rome was established by Vilmos Fraknói, who granted the institute in his villa along with his library to Hungary in 1913. The Collegium Hungaricum in Rome was established in 1927 (Magyary, 1927, pp. 454-472).

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partner countries and Hungary, and they acted like specialised embassies on science and culture. These scientific centres have lost their privileged role after the Second World War. They were reorganised in the 1960s, after which they lost their scientific character and were turned into mere cultural institutes (Ujváry, 2013, p. 18).

Zoltán Magyary published his book "Basics of Hungarian Science Policy" in 1927. He summarised the main principles, aims and tasks of international scientific cooperation in his comprehensive work (Magyary, 1927, pp. 471-472). Magyary emphasised in his book that one of the most important duties of the Ministry of Religion and Education was to build up and improve the contact with international partners, partner institutions, possibly also on a personal level. He was convinced that using science for diplomacy purposes would result in benefits for the whole country.

He was aware of the fact that building up long-lasting scientific relationships is a time-consuming process, and only excellent scientists with additional organisational skills are able to build up stable connections abroad. He stressed that such experts, or envoys of science, as he called them, should not be used for political and/or economic purposes, as this would restrict the time and energy available for scientific networking and would endanger the purely scientific character of their work. Ideally, these envoys of science could speak the language of the host country, possessed a substantive network of both researchers and policy makers, were able to obtain and send information, and create connections between Hungarian scientists and their international counterparts. In addition to their networking activities he considered it their task to assess and analyse best practices and cooperation opportunities, on which they sent reports back home. The scientific community in the partner countries also had to be informed about scientific achievements in Hungary via personal meetings, but also via scientific journals, possibly published by acknowledged local publishing companies. These scientific experts were also entrusted with the supervision of the study of the young generation abroad. In addition to facilitating their education, they assisted them in building up their professional networks in the partner country.

Appointing such envoys of science in the most important scientific centres all over the world was the crux of the programme of Magyary. He would have preferred to extend the network of the previously described Collegiums, as this would have enabled a higher number of students, young scientists to study abroad. Going one step further, the establishment of foreign cultural and scientific institutions as well as a stable scholarship programme which ensures the constant

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education of a number of young scientists in these institutions could have guaranteed a growing number of internationally embedded researchers and the prosperity of the home country.

Magyary was convinced that properly selected, excellent scientists could be trusted to be allowed to lead their own institutes. They were the persons with local experience, they knew the traditions and opportunities in the host country, so their work was impervious to political targets set by politicians of the sending country, who should restrict their support to providing a stable financial background.

If we want to describe the institutional setting of this period we might say that the government body responsible for horizontal coordination, planning, priority setting, and budgeting was the Ministry of Religion and Education. At the same time, the political will for decentralisation resulted in forming a number of scientific councils, and cultural and scientific institutions abroad. Academic freedom was not only guaranteed for scientists but also for these institutions. The role of the government was limited to defining policy goals and providing stable financial background for implementation. New scientific institutions were established in fields where Hungary had a comparative advantage.

International cooperation and the internationalisation of science enjoyed top priority. Science and scientific envoys were used for diplomatic purposes. When applying the principal-agent theory we might say that after an extensive selection procedure based on scientific excellence the chosen envoys, the agents, were trusted by the principal, the government. As the envoys agreed about the objectives set by the principal, they preferred compliance over defection and both actors realized maximum utility. The successful model of scientific and cultural institutions and scholarships abroad has created the basis for a sound science diplomacy in Hungary.

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III.3. The Second World War

As in so many countries, in Hungary research and development during the Second World War was put to use for the war-industry. Scientific fields, which were able to support Hungary's military performance, were heavily financed while at the same time all the other fields were neglected. As a result of this bias, the fields that were supported during the second world war have gained in importance and productivity but all the others have almost disappeared. The destruction wrought in Hungary by the last phase of World War II (1944-1945) had a particularly serious effect on research. The emphasis here is not so much on the damage of buildings or installations (though these were also significant) but on the loss of people, amongst whom the persons with a scientific education.

Immediately after the Second World War the S&T system of Hungary was reorganised on the basis of the German model. Universities have been reformed after the Humboldt structure, with both educational and research functions (Biegelbauer, 1999). Industrial research was not centralised but belonged to the private sector. The Hungarian Academy of Sciences was an institute representing renowned scientists with an indirect effect on science policy itself. Due to restricted financial possibilities after the war, the state has played hardly any role in science policy. There were about 10 research institutes in Hungary founded before 1948. Most of the basic research activities were carried out at university departments while applied research and development was done at the R&D departments of large enterprises, such as Chinoin Pharmaceutical works, or the United Incandescent Lamp and Electrical Factory (Seppälä & Paczolay, 1985).

III.4. The Soviet System

The first impressive results of the planned economy in the Soviet Union had a strong influence on intellectuals the world over. After 1946 the growing importance of the Communist Party also affected the R&D system of Hungary. In 1948, communists came into power and included rhetoric on science in their platform declarations. This declaration contained the key elements of a policy on the guidance of science, which was new to Hungary (applied, however, in the Soviet Union for

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25-30 years). According to this policy, science was to play a major role in advancing the economy of the country. The Hungarian Scientific Council was created in 1948 as the central body for scientific planning.

The communist political leadership decided on the reorganisation of the Hungarian Academy of Sciences (HAS), and it became an organisation with decisive influence for many years to come. Because of their alleged political unreliability 100 members of HAS were dismissed in 1949, and the Academy received new rights and functions, such as education and support of the new generation of scientists, supervising the activities of scientific associations, maintaining international cooperation, functioning as a scientific publishing house. The Academy provided scientific advice for the government and the Party, and it took decisions about most of the financial resources for science. In this way the Academy was turned into a kind of “ministry of science”. The implementation of all the newly established functions was a daunting challenge, because the Academy was hardly represented at government level. The main decision making body remained the Hungarian Socialist Workers’ Party (Magyar Szocialista Munkáspárt, MSZMP).

HAS, just like all the other academies in socialist countries, started to establish its network of research institutes after the political takeover by the communist regime. The network was built taking into consideration the societal and scientific needs determined by the Party. In 1957 already 29 institutes existed. In the next period – from 1957 to the end of the 1960s – institutions were formed on new fields and on neglected areas of science and technology. In the third period, after the Science Policy Directives of the Central Committee of the Hungarian Socialist Workers Party were published in 1969, the improvement of existing institutes was set in motion. The number of research institutes in 1975 was 38. In addition to its own institutes the Academy also supported the work of a further 100 university faculties. The budget of academic institutes reached 12% of the total R&D expenditure of Hungary. 7500 employees were working at academic institutes, 2500 of which were researchers in 1975. This number meant 12.3% of all the researchers working in Hungary (in FTE[31]) at that time (MSZMP, 1978, pp. 185-194).

In the 1970s multilateral cooperation among science academies of socialist countries intensified, which resulted in joint or at least coordinated research activities on certain selected fields.

[31] FTE: Full Time Equivalent: one FTE is equivalent to one employee working full-time.

Researchers were encouraged to learn foreign languages, 63% of young scientists under 30 had language exams. In order to provide possibilities for travelling abroad, mobility schemes have been established. 75% of the researchers of academic institutes used to travel abroad every year. The changes introduced by the communist regime had a negative effect on the research activities of universities: they had to stop their research activities and had to concentrate solely on the education of students.

Table 7: Number of students at Hungarian universities between 1920 and 1990

Year	Number of students
1920	12902
1930	12611
1950	32501
1960	44585
1970	53821
1980	64057
1990	79206

Source: (Biegelbauer, 1999, p. 104)

At the same time the number of university students started to increase dramatically. This trend continued until the systemic change in 1989, putting a larger and larger burden on universities.

Industrial research was centralised and supervised by ministries. Private companies were not supported to carry out research activities. The number of R&D personnel has grown between 1953 and 1961 from 18.000 to 29.000, the number of researchers from 5.000 to 11.000 (Szakasits, 1965, pp. 125-128).

Research priorities themselves were also subject to considerable change after 1948. This change came down to an increase in the importance of natural and technical sciences in general. In social sciences and humanities Marxist philosophy prevailed, and articles were predominantly written in the Russian language, while English and American studies were curtailed. Certain fields of natural and social sciences, e.g. cybernetics, genetics, psychology and sociology, were temporarily banned. The Institute of Sociology was not founded until 1963, while the Computer and Automation Institute was only established in 1973. Some data indicated a much reduced priority of ethnography and arts, while the importance of the defence industry has increased (Seppälä & Paczolay, 1985).

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The period between the end of WWII and the middle of the 1950s was called a golden age of science in the secondary literature. Although science was strongly supported in the countries under Soviet rule, there were some very significant differences between the characteristics of this period in the US, other Western countries and in the communist countries. Although the number of research institutions and their budget increased, they were far from being free and independent. Instead of trust and freedom of science, central planning determined research priorities and the scope of research activities. The reform-process was successful from a Soviet point of view. In 1953, the year when Stalin died, the Hungarian R&D system was a close copy of its model, the Soviet system. Input and output of research and development was rigidly determined top down from a centrally organised government.

III.4.1. New Economic Mechanism

The enthusiasm of Hungarian intellectuals for communism has diminished during the regime of Mátyás Rákosi, whose dictatorship was one of the main reasons for the uprising in 1956. After the suppression of the revolution a high number of intellectuals had to flee the country, many others were imprisoned. In the next few years, János Kádár, the newly appointed General Secretary of the Hungarian Socialist Workers' Party, has introduced a pragmatic system, which also had an impact on the field of science policy.

At the end of the 1950s some new measures have been taken to catch up on the backlog of Hungary in the field of science and technology. Whilst in the rest of the world science was restricted because of the emergence of the protection of the environment and the growth of civil movements, , the STI system and the research community in Hungary did not have similar shackles in the 1960s and 1970s, and this was definitely the case when compared to the previous decade. Thoughts on environment protection and civil movements hardly had an impact on the politics in Hungary, which it was mainly determined by the Hungarian Socialist Workers' Party and its leader. Even if framework conditions were planned centrally, after the introduction of the New Economic

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Mechanism[32] and the Science Policy Directives of the Central Committee of the Hungarian Socialist Workers' Party, Hungarian scientists could enjoy more freedom than before.

From another point of view, however, Hungary did develop along similar lines as other countries, e.g. the funding provided for basic and applied research. Basic research and applied research were not only financed in different ways but there were separate funds and institutions established to coordinate and supervise these activities. In order to finance industry-related research the Technological Development Fund (Műszaki Fejlesztési Alap, MŰFA) was created in 1959, the Central Technological Development Fund (Központi Műszaki Fejlesztési Alap, KMŰFA) in 1961. Each Hungarian company was obliged to contribute to these funds, which were established to support industry-related technological projects. The first National Long-range Plan for Scientific Research (Országos Távlati Tudományos Kutatási Terv, OTTKT) was approved by the cabinet in 1960. The National Committee for Technological Development (Országos Műszaki Fejlesztési Bizottság, OMFB) was established in 1961 with the role of managing KMŰFA as well as initiating, developing and implementing technology policy. Its role was to elaborate concepts on technological policy and to handle the central management of technological areas of outstanding importance, insofar as development and applications were concerned. Parallel with the establishment of MŰFA and OMFB, a number of new HAS institutions were created in the field of the natural sciences. The Academy has become responsible for the coordination of theoretical and experimental basic research and of the social sciences and humanities. OMFB and other ministries coordinated applied research and scientific development. HAS and OMFB were responsible for the preparation and implementation of most of the science-related decisions. In industrial research institutes, the director of the institute had the right to decide about the research carried out in the institute. At universities, heads of departments also enjoyed some freedom to decide on priorities in basic research. Another important achievement was the establishment of the Science Policy Committee in 1969, which replaced the earlier Science Council. It had the task of setting out the main lines of science policy and establishing the system of R&D expenditure, although with a very limited budget.

[32] The "New Economic Mechanism" was introduced in 1968 with the aim of adding market elements to the centrally planned economy. This had an overall influence on the whole economy and it affected the research and development sector, too.

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If we want to analyse the institutional structures of the era by applying the OECD model, we can see that the tasks of horizontal coordination and administration mainly belonged to the National Committee for Technological Development and the Hungarian Academy of Sciences. The main advisory body was the Science Policy Committee. This institutional setting – under changing names – remained in place for decades ensuring stable background conditions for carrying out scientific research.

As part of the New Economic Mechanism, the Central Committee of the Hungarian Socialist Workers' Party introduced Science Policy Directives in 1969, which reformed the R&D system. They were updated in 1977 and 1985. One of the main achievements of the directives was the freedom of arts and sciences, which was guaranteed by the Central Committee. Although this freedom was to a large degree limited, Hungarian scientists enjoyed more freedom than their colleagues in other socialist countries in the region.

Being a very important science policy document a more detailed presentation of the Science Policy Directives follows with a focus on international scientific relations (MSZMP, 1978, pp. 11-46). Following the declarations of the Science Policy Directives, science policy was meant to be an inherent part of the general policy of the Party. The communist leadership realized that freedom for science was an indispensable condition for carrying out research. At the same time, researchers were expected to be committed to socialism and social development. The Party mainly supported scientific research related to centrally determined social needs, but as far as possible they also supported individual scientific ideas. As science needed highly qualified experts, the Party was committed to select politically, ideologically committed professionals, whose further education, motivation was taken care of. It was decided that scientific, political and ideological education of scientists had to be guaranteed in the long run. However, the number of scientists was not raised.

Similarly to the conclusions of Minister Klebelsberg, the directives also emphasized that, due to the small size and limited resources of Hungary, a strong focus on some selected scientific fields was highly recommended, areas in which it was realistic to expect high-quality research. Critical mass to carry out world-class research was often missing even in these strictly chosen scientific fields. The lack of critical mass was the main argument for encouraging international cooperation.

Research was funded – also after the reform of the new economic mechanism – by the financial means of the Technical Development Fund and the state budget. Institutional funding was partly replaced by financing concrete tasks and activities in order to make the whole system more competitive. The remuneration of scientists was also changing accordingly – monthly salaries were not raised, but additional performance-based payments (bonus, premium) were increasing. Research budgets for institutions were guaranteed for more than one year to ensure long-term planning. The significance of applied and industry-related research was to be increased, but not to the detriment of basic research.

Table 8: Budget spent and number of researchers in different scientific fields (%)

Disciplines		**1969**	**1975**
Natural sciences	Budget spent	10.4	13.5
	Number of researchers (FTE)	13.5	13.1
Medical and health sciences	Budget spent	4.2	3.2
	Number of researchers (FTE)	7.0	7.2
Agricultural and veterinary sciences	Budget spent	13.4	11.6
	Number of researchers (FTE)	9.3	10.1
Engineering and technology	Budget spent	67.5	64.8
	Number of researchers (FTE)	57.9	55.0
Social sciences	Budget spent	4.5	6.9
	Number of researchers (FTE)	12.3	14.6
Type of R&D			
Basic research	Budget spent	14.3	13.8
Applied research		32.1	32.2
Experimental development		53.6	54.0

Source: (MSZMP, 1978, p. 405)

As we can see in the table above, the share in budget and number of researchers of the various disciplines and types of research has hardly changed between 1969 and 1975. However, there is a clear increase both in terms of budget spent and the number of researchers active in the social sciences. This was the field under tight control of the Party.

Table 9: Main science and technology indicators in 1969 and 1975

Indicator	**1969**	**1975**
Total R&D personnel	61365	81289
Total R&D personnel per total employment (%)	1.26	1.59
Total number of researchers	22207	34798
GERD/GDP (%)	2.51	3.46

Source: (MSZMP, 1978, p. 404)

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From the table above one can see that the first six year term of the directives proved to be successful: all the indicators have increased between 1969 and 1975, the GERD/GDP ratio was exceptionally high.[33]

III.4.2. International relations

The Science Policy Directives also stated that the development of sciences was strongly dependent on international relations. Small countries with less well developed economies, such as Hungary, were very much exposed to the international division of scientific labour, because they were only able to achieve novel results in carefully selected priority areas. Although the number of scientific connections of Hungary were increasing, they remained insufficiently well developed.

Bearing all this in mind, it appeared crucial for Hungary to cooperate with other, mainly socialist, countries. The framework for cooperation with these socialist countries was the Council for Mutual Economic Assistance (COMECON). Sharing R&D results among COMECON countries helped foster the scientific and economic development of all the member countries. However, even within the framework of this regional organisation bilateral relations remained the dominant form of cooperation. Moreover, the share of the Soviet Union in cooperation was two thirds of all of Hungary’s bilateral cooperation activities.

Mutually advantageous cooperation with capitalist countries was also supported. Though some of these countries were accused of using cooperation for spying and ideological attacks, Hungary could not afford to isolate itself. Signing intergovernmental agreements with other countries was beneficial for Hungary, and this is the reason why the first agreements date back to the 1960s. Cooperation with Western countries was mainly restricted to researchers’ mobility schemes and to the participation in scientific events. Hungary was typically missing out on joint research with economic objectives.

A shape for international scientific connections that prevailed were short and long-term travelling arrangements of visits of Hungarian scientists to foreign countries. The number of such visits was rapidly increasing: in 1969 the number of scientific visits was over 11 thousand, and this number

[33] GERD was not calculated in line with OECD and Western standards, it was overestimated by the Party by about 0.5%

increased to over 19 thousand by the year of 1975. (MSZMP, 1978, p. 404). The Science Policy Directives were appreciative of the fact that terms and conditions for study visits and mobility schemes should be flexible both in terms of the choice of scientific fields and in terms of selected partner countries, and that these choices should be made by taking the needs and preferences of the scientists themselves into consideration. In order to ensure a maximum of flexibility, general agreements were sometimes substituted for more specific inter-institutional agreements, and individual research institutions were given the right to sign such agreements. This flexible approach very much complied with the bottom-up needs of scientists.

Table 10: Foreign trips in different scientific fields in 1980 (%)

Technical sciences	47.1
Natural sciences	21.1
Agricultural sciences	6.9
Medical sciences	10.1
Social sciences	14.8

Note: total number of foreign trips was 20 214 in 1980. Source: (KSH, 1982, p. 32)

As we can see, the number of visits further increased between 1975 and 1980. Most of the scientists travelling abroad were from the technical and natural sciences. If we compare the ratios with the relative share of the budget spent and the number of researchers in the fields above, albeit that the technical sciences had the largest share of trips abroad, they were underrepresented compared to their share on budget and research staff. Natural sciences, medical and social sciences performed better in terms of travels than their share of budget and research personnel.

In addition to bilateral contacts, participation in multinational schemes has also gained in importance in the 1970s. Although Hungary’s active participation in international scientific organisations increased substantially in these years, the possibilities of membership (scholarships, research assignments) this increase brought with it were not always utilized to the fullest possible extent, because the management of Hungary’s participation in international scientific organisations was suboptimal.

The Science Policy Directives took a critical stance on the predominance of basic research, and recommended a shift from basic to applied research in order to better solve societal challenges and to better facilitate economic development. As a result of this move, the weight of applied research and experimental development carried out at the Hungarian Academy of Sciences has increased after 1970, all this in line with global trends.

Table 11: Share of various research activities at HAS (in %, based on R&D expenditures)

	Basic research	**Applied research**	**Experimental development**
1970	58.6	28.4	13.0
1975	49.2	27.3	23.5
1980	45.6	37.0	17.4
1985	41.0	45.0	14.0

Source: (Székely & Tolnai, 1988, pp. 50, 62)

Table 12: Share of various research activities in Hungary (in %, based on R&D expenditures)

Country	**Year**	**Basic research**	**Applied research**	**Experimental development**
Hungary	1969	14.8	36.6	48.6
	1976	14.3	34.8	50.9

Source: (Darvas, Juristovszky, Mosoniné Fried, & Vas-Zoltán, 1982, p. 151)

If we compare the share of research activities carried out in the institutions of the Hungarian Academy of Sciences (Table 11) with the ones on the country level (Table 12), we can see that the share of basic research at HAS was definitely higher than on the national level, which is in line with its historical role of being a centre for basic research in Hungary.

Based on the US model, a significant share of the budget of research institutes had to be obtained by applying for competitive funds. The share of institutional funding provided by the state has steadily diminished. This decrease mainly effected universities and academic institutions, whereas industrial research institutes were transformed into for-profit companies. The autonomy and prestige of universities started to increase, research started to become an additional function in addition to education.

The share of industrial research increased, and this was also reflected by the growing number of researchers: in 1967 31.9% of scientists worked in the industry, four years later this rate reached 35.2%. Because the New Economic Mechanism (NEM) resulted in social disparity, which caused political dissatisfaction inside of the Party, János Kádár suspended NEM in 1972. As a result of this suspension, the number of researchers employed in the industry started to decrease again and reached the 1967 level of 31.9% in 1974 (Löppönen & Tamás, 1985). Thanks to the commitment

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of the government towards research and the growing contributions paid by companies into the Technological Development Fund, the level of GDP related R&D expenditure has increased in the 1970s and reached 3%.[34]

Table 13: Gross domestic Expenditure on R&D (GERD)/GDP, 1971-1981

Year	**GERD/GDP**[35]
1971	2.48
1973	2.55
1975	2.89
1977	3.07
1979	3.01
1981	3.00

Source: (Csöndes & Räty, 1985, p. 183)

In spite of the high GERD and large shares of industry related R&D expenditure and personnel the results and outcomes of Hungarian industrial R&D were quite limited.

Table 14: Hungarian R&D units by sectors (1981)

Sector	**Personnel (%)**	**Expenditure (%)**
Business enterprises (Production companies)	37.7	38.6
R&D institutes serving production companies	20.5	28.9
R&D performed at Higher Education institutions	19.3	11.2
Public services sector - HAS - Public health etc.	22.5 - 11.8 - 10.7	21.3 - 14.0 - 7.3
Total	100.00	100.00

Source: (Csöndes & Räty, 1985, p. 187)

The share of exported high-tech products hardly increased between 1968 and 1983. Obligatory KMŰFA contributions did not directly result in applicable innovations, because although companies were forced to pay contributions, they were – due to the lack of competition and of market demand for technical development – rarely interested in the scientific development their money was invested in. Technology transfer from science towards industry only happened from

[34] GERD/GDP data for 1975 in table 13 differs from the one in table 9. The latter data, published by the Party was considerably higher than the data published by more independent sources.

[35] These indicators are not comparable with OECD indicators as they were using a different methodology and they overestimate real data by about 0.5%

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time to time, and it strongly depended on the dedication and motivation of the scientists themselves (Balázs, 1993, p. 543).

The Party concluded in 1981 that long-term planning could not adjust to quickly changing scientific trends, so planning in science and technology was adjusted to the five-year rhythm of economic planning. This more flexible, short-term planning was in line with global trends, just as the focus on technology and industry-related research. The most important task facing the Hungarian national economy in this period was to increase efficiency, mainly by transforming the structure of the economy and production. Changes in the research infrastructure and in research priorities were meant to serve this purpose. In research priorities, the trend observed in the previous years continued, with an increased emphasis on applied research and development, directly related to production. The aim was to have a few well-equipped interdisciplinary research institutes that are able to produce important new discoveries. Basic research was mainly carried out by university departments and academic institutes, while applications and innovative R&D products were developed by the relevant sections and departments of production enterprises.

In 1985 the Hungarian Socialist Workers' Party revised science policy again. It was decided to fund basic research more intensively but some fields of applied sciences with high potential were also prioritized, such as the fields of electronics, ICT, material sciences and biotechnology. The list of tasks and responsibilities of the Hungarian Academy of Sciences and OMFB have been more precisely described and further extended. The Hungarian National Scientific Research Fund (OTKA) was established in 1986 providing subsidies for basic research. Together with the Academy of Sciences and OMFB, OTKA offered a stable and reliable institutional and financial background for the scientific community in Hungary, which ensured relatively smooth transition in the years of the democratic transformation.

When using the OECD model for describing the institutional setting established in the Soviet era, we might see, that the scientific institutions of the Hungarian Academy of Sciences have become centres of excellence in basic research. OTKA was financing basic research with a stable programme portfolio between 1986 and 2015. Applied research was mainly carried out by business enterprises and related research organisations and was financed by KMÜFA. Planning, general priority setting and budgeting was determined by the Party, basic research was managed and

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administered by the Academy of Sciences, applied research was managed and administered by OMFB.

The importance of international cooperation was acknowledged by the Party so mobility of scientists was supported and intergovernmental scientific and technological agreements were signed. The first generation of such agreements was signed in the 1960s, creating the basis for bilateral cooperation with both Eastern and Western countries. These measures have had long-lasting positive effects on the cooperation between Hungarian and European scientists.

In conclusion it is fair to say that in the period between the two world wars science policy supported decentralisation, internationalisation, education as well as the training of the scientific elite. The system was built on trust, agents also accepted and supported the targets set by the principals, which resulted in cooperation and the establishment of successful institutions. In the Soviet system agents were not trusted, science policy was planned and strictly controlled by the principal. In spite of high GERD/GDP the system was not efficient, agents were not motivated to comply and thus underperformed.

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IV. Science Policy of Hungary in the 21st Century up to 2018

To set the scene for international scientific cooperation of Hungary in the last three decades (1990-2018), this chapter will provide a more detailed description of the main actors of science policy until June 2018. After an overview of political, economic and institutional changes of the last 30 years, this chapter sets out the introduction of main STI indicators, as well as programme portfolios initiated by governments after the systemic change. In spite of the constant reorganisations of science policy institutions, similarities between repeatedly developed programme types will testify the strong path dependency of the STI system of Hungary.

IV.1. National Science Policies Between 1990 and 2018

After the retirement of János Kádár as General Secretary of the Hungarian Socialist Workers' Party in 1988, a younger generation of "reform-communists" took over the leadership of the country, which led to the political change in 1989. The transformation from a planned economy along socialist lines to a free market economy already commenced prior to this political transformation. The Hungarian R&D management system during the transition period was quite stable, which was primarily attributed to the fact that the reform of the STI system was already under way in the 1980s. Some degree of continuity existed in the restructuring process, mainly when it came to the institutional financing of academic institutions.

The first free national elections were organized in 1990, the one-party system had been replaced by a multiparty parliamentary democracy, and the planned economy was replaced by a market economy based on private ownership. Substantial structural changes were required to turn Hungary into a country with a viable economy, but changes during this transition period produced economic recession rather than any prospect of prosperity. Most Hungarian citizens associated the economic hardships of the 1990s with the new economic and political system, despite the fact that these measures to alter the economy were needed because of the inherited disadvantages of the previous system of planned economy. In order to meet voters' expectations, politicians were willing to cushion changes in largescale macroeconomic policies, changes they were apt to introduce at earlier point in time than profitable from an economic point of view.

In the transition period, most of the efforts of politicians were devoted to solve short-term problems, and thus it proved hardly possible to pay sufficient attention to any emerging global trend and set out an appropriate strategy to improve Hungary's long-term competitiveness. Such a trend in S&T policy on the global scale was a shift from direct R&D support to promoting interaction, communication and cooperation among all the relevant stakeholders in the innovation chain. In Hungary, as in other countries, a sound, coherent research, development and innovation policy should have been one of the main elements of an overall science development strategy. In spite of a number of attempts in the 1990s, no such strategy really took off the ground.

However, after the years of relative stability in the transition period up to 1994, major S&T government bodies have been in a process of constant reorganisation, so a stable and reliable institutional system, which could have been a cornerstone for carrying out longer term R&D strategies and plans, did not come into existence. The lack of STI strategies, the instability of institutions, and changes to support schemes and their conditions have compromised the progress and improvement of the Hungarian scientific community. Against this difficult background, scientists had to become more excellent if they wanted to compete successfully in the international scientific arena.

In this subchapter, I want to set out a brief overview of these changes to institutional structures, and their underlying policy documents. I will also describe some general trends in science policy in Hungary between the systemic change and 2018 that have had impact on the framework conditions for Hungarian scientists in the period of the years of transition.

In the years of the Antall/Boross[36] (1990-1994) and the Horn (1994-1998) governments R&D was neither sufficiently funded, nor were the necessary legal frameworks and strategies put in place. For one part, this neglect of attention to scientific endeavours was partly caused by a sheer lack of political interest, and for another part by the fact that universities and the Hungarian Academy of

[36] After the death of József Antall at the end of 1993, Péter Boross was appointed as Prime Minister until the next elections in 1994.

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Sciences (HAS) were competing for top positions in the hierarchy. Lack of sufficient financial resources also always makes for a good excuse not to pass laws on funding and fostering of S&T or innovation.

The Boross government started to restructure the Hungarian R&D system by harmonizing academic titles, replacing the Science Policy Committee by the Science Policy Council, establishing the position of a Science Minister, and revaluating the OMFB. Only the latter was a factor that proved effective: under the leadership of Ernő Pungor (1990-1994), OMFB started to play a significant role in shaping science policy in Hungary. Dr. Pungor exercised a decisive influence on Hungarian science policy. He was not only the President of OMFB but he also founded the Bay Zoltán Institute for Applied Research.[37] Dr. Pungor also introduced competition based financing in technological development.

The role of OMFB started to diminish after it was put under the supervision of the Ministry for Industry and Trade in 1994. While during 1990 - 1994 OMFB's president was a minister without portfolio, in 1994-99 its presidency was taken down a few pegs to the position of a secretary of state, supervised by yet another minister, and after January 2000 the president had the mere rank of a deputy secretary of state. These changes also show the decreasing weight R&D carried in national policy making in these years.

It was the scientific community itself that took the initiative to develop new science policy guidelines in 1993. Three bills were passed in 1993-1994: the Hungarian Scientific Research Fund Act of 1993, the Higher Education Act of the same year, and the Hungarian Academy of Sciences Act of 1994. In the centrally planned economic system, academic research was directly controlled by the Council of Ministers and by the Science Policy Committee of the Communist Party. Following the transformation, the Hungarian Academy of Sciences Act stipulated shared responsibilities for academic research between the government and the parliament. Following the new legislation HAS has become a so-called public body or public-law association fully

[37] The Bay Zoltán Foundation for Applied Research (currently Bay Zoltán Nonprofit Ltd. for Applied Research) was established in 1993, based on the model of the Fraunhofer Society. The institution has grown into Hungary's leading network of applied research institutes. The aim of Bay Zoltán Nonprofit Ltd. has been to improve the competitiveness and efficiency of enterprises in Hungary through successful innovation and technology transfer, in close cooperation with domestic and leading foreign partner institutions.

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independent from the government. The Academy's activities and policymaking processes have become more transparent than prior to this Act.

The research network of HAS enjoyed institutional stability in the early, most critical years of transition in the early 1990s. HAS presidents successfully rebuffed political changes and secured a peaceful transition period for scientists involved in basic research, a fact highly appreciated by the research community. In the long run, however, competitiveness was the most decisive factor – decisions about finance, organisation and human resources had to be taken to support the most productive and eminent research units. The first period of reorganisation of HAS was set in motion in December 1997 and was more or less finalised by the end of 2000. A second consolidation phase was carried out in 2011 – the previous 38 research institutes and 2 research centres were reorganized into 5 research institutes and 10 research centres. The aim of both reorganisations was to make the whole system more efficient.

Institutions in the higher education sector have become autonomous, they were responsible for training researchers and awarding scientific qualifications. Research activity in Hungarian universities was strengthened during the transition period, even though funding was still far from adequate.

After 1990, new possibilities have emerged in the field of international cooperation. Hungary has joined the most significant international R&D institutions and programmes like COST (1991)[38], CERN (1992)[39], EUREKA (1992)[40], NATO Partnership for Peace (1994)[41], OECD Partners in Transition (1991)[42] programme. In addition to COST and EUREKA some further EU programmes,

[38] COST: European Cooperation in Science and Technology. COST is a unique means for European researchers, engineers and scholars to jointly develop their own ideas and new initiatives across all fields of science and technology through trans-European networking of nationally funded research activities.
[39] CERN: the European Organisation for Nuclear Research is one of the world's largest and most respected centres for scientific research.
[40] EUREKA: an intergovernmental innovation oriented organisation for pan-European research and development funding and coordination.
[41] The Partnership for Peace (PfP) is a programme of practical bilateral cooperation between individual Euro-Atlantic partner countries and NATO. It allows partners to build up an individual relationship with NATO, choosing their own priorities for cooperation.
[42] Partners in Transition programme of OECD was addressing the formerly centrally planned countries in Europe to assist historic transition.

such as PHARE[43] or TEMPUS[44] contributed to the successful survival of the R&D system in Hungary, particularly in the higher education sector (Mosoniné Fried, 2004, p. 252).

Bilateral intergovernmental agreements have been signed with some 30 countries, hundreds of bilateral – mainly mobility – projects have started in the 1990s (Balogh T. , 2008). The network of S&T attachés has been renewed. OECD published an innovation country report in 1993 and the Review of Recent Developments in Science and Technology in Hungary in 1995. 1995 was also the first year when OMFB launched a call to support the participation of Hungarian researchers in EU Framework Programmes on research and development. After 1995 researchers were able to join proposals in FP4 on a "project-by-project" basis.

The Horn government (1994-1998) again made some major alterations of the measures of the previous government: the Science Policy Council was replaced by the Science Policy Collegium – without any significant change in its role. The position of the Science Minister was discontinued; OMFB was integrated into the Ministry of Industry and Trade. The influence of the latter Ministry was further increased by the creation of the so called Fund for Economic Development (Gazdaságfejlesztési Alap, GFA), which was merged with the previously dominant Central Technological Development Fund (KMŰFA). The result was a new fund, called Central Technological Development Programme, supervised by the Ministry of Industry and Trade (the abbreviation KMŰFA did not change). The financial support provided by KMŰFA has decreased significantly between 1993 and 1995. The first technology foresight programme (Technológiai Előretekintés Program, TEP) of the region started in 1997.

Under the first Orbán government (1998-2002) some new policy documents and programmes saw the light. In 1999, Ádám Török has become the president of OMFB. New types of calls for proposals have been launched, focusing on industry related research supporting SMEs and large enterprises. In July 1999, Hungary has become an official member of the EU's 5th Framework Programme. In return for Hungary's contribution to the EU Hungarian researchers enjoyed full

[43] PHARE was one of the three pre-accession instruments financed by the European Union to assist the applicant countries of Central and Eastern Europe in their preparations for joining the European Union.
[44] TEMPUS supports the modernisation of higher education in the Partner Countries – among others – in Eastern Europe.

rights in the Framework programme. OMFB has launched calls and established an office in Brussels (HunOR office) to facilitate researchers' participation.

In 2000, the European Commission in Brussels announced the concept of the European Research Area, which also had an impact on national policymaking in Hungary. A strategic document called Science and Technology Policy 2000 was accepted in 2000 by the Hungarian government. The document formulated some concrete policy objectives: additional state funds were to be made available for R&D in 2001-2002; funds were to be allocated to large projects in priority areas in line with the priority fields of the 5th Framework Programme; researchers' wages were adjusted; the share of GERD /GDP was to reach 1.5% by 2002. BERD was to reach 50% of GERD (OM, 2000).

In the years of the Medgyessy/Gyurcsány/Bajnai governments[45] (2002-2010) another set of reforms has been introduced. Based on the concept of András Siegler, Deputy Secretary of State for Research and Development, a law on the Research and Technological Innovation Fund was passed in 2003 (Országgyűlés, 2003), in an attempt to provide a stable financial background for R&D. The fund integrated company contributions with government support and replaced previous governmental funds supporting R&D. Back to back with the creation of the new fund, on 1 January 2004, an independent organisation, the National Office for Research and Technology (Nemzeti Kutatási és Technológiai Hivatal, NKTH), was set up to coordinate R&D policy making in Hungary. It was a legal successor of the Deputy State Secretariat for Research and Development and of OMFB, and the latter was discontinued by the same law on the Research and Technological Innovation Fund. NKTH was also responsible for planning and supervising the programmes, supported by the new fund. In order to provide scientific advice to the government, a Research and Technological Innovation Council was established (Kormány, 2003). R&D has become part of the first National Development Plan. A law on technological innovation was passed in 2004 (law CXXXIV./2004.). The new law did not focus on international cooperation, it only ensured the fulfilment of international and European obligations resulting from previously signed agreements.

[45] The Hungarian Socialist Party and the Alliance of Free Democrats have formed government after the elections in 2002. Prime Minister Péter Medgyessy has resigned in 2004. Without holding new elections, Ferenc Gyurcsány was appointed as a new Prime Minister. In 2006, the same party coalition has won the elections again, Ferenc Gyurcsány was appointed as Prime Minister. In 2008 the Alliance of Free Democrats has left the coalition, in 2009 Ferenc Gyurcsány has resigned, Gordon Bajnai has become Prime Minister of Hungary for one year, until the next elections in 2010.

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Miklós Boda[46], president of NKTH has launched several new programmes, financed by the research and technological innovation fund.

The medium-term strategy on science, technology and innovation of the Gyurcsány government was finalised in 2007 (Kormány, 2007). The supervision of NKTH was moved from the Ministry of Education to the Ministry of Economy. The new president of NKTH became Ferenc Pártos in August 2007. Due to his strong ties to industry, there was a shift towards industrial research under his presidency. Both the supervising ministry and the new president changed the direction of attention of NKTH into a more economy-based one. Between 2008 and 2009 R&D was represented by Károly Molnár, a minister without portfolio in the government. His function was discontinued in the Bajnai government, and R&D was supervised by the Ministry for National Development and Economy. Gyula Csopaki was acting as the president of NKTH between the end of 2008 and 2010.

The second Orbán government (2010-2014) has again changed the institutional setting. The National Innovation Office (Nemzeti Innovációs Hivatal – NIH) was established on 1 January 2011 by government decree 303/2010. NIH was responsible for planning and implementing Hungarian STI policy, analysing R&D statistics, facilitating R&D investments, SME-incubation, supporting the innovation activities and market access of SMEs etc. It was also the implementing body of bilateral and multilateral international agreements and European programmes. It was supervised by the Ministry for National Economy. NIH was not a funding agency, the Research and Technology Innovation Fund was managed by the National Development Agency, supervised by the Ministry of National Development. György Mészáros was president of NIH until 2014, when Endre Spaller was appointed as new president. The development of the new structure was justified by the need for an efficient implementing agency but the new institutional system has become too fragmented with many overlaps. NIH itself has lost some of the main responsibilities of NKTH, e.g. strategy making and managing R&D funds.

[46] Miklós Boda was appointed as president of the National Office for Research and Technology in 2004 and resigned at the end of 2006. Until the next president, Ferenc Pártos was appointed, Ilona Vass was acting president of the office.

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Another major overhaul of the S&T system in Hungary took place in 2015 when the National Research, Development and Innovation Office (NRDIO) was created in yet a new endeavour to centralize the management of R&D funds in Hungary[47].

All the national programmes and strategies currently in place addressing R&D have been adopted after 2013. Most of them have close ties to European-level programmes, planning and funding. These R&D documents and regulations are the followings:

- The 2013-2020 National Research, Development and Innovation Strategy, "Investment in the Future" (NGM, 2013), aims at raising R&D investment and supporting the development of a knowledge-based, internationally competitive R&D system that would strengthen the competitiveness of the Hungarian economy. Based on this document the development of a new knowledge-driven economy is facilitated via three main processes: production of knowledge, use of knowledge, and transfer of knowledge. The strategy acknowledges that the implementation of the Horizon 2020 programme of the European Union has important consequences for Hungary, and that national R&D policy is thoroughly determined by the international framework. Policies related to international cooperation will be described in Chapter V.1 in more detail.
- The Higher Education Strategy, "A Change of Pace in Higher Education" (2014), sets the directions for achieving a competitive higher education system in the next 15 years.
- The National Reform Programme is a programme related to the Europe 2020 Strategy. Its strategic goal is to increase the level of GERD/GDP in Hungary to 1.8% by 2020 (EC, 2010a). The Hungarian government submits a new Reform Programme every year summarising the main annual results and listing additional work to be done until 2020.
- The National Smart Specialisation Strategy (NIH, 2014). In order to achieve the objectives of the National Reform Programme, the government adopted the National Smart Specialisation Strategy (S3), which aims at improving research capacities in all regions, especially research infrastructures that can accelerate the growth of the Hungarian economy. The adoption of an S3 Strategy was also the precondition for receiving EU

[47] The fourth Orbán government (18 May 2018) has reorganised the science-policy landscape of Hungary again by setting up a new ministry, the Ministry for Innovation and Technology. At the time when I finished collecting data for my thesis (June 2018), the new system has not been fully established yet, so I do not describe and analyse its functioning.

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support from the European Structural and Investment Funds (ESIF). The Strategy defined the following national priorities, which set the frame for nationally planned programmes financed by ESIF: Healthy society and wellbeing, Advanced technologies in the vehicle and other machinery industry, Clean and renewable energies, Sustainable environment, Healthy and local food, Agricultural innovation. The Strategy also defined two horizontal, overarching priorities: ICT and Inclusive and sustainable society.

- Irinyi Plan: the innovation based re-industrialization strategy of Hungary was adopted in 2016 (NGM, 2016). By means of this strategy, Hungary intends to become one of the EU countries with the most highly developed industrial sector by 2020.
- The Act 2014/LXXVI about scientific research, development and innovation, the so called Innovation Law (Országgyűlés, 2014), which also established and regulated the work of the National Research, Development and Innovation Office (NRDIO).

Figure 1: Hungarian R&D governance structure as of April 2018

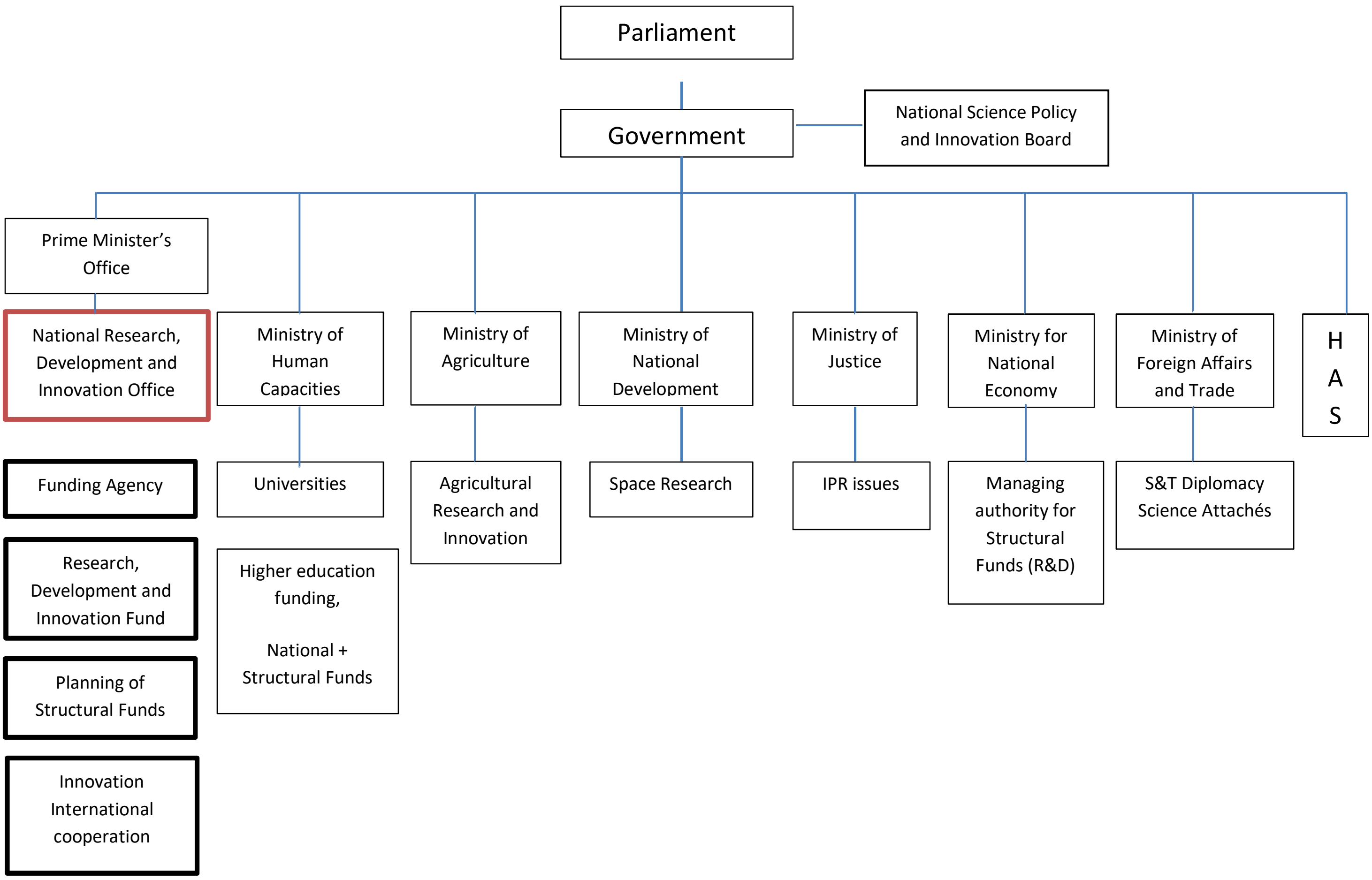

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Figure 1 summarises the Hungarian R&D governance structure in 2018. The figure shows all the main policy actors having an influence on science policy making on the national level in Hungary. As these actors determine the conditions for cooperation in research, development and innovation, a more detailed description of their roles and responsibilities will be provided in this chapter. After the introduction of the main policy actors, a more in-depth analysis of functions and responsibilities of NRDIO follows. I finish this chapter by a short summary of the changes of the Hungarian science policy landscape since the systemic change, showing the path dependency of the institutional system and how this effects the scientific community and their cooperation with other countries.

Key players in the Hungarian R&D system, which are shown in this figure, are organized on various levels. At cross-cutting high political level the parliament influences R&D policy through its Education, Science and Research Committees. In the government, science is represented via the *Prime Minister's Office* (directly supervising NRDIO). A policy advisory body has been also established in 2013: the National Science Policy and Innovation Board (NTIT), which is chaired by the Prime Minister and co-chaired by the President of the Hungarian Academy of Sciences.

The *National Research, Development and Innovation Office* (NRDIO) is the central government organ responsible for science and technology policy since its creation on 1 January 2015 by the Act 2014/LXXVI about scientific research, development and innovation. Dr. József Pálinkás, former President of the Hungarian Academy of Sciences was appointed as President of NRDIO on 1 January 2015.

NRDI Office is a national strategic and funding agency for scientific research, development and innovation, the primary source of advice on R&D policy for the Hungarian government, and an R&D funding agency. As a funding agency, it is responsible for the handling of the National Research, Development and Innovation Fund (NRDI Fund). The NRDI Fund is a unified fund also created by the same law as NRDI Office; it succeeds the former Research and Technology Innovation Fund[48] and the Hungarian Scientific Research Fund (OTKA)[49]. By the creation of NRDI

[48] The Research and Technology Innovation Fund – and partly also its successor the NRDI Fund – used to derive from the obligatory innovation contribution paid by business organisations, based on their net income topped up by government money.

[49] Since its creation in 1986 the Hungarian Scientific Research Fund (OTKA) has been an independent national institution supporting internationally excellent discovery research at Hungarian institutions in a peer review system involving domestic and international reviewers. OTKA's activity was primarily financed by state budget. Its grants provided extra resources for the best researchers and research institutions in Hungary. OTKA represented Hungarian

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Fund the financing of basic research did not come to an end – previous OTKA schemes have been further supported by the new fund. Successful applied research programmes, financed by the former Research and Technology Innovation Fund, have been also continued and supported by the new fund, but the previous programme portfolio has also been supplemented by additional elements. Evaluation and monitoring of all the programmes launched and financed by NRDI Fund also belong to the responsibilities of NRDIO.

NRDI Office also plays a role in planning Operative Programmes (Economic Development and Innovation Operative Programme – GINOP and Competitive Central Hungary Operative Programme – VEKOP), and funding research, development and innovation in the frame of the Széchenyi 2020[50] framework. Operative Programmes are co-financed by the European Structural and Investment Funds (ESIF) and the Hungarian government. The process is coordinated externally with the EU and internally with other government organisations. GINOP and VEKOP resources are allowed to be spent on research infrastructures, on increasing competitiveness by cooperation of research consortia, and on the excellence of strategic R&D centres.

As for international cooperation, NRDIO supports the government's international S&T policy, it initiates the signing of international STI agreements, participates in their preparation and coordinates their implementation. The Office is responsible for the coordination of the S&T attaché network, cooperates with Hungarian embassies abroad and foreign embassies in Hungary as well as with EU institutions. NRDIO takes part in the planning of documents concerning the European Research Area and supports other EU related R&D activities. It also represents Hungary in international STI organisations and initiatives.

science by actively participating in international organisations, by contributing to international calls from its own resources and by participating in jointly financed cooperative research programmes launched by European research funding organisations. Established in 1986 and functioning as an independent fund since 1991, OTKA was the only source, funding exclusively basic research in Hungary. Similarly to the European Research Council (ERC) and also as a founding member of Science Europe, it supported high-level basic research without expecting immediate applied results. OTKA supported numerous early-career researchers but its support strategy also provided the opportunity to carry out high-level research at any stage of a researcher's career. Its calls were completely bottom-up both in terms of scientific fields and – in the case of international calls – in terms of the international partner country selected for cooperation.

[50] Széchenyi 2020 programme is the Hungarian equivalent of the Europe 2020 programme to facilitate economic growth. It was also set up to manage the Hungarian share of European Structural and Investment Funds.

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NRDIO is responsible for almost all the functions the OECD model for S&T systems specifies:

1. It is the responsible body for *horizontal coordination*; the office is mandated to decide about scientific planning, priority setting and budgeting.
2. Next to NTIT it also gives scientific *advice* for the government, it provides evidence and advice to the policymaking process. NRDIO is responsible for the selection of national priorities and objectives.
3. NRDIO is *planning* strategies but also concrete funding programmes, it creates its own programme portfolio. In terms of planning the OECD model would give preference to flexible approaches over deterministic ones, to bottom-up initiatives on scientific matters over top-down ones, and to medium or long-term planning instead of short-term strategies. The new mid-term R&D strategy is being developed at the moment but currently flexibility and bottom-up initiatives are not among the characteristics of the Hungarian system, which has a very strong path dependency.
4. NRDIO plans its own *budget*, which needs to be approved by the government.
5. Research *priorities* of calls for proposals are determined by NRDIO.
6. As a funding body it *allocates resources* to calls for proposals and other R&D related activities.
7. It is also an *administrative* body, managing R&D programmes.

The Peer Review of the Hungarian Research and Innovation System[51], published in 2016, also commented on the exceptionally strong role of NRDIO (EC, 2016b, pp. 20-21). It called NRDIO a one-stop-shop, integrating horizontal and vertical responsibilities. Horizontal integration refers to funding both science and innovation, using financial tools of both Structural Funds[52] and the NRDI Fund. Vertical integration refers to designing, implementing, funding, monitoring and reforming all the support measures launched by the Office.

The report generally welcomes the establishment of NRDIO, which might end long years of constant transition and fragmentation, but it also emphasises that its unique role poses challenges:

[51] This Peer Review was a tool of the so called Policy Support Facility of the European Union. The review was carried out by international experts; it was an in-depth assessment of Hungarian RDI system. The panel has listed main conclusions and has given recommendations. The review was requested by NRDIO itself.

[52] NRDIO is only responsible for planning innovation related programmes financed by Structural Funds, the Funds are coordinated by the Ministry of Economics.

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- NRDIO should not become disconnected from overall political strategy and national priorities;
- It should not become an inward-looking institution;
- It should not lack external advice, engagement and control.

NRDIO should have a supervisory board, with a say on its strategic directions, ensuring the checks and balances appropriate in relation to the extensive responsibilities and budgets overseen by NRDIO.

The Peer Review report also devoted a chapter to international cooperation. It proposes Hungary to boost the internationalisation of its R&I system first of all by using international expertise in designing, implementing and evaluating R&I programmes. National programmes should be harmonised with European priorities. National Contact Points[53] and national supporting measures should further encourage and support the participation of Hungarian researchers in European framework programmes. The potential of scientific attachés should also be better exploited, attachés are encouraged to map cooperation opportunities with the scientific community of the partner country and give recommendations on how to take advantage of foreign policy initiatives that could be used as best practise examples in Hungary (EC, 2016b, pp. 31-33).

In addition to NRDIO, ministries also play a role in science policy making in Hungary. The *Ministry of Human Capacities* supervises the higher education sector; it provides funding for Hungarian universities by managing national and European funds. The *Ministry of Agriculture* is responsible for agricultural research and operates its own network of research institutions (institutions of the National Agricultural Research and Innovation Centre). The *Ministry of National Development* is responsible for Space research. IPR issues belong to the *Ministry of Justice*, supervising the Hungarian Intellectual Property Office. The *Ministry for National Economy* is an important partner for NRDIO by being the managing authority for R&D related Structural Funds (GINOP, VEKOP) planned by NRDIO. The *Ministry of Foreign Affairs and Trade* supervises the network of Science Attachés and is responsible for science diplomacy.

[53] The network of National Contact Points (NCPs) is the main structure to provide guidance, practical information and assistance on all aspects of participation in European framework programmes on the national level.

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At the research performer's level the Hungarian Academy of Sciences, higher education institutions and companies play important roles. The role and significance of the *Hungarian Academy of Sciences* has changed several times since its creation in the 19th century.

Table 15: Functions of HAS (1919-1997)

	1919-1948	**1949-1989**	**1990-1997**
Scholarly association	Yes	Yes	Yes
Financing institution	Yes	Yes	Yes
Strong interest group	No	Yes	Yes
Umbrella organisation with specialized R&D institutions	No	Yes	Yes
Granting academic titles	No	Yes	CSc (Candidate of science) until 1997 and DSc (Doctor of science)
Government advise	No	Yes	Yes /No
Ministry of Science	No	Yes	No

Source: (Biegelbauer, 1999, p. 117)

The status of the Academy was defined by the Hungarian Academy of Sciences Act (XL. Law about HAS in 1994). Its main responsibility is to represent excellent, high-quality research in various scientific fields and to distribute scientific results. HAS also has extended international activities, it supports the scientific activities and careers of young, promising scientists and defends science ethics in public life.

Universities and *colleges* are also important building blocks of the R&D system in Hungary. They have gained on competences after the systemic change and they have become more autonomous organisations. Hungary has more and more large multinational *companies* settling down in the country. These large, mostly export-driven, efficient and profitable foreign-owned firms, operating high-tech equipment, account for the impressive microeconomic statistics, e.g. percentage of GERD financed by the business sector (see Figure 3). Many of their local suppliers – either foreign-owned or domestic – also carry out scientific activities.

There is also a large number of indigenous, mostly small or medium-sized enterprises, usually lacking capital for development, applying obsolete technologies, and thus facing the threat of bankruptcy, or stagnation with constant, hard struggle for survival – at best a rather risky future with low growth prospects. They are often targeted by government programmes in order to boost their innovation potential.

A large share of the best Hungarian company R&D laboratories are owned by foreign firms. They are able to recruit the best scientists and engineers, can afford the most sophisticated facilities, and since they are mostly in the mainstream of the given research field, they are awarded relatively high domestic research grants as well. Domestic SMEs are often lagging behind and have a smaller chance to receive domestic funding (Mosoniné Fried, 2004, p. 254). In order to counterbalance this trend a large number of programmes, incubators, supporting organisations, technology transfer institutions have been recently created.

IV.2. Development of Main R&D Statistics and Programme Portfolios in Hungary

In this subchapter I want to introduce the main input and output R&D indicators as well as the programme portfolios developed under various Hungarian governments since the 1990s. Results of interventions will be compared to the findings of the European Innovation Scoreboard country report of 2018.

IV.2.1: Main R&D Indicators

In the early years of transition in the 1990s, the way to align the R&D sector with the conditions of a market economy was not clear. The R&D sector´s strong dependence on the state budget and their cooperation with COMECON partners were conditions rather unfavourable to a successful restructuring process. The main effect of the difficulties of the economic restructuring process on the R&D system was the significantly decreasing funding provided for research.

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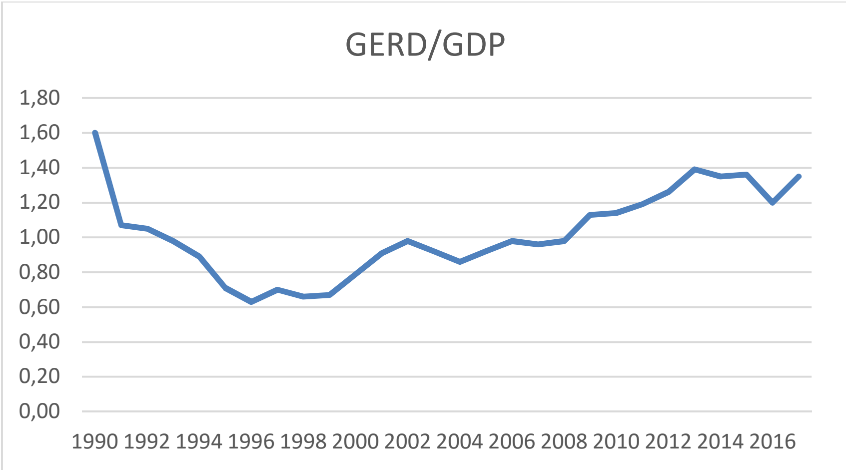
Figure 2: GERD/GDP between 1990 and 2017 in Hungary



Source: (KSH, Központi Statisztikai Hivatal, 2018)[54]

In the 1970s and 1980s GERD/GDP reached 2 to 3 %. R&D expenditures have already significantly dropped in the late 1980s. Whereas 1.6% of GDP had been devoted to R&D in 1990, this ratio fell to 0.63% by 1996[55] and has remained under 1% until 2008. Given that GDP only reached its 1989 level in 1999, it is indeed a dramatic drop. In the same periods EU countries on average spent around 1.7-1.8% of their GDP on R&D (OECD, OECD.Stat, 2018). Hungarian expenditures appear in an even less favourable light if we take into consideration that GDP per capita in EU countries was three times higher than the Hungarian one (Havas, 2002, p. 21).

After a trend of increasing GERD/GDP after 2008, the drop in 2016 shows the effects of the last restructuring of the Hungarian R&D system. As long as the new programmes launched by the newly set up research funding agency, the National Research, Development and Innovation Office have not been started, significant amounts of funding could not be allocated to these programmes. When the newly launched programmes were fully operating, GERD/GDP returned to the level of previous years, which falls still far below the target of 1.8% set by the National Reform Programme.

Given the principles of the market economy, politicians expected companies to play an increasing role both in co-financing and executing R&D, and, as a consequence of this, the government's

[54] OECD methodologies to collect and interpret R&D data have only been applied strictly in Hungary since 1994, so we should compare data before and after 1993 carefully.

[55] Given the drastic stabilisation programme launched in 1995 there were no extra funds available to promote R&D and innovation. In fact, finance for R&D reached its lowest level in these years.

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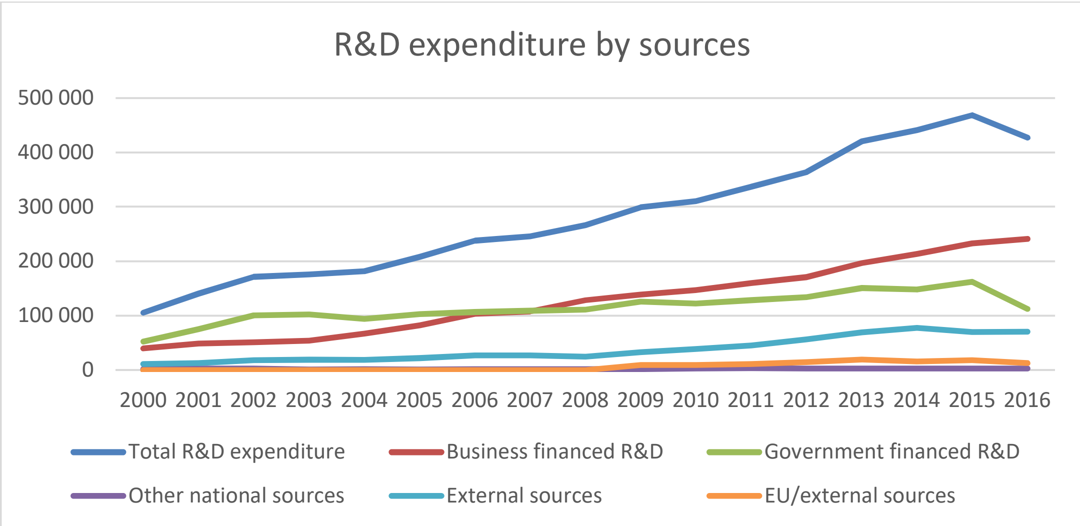
share in funding to diminish. However, a shift in quite the opposite direction occurred in 1990-94. Because in the early 1990s most Hungarian companies were suffering from the loss of market shares and shrinking revenues, they were not in a position to afford to generate adequate funds for R&D. Unlike Hungarian firms with low R&D investment capacity, the number and amount of R&D investment of foreign-owned companies started to grow in the 1990s. The share of foreign affiliates in Hungarian BERD grew from 22.6% in 1994 to 78.5% in 1998 (Havas, 2002, p. 23).

Figure 3: Hungarian R&D expenditure by different sources (in million HUF)



Source: (KSH, Központi Statisztikai Hivatal, 2018)

As the figure above shows, government funded R&D exceeded business expenditures until 2006. After this turning point the difference between business and government spending is constantly increasing. The contribution of the business enterprise sector has steadily grown after 2003, mainly due to some large international companies, whereas government expenditure has dropped in 2015 after a slow increase during the years between 2008 and 2015. The small amount of government funding is even more alarming if we take into consideration that 37% of government funds have derived from EU Structural Funds in 2015 and 17% in 2016 (Dőry, Csonka, & Slavcheva, 2018, p. 12). The first budget estimations of the next Multiannual Financial Framework of the European Union for the period 2021-2027 points in the direction of Hungary receiving considerably less from the Structural Funds. This might further decrease the level of government expenditure on R&D, if no more national funds will be mobilised. Public R&D expenditure is also very low compared to the European average (EU, 2018).

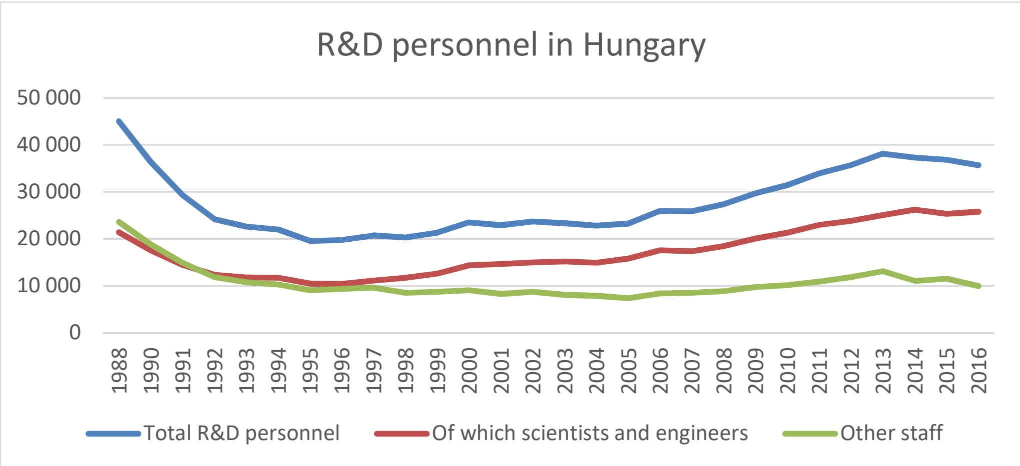
Table 16: Percentage of GERD financed by abroad in Hungary and in the EU

	2000	2005	2010	2013	2014
Hungary	10.63	10.67	12.35	16.57	17.54
European Union average	6.94	8.73	8.91	10.12	

Source: (OECD, OECD.Stat) EU average data is an estimate based on national sources

International funding started to play an important role in financing R&D in Hungary after 1990. 3-5% of the total R&D of funding has come from international sources, mainly within the framework of bilateral and multilateral R&D programmes (Biegelbauer, 1999, p. 114). The percentage of GERD financed by other countries has reached 17.5 % by 2014. This ratio is significantly higher than the average 10% of the countries of the European Union. The orange graph line of Figure 3 shows the amount received by Hungarian scientists from European framework programmes as part of all the external sources (light blue line). The share of EU framework programmes in external resources was 25% and 18% in 2015 and 2016 respectively, which shows the importance of such European programmes for financing R&D in Hungary.

Figure 4: R&D personnel in Hungary between 1988 and 2016 (in FTE)



Source: (KSH, Központi Statisztikai Hivatal, 2018)

Numbers of R&D personnel have also seriously decreased in the transition years. This number was down by 56.5% in 1995 compared to 1988; the 2000 total was still 47.8% lower than the 1988 level. In some cases, this cut in numbers was necessitated by the wish to increase efficiency, in other cases, however, its cause was a significant loss of useful knowledge and skills developed and accumulated over time (Havas, 2002, p. 22).

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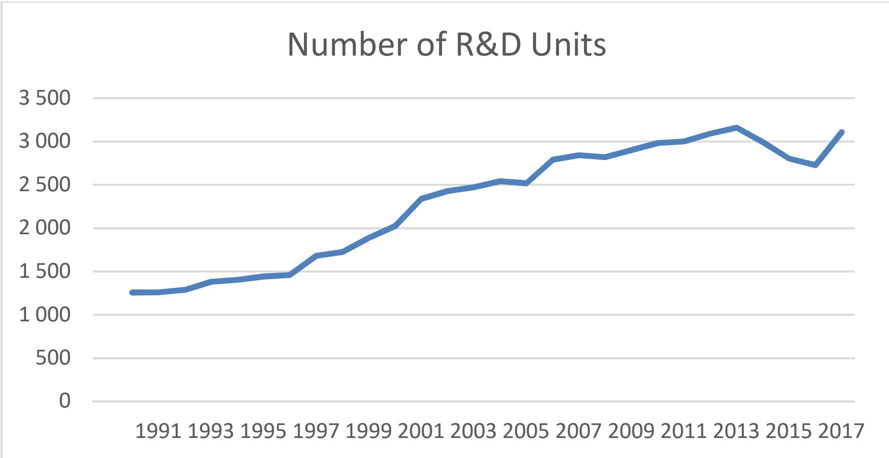
The composition of the various types of R&D personnel has also changed: the number of researchers and engineers increased relative to the number of supporting staff (Havas, 2002, p. 22). The low number of supporting staff often resulted in forcing highly qualified scientists to perform simple, administrative tasks, instead of solving scientific problems, which is obviously a waste of time and energy of trained, expensive resources. Limited time for and capacity of scientists also results in lower numbers of applications for national and international grants.

Figure 5: Number of R&D units in Hungary between 1980 and 2016



Source: (KSH, Központi Statisztikai Hivatal, 2018)

We can see better results in terms of the number of institutional units carrying out research activities. After some years of stagnation and a slight decrease in the 1980s-1990s the number of units returned to the level of 1980 by 1995. The number of units has continuously grown until 2013 when it reached its maximum at 3159. After this peak, the number of R&D performing units has been decreasing year by year again. (KSH, Központi Statisztikai Hivatal, 2018).

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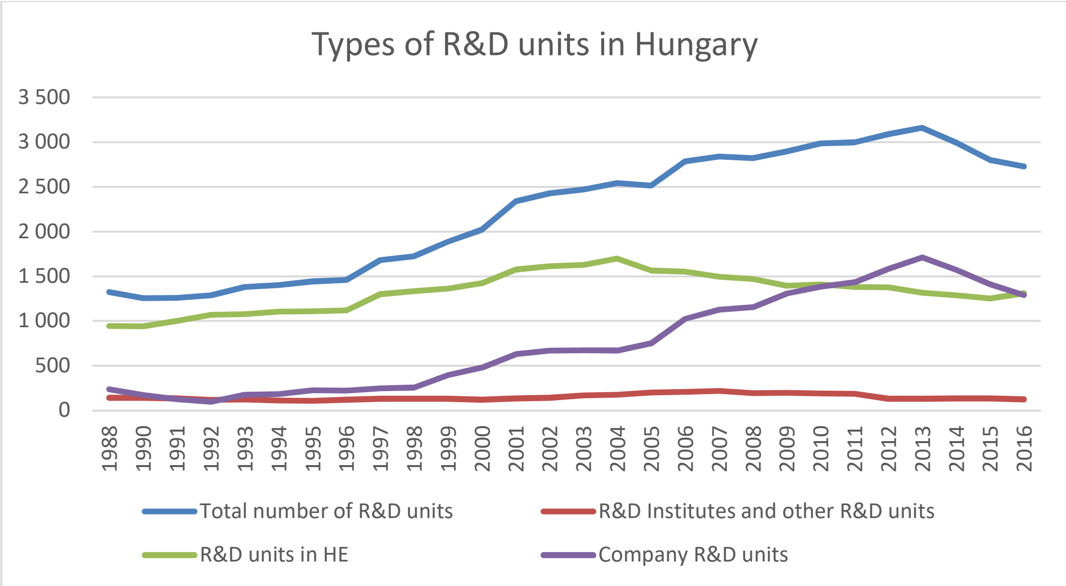
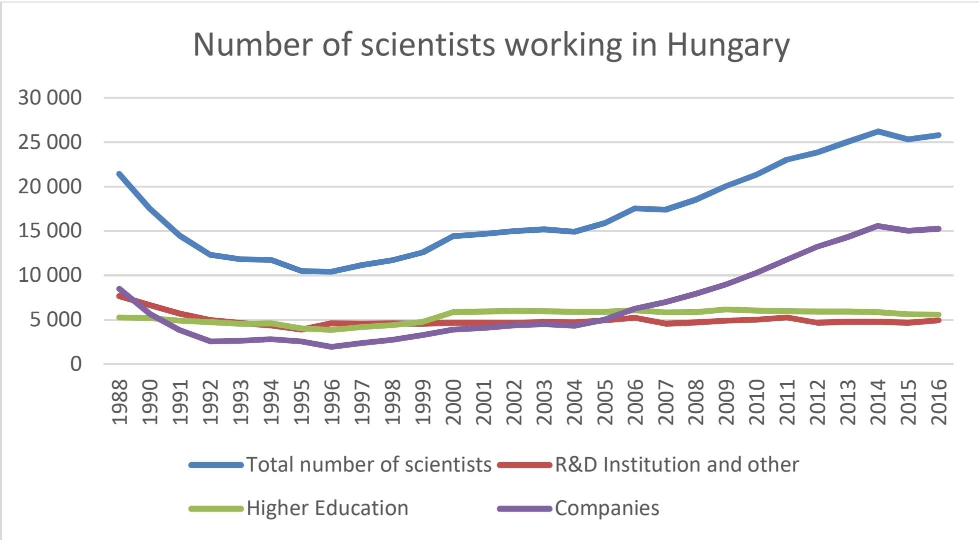
Figure 6: Types of R&D units in Hungary



Source: (KSH, Központi Statisztikai Hivatal, 2018)

The number of company R&D units decreased very rapidly between 1989 and 1992, most of them were closed or stopped working when companies went bankrupt. About 60% of companies' R&D employees had to seek alternative employment (Mosoniné Fried, 2004, p. 246). The number of company R&D units already started to increase after 1996, reached and even exceeded the original number of 235 in 1988 by 1998 and continued to grow – rapidly – until 2013. By that time it even exceeded the number of R&D units at higher education institutes, which after a slow increase started to fall in 2004. This negative trend for R&D at Higher Education Institutes has not changed until 2015. Thanks to the relative stability of the institutional network of the Hungarian Academy of Sciences, the number of R&D units at research institutions has been quite stable.

Figure 7: Scientists (in FTE) employed in R&D institutions in Hungary

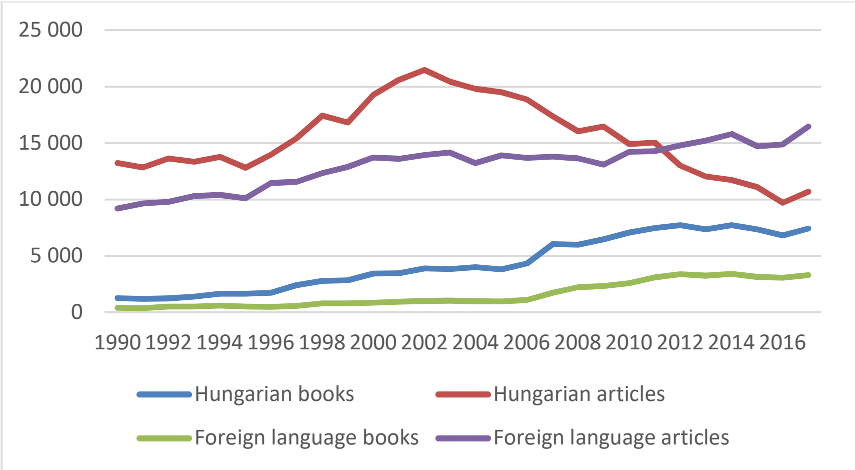


Source: (KSH, Központi Statisztikai Hivatal, 2018)

If we compare Figure 6 with Figure 7, we can see that in spite of the fluctuating number of R&D units at higher education institutions, the number of scientists working there remains constant. The number of scientists at R&D institutes dropped by about 25% in the years after the systemic change, and this drop was not reflected in the number of units they were working in. After this first drop, their number stabilised. The trends in the total number of scientists are mainly determined by the changes in the number of researchers employed at companies, which dropped by more than 50% between 1988 and 2000. The growth, which already started in the number of R&D units around 1998, was only palpable in the number of scientists after 2005.

As for output indicators, I will briefly set out recent statistics about Hungarian scientific output in terms of publications and patents.

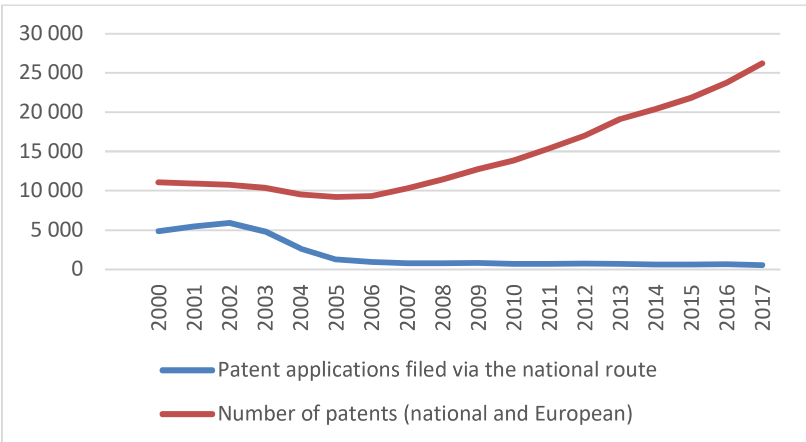
Figure 8: Number of Hungarian publications



Source: (KSH, Központi Statisztikai Hivatal, 2018)

As Figure 8 shows, until 2011 both the number of books and articles published in Hungarian language exceeded the number of foreign language publications. Nevertheless, whereas the number of foreign publications has constantly been growing, the number of Hungarian articles started to drop dramatically after its peak in 2002. There was a turning point in 2011 when the number of foreign language articles started to exceed the number of Hungarian articles. At the same time international co-publication activity is also on the rise (EU, 2018, p. 66). This figure very well shows that Hungary follows the rising trend of international co-publications.

Figure 9: Number of patents in Hungary



Source: (KSH, Központi Statisztikai Hivatal, 2018)

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Figure 9 shows the radical decrease in the number of patent applications filed via the Hungarian system between 2000 and 2006. This was a result of Hungary joining the European Patent Convention in 2003. After this date, patents did not need to be submitted separately in Hungary to be valid. A general decrease in the total number of patents also occurred between 2003-2006, and the number of patents in total started to increase afterwards and there is a constant growth up to 2017.

On the initiative of the European Commission, under the Lisbon Strategy, a new instrument, the European Innovation Scoreboard (EIS), was developed in 2000, to provide a comparative assessment of the innovation performance of EU Member States.

Table 17: Hungary's innovation performance compared to the EU

Hungary	**Performance relative to EU 2010 in**		**Relative to EU 2017 in 2017**
	2010	**2017**	
SUMMARY INNOVATION INDEX	**69.5**	**69.3**	**65.7**
Human resources	**59.2**	**54.6**	**45.7**
New doctorate graduates	53.8	62.4	44.8
Population with tertiary education	61.9	47.8	42.1
Lifelong learning	62.5	53.1	52.0
Attractive research systems	**52.0**	**66.4**	**58.4**
International scientific co-publications	87.8	141.6	87.0
Most cited publications	59.2	60.5	58.3
Foreign doctorate students	29.3	48.9	44.2
Innovation-friendly environment	**85.0**	**117.9**	**88.1**
Broadband penetration	100.0	177.8	100.0
Opportunity-driven entrepreneurship	76.1	82.4	76.5
Finance and support	**45.8**	**50.0**	**46.4**
R&D expenditure in the public sector	55.7	23.9	24.8
Venture capital expenditures	33.1	83.4	68.4
Firm investments	**72.2**	**87.5**	**78.3**
R&D expenditure in the business sector	52.8	73.8	66.3
Non-R&D innovation expenditures	106.1	107.1	98.0
Enterprises providing ICT training	64.3	85.7	75.0
Innovators	**25.0**	**15.1**	**17.6**
SMEs product/process innovations	21.2	13.7	16.7
SMEs marketing/organisational innovations	34.0	16.0	19.4
SMEs innovating in-house	19.5	15.5	16.6
Linkages	**85.8**	**70.2**	**69.5**
Innovative SMEs collaborating with others	59.7	50.0	49.8
Public-private co-publications	82.4	85.8	85.0

Private co-funding of public R&D exp	116.0	73.5	72.5
Intellectual assets	**35.0**	**39.5**	**39.2**
PCT patent applications	36.6	36.4	38.0
Trademark applications	51.0	62.5	55.3
Design applications	21.3	25.1	26.0
Employment impacts	**125.7**	**124.9**	**124.3**
Employment in knowledge-intensive activities	85.7	76.6	69.4
Employment fast-growing enterprises	154.2	159.4	170.4
Sales impacts	**113.4**	**99.0**	**95.1**
Medium and high tech product exports	147.8	139.6	131.8
Knowledge-intensive services exports	63.1	63.6	60.7
Sales of new-to-market/firm innovations	131.4	92.1	91.2

Source: (EU, 2018, p. 66)

Based on the conclusions of the 2018 edition of EIS (EU, 2018, p. 66), Hungary is a moderate innovator, whose relative innovation performance compared to the EU average in 2017 was 65.7%. Hungary performs very well in two categories: employment impacts (124.3%) and sales impacts (95.1%) due to the high percentage of employment at fast growing enterprises (170.4%) and the share of high-tech product export (131.8%). Both results are related to the good performance of multinational enterprises, active in the country. Hungary's performance is also quite good in the innovation-friendly environment category with 88.1% – which is mainly attributed to the high level of broadband penetration (100%) –, as well as in the firm investments category (78.3%). However, this latter is due to the high level of non-R&D innovation expenditures (98%) – the R&D expenditure of enterprises is well below the EU average (66.3%). The human resources index is 45.7%, including subcategories like the number of new doctorate graduates (44.8%), population with tertiary education (42.1%) and lifelong learning (52 %). The percentage of population with tertiary education has dropped; in 2010 it was still 61.9% of the EU average. Inside of the attractive research systems category (58.4%) the number of international scientific co-publications has significantly increased in Hungary (the relative performance compared to the 2010 EU average level has grown from 87.8% to 141.6%) but as the co-publication activity on the European level has also increased in the same pace, the Hungarian relative performance has not changed (87%). In the finance and support category (46.4%) the relatively high percentage of venture capital expenditures (68.4%) counterbalance the very low rate of public R&D expenditure (24.8%), which number has again dramatically decreased since 2010 (55.7%). In spite of all the national efforts and dedicated programmes, there was also a decrease in the linkages category (2010: 85.8%, 2017: 69.5%). Only the number of public-private co-publications has slightly increased and reached 85%

of the EU average, but the subcategories: cooperation with innovative SMEs (from 59.7% to 49.8%) and the private co-funding of public R&D (from 116% to 72.6%) have decreased. In spite of all the government initiatives and support schemes, Hungary has very bad results in the innovative SME category (17.6%) and the situation has just become worse compared to the 2010 level (25%). Hungarian SMEs perform badly in each subcategory: product/process innovation (16.7%), marketing/organisational innovation (19.4%) and in-house innovation (16.6%). Also in the intellectual assets category – with patent applications (38%) as a leading indicator – Hungary performs well below the EU average with 39.2%. All in all, both on the input and on the output side, Hungary's innovative capacity is low in a European comparison.

IV.2.2. Programme Portfolios in Hungary Between 2000 and 2018

As described in chapter IV.1, all the governments after the systemic change have restructured the STI policy landscape in Hungary. The newly established, reorganised funding agencies have developed new programme portfolios based on preferences of the governments. As the analysis below will show, the main structure and content of programmes have constantly been reproduced in spite of all the changes in policies.

A strategic document, the Science and Technology Policy 2000, was accepted in 2000 by the first Orbán government. Based on this policy document, large-scale programmes have been initiated such as the National Research and Development Programmes or the Technological R&D call (see table 18), covering various scientific fields. Research, development and innovation was one of the seven programmes outlined in a national development strategy, called Széchenyi Plan, also launched in 2000. OTKA has been financing basic research programmes in a bottom-up way, including specific programmes for early-stage researchers or international cooperation. Otherwise, international cooperation was limited to financing researchers' mobility with a large number of partner countries.

Table 18: Calls for proposals launched by the Ministry of Education between 2000-2003[56]

	2000	2001	2002	2003
International cooperation	Mobility – 10	Mobility – 19	Mobility – 11	Mobility – 16
Thematic R&D programmes (focus areas)		National Research and Development Programmes		Technological R&D call/ thematic R&D programmes
Basic research	OTKA programmes	OTKA programmes	OTKA programmes	OTKA programmes
Industrial research, commercialisation, innovation		Key Technologies call	Innovative technologies (ICT); Technological development programme	Technological R&D call/ SME support and innovation
Industry-academy cooperation		Applied R&D		
Research infrastructures		R&D instruments	ICT instruments	Technological R&D call/ infrastructures
Human resources development				Technological R&D call/ HR development
Other		Science-popularization, participation in conferences etc.		

Source: (NKFIH, 2018)

In 2004, the National Office for Research and Technology was established in order to coordinate R&D policy making in Hungary. Under the presidency of Miklós Boda between 2004 and 2006, a comprehensive programme portfolio has been set up. The programmes were financed partly by the Research and Technological Innovation Fund and partly by European Structural Funds. The Gábor Baross Regional Innovation Programmes have supported technology transfer, innovation, the development of research infrastructures, as well as international cooperation on a regional level. The Co-operative Research Centres (CRC) programme was launched to foster strategic, long-term co-operation between higher education institutions, other non-profit R&D units and businesses, by establishing CRCs. In addition to a high number of mobility calls, new programmes have been

[56] In the next five tables calls are ordered based on the date of proposal submission. Numbers written after types of calls show the number of the same type of calls in that year.

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developed to facilitate the participation of Hungarian scientists in European programmes – e.g. the Consortium Building Programme was launched to assist Hungarian participation in the EU's 5th RTD Framework Programme – as well as two other calls to support joint research with international partners. These calls were only partly based on bilateral agreements, they were mainly open for international partners, and cooperation was defined by priority areas.

Table 19: Calls for proposals launched by the National Office for Research and Technology between 2004 and 2007

	2004	**2005**	**2006**	**2007**
International cooperation	Mobility – 13 EU – 1	Mobility – 10; EU – 1; International R&D cooperation programme – 2	Mobility – 15	Mobility – 11 EU – 1
Thematic R&D programmes	National Research and Development Programmes; Agricultural programme	Innovative key sectors; National Research and Development Programmes	Innovative key sectors; National Research and Development Programmes	National Research and Development Programmes
Basic research	OTKA programmes	OTKA programmes	OTKA programmes	OTKA programmes
Industrial research, commercialisation, innovation	Regional Innovation Agencies; Innovation in companies; Spin-off programme; Applied research programme	Regional Innovation Programmes – 8; Implementation of innovative ideas;	Regional Innovation Programmes – 8; Company Innovation programme; Technological innovation cooperation of companies;	National Technology Platforms
Industry-academy cooperation	Regional University Knowledge Centres; Co-operative Research Centres	Tech-transfer call; Regional University Knowledge Centres; Co-operative Research Centres	Regional Research Centres at Enterprises; Knowledge transfer call	
Research infrastructures	Research infrastructures of PRIs	R&D ICT infrastructures; Regional Innovation Programmes	Regional Innovation Programmes	
Human resources development			Excellent young scientists award; HR development, new scientific generation	
Other	"Mecenatúra": social conditions	Incubation centre for biotechnology;	Research lab - nanotechnology	

	for technological development			

Source: (NKFIH, 2018)

A new president of the National Office for Research and Technology was elected in 2007. The transition period between the two presidents was marked by a drop in the number of programmes, but after one year the situation was stabilised: most of the previous programmes have been continued. In addition to the already existing regional innovation programmes, in this period (2008-2010) national technology platforms and regional innovation agencies were also supported, showing the focus on innovation on the part of the new president, whose policy was also espoused by his successor until 2010. Back to back with a large number of mobility calls an increasing number of bilateral programmes, supporting joint research, has been launched with China (Shenzen), France, India, Israel and Singapore.

Table 20: Calls for proposals launched by the National Office for Research and Technology between 2008 and 2010

	2008	**2009**	**2010**
International cooperation	Mobility – 11 EU – 3 International R&D cooperation programme – 2	Mobility – 17 EU – 2 International R&D cooperation programme – 2	Mobility – 11; EU – 6; International R&D cooperation programme – 5
Thematic R&D programmes	National Technology Programme (innovation focus, 2 rounds);		National Technology Programme (strategic research)
Basic research	OTKA programmes (joint programme)	OTKA programmes + targeted basic research	OTKA programmes + basic research for innovation
Industrial research, commercialisation, innovation	Regional Innovation Programmes – 7; Social aspects of Innovation; National Technology Platforms; Regional Innovation Agencies (2 rounds)	Regional Innovation Programmes – 8; Innovative ideas programmes – 3	Innovation in companies
Industry-academy cooperation	Regional Innovation Programmes	Regional Innovation Programmes	
Research infrastructures	Regional Innovation Programmes	Regional Innovation Programmes	
Human resources development		Development of R&D resources – 2	
Other	R&D liaison office in Brussels;	Industrial property rights; Space;	Space;

	Cybergeneration	"Mecenatúra": social conditions for technological development	"Mecenatúra": social conditions for technological development; Preparation for ELI

Source: (NKFIH, 2018)

The most dramatic change in research funding happened when the National Innovation Office was created in 2011 as a successor of NKTH. The new institutional restructuring seriously affected the programme portfolio, developed by NKTH as NIH stopped financing even approved proposals. In 2011, only calls of OTKA, supporting basic research from their separate funds, have been published. The long break in financing proposals has stopped some of the international research programmes: the cooperation with France, Shenzen and Singapore has come to an end. The cooperation with India and Israel has restarted in 2014 after years of stagnation. There have been a number of new programmes supporting the competitiveness of companies but the programme portfolio of NIH has not become as comprehensive as the one in the previous period.

Table 21: Calls for proposals launched by the National Innovation Office between 2011 and 2014

	2011	**2012**	**2013**	**2014**
International cooperation	International R&D cooperation programme - 1	Mobility – 4; EU – 3;	Mobility – 5 EU – 8 Basic and industrial R&D projects based on international cooperation	Mobility – 5; International R&D cooperation programme – 2
Thematic R&D programmes			National Brain Programme	
Basic research	OTKA programmes	OTKA programmes	OTKA programmes	OTKA programmes
Industrial research, commercialisation, innovation		Market oriented R&D in Central Hungary; R&D "umbrella" projects	Competitiveness and excellence in R&D; Market-oriented R&D (general + Central Hungary + agriculture); R&D "umbrella" projects	Competitiveness and excellence in R&D; Start-up eco-system
Industry-academy cooperation				
Research infrastructures				Development of e-Health infrastructures
Human resources development				

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Other		HU participation in EIT KICs	Industrial property rights	

Source: (NKFIH, 2018)

The creation of the National Research, Development and Innovation Office (NRDIO) has also had a substantial impact on the R&D landscape in Hungary: hardly any calls for proposals have been launched in 2015, which also showed up in less favourable GERD statistics in 2016 (see Figure 2). After 2016, a systematic programme portfolio-building started. Programmes financed by NRDIO often complemented calls financed by European Structural and Investment Funds, both in thematic and regional priorities. By 2017 the whole spectrum of programme types has been covered by at least one dedicated call for proposals. As for international cooperation there is a clear shift from mobility financing towards joint research with international partner countries. New programmes have been initiated with countries such as China, India, Iran, Israel, Russia, Thailand, Turkey and Vietnam.

Table 22: Calls for proposals launched by the National Research, Development and Innovation Office between 2015 and 2018

Programme type	2015	2016	2017	2018
International cooperation	Mobility – 5 International R&D cooperation programme - 1	Mobility – 8; EU – 2 + 2 ERA-NET Co-fund; International R&D cooperation programme – 3	Mobility – 2; EU – 3 + 5 ERA-NET Co-fund; International R&D cooperation programme – 7	Mobility – 6; International R&D cooperation programme – 1
Thematic R&D programmes	ELI ALPS laser project (GINOP)		National Excellence Programme; Excellence of strategic R&D centres (GINOP, VEKOP)	National Excellence Programme
Basic research	Integrated OTKA Programmes	Integrated OTKA Programmes	Integrated OTKA Programmes	Integrated OTKA Programmes
Industrial research, commercialisation, innovation		Prototype development (GINOP); Company R&D (VEKOP)	Company R&D (GINOP, NRDIF); Export support for companies; Innovation eco-system (start-ups);	Company R&D; Innovation in SMEs; Prototype development (GINOP, VEKOP); Company R&D combined with credit (GINOP);

				Competitiveness of SMEs (GINOP)
Industry-academy cooperation		National Competitiveness and Excellence Programme (academy focus); HE-Industry Cooperation Centres	National Competitiveness and Excellence Programme (academy focus); Competitiveness and Excellence Cooperation (industry focus, GINOP, NRDIF)	Competitiveness and Excellence Cooperation (industry focus); HE-Industry Cooperation Centres (GINOP)
Research infrastructures			Reinforcement of research infrastructures (GINOP, VEKOP)	
Human resources development			Excellent scientists programme	Excellent scientists programme
Other			Summer employment of Hungarian young scientists studying in the UK;	Summer employment of Hungarian young scientists studying in the UK;

Source: (NKFIH, 2018)

In spite of constant reorganisations, changing names and presidents, the main actors of the institutional structure of the Hungarian STI system have not changed in substance since the 1960s. There has always been an advisory body – today it is called National Science Policy and Innovation Board (NTIT) – but it has never played a very influential role. OMFB and its legal successors (NKTH, NIH, NKFIH) were responsible for funding applied sciences and experimental development while HAS – and later universities – coordinated basic research. There were definitely differences in tasks and responsibilities, often determined by the plans and programme of the presidents in charge, but the core role of the “Offices” has remained the same.

The structure of funding – in spite of the large number of newly established, merged or terminated funds – has not considerably changed either. OTKA was established before the transition period and it financed basic research projects on the basis of scientific excellence until 2015. Even after being merged with the National Research, Development and Innovation Fund – which is also the successor of MÜFA, KMÜFA and the Research and Technological Innovation Fund – previous OTKA programmes are further launched and supported.

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Although programmes financing technology transfer, industry-university cooperation and SMEs are returning elements of all the programme portfolios, the efficiency of these measures are questioned by the results of the European Innovation Scoreboard. In spite of the general target of boosting business R&D, only large international companies perform above the EU average. These multinational companies are often the beneficiaries of national funds, mainly provided by Operative Programmes, financed by the European Regional Development Fund. SMEs rarely profit from the existing incubator and accelerator possibilities, they are sometimes not even aware of the necessity of innovation. This attitude could be changed by education, but Hungary does not perform well in human resources related indicators either. Newly introduced, credit-based instruments might also serve the competitiveness targets of the country.

So, we might conclude that in spite of new plans and new restructuring efforts, due to the path dependency of the system, both the institutional system and programmes keep reproducing themselves. Breaking out of compartmentalized thinking and thinking outside of the box would be necessary to develop governance agility, which matches new technological and economic challenges.

Even if the scientific community could benefit from the new, improved elements of programme strategies, constant reorganisations take their toll. Government funding for public research institutions and university research is low, scientists are underpaid. A large portion of funds is distributed via open calls. If these calls are constantly being reorganised and eventually even discontinued, scientists will not only lose their trust in the system but also the access to adequate financing for their research activities.

All this is also true for international cooperation. Reorganisations typically go hand in hand with the suspension of payments, which not only has a negative effect on the work of the Hungarian applicants, but also on his or her cooperation with international partners. Longer reorganisation and suspension periods not only ruin the personal networks of scientists with their foreign counterparts, but also lead to the termination of bilateral scientific agreements in certain cases. Re-establishing of such broken contacts is often more challenging than establishing of new ones.

After the systemic change, new research funding and management institutions have tried to avoid the appearance of corruption by developing strict rules, legal frameworks, long and complicated descriptions for calls for proposals. All these efforts should have served the purpose of transparency

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and legality, but they have only resulted in programmes and conditions, which were confusingly difficult to understand and comply with. Constant reorganisations also acted against transparency.

In terms of the game theory, one could write: The new rules have caused additional administrative efforts both on the side of the principal and on the side of the agents. Instead of being trusted, agents have been strictly controlled by the principal. New programmes have been developed based on existing strategies or according to the preferences of policy makers and/or presidents. Scientists typically have to adapt to priorities and conditions set by policy makers, which are not always in line with their scientific fields and research interest. In order to stabilise the game – in this case the Hungarian STI system – more trust, the involvement of the scientific community, a stable funding system and programme portfolio, based on a consistent STI strategy would be necessary. Stability and trust would be also the cornerstone for sustainable international scientific cooperation.

V. International Science Policy in Hungary in the Beginning of the 21st Century

V.1. Policy Objectives for International STI Cooperation

Globalisation and the emergence of new centres of STI excellence result in a shift in knowledge production from the traditional powerhouses like Europe, the US and Japan towards other countries and world regions, such as the BRICS countries. This changing landscape and dynamics gives rise to a more intense competition for scarce human resources and talent. These changes ties in with the urgency of tackling global challenges such as climate change, sustainable energy production, biodiversity, and challenges to health. These global societal challenges in their turn lead to a rapidly intensifying policy attention for international research cooperation and to the recognition that international STI-cooperation should be designed as strategically as possible so as to maximise its impact.

Boekholt et al identifies two kinds of paradigms as the main drivers for international STI cooperation (Boekholt, Edler, Cunningham, & Flanagan, 2009, pp. 13-17). One is the narrow STI cooperation paradigm driven by science, and built around the *scientific excellence objective*. This

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paradigm aims at both enhancing R&I quality as well as R&I capacity. It encompasses the access to excellent scientific knowledge produced elsewhere, the contribution to high-quality science through cross-fertilisation, the enlarged scale and scope of research activities, capacity-improvement through people and institutions as well as attracting the best talents for research. It is called the narrow paradigm, because it is strictly science-oriented and has a strong link to the scientific community. It still forms the core of international research cooperation.

The other is the broad STI cooperation paradigm, according to which STI cooperation becomes an instrument to achieve other policy objectives. In this paradigm the four main areas underpinning STI cooperation are:

- Improving national competitiveness (*Competitiveness objective*), which means both outward oriented strategies, providing national stakeholders with information, contacts and market access in the partner country and inward oriented strategies, with a focus on attracting foreign investment.
- Tackling global societal challenges (*Global challenges objective*), which on the one hand means the cooperation between developed countries because global challenges are too large to be tackled by a single country, and on the other hand the cooperation with less developed countries, because their sincere commitment is a precondition for any success in implementing sustainable solutions.
- Supporting less developed countries by developing STI capabilities (*Development objective*). Here the incentives for funders and recipients differ to a greater extent: whereas developed countries see this kind of cooperation in terms of humanitarian and diplomatic interventions, less developed countries see it as opportunities to improve their scientific performance.
- Creating good and stable diplomatic relationships (*Science diplomacy objective*). This objective is typically applied to facilitate external policy, and its content depends largely on the external policy objectives of the countries involved.

Some of the policy objectives of the broad STI cooperation paradigm are almost completely in line with the global tendencies set out at the beginning of this chapter: globalisation of R&D has put competitiveness policy goals higher on the policy agenda. Tackling global challenges have been an incentive to set up wider global research programmes and more comprehensive infrastructures.

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Historical, cultural ties and development cooperation all have an impact on the geographical direction and thematic focus of cooperation.

Austria, Germany and the European Union have specific strategies for international STI cooperation. Hungary does not have a separate international strategy, but its national strategy contains some references to international cooperation.[57] The tables below will help us to see and assess how the different policy objectives are fleshed out in the various strategic documents.

The Hungarian national R&D strategy was built around three priority axes and a number of specific objectives (NGM, 2013)[58]. The first priority axis is creating internationally competitive knowledge bases underpinning economic and social progress, using instruments such as education and talent management, strengthening of research organisations or internationally competitive R&D infrastructures. The second priority axis is promoting cooperation in knowledge and technology transfer, efficient both on the national and international levels, involving traditional innovation cooperation and efficient participation in EU, and international calls for proposals and initiatives. The third priority axis is creating demand for R&D in innovative enterprises intensively utilizing the results of science and technology.

Several instruments were assigned to these strategic objectives for implementation. The table below shows the objectives and related instruments relevant to international cooperation.

Table 23: International elements in the Hungarian strategy: Investment in the Future

Objectives	Instruments
Excellence	*Strengthening of research organisations*: developing excellent research institutes by using EU funding. *Efficient participation in EU and international calls for proposals and initiatives:* focused support for bilateral science and technology and industrial R&D co-operations in the relations with prioritized countries.
Resources	*Education and talent management*: talent identification and development in the formal, non-formal and informal education, development of scholarship programmes. *Strengthening of research organisations*: support of international mobility of researchers and encouragement of their national reintegration; attracting PhD

[57] I do not have data about the international pillar of the currently running Turkish international strategy.
[58] I only mention those specific objectives that are relevant for international cooperation.

	students and postdoctoral researchers from the BRICS+ countries; training of researchers by using the EIT knowledge triangle model. *Internationally competitive R&D infrastructures*: joining large international infrastructures; networking between infrastructures; increased utilisation; open register with free capacities. *Efficient participation in EU and international calls for proposals and initiatives:* securing of a more efficient access and participation in the EU programmes and initiatives (Joint Programming Initiatives, European Innovation Partnerships, EIT KICs, NCP network, R&D representation in Brussels, national supporting programmes, national additional funding, support in partner search).
Competitiveness	*Traditional innovation co-operations*: encouragement of cross-sectoral (science and industry) and business cooperation both at national and international level. *Efficient participation in EU and international calls for proposals and initiatives:* better cooperation with the Enterprise Europe Network *Demand creation for R&D*: supporting knowledge and technology intensive companies to enter foreign markets by consultancy, training and other services; encouraging of cross-border R&D cooperation; service-provider offices in prioritized countries.
Solutions to Challenges	*Strengthening of research organisations*: Coherent strategy for university research as a response to the global challenges.
Development	-
Science diplomacy	*Efficient participation in EU and international calls for proposals and initiatives*: further development of the network of science and technology attachés and enhancement of its activities in strategically important areas; strengthening of the R&D components of macro-regional co-operations.

Source: (NGM, 2013)

Hungary, with a relatively low GERD and a small scientific community, is mainly focusing its efforts on the efficient exploitation of nationally or internationally available resources. This strategy comprises both human resources development and coordinated use of large international research infrastructures. In order to use these available resources as efficiently as possible, scientific excellence is also be promoted by a number of instruments. All these instruments are planned to contribute to the competitiveness objective, which is expected to increase economic and social wellbeing. Instruments related to the Science diplomacy objective are quite vaguely circumscribed, while addressing how to achieve the global challenges objective is hardly mentioned at all. No instruments for the Science for development objective are mentioned in the strategy.

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Table 24: Main objectives of the Austrian Beyond Europe strategy

Objectives	
Excellence	Establishment of joint labs; Development of programmes to promote international RTI cooperation; Conducting joint calls for science/industry; Targeted support for the internationalization efforts of Austrian universities and RTI institutions; Targeted expansion of human resources programmes, especially in the field of post-doctoral programmes and industrial PhDs; Removing barriers for and promoting incoming mobility of researchers; Stronger cooperation between science and innovation players; Development of project-oriented cooperation in basic research to stimulate cooperation and capacity building.
Resources	Establishment of a networking platform "Internationalization in the field of RTI" to ensure the regular exchange of information of stakeholders; Increased participation in EU-FTI internationalization activities and instruments. Increasing the use of EU measures for internationalization in Horizon 2020 (e.g. ERA-NET and ERA-NET plus); Increased use of EUREKA and COST; Increased use of SFIC (Strategic Forum for International Cooperation of the Council); Increased participation in joint 'awareness raising' activities of EU member states; Development and use of alumni networks.
Competitiveness	Promotion of bilateral RTI cooperation of companies (bottom-up); Strengthening the international aspects of the FrontRunner program to strengthen strategic market positions; Strengthening national technology transfer measures in selected target countries; Development of the innovation protection program to support the internationalization of companies.
Solutions to Challenges	Development of a coordinated mix of instruments (basic research, applied research, joint labs, technology transfer measures) around Austrian strengths in the subject area of Societal Challenges.
Development	-
Science diplomacy	Improvement of the foreign representation of Austria in the field of RTI through the establishment of Offices of Science and Technology in a few selected focus countries; Establishment of FTI attaché positions at selected Austrian embassies to develop RTI relations with the respective destination country;

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	Organization of a joint external presence in the field of FTI using the networking platform "Internationalization in the field of RTI"; Increased use of instruments of bilateral FTI cooperation (e.g. Economic-technical agreements, MoUs); Increase participation in EU macro-regional strategies (e.g. EU Danube Region Strategy).

Source: (Austrian Federal Government, 2013b, pp. 5-6)

The Austrian Beyond Europe strategy (Austrian Federal Government, 2013b) addresses five out of the six objectives with very concrete instruments. It lists all the classical instruments of international STI cooperation, such as the use of STI agreements, calls for proposals, mobility programmes under the heading of the excellence objective. This suggests that the Austrian policy documents consider internationalization in general as a good tool for increasing scientific excellence. Under the heading Resources, similarly to Hungary, Austria focusses on the efficient use of existing schemes and programmes in order to support their scientific community. Although Austria has very concrete instruments for facilitating the competitiveness of their companies at its disposal, it has only very general ideas about how to tackle global challenges and Austria does not address the development objective at all. Because it is a strategy for international scientific cooperation, the science diplomacy objective is very well articulated. The strategy prioritizes different country groups, based on their relative importance for Austria, and these countries are addressed with actions and programmes on various levels.

Table 25: Main objectives of the German internationalisation strategy

Objectives	
Excellence	*Strengthening excellence through worldwide cooperation*: to consolidate Germany’s position as an internationally attractive location for study and research. At the same time to remove barriers to the international mobility of German scientists. Europe remains an important point of reference in these efforts, so deepening of the European Research Area is promoted.
Resources	*Internationalising vocational training and qualification*: to expand cooperation in vocational training with industrialized and emerging countries, to increase the mobility of trainees and to further simplify the recognition of qualifications that foreign professionals have obtained abroad. The fight against youth unemployment in Europe remains an objective.
Competitiveness	*Developing Germany`s strength in innovation on the international stage*: to promote networking and to support small and medium-sized enterprises (SMEs) in international cooperation on innovation. To create the best possible framework conditions for cooperation (e.g. intellectual property).

Solutions to Challenges	*Overcoming global challenges together*: to step up efforts to ensure that barriers to effective research into global challenges are surmounted and that the relevant stakeholders at the European and international level can interact more closely with each other.
Development	*Working with emerging and developing countries to shape the global knowledge-based society*: to expand existing cooperation with emerging and developing countries and create new partnerships. To spread good practices in scientific endeavour and contribute to the implementation of uniform global guidelines and standards.
Science diplomacy	The *foreign science policy chapter* focuses on the contact with alumni organisations, location marketing (with its internal excellence and external communication component), the network of representations of German research associations, higher education and academic institutions abroad as well as on cooperation and synergies with international organisations.

Source: (BMBF, 2016)

The German Strategy for the Internationalization of Education, Science and Research (BMBF, 2016) has five, more general policy objectives. In addition to these objectives, a separate chapter of the strategy is devoted to foreign science policy instruments. The strategy is built around the already existing very strong national research base, it rather acts as a facilitator for building up networks and partnerships. Training, mobility and location marketing all contribute to the aim of showing up Germany as an internationally attractive location for study and research. Tackling global challenges and science for development well fit into the partnership concept.

Table 26: Main objectives of the international R&I strategy of the European Union

Objectives	
Excellence Resources Competitiveness	Strengthening the Union's excellence and attractiveness in research and innovation as well as its economic and industrial competitiveness by creating win-win situations and cooperating on the basis of mutual benefit; by accessing external sources of knowledge; by attracting talent and investment to the Union; by facilitating access to new and emerging markets; and by agreeing on common practices for conducting research and exploiting the results.
Solutions to Challenges	Tackling global societal challenges by developing and deploying effective solutions more rapidly and by optimising the use of research infrastructures
Development	Supporting the Union's external policies by coordinating closely with enlargement, neighbourhood, trade, Common Foreign and Security Policy (CFSP), humanitarian aid and development policies and making research and innovation an integral part of a comprehensive package of external action.

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Science diplomacy	'Science diplomacy' will use international cooperation in research and innovation as an instrument of soft power and a mechanism for improving relations with key countries and regions. Good international relations may, in turn, facilitate effective cooperation in research and innovation.

Source: (EC, 2012, p. 4)

The European strategy, "Enhancing and focusing EU international cooperation in research and innovation: A strategic approach", provides more general policy objectives than any concrete instruments for implementation. Its first overarching objective merges the excellence, resources and competitiveness categories, putting cooperation with mutual benefits into a central position as a common denominator.

Overall, we might conclude that all the strategies described focus on the same set of objectives, however, there are certain differences in how much emphasis is put on the single priorities. Smaller countries – like Hungary or Austria – with limited resources concentrate on the excellence, resources and competitiveness objectives. They have to promote excellence in order to become competitive with the scarce resources available. Science diplomacy plays a facilitating role in meeting the objectives above. Germany intends to further improve its already existing strong research base by networking, partnerships and training. It wants to create and present itself as an attractive location for research. The European Union, an international organisation, represents the diverse interests of its member states and sets out quite general policy statements as objectives.

Because the science attaché network plays an important role in Hungary in promoting the three objectives: scientific excellence, resources management and competitiveness, I will describe this network of the Hungarian system in the next chapter in more detail. The most common types of instruments for implementing policy objectives, international S&T agreements will be introduced in chapter V.3.

V.2. S&T Attaché Network of Hungary

International scientific relations of Hungary are also fostered and managed by delegated Science and Technology attachés. They support the international and European integration of the Hungarian S&T community by acquiring and disseminating information and by building connections between

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institutions. They present research related to natural sciences, engineering, technology and product development, as well as related to innovation, to a wider community. Science diplomats, as the S&T attachés are also called, serve both institutes of scientific research and science management of the whole scientific community.

Good cooperation in science can be a first step towards cooperation in other, more sensitive areas. Science provides a non-ideological environment for the participation and free exchange of ideas between people, regardless of cultural, national or religious backgrounds. This type of interactions can be facilitated by activities of science diplomacy in various ways (Royal Society, 2010, pp. 5-7). *Science in diplomacy* provides scientific advice for policy makers, especially in the field of foreign policy. *Diplomacy for science* facilitates international science cooperation. And last but not least science cooperation might be also used to improve international political relations between countries (*science for diplomacy* function).

So science diplomacy seeks to strengthen the symbiosis between the interests and motivations of the scientific and foreign policy communities, which interests are not always well aligned. International cooperation for scientists is important because it allows them to have access to the best researchers, research facilities and new sources of funding. Foreign policy is out to use potentially useful networks and channels of communication of scientists to support wider policy goals. It helps if there are effective mechanisms and opportunities for dialogue between policymakers, academics and researchers working in the foreign policy and scientific communities, to identify projects and processes that can further the interests of both communities. However, it is important that scientific and diplomatic goals should remain clearly defined and separated, to avoid unnecessary and undesirable politicisation of science (Royal Society, 2010, pp. 5-7).

Zoltán Magyary, in his Basics of Hungarian Science Policy from 1927, highlighted the importance of delegated scientific experts stationed abroad (Magyary, 1927, pp. 471-472). He described the ideal candidates as experts, preferably researchers themselves, with a large network consisting of both scientists and policy makers, with excellent organizational and language skills, as well as with the ability of creating and maintaining ties between Hungarian researchers and their peers abroad. They were to report about best practices and possibilities for cooperation in the partner countries, as well as informing the scientists in their host countries about scientific achievements in Hungary.

Magyary was in favour of focusing the activity of science attachés only on scientific networking and science-related activities because any additional activities would detract from these primary tasks, daunting and time consuming as they already are. He considered science as the only field that is unbiased and impartial enough to be employed as a tool for diplomacy, fit to initiate or improve cooperation between both friendly and antagonistic partner countries. His contention was that merging other elements, and particularly those hailing from economics and politics, with the science portfolio would turn out to be detrimental to the purpose of science as a diplomatic tool, since the advantage of the impartiality of science would be jeopardized. He was convinced that objectivity and impartiality was the key success factor of the position of science in order to have an impact on politics in general. The upshot of his argument was that a purely science-based portfolio is the most effective prerequisite for carrying out successful "science for diplomacy" activities, which at that time seemed to enjoy preference over the "diplomacy for science" function.

Magyary was also of the opinion that science diplomats should enjoy freedom when it came to planning and implementing their activities, because the attachés are the ones who are best knowledgeable about local customs, unwritten rules, traditions, and opportunities in their host countries. National governmental authorities were not to interfere with their activities, but were supposed to dedicate their efforts to providing stable financial conditions and secretarial and mental support. These main tasks, as described by Magyary, are still the important duties of science attachés today. However, the increasing emphasis on innovation and innovation related activities in the business sector made a significant change in the portfolio of science attachés.

The current system of science attachés was established in 1992 by a Government Resolution. The National Committee for Technological Development (Országos Műszaki Fejlesztési Bizottság, OMFB) was responsible for the co-ordination of the network at that time on behalf of the Hungarian Government. The Department of Attachés and Information was in charge of monitoring and supervising the work of attachés in close cooperation with the Directorate of Cultural and Scientific Co-operation in the Ministry of Foreign Affairs.

The network of attachés has been continuously in operation since 1992. The first eight positions were established in Bonn (this post moved to Berlin in 2001), Helsinki, London, Paris, Tel-Aviv, Tokyo, Vienna and Washington. The position in Brussels was opened in 1993, the one in Moscow in 1994, the one in Rome in 1995 and the one in Beijing in 2006.. This original structure has been

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changed in recent times. Three positions were discontinued (Helsinki, Rome and Vienna) and three new positions were established in New Delhi, San Francisco and Seoul. Tasks pertaining to science diplomacy are also carried out at Embassies without delegated science attachés, mainly by diplomats specialized on foreign trade, education or culture.

There are various selection criteria underpinning the choice of partner countries to have delegated science attachés in them. Obviously, many posts have been created in important scientific and economic centres of the world, such as Germany, France, the United Kingdom, the United States and Japan. Israel and Korea were also selected because of their outstanding STI performance. Russia, India and China are amongst the countries chosen to have a science attaché because as emerging BRICS countries they are potentially good candidates for valuable scientific cooperation. The selection of new posts is partly caused by the changes in priorities in Hungarian foreign policy in general. In 2010, the Hungarian government published a policy declaration to open the country up to the global world (Külügyminisztérium, 2013, p. 25). This declaration amounted primarily to a plan for economic expansion of Hungary towards Eastern markets (China, India, Russia and the ASEAN countries), and later by the "Southern Opening" towards African and Latin-American countries.

This policy of global opening had a bearing on some of the locations of science attachés. Three of the positions in Europe were discontinued, and three new positions were opened outside of Europe, two of which in Asia. This shift reflects a change in science policy and hence in the task-portfolio of science attachés. Finding new opportunities in the field of science and innovation has started to prevail over merely maintaining existing relations in science and technology cooperation. Having strong contacts with other EU member states seemed to go without saying, and to an increasing extent European fora were to serve for networking and cooperation on the European level.

The current attaché network is jointly operated by the National Research, Development and Innovation Office (NRDIO) and the Ministry of Foreign Affairs and Trade (MFAT). Attachés are financed by MFAT, and the professional guidance and supervision is carried out jointly by the Department for International Affairs of NRDIO, and the Department of Science Diplomacy of MFAT. Science attachés also work under the direct supervision of the Ambassador. Unlike in the age of Magyary, strong connections with supervisory institutions are considered necessary for success. Setting up a task-portfolio for the science attachés, and perusing, analysing and disseminating the information in the reports sent back home are tasks incumbent on NRDIO and MFAT. Attachés are allowed and encouraged to proactively initiate new ways of cooperation but they always have to harmonize their ideas with these two supervising institutions.[59]

The position of an S&T diplomat requires other skills and knowledge in comparison to general diplomats. In some countries classical career diplomats are also nominated into such positions, and they receive additional training by ministries, agencies and other institutions carrying responsibility for STI. In other countries science attachés have to possess more specific scientific know-how of the home country, and preferably of the host country. In the latter case science attachés will learn general diplomatic skills in ministries responsible for foreign affairs. In Hungary attachés are selected in an open tendering process. Candidates who are selected are subjected to protracted preparatory procedures, they visit the most important research institutions, universities and government offices responsible for STI. The Hungarian system still favours experts compared to career diplomats.

Classical S&T attaché tasks have not significantly changed in the last decades. A ministry regulation of 2016 lists the following[60]:

- to monitor and to analyse science and technology policy and international relations of the host country, thereby contributing to the formulation of Hungarian S&T policy;
- to prepare and implement bilateral S&T agreements;
- to report on significant S&T policies, best practices in the host country, including institutional framework, support programmes, project management and to monitor the STI cooperation of the host country with multilateral organizations;
- to give information in the host country about Hungarian S&T policy, its implementation and opportunities for cooperation;

[59] The two science attachés located in Brussels have different tasks and responsibilities from all the other science attachés. They are not responsible for bilateral cooperation with the host country, but they represent Hungary as a Member State of the European Union in the field of science and technology. As such, they are employed at the Permanent Representation of the Hungary in Brussels.

[60] The tasks of science attachés are regulated by directive 10/2016. (VI. 8.) of MFAT (KKM, 2016). In both cases when I list tasks of attachés – in the first case the classical or conventional tasks in the second case innovation related tasks – I refer to this directive. I have separated the two sets of tasks in order to highlight the shift towards business and innovation related tasks caused by the turn in government policy in 2010. Classical tasks of science attachés have hardly changed in the last decades, whereas the importance of innovation and business related tasks has been constantly growing.

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- to identify scientific and technological areas of mutual interest for both countries which are suitable for bilateral cooperation;
- to build up and maintain contacts with S&T policy makers and other stakeholders at universities, research institutes, and enterprises in the host country as well as with representatives of other EU countries;
- to assist Hungarian R&D institutes and organizations in establishing contacts as well as in preparing joint applications for funding sources;
- to represent Hungary at scientific and technological meetings and similar activities, including EU – especially R&D Framework Programme – related events;
- to assist in generating new joint R&D proposals;
- to build up networks of Hungarian scientists abroad, as well as to contact scientists with working experience in Hungary;
- to prepare, implement, coordinate and evaluate visits and missions.

Until 2010 diplomacy was expected to facilitate the adaptation of Hungarian politics to external processes in order to increase the international acceptance of the country. In 2010, the newly elected Orbán government introduced a new paradigm: on top of the usual broad range of international diplomatic issues, Hungarian foreign representations had to focus their activities on trying to increase economic competitiveness by entering new markets and attracting foreign direct investment into the country.

The portfolio – and name – of the Ministry of Foreign Affairs (MFA) was extended in 2014, after the re-election of the Orbán government. Since 2014 the Ministry is called the Ministry of Foreign Affairs and Trade (MFAT), so it is also responsible for foreign trade. This new mandate of foreign policy centred on business and economic growth has had an impact on the task portfolio of science attachés. Although supporting technology-transfer and innovation has always been on the list of tasks for science attachés, the preponderance of this has considerably increased after 2014. In addition to the more conventional tasks for science attachés listed above, a fairly large number of activities specifically related to innovation were also listed in the directive from 2016, regulating the work of S&T attachés, like fostering cooperation activities of universities and enterprises in innovation clusters, supporting innovation and technology transfer, attracting research-based and

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high-tech industrial investors and FDI to Hungary. As a result, science attachés have to work closely together with their colleagues responsible for economic cooperation.

In May 2017 I carried out a small-scale survey among former and current science attachés. I sent around a questionnaire with ten questions on their tasks, responsibilities and results achieved.[61] The questionnaire was sent to 34 science attachés,[62] the number of respondents was 30, a response rate of 91%. The survey was complemented by semi-structured interviews[63] with one current and two former S&T attachés and the Head of the Department of Science Diplomacy in the Hungarian Ministry of Foreign Affairs and Trade.

The following hypotheses guided the questions in the questionnaire:

- There is strong correlation between time spent on activities and results achieved by science attachés;
- The diplomacy for science function is recently more characteristic for the work of the attachés than the science for diplomacy function;
- The power of supervising institutions to influence the work of science attachés has changed over time;
- Tasks and focus areas of attachés' work have changed over time;
- There is a balance between external/foreign and internal/national factors influencing the work of attachés;

[61] The ten questions are: 1. When were you a science attaché? 2.a How much time did you spend on the following tasks: reporting, networking, representation, delegations, Hungarian scientists' networks, enterprises, EU? 2.b Have you reached significant results on the previously mentioned fields? 3. Which form of science diplomacy was mainly decisive for your work? 4. Who/which party has initiated the cooperation? 5. Who/which institution has mainly influenced your work? 6. Have your tasks during your foreign service/between your two different foreign services changed significantly? 7. If yes, what was the main cause? 8. If you have carried out industry/ innovation related tasks, how did this influence your work? 9. What is the main added value of your work for Hungary? 10. What was your main personal success? The original questionnaire can be found in annex I. of the thesis.

[62] I have not found a complete list of science attachés selected after 1992 and a significant number of attachés have been selected more than once. The total number of attachés in the selected period (1992-2017) was around 60, but I was not able to contact all of them, so about 56% of all the attachés have received the questionnaire.

[63] Questions of the semi-structured interview were formulated around the following topics: Who is setting the political agenda: national institutions, prominent personalities, national strategies or the European Commission? What is the role of MFAT and NRDIO in shaping bilateral scientific cooperation? How do international events influence national science policy and vice versa: how does national S&T policy effect international scientific cooperation? What is the role of national science policy in shaping international scientific cooperation? Is there a difference between the level of science diplomacy activities of Embassies with or without science attachés?

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- The majority of attachés are against mixing the science portfolio with economic components.

First of all attachés had to indicate the period of time of their foreign service so as to be able to track changes over time. The second question consisted of two parts: in the first part respondents had to give an answer to the question how much time they devoted to core S&T attaché activities listed below. In the second part of the question they were asked about the results they achieved in the given fields. In both cases they had to select an answer out of four categories (No result, a bit, quite some, a lot). The tasks have been aggregated and divided into seven groups:

1. *Reporting* about the R&D programmes, international relations and important R&D events of the host country;
2. *Networking*, partner search and matchmaking;
3. *Representation*, information, promotion, PR;
4. *Delegations,* organisation of visits, cooperation with scientific stakeholders of the host country;
5. *Hungarian scientists' network,* building up networks of Hungarian scientists living abroad, supporting their reintegration into the Hungarian STI environment;
6. *Enterprises,* supporting Hungarian enterprises, searching for investment opportunities;
7. *EU* Member State, representing Hungary as a Member State of the European Union.

Table 27: Tasks of scientific attachés: time spent and results achieved (most frequent answer)

Task	Time spent	Results achieved
Reporting	A lot	Moderate
Networking	**A lot**	**A lot**
Representation	Moderate	Moderate
Delegations	Moderate	Moderate
Hungarian scientists' networks	A bit	No result
Enterprises	A bit	A bit
EU Member State	A bit	A bit

Source: Questionnaire with Hungarian Science Attachés (annex I.)

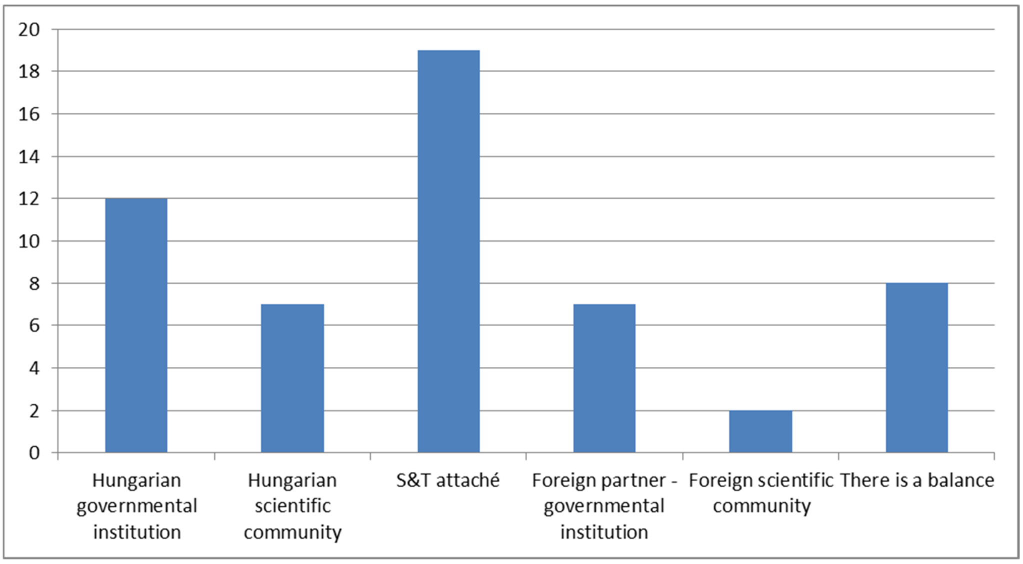
These data show that attachés spend most of their time and energy on reporting back to Hungary, and on networking activities. There is a correlation between time spent on activities and the corresponding achieved results. This is not only the case on an aggregated level but also on the level of individuals. Nevertheless, it is important to see that although a lot of work has been invested into reporting, the results achieved in this area are moderate. This difference might be explained by the inadequate perusal of reports and the limited uptake of recommendations by government institutions. This data was also underpinned by individual responses at the end of the questionnaire emphasizing the lack of receptivity on the part of government officials for best practice examples. The least result is achieved in the area of building up networks of Hungarian scientists living abroad. However, this is also not among the most time-consuming activities of attachés. The last task was a quite special one, as on the one hand, it is not relevant for positions in all the host countries, and on the other hand, it is the most important activity in some countries (e.g. attachés working in Brussels). So the aggregate data show low numbers but in case of the three attachés working in Brussels this was the most important task with the highest impact achieved.

It also stands out that the more classical tasks such as reporting, networking, representing Hungary in the host country, and organizing visits still take up considerably more time than the recently added tasks of supporting enterprises. Even if we look at the period in which individual attachés were working abroad, there is no clear dividing line between the time spent on these tasks by recently delegated attachés or attachés working in the 1990s. Although in most of the cases there was strong correlation between time spent on a specific task and achieved results, it is difficult to judge whether results could be increased also in the field of supporting Hungarian enterprises simply by increasing the time spent on it.

In the third question attachés had to determine which function in the area of science diplomacy is the most decisive for their work. There was only one vote (3.4%) for the science in diplomacy function. This is due to the fact that science in diplomacy typically plays a central role in influencing foreign policy inside of Hungary, in MFAT. Science diplomats have such responsibilities when they have to prepare Ambassadors to conduct a scientific meeting in the foreign representation. 27.6% considered his or her work mostly related to the science for diplomacy area and the majority of respondents (69%) felt his or her work closely related to the diplomacy for science dimension. There is no clear trend over time, but attachés appointed after 2010 almost exclusively marked diplomacy for science as decisive to their work. If we compare this with the priority setting of Zoltán Magyary we see a clear shift from science for diplomacy towards diplomacy for science. At the time of Magyary famous researchers were sent abroad to build up a positive image about Hungary and to use the positive picture for establishing new contacts. This trend was still characteristic around the systemic change when Hungary was interested in joining international STI organisations. Currently the focus is more on establishing cooperation opportunities – possibly with marketable results – for scientists by diplomats.

In the questionnaire the fourth question was about the initiator of cooperation. It was possible to select one or more possibilities from the following options: Hungarian governmental institutions, the governmental institutions of the partner country, the Hungarian or foreign scientific community, or the science and technology attaché him or herself. Respondents could also opt for a balanced answer, by which is meant a mix of the various possible initiators.

Figure 10: Initiators of STI cooperation (number of answers)



Source: Questionnaire with Hungarian Science Attachés (annex I.)

We can clearly see that attachés consider themselves as the most active players in initiating cooperation between Hungarian scientists and their foreign counterparts. Hungarian stakeholders – both government institutions and scientists – are perceived more active than their partners abroad but many respondents think there is a balance between initiatives coming from home and from the partner country. There was one comment about the usefulness of the experience and advice of fellow science diplomats in the receiving country. The semi-structured interviews emphasized that the general framework, working conditions and main priority areas are determined by the government of Hungary; ambassadors and diplomats are free to set items on the agenda fitting in this overall framework. So Hungarian government strategies and national science policy set the agenda and framework conditions for the work of the attachés and it is the national interest that shapes the science policy agenda.

In the fifth question, attachés were also asked to rank the impact of various actors on their work. They could choose from the options: Ministry of Foreign Affair and Trade (MFAT), National Research, Development and Innovation Office (NRDIO), the Ambassador, the partner institutions or themselves.

Table 28: Impact of various actors on the work of science attachés – most frequent answer

Institution	**Impact**
MFAT	Strong
NRDIO	**Very strong**
Ambassador	Average
Partner institution	Hardly any
I can set my own targets	Hardly any

Source: Questionnaire with Hungarian Science Attachés (annex I.)

Aggregated data show the predominance of the National Research, Development and Innovation Office (NRDIO), followed by the Ministry of Foreign Affairs and Trade (MFAT) as the main actors exerting influence on the work of attachés. The partner institutions and attachés themselves were hardly in a position to determine tasks. In the case of this question, unlike in the case of other questions, attachés having worked over different periods in time answered in different ways. Table 29 shows the results according to the time the attachés were employed in foreign service.

Table 29: Average impact of various actors on the work of science attachés (1=no impact, 5=very strong impact)

	MFAT	**NRDIO**	**Ambassador**	**Partner**	**Attaché**
before 1990	3	3	2	4	3
1990-2000	3.25	4	2.5	3	3.5
around 2000	2.17	4.5	2.7	2.7	3.3
2000-2010	4	5	2	2.7	2
around 2010	2.6	3.4	2.6	2	4
after 2010	3.3	3.2	3.5	2.2	2.9

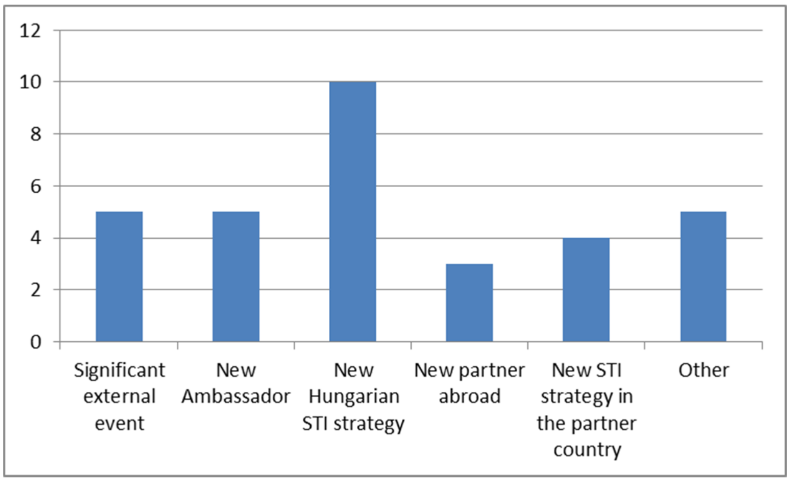
Source: Questionnaire with Hungarian Science Attachés (annex I.)

The influence of the role of MFAT has grown after 2010. The growing importance of science diplomacy, the establishment of a department dedicated to science diplomacy inside of MFAT must have been the decisive factor in this, a conclusion that was confirmed by the Head of Department responsible for the area. As against the growing impact of MFAT, the influence of NRDIO has diminished among attachés appointed around and after 2010. The diminishing influence of NRDIO might be explained partly by the termination of the unit responsible for science attachés and partly by the new division of tasks between MFAT and NRDIO. This trend and changing roles have also been confirmed by the interviews. The role and influencing power of MFAT has further increased by its dedicated budget for science diplomacy events/programmes initiated by and organized at embassies.

There is a slight decrease in the importance of the role of partner institutions. This might indicate a possible shifting trend from the role of foreign partners towards the increasingly important role of national policy making in the home country. There is one more interesting conclusion to be drawn: the strength of the level of guidance in general has diminished after 2010. This result was also reinforced by the interviews. One of the interviewees was of the opinion that bilateral cooperation and the work of attachés is mainly determined by the leading personalities of S&T politics in the partner countries and the way these leaders interact with each other. Good relationships between prominent personalities can facilitate cooperation to a large extent, and it creates the ideal supporting conditions for the work of attachés.

In the sixth question I have asked whether there was any change in the tasks of attachés during their service (or between their various services). Slightly more than half of the attachés – 51.7% – have experienced significant changes in their tasks during the time of their foreign service or between the multiple times they have been delegated (some of the attachés were selected two or three times). In the seventh question I have asked what the causes of these changes, if any, were. Attachés were allowed to indicate multiple decisive factors when answering this question.

Figure 11: Causes of changes in the work of science attachés (number of answers)



Source: Questionnaire with Hungarian Science Attachés (annex I.)

Most of the changes were attributed to changes in the STI strategy and policy in Hungary, which is in line with the answers given to the previous question about the role of institutions having the most significant impact on the work of the attachés. New ambassadors, new partners and strategies abroad had a smaller impact on the set of tasks of the attachés. The option of a significant external event (e.g. joining the EU) was mainly selected by attachés working exactly around the time when Hungary joined the EU, so Hungary joining the EU can be considered as a game changer in that period. Other external events, such as being delegated to a new post and being asked to replace colleagues were mentioned as other reasons for changes.

As to the background for the eights question on innovation and business-related tasks: an internal report was written in 2011 in the National Innovation Office about an experiment in Helsinki where the science attaché was commissioned to also act as an economic attaché. His experience of such a mixed range of duties was negative mainly because of the heterogeneous features of the tasks of a science attaché on the one hand and those of an economic attaché on the other. While the activity of economic attachés should result in short-term benefits and economic profit, the work of science attachés are supposed to lead to more long-term strategic benefits with indirect economic results. The attaché in question had to devote 80% of his time to business related tasks, which made it impossible to perform his original, science-related tasks at the required level. As a result the internal report recommended a separation, as stringent as possible, between science policy tasks and economy-related tasks. To the question about the attitude of attachés to innovation and business-related tasks I have received answers that go against this approach. [64]

Table 30: Impact of innovation and business-related activities on the task-portfolio of Science Attachés

Statement	**Number of answers**
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat	19
Such new duties cost too much time and energy	2
The importance of such a mixed position is evaluated higher by partners	12
It is rather confusing – partners cannot judge if the attaché is an economic or a scientific one	0
The additional field of work opens new possibilities for the attaché	13
Short-term result oriented economic work affects the negotiating position of the S&T attaché in a negative way	0
My work is not significantly affected by innovation related tasks	0
Other	3

Source: Questionnaire with Hungarian Science Attachés (annex I.)

Based on the analysis of individual questionnaires the new focus on foreign trade and economy of MFAT did not play a decisive role on business related activities of attachés – responses given before and after 2010 do not significantly differ. The difference rather seems to be dependent on the countries the attachés are active in. We can see from Table 30 that business-related activities are very much considered to be an added value, activities which identify new opportunities for science attachés. It tends to increase their reputation and the efficiency of their way of working and networking. Answers received in the "other" category emphasized that the balanced mixture of these activities work to the advantage of science attachés. Supporting innovative SMEs and spin-off companies is advantageous when it is an integral part of their work, science-based and business-related activities are considered as complimentary to each other in a way that benefits the impact of the work of science attachés.

The last two questions, 9 and 10, were open questions. In question nine science attachés were asked to summarize the benefits of their work for Hungary. In question ten, they had to mention the main personal results they achieved during the time of their foreign service.

[64] Science attachés were asked to provide an answer only if they were involved in tasks around supporting business enterprises. There were answers from 20 respondents, who were asked to indicate all the items they deemed relevant to their work.

In line with the answers given to the question about the time spent on their tasks, most of the attachés mentioned their contribution to networking, matchmaking activities, the preparation and implementation of bilateral S&T agreements as their main benefits to Hungary. It appears that the main bulk of the tasks of science attachés are conceived by them as directly beneficial to Hungary. Building up contacts both for governmental and scientific cooperation was often linked to obtaining and analysing information, best practice examples in the partner country. Personal presence at meetings, network-events, training-sessions, and so on, was mentioned multiple times – for example in the case of Russia and Japan – as a necessary precondition for communication and successful networking. Representing Hungary, the Hungarian government, and especially the Hungarian scientific community, was also mentioned very often as an important part in the task-portfolio. Representing the government itself was often considered as a core task and not seen as an added value. The same applied for receiving delegations which was mentioned only once as a real benefit for the country. Increasing the visibility of Hungarian R&D results, attracting R&D investment were also mentioned as positive parts of the task-portfolio of the science attachés.

Hungarian governmental institutions were criticized for a lack of a proper strategy and receptivity of adopting best practice examples of other countries as well as for not perusing the results of the work of the attachés properly. Science attachés also counted pushing the implementation of outdated intergovernmental agreements as counterproductive activities on the part of governmental institutions. Attachés were further dissatisfied with the overly bureaucratic mechanisms, characteristic for most of the public sector, and hence with the lack of pace. In some cases clear guiding principles and well-defined tasks were also felt missing. Such critical remarks were mainly voiced by attachés working abroad around 2010.

Building up networks of Hungarian scientists working abroad just as working for an increased participation of Hungary in EU Framework Programmes were hardly mentioned as worthwhile items on the list for support of Hungary on the part of science attachés. Neither has supporting SMEs and innovative enterprises been listed very often, which is in line with the results given to the second question of the questionnaires on the importance of tasks of attachés. At the same time it contradicts the answers given to the eights question in the questionnaire on the influence of innovation and business-related activities on the work of science diplomats.

In the second open question, question ten, science attachés were asked to list their main personal results achieved during their time of service. In most of the cases main achievements were related to bilateral networking activities. Attachés played an active role in the preparation and signing of new bilateral and multilateral agreements or in the renewal of existing ones. They organized several bilateral scientific events for matchmaking. Joint laboratories or even a scientific institution (Fraunhofer) were established, industrial R&D programmes and calls were launched, clubs and associations of Hungarian scientists were formalized. Scientific excellence in Hungary was presented during Hungarian Science Days and other dedicated events, whereas some exhibitions were specifically targeted at innovation. Innovation and technology-related actions were also listed more often: a number of high-tech companies invested in Hungary, or previous cooperation was extended by adding further industrial cooperation. The importance of trust and the advantage of being appointed to the informal leader of the S&T attaché community in the host country were highlighted by some of the attachés. They could profit from their informal leadership in various ways: they had more possibilities to promote Hungary and they had daily contact with science policy makers in the partner country.

In addition to the questionnaire there was a separate question in the interviews about the level of science diplomacy activities at embassies with or without science attachés. All the respondents agreed that there is a marked difference, and they indicated that it is justified to have attachés whose work is exclusively dedicated to science and innovation at countries of particular importance. The activity of other embassies in this field mainly depends on two factors: the scientific potential of the country and the commitment of the ambassador.

After analysing the results of the questionnaires and the semi-structured interviews, I can draw the following conclusions:

- There is a strong correlation between the time spent on tasks and the results coming out of these tasks achieved by attachés. Most of the time spent and results achieved are related to networking and matchmaking activities, including the preparation and implementation of bilateral agreements. This conclusion was also confirmed by the responses given to the two open questions at the end of the questionnaire.
- The answers given to the question whether there was any significant change in the work of the attachés during their foreign service or between their services suggests that in 51,7% of

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the cases there were such changes. Most of the changes were attributed to changing STI strategy and policy in Hungary. Around the years of Hungary's accession to the EU the option "significant external event (e.g. joining the EU)" was also selected by a number of attachés. In spite of the high number of attachés who experienced changes on a personal level, the compilation of tasks and focus areas have not changed over time on an aggregated level. In addition to networking activities, reporting back home, and representing Hungary's scientific excellence abroad are at the top of the list of tasks. The importance of innovation related tasks has not significantly changed over time either.

- More than two third of the attachés find the diplomacy for science function more relevant to their work than the science for diplomacy function. This is due to the changes in national science policy targeted at short-term economic benefits, which is also reflected in recruitment conditions for science attachés.
- The scope of the power of governmental institutions to have an impact on the work of the attachés has changed over time. Before 2010 predecessor institutions of NRDIO have played the most influential role, and that role was changed around 2010. In recent years there is no such single institution with a similar strong impact on the work of science attachés. This has resulted in a lack of proper guidance.
- My hypothesis did not prove to be correct concerning the extension of the portfolio of the science attachés by innovation and technology related tasks. I expected to experience resistance towards business oriented tasks, but a vast majority of the attachés think the support of innovation and technology transfer related activities an added value to their work, rather than an unnecessary burden.

V.3. Bilateral Scientific and Technological Agreements

International research and development cooperation is often supported by bilateral intergovernmental and inter-institutional science, technology and innovation agreements. These agreements particularly intend to intensify international scientific cooperation between partner countries. These typically act as umbrella-instruments that cover various activities like grant and fellowship programmes, exchange and mobility programmes, or joint research programmes.

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As we have seen in chapter III, the socialist regime in Hungary also acknowledged the importance of bilateral STI cooperation. Although the socialist regime was primarily focusing on participation in scientific conferences and scientific mobility mainly with the Soviet Union and other socialist countries, the government fully realized that cooperation in this field with Western countries would also be advantageous for Hungary. Hence, the process of further opening up towards the West was steadily pursued after 1968. Some of the first bilateral intergovernmental STI agreements date back to this period (NKFIH, 2015). An agreement with Austria was signed in 1969, with France in 1966, and with Greece and Spain in 1979. After the revision of science policy in 1985 and the establishment of the Hungarian National Scientific Research Fund in 1986 two important agreements, one with Germany (1987), and one with the United Kingdom (1987) were signed. The agreement with Turkey was sealed in 1989.

The systemic change provided yet another impetus to this process: new agreements have been signed in the 1990s with countries such as Israel (1991), India (1992) Finland (1993), and neighbouring countries such as Slovenia (1994), and Ukraine (1995). Until the 21st century the main argument for having such agreements was predominantly a political one: science paved the way and eventually opened doors to establish diplomatic ties between partner countries.

Intergovernmental STI agreements with further neighbouring countries were signed around 2000 – the Check Republic came first in 2001, followed by Croatia and Slovakia (2002), and later Serbia (2004). The last intergovernmental agreement Hungary signed was also with a country in the region, viz. Montenegro (2012). These agreements served and still serve diplomatic functions as well supporting other ties established within the four corners of a broader neighbourhood policy.

These bilateral agreements provide evidence for the more general contention that young EU member states tend to keep bilateral cooperation agreements in place as valuable tools for their scientists to gain access to complementary expertise and capabilities in their national institutions, on top of their role of providing additional funding tools. For more well-established EU member states the role of bilateral agreements tends to diminish over time, their place being taken up by European networks, except for their relations with third countries (Boekholt, Edler, Cunningham, & Flanagan, 2009, p. 17).

However, if agreements are primarily motivated by political and diplomatic intentions, and if they lack sufficient commitment from the part of the scientific communities of the partner countries,

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these agreements more often than not end up in being mere empty-worded documents. They rarely act as an effective incentive to genuine scientific cooperation. Even if scientific cooperation has commenced on this fragile basis, after some time it is usually discontinued on account of insufficient incentives for researchers to put research contents into actual practice. The reasons for signing and implementing intergovernmental agreements are only sufficient if all the decisive factors – political commitment, economic competitiveness, and interest of the scientific community – are supported by the agreement. Only when all these conditions are met, both countries involved will have an incentive to set up and maintain a stable framework for long term cooperation.

A viable alternative for Intergovernmental STI Agreements are Memoranda of Understanding (MoU) signed by cooperating institutions. MoUs have a number of advantages that intergovernmental STI agreements do not have. They can be signed with much less administrative rules and regulations, and they can provide a more flexible framework for pilot initiatives because they can be discontinued more easily than intergovernmental agreements (Schuch, Wagner, & Dall, 2011). As a result, in recent years there is a general shift towards MoUs to the detriment of the more burdensome process of engaging in intergovernmental agreements.

The head of the precursor of the NRDI Office signed the first inter-institutional MoU with Wallonia in 2005, and this MoU was followed by a number of later agreements (NKFIH, 2015). However, in Hungary these less elaborate forms of cooperation did not take the interests of the scientific community more into consideration than their intergovernmental predecessors did. Inter-institutional agreements still often end up in drawers and archives instead of being put to use for genuine cooperation.

The former president of NRDI Office, József Pálinkás (2015-2018), was very much committed to sign only such new agreements that were supported by already existing concrete scientific projects, underpinned by clear cooperation ideas between the scientists of both countries. Under his presidency the NRDI Office only signed a new inter-institutional Memorandum of Understanding with Iran, which was immediately followed by a joint call for research project proposals.

It is one of the main aims of both types of agreements, i.e. intergovernmental STI agreements and Memoranda of Understanding, to help put into place a framework for launching bilateral calls for proposals. Such calls for proposals are mainly used to cover travel and subsistence costs for individual researchers based on a cost-sharing principle between the partners. These mobility projects are meant to support the creation of scientific cooperation networks, which should ideally lead to participation in larger cooperative R&D projects financed by multilateral funding programmes (e.g. EU Framework Programmes). In specific cases, such as e.g. Austria, mobility financing is still the main focus of bilateral calls for proposals.

There is, however, a clear and growing trend to shift from funding mere mobility of researchers to funding research projects. Financing research projects is a particular characteristic feature of cooperation with new partner countries, which are typically third countries. Calls for proposals of research projects provide a larger amount of funding for a smaller number of projects, and this in turn gives rise to a highly competitive selection mechanism, and subsequently to higher scientific quality of the research projects. By supporting such programmes, governmental bodies expect scientific results that would not have been achieved without national support.

In principle, STI agreements could be shaped and designed in such a way as to meet a variety of objectives, like the objective to build a bridge to Framework Programmes, or the objective to increase economic competitiveness. Addressing a variety of objectives requires bespoke solutions in these STI agreements. In the past, however, more or less standardised one-size-fits-all approaches with partner countries have been implemented (Schuch, Wagner, & Dall, 2011). This off-the-peg approach is a characteristic feature of calls for mobility, which are typically open when it comes to the thematic research topics addressed in these calls.

However, a number of changes to this uniform approach are starting to take effect. Although most STI agreements still employ a single basic programmatic design, the details of the terms and conditions of concrete calls are primarily determined by Protocols written and agreed to by Joint Committees. These Protocols identify scientific fields for cooperation that are in line with national priorities and with existing cooperation activities between the partner countries. The parties involved also decide whether they issue calls funding basic research, applied research, or rather experimental development. This in turn determines the main target group of the calls.

Because I would like to shed more light on the similarities and differences between the background documents for cooperation in the case of the three selected partner countries of Hungary – viz. Austria, Germany and Turkey – a short introduction of the agreements with these countries follows.

The Agreement on Scientific and Technological Cooperation between the Hungarian People's Republic and the *Republic of Austria* was signed on 28 May 1969, and was twice repeated by executive decrees with identical content: once in 1972[65] and once in 2008[66]. This agreement has a general character, and sets out a number of concrete activities for science and technology cooperation: exchange of scientific and technological documentation between relevant institutions, exchange of scientists and experts in order to facilitate knowledge sharing, support for short term visits of scientific and technological experts, organisation of and participation in joint trainings and conferences, organisation of scientific and technological exhibitions, as well as the elaboration of a joint framework for industrial cooperation.

The agreement also stipulates the establishment of a Scientific and Technological Joint Committee, which sits together every, or every other year in Budapest and Vienna in turn. This Hungarian-Austrian Joint Committee is responsible for setting up concrete work programmes for cooperation. Such work programmes are drafted to list actual ways of cooperation within the framework of the general agreement. The cooperation on a government level between the two countries is mainly intended to launch mobility calls for researchers. The terms and conditions of such calls are set out by the work programmes set up and signed by the Joint Committee.

The agreement with the *Federal Republic of Germany* was signed on 7 October 1987 in Bonn.[67] It lists the following forms of cooperation: exchange of scientific-technological information and publications, organisation of scientific events, exchange of delegations and scientific experts, joint use of research infrastructures as well as joint planning and implementation in the fields of basic research, applied research and technological development. The agreement also established a Scientific-Technological Joint Committee.

Mobility funding has been a main way of cooperation for many years, but the German government decided stopping this form of bilateral cooperation in 2005. After this date they launched a regional call with the same objective of encouraging the mobility of scientists. Hungary occasionally joined

[65] 1972. Évi 10. törvényerejű rendelet a Magyar Népköztársaság és az Osztrák Köztársaság között Bécsben, az 1969. évi május hó 28. napján aláírt tudományos és műszaki együttműködési egyezmény kihirdetéséről (NRDIO internal document)

[66] 114/2008. (IV. 30.) Korm. rendelet a Magyar Népköztársaság és az Osztrák Köztársaság között Bécsben, az 1969. évi május hó 28. napján aláírt tudományos és műszaki együttműködési egyezmény kihirdetéséről.

[67] Egyezmény a Magyar Népköztársaság Kormánya és a Németországi Szövetségi Köztársaság Kormánya között a tudományos kutatásban és a műszaki fejlesztésben való együttműködésről / Abkommen zwischen der Regierung der Ungarischen Volksrepublik und der Regierung der Bundesrepublik Deutschland über Zusammenarbeit in der wissenschaftlichen Forschung und technologischen Entwicklung (NRDIO internal document)

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this regional scheme by launching a bilateral scheme in order to obtain the necessary funding for Hungarian researchers. The last joint projects were approved in 2014 during a bilateral expert meeting.

In 2004 a Joint Declaration was signed by the Ministry of Education of Hungary and by the Federal Ministry of Education and Research of Germany.[68] This Declaration intended to establish a joint Fraunhofer institute in Hungary, which in the end failed to take off. The Declaration also put emphasis on the importance of connecting scientific research with industry as well as the cooperation between German-Hungarian research centres and regional knowledge centres, all of which it is hoped to lead to innovative solutions and economic growth.

The Agreement on Scientific and Technical Cooperation between the government of the Hungarian People's Republic and the government of the *Republic of Turkey* was signed on 5 June 1989 in Ankara.[69] The agreement lists activities for cooperation like the exchange of scientists, researchers, technical personnel and experts, the implementation of joint research projects on subjects of mutual interest, convening of seminars, symposia, other meetings and training-sessions as well as the exchange of research results, publications and information between research institutions.

This agreement explicitly leaves open the possibility for further forms of cooperation. The agreement recommends the Contracting Parties to meet regularly and to agree on executive programmes which regulate concrete forms of cooperation for a fixed period. Such a Protocol on Cooperation in Science and Technology was signed by the Scientific and Technical Research Council of Turkey (TÜBITAK) and the National Office for Research and Technology (NKTH) of Hungary in 2005.[70] In addition to the joint activities set out by the intergovernmental agreement, the Protocol also facilitates the joint use of research and development facilities, as well as the

[68] Közös nyilatkozat a tudományos kutatási és technológiai fejlesztési együttműködésről a Magyar Köztársaság Oktatási Minisztériuma és a Németországi Szövetségi Köztársaság Szövetségi Oktatási és Kutatási Minisztériuma között / Gemeinsame Erklärung über Zusammenarbeit in der wissenschaftlichen Forschung und technologischen Entwicklung zwischen dem Budesministerium für Bildung und Forschung der Bundesrepublik Deutschland und dem Ministerium für Bildung der Republik Ungarn (NRDIO internal document)

[69] Agreement on Scientific and Technical Cooperation between the Government of the Hungarian People's Republic and the Government of the Republic of Turkey (NRDIO internal document)

[70] Protocol on Science and Technology between the Scientific and Technical Research Council of Turkey (TÜBITAK) and the National Office for Research and Technology (NKTH) of Hungary (NRDIO internal document)

development of such joint research projects. It also decided to establish a Joint Committee, which formed. This Protocol was the basis for cooperation for many years.

As we can see, the previous three intergovernmental S&T agreements foster cooperation by setting out a similar range of activities (viz. exchange of information and scientific documentation, organisation of events and conferences, exchange of scientists). The content of the agreements is open-ended, the agreements delineate very general frameworks that allows almost any form of cooperation. The manner of going about cooperation in actual practice is determined by the mutual interests of the parties involved on a case by case basis. New ways of cooperation are often defined and agreed on during the Joint Committee meetings convened under the aegis of these S&T agreements. Such new initiatives are sometimes followed by signing new agreements, declarations or work programmes, some others are implemented in the general framework of existing intergovernmental S&T agreements. Agreements rather facilitate platforms for communication than define the actual ways of cooperation.

V.4. Joint Cooperation in the Framework of the European Research Area

As it has been already suggested in the previous chapters, scientific cooperation among European countries mainly occurs in the framework of the European Research Area. With their constantly increasing budget, European framework programmes for research and development are developing into more and more popular tools for financing collaborative research, and they constitute viable alternatives to national funding, especially in the case of multilateral R&D projects. In addition to member states of the European Union, associated countries of the framework programmes are also competing for available resources.

As one of the main topics of my thesis is the impact of programmes on the European level on bilateral cooperation, I will introduce the performance of the four countries I focus on – viz. Hungary, Austria, Germany and Turkey – in the framework programmes in this chapter. This country-specific description is followed by a comparative analysis of participation statistics of the four countries in FP7 and Horizon 2020. A short subchapter deals with different support programmes, facilitating successful participation in framework programmes.

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V.4.1. Hungary

R&D expenditure in Hungary considerably decreased after the political transformation: while 1.6% of the GDP was spent on R&D in 1990, the same ratio was 0.63% in 1996. Gross domestic expenditure on R&D (GERD) as a percentage of GDP started to grow slowly after 2000. It reached 1.39% in 2015 (KSH, Központi Statisztikai Hivatal, 2017), which is still not only far below the general 3% target of the Europe 2020 strategy, but also below the national target of 1.8% (EC, 2010a). Concerning the ratio between R&D financed by the government and industry, the balance tilted in the direction of government funding for Hungary and it did so until 2007-2008. After this day government expenditure stagnated, and this stagnation was countered by a quick growth of industry financing, this trend setting in around 2008. In 2014 the percentage of GERD financed by the government was 33.49% while the share of industry was 48.28% (OECD, 2016). International funds – with a share of around 15% – also play an important role in the funding of R&D in Hungary. The Fourth Framework Programme (FP4, 1994-1998) was the first European Framework programme Hungarian researchers took part in. Their participation was initiated based on personal connections, i.e. researchers were invited to join some international consortia by their partners. Because of Hungary's pre-accession status to the EU, Hungarian researchers were already able to participate in the Fifth Framework Programme (FP5, 1998-2002). The country had to pay contribution into the budget of the Framework Programme in return.

Table 31: Hungarian contribution to the Fifth Framework Programme (1999-2002)

	1999	**2000**	**2001**	**2002**	**Total**
Full Hungarian contribution (million euro)	19.05	19.88	21.53	22.14	82.60
Real contribution reduced by the preferential rate (%)	40	60	80	100	71.31
Real, payable contribution (million euro)	7.62	11.71	17.18	22.14	58.91
Government contribution (million euro)	4.05	6.28	9.22	11.73	31.22
PHARE contribution (million euro)	3.53	5.43	7.96	10.41	27.69

Source: (Nyiri, 2002)

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Hungary received a preferential rate when financially contributing to FP5. A considerable share of this contribution was paid by the PHARE instrument[71]. Based on data from November 2004, Hungarian participants joined in 817 retained proposals in FP5, and they received 64.19 million euro funding in total (Jeney, 2006, p. 90). If we compare real government expenditure with received EU funding, then Hungary's participation in FP5 can be considered successful. If Hungary did not have a preferential rate and the possibility to partly use PHARE funds to pay its contribution results would have been much less favourable: Hungary could have retrieved about three-quarters of its contribution.

From the very beginning of the Sixth Framework Programme (2002-2006) Hungarian researchers were able to participate and apply with the same rights as their partners in EU member states. After the definitive accession of Hungary in 2004 Hungary was a full member state with equal rights to participation in FPs. As Hungary has been a member of the European Union since 2004 it was also automatically a full-right member of FP7.

There were 1185 successful Hungarian applicants in FP6, which was 1.59% of all the successful applicants. These 1185 researchers were granted 149.765 million euro support by the EU, which was only 0.9% of the total budget of FP6 (EC, 2008, p. 19). Table 32 shows Hungary's participation in the Seventh Framework Programme (FP7, 2007-2013).

Table 32: Hungarian and EU participation in the Seventh Framework Programme

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013-**	**Total**	**Success rate**
Successful participants (Hungary)	307	200	229	202	209	222	290	1500	20.3%
Successful participants (EU)	21989	14548	20837	17887	20175	21869	21214	138519	21.8%
Received funding (Hungary, million euro)	46.6	37.1	40.5	34.8	41	46.1	43.4	289.5	15%
Received funding (EU, million euro)	6486	4857	6013	5601	6305	7606	8542	45410	19.1%

Source: (EC, 2015, p. 143)[72]

[71]PHARE (Poland and Hungary Assistance for the Reconstruction of the Economy) is a pre-accession instruments financed by the European Union to assist the applicant countries of Central and Eastern Europe – among others Hungary – in their preparations for joining the European Union.

[72] The Seventh FP7 Monitoring Report was the last official monitoring report of FP7, which did not consist final data. Final data is available in the Horizon 2020 dashboard under FP7 results (https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-dashboard)

There is a huge discrepancy between Hungarian success rates of the number of successful applicants and the amount of budget received. While the success rate for applicants is 20.3%, which is slightly below the EU average of 21.8%, Hungary considerably lags behind the EU average (19.2%) in the amount of budget received with its rate of 15%.

Nevertheless, as Figure 12 and 13 show on page 132, Hungary occupies the 16th position on the list of EU member states in FP7 both in terms of the number of successful participants and the amount of budget received. This is a good result when compared to other new member states. Only Poland, another a new member state, ranked higher than Hungary. It is also interesting to note that the amount of funding per proposals has been growing from FP6 to FP7: the average support per project has grown from 126 000 to 186 000 euro.

V.4.2. Austria

GERD/GDP ratio in Austria has been constantly growing since 2000. The originally high rate of 1.89% has grown to 3.1% until 2015 (OECD, 2016). Although Austria has reached the general Europe 2020 target this way, they were even more ambitious while planning their own national GERD/GDP target: Austria plans to spend 3.76% of its GDP on R&D by 2020 (EC, 2010a). As for the ratio between government and industry financed R&D, government expenditure ran to 32% of the GERD while industrial expenditure (including sources from abroad) reached 62%, so Austria has also fulfilled the BERD objective of Europe 2020 (Polt, W., 2015, p. 3).

Austria joined the European Union on 1 January 1995, so it has automatically become a member of the Fourth Framework Programme (FP4) starting in 1994. Austria performed well in the framework programmes from the very beginning, although in FP4 government contribution to FPs still exceeded the funds obtained from the EU. In FP5, the government contribution and the funds received from the EU were equal. This growing trend of obtaining more funds received from the EU continued: in FP6 and FP7 EU funds significantly exceeded Austria's financial contribution to the FPs. In FP7 125% of the national contribution was reverted back to Austrian scientists.

Table 33: Austrian participation in the Fourth, Fifth and Sixth Framework Programmes

	FP4	FP5	FP6
Successful participants (Austrian)	1 923	1 987	1 972
Share of successful Austrian proposals (compared to total)	2.3%	2.4%	2.6%
Number of Austrian coordinators	270	267	213
Share of Austrian coordinators	1.7%	2.8%	3.3%
Received funding (million euro)	194	292	425.2
Share of received funding (compared to total)	1.99%	2.38%	2.56%
Received funding in percentage of Austrian contribution to the FPs	70%	104%	117%

Source: (Ehardt-Schmiederer, M., 2009, p. 47)

Table 34: Austrian participation in the Seventh Framework Programme

	2007	2008	2009	2010	2011	2012	2013-	Total	Success rate
Successful participants	577	350	546	462	557	542	603	3637	22.3%
Received funding (million euro)	177.4	144.6	164.2	144	179	169.2	192.6	1191	20.9%

Source: (EC, 2015, p. 117)

In the Seventh Framework Programme Austria performed above the average both in terms of the number of successful participants (Austria: 22.3%, EU average: 21.6%) and in terms of budget received (Austria: 20.9%, EU average: 19.2%). Just as in the case of Hungary the amount of funding per project has been growing: in FP6 the average support per retained proposals was 216 000 euro, in FP7 this amount reached 331 000 euro. The average amount of funding received by Austrian scientists was almost twice as high as the funding received by their Hungarian colleagues.

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V.4.3. Germany

The Federal Government's expenditure on R&D rose considerably – by 9.0 billion euros – between 2005 and 2017 to reach the 17.2 billion euros target in 2017. At the same time, in 2015, the R&D expenditure of the German industry increased by 10% to 62.5 billion euros. State and industry together spent almost 90 billion euros on R&D in 2015, which represents approximately 3% of Germany's GDP. This means that Germany – just like Austria – has achieved the target of the Europe 2020 Strategy of spending an annual 3% of GDP on R&D (BMBF, 2017b, p. 9).

Table 35: German participation in the Seventh Framework Programme

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013-**	**Total**	**Success rate**
Successful participants	3036	1835	2736	2316	2661	2938	3157	18700	24.1%
Received funding (million euro)	1157	795	1026	953	1056	1209	930	7130	23.3%

Source: (EC, 2015, p. 127)

Germany was not only the most successful country in the 7th Framework Programme in terms of successful participants and funding received, but the success rate of German applicants was also far above the European average – they even exceeded the Austrian rate. The funding received by German scientists in absolute numbers was 25 times as much as the support won by their Hungarian colleagues. German scientists cooperated with researchers from 159 countries – out of the 176 participating ones in the framework programme – in about 8800 projects (BMBF, 2016, p. 15).

V.4.4. Turkey

Turkey has been an associated member in EU Framework Programmes for Research and Development since 2002, and it signed the Association Agreement to Horizon 2020 on the 4th of June 2014. As far as the activity of Turkey in the EU's R&D programmes is concerned, there is a strong participation of Turkish scientists in Marie Skłodowska Curie Actions, in the Research for the benefit of SMEs instrument, as well as in the thematic fields ICT and Environment (Smits, 2014).

Table 36: Turkish participation in the Seventh Framework Programme

	2007	2008	2009	2010	2011	2012	2013	Total	Success rate
Successful participants Turkey	141	119	183	206	200	182	181	1212	16.1%
Successful participants C&A countries	1583	1221	1730	1455	1543	1699	1072	10303	21.9%
Received funding Turkey	25.15	16.32	24.04	21.33	30.04	37.09	41.99	196	7.2%
Received funding C&A countries	482	442	599	484	513	722	417	3658	18.7%

Source: (EC, 2015, pp. 99-100)[73]

As Table 36 shows, the total number of successful applicants in Turkey was 1122 with a funding of 165 million euro. The success rate of Turkish researchers was around 16.1%, which is below the EU average (21.6%). It is remarkable that the success rate of Candidate and Associated countries (C&A countries) was even higher than the one of the EU28 countries (21.9%) because of the successful participation of Israel, Norway and Switzerland. The difference is even more telling if we have a look at the success rates in terms of obtained EU contribution: compared to the 19.2% EU average Turkey had a success rate of 7.2%. The reason for this difference between the success rates in funding and in the number of applicants might be that those projects in which Turkey coordinates and hence receive more funding rarely win. This can not only be explained by a lower level of scientific excellence, but can presumably also partly be explained by a lack of management experience and limited lobby power inside of the consortium.

V.4.5. Participation of Hungary, Austria, Germany and Turkey in FP7 and Horizon 2020

If we compare the participation of Austrian, German, Turkish and Hungarian researchers in the Seventh Framework Programme (see Table 37) we can see the following: the difference in the success rate of received funding is much larger than the difference in the success rates of applicants. The difference in the amount of funding received is even larger if we look at funding received by

[73] I did not have aggregate data for Associated Countries (Total number and for 2013).

Austrian and German researchers in absolute numbers. This can be partly explained by higher salaries in these countries. Another reason for higher amount of financial support is the fact that Western European countries are more willing to take up the role of a project coordinator: three times as many Austrians, and fifteen times as many German scientists were project coordinators than Hungarians. However, none of these reasons fully explain the difference in success rates. Western European countries are liable to look for an explanation in the higher level of scientific excellence in their countries, a reason why Eastern European and certain associated countries – such as Turkey – are prone to feel excluded from traditional, closed clubs of Western European consortia.

Table 37: Austrian, German, Turkish and Hungarian participation in the Seventh Framework Programme

	Austria	**Germany**	**Turkey**	**Hungary**
Number of applicants	15057	71609	-	7391
Requested EU contribution (million euro)	5333	29919	-	1858
Successful applicants	3368	17263	1122	1500
Received funding (million euro)	1115	6972	165.4	278.9
Success rate (applicants)	22.3%	24.1%	16.1%	20.3%
Success rate (funding)	20.9%	23.3%	7.2%	15%
Number of coordinators	675	3121	-	207

Source: (EC, 2015)

We might also analyse the results based on a three-dimensional model. The three dimensions are: 1. scientific excellence, which might be poor or high, 2. propensity to apply, which might be low or high, 3. budget, which might be realistic or unrealistic. A typical Hungarian applicant's scientific performance is in the middle range, his or her propensity to apply is high – although decreasing – and the expected budget is often not realistic, i.e. too high. An average German applicant performs high-quality research pared to high willingness to apply and a realistic budget. So Hungarians mainly stand a chance to win if they are able to join proposals with renowned Western partners.[74]

[74] A recent study of the Scientific Foresight Unit of the Science and Technology Options Assessment (STOA) group of the European Parliament also emphasized that cooperation with the TOP 15 institutions in FP7 has considerably increased the participation success rate of EU-13 organisations. (Pazour, et al., 2018, p. 129)

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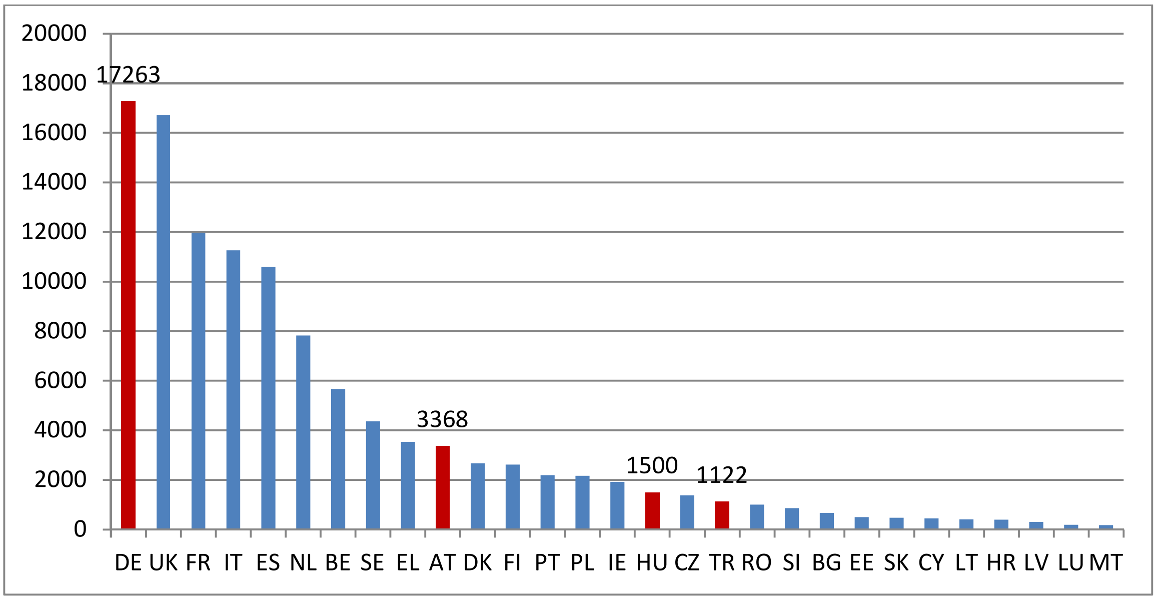
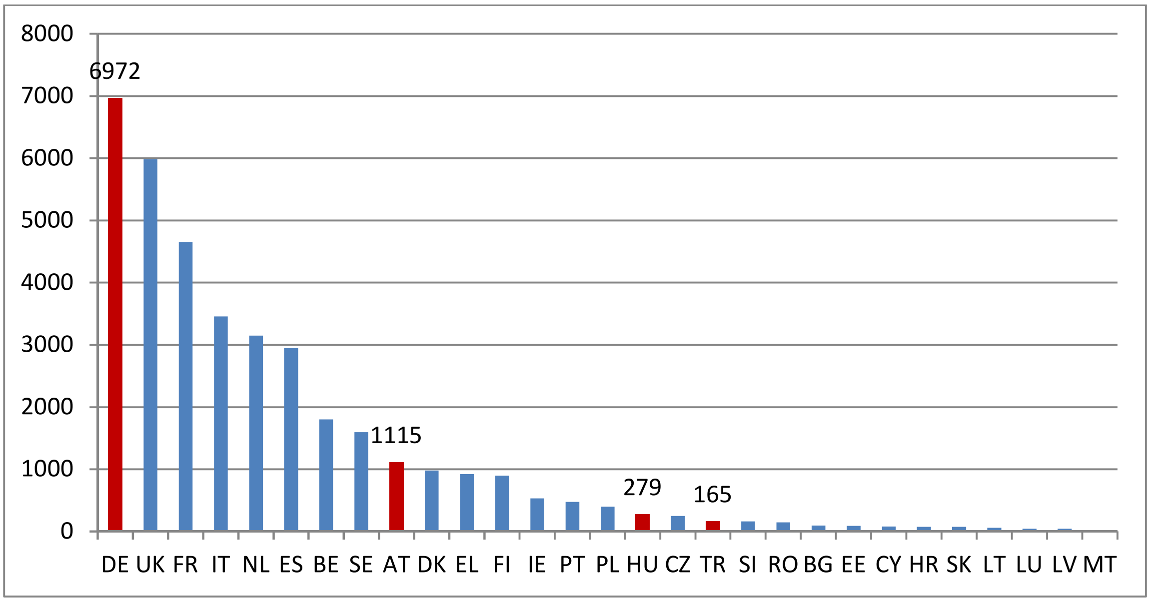
However, in such consortia only the most excellent researchers are able to play the most prominent and visible role. If not, their part – especially in terms of budget – would be merely symbolic.
In order to put the results of the four countries in a wider context, successful applicants and received funding in each member state are compared with a range of other countries, presented in the figures below.

Figure 12: Number of successful applicants in the Seventh Framework Programme



Source: (EC, 2015, p. 99)

Figure 13: Received funding in the Seventh Framework Programme (million euro)



Source: (EC, 2015, p. 100)

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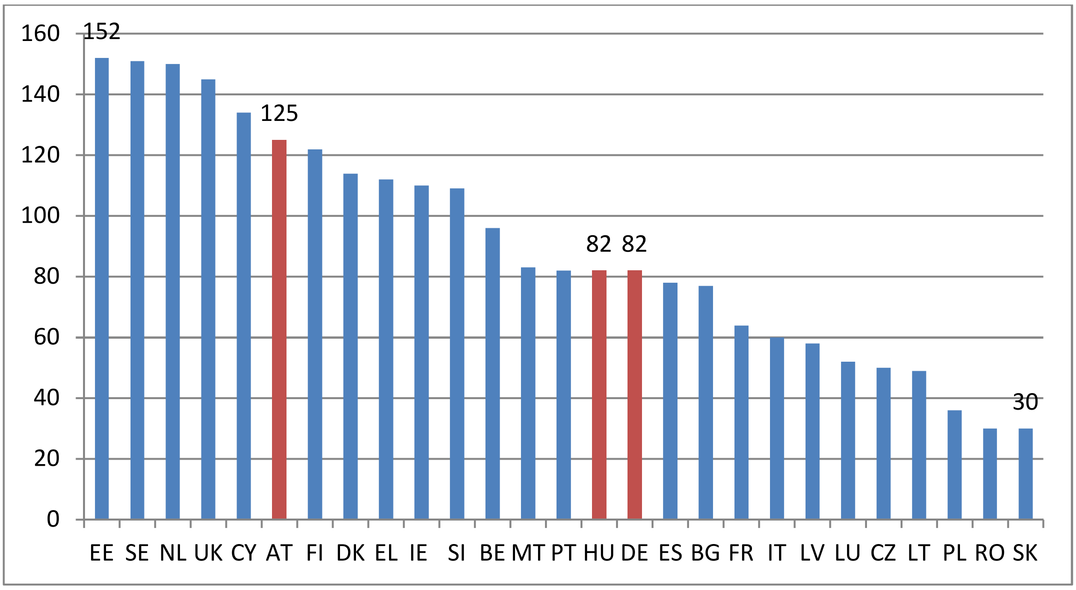
Both figures show that the 15 old member states performed much better, both in terms of the number of successful applicants, and in terms of the amount of funding received, than countries that joined the EU in or after 2004. There are only old member states on the first 13 and 14 places of the ranking lists respectively. Although in absolute numbers Germany, the UK, France and Italy are leading the ranking lists in FP7 both in terms of successful applicants and received funding, the result is quite different if we compare received funding with member states' contributions to the Framework Programme.

Figure 14: Ratio of received funding and national contribution to the Seventh Framework Programme

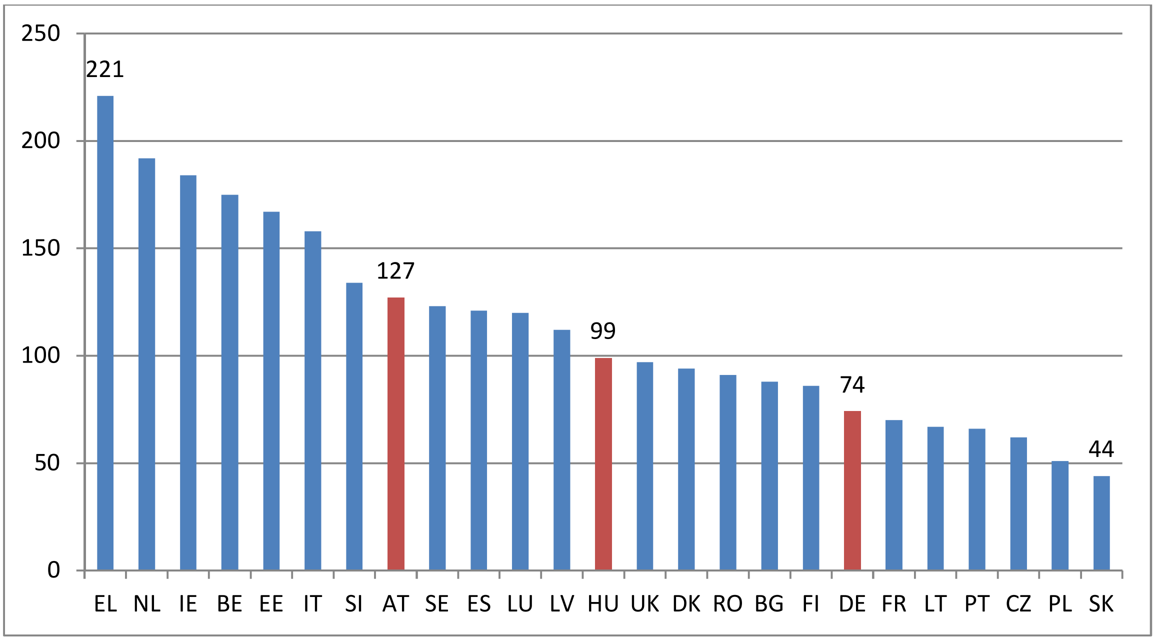


Source: (Ehardt-Schmiederer, M., 2014, p. 58)

As we have already indicated, Austria is a net beneficiary of the framework programmes since 1998 – in FP7 Austrian scientists received 125% of the contribution paid by Austria. Although Hungary received only 82% of its contribution, this data is equal with the – in absolute numbers receiving the most funding – German rate. A new member state, Estonia has the best ratio in this comparison: received funding exceeds national contribution by 50%. Otherwise most of the new member states lag behind, only Estonia, Cyprus, Slovenia and Malta had better ratios than Hungary. When analysing this indicator, we should take into consideration the large differences in national contributions to the FPs. Countries with a lower GNI and a lower national contribution might have disproportionately better results, which will automatically change with economic growth, growing GNI and growing national contributions. With this in mind, the result of Austria, which is already a net contributor to the European Union's budget, is even more remarkable. As for Turkey, the percentage of EU contribution to project costs is 73% (Fresco, 2015, p. 120).

The ranking changes again if we compare the number of successful applicants with the number of full-time researchers employed in a given country. This latter indicator is calculated as a share of the total number of researchers employed full-time in the European Union, which is put as a measuring rod at 100%. This data shows the performance of member states from a different angle, it shows the activity of the research community in relation to its size.

Figure 15: Success rates related to the number of researchers (FTE) in the Seventh Framework Programme



Source: (Ehardt-Schmiederer, M., 2014, p. 56) No data for Cyprus and Malta.

This indicator shows that Austria again performs better than the EU average. Hungary's share in retained proposals is in balance with the number of FTE researchers in the country (99%). Germany performs quite badly (74%) viewed from this perspective, but this is mainly due to the fact that countries with a high number of scientists – which is a positive indicator in itself – might have worse results than countries with a small research community in this comparison. Except for the Baltic countries and Slovenia, new member states again perform below average with regard to this indicator. However, it is interesting to see that Greece, which is far ahead of all the other countries in this ranking, employs 8.72 researchers per thousand total employment, and this rate is even above the EU average of 8.03. This ratio in Austria is 9.87, in Germany 9.01, in Hungary 5.88 and in Turkey 3.57. The higher than average ratio makes the results of Austria again very impressive (OECD, 2016).

At the time of writing, May 2017, available data about Horizon 2020 (H2020) only show us some initial results, which may or may not be representative of the results for the whole lifetime of the programme. Nevertheless, it can already be seen that competition has further increased compared to previous framework programmes. The number of submitted proposals is constantly increasing, which results in decreasing success rates in each member state. The average success rate of EU countries dropped from 21.6% to 14.5%. Hungary performs under this average: compared to the success rate in FP7, which was 20.3%, currently only 10.7% of Hungarian applications are successful. This might be partly explained by the fact that Hungarian applicants are very active in programmes with a very low success rate (e.g. SME instrument with a general success rate of 8% in Phase 1 and 4.8% in Phase 2). Austrian and German applicants perform above the EU average again: 16.6% and 16.1% of their applications are successful respectively. The success rate for Turkey is also lower – 10.2% instead of the previous 16.1% – but the difference is relatively small (5.9 %).

Table 38: Austrian, German, Turkish and Hungarian participation in Horizon 2020

	Austria	**Germany**	**Turkey**	**Hungary**	**EU**
Number of awarded projects	1175	3972	314	440	14297
Rate of all awarded projects (in %)	8.2	27.8	2.2	3.1	100
Number of successful participants	1684	7428	411	550	59791
Rate of all participants (in %)	2.8	12.4	0.7	0.9	100
Received EU contribution (million €)	718.2	4238.3	109.4	164.7	25457.9
Proportion of EU funding (in %)	2.8	16.6	0.4	0.6	100
Number of coordinators	353	1631	87	102	14297
Success rate (of eligible participation)	16.6	16.1	10.2	10.7	14.5

Source: eCORDA data as of 31. May 2017.

As in the case of FP7, statistics point out that the relative performance of Austria and Germany related to the received EU contribution is even better. The share of successful participants and received budget is the same (2.8%) in the case of Austria; Germany's share in the received funding (16.6%) is even larger than its share in the number of successful participants (12.4%). In contrast, Hungary's and Turkey's share of received funds is about two-thirds of their share of successful participants.

Western countries are still more willing to coordinate projects, especially in the case of Germany this ratio is very high: 41% of the projects with German participation was coordinated by a German scientist. However, taking on the role of project coordination cannot be the only explanation for the larger amounts of funding, because the share of coordinated projects is almost the same in the case of Austria (30%) and Turkey (27%). In the case of Hungary the same indicator is 23%. The relative high ratios are partly due to the single-beneficiary programmes like grants of the European Research Council, Marie Skłodowska-Curie Actions or the SME instrument.

We can also see that the number of successful participants is much higher than the number of winning projects. This means that in many of the winning projects there is more than one partner per project from the same country. The countries under consideration again show up large differences in this regard. There are 1.87 German participants in each awarded project with German participation, for Austria this number is 1.43, for Turkey 1.3, and for Hungary only 1.25.

Looking at successful thematic fields based on further eCORDA[75] statistics Austria is strong in the fields of ICT, nanotechnology, transport, energy as well as the social sciences and humanities. Germany has excellent results in the scientific excellence pillar – especially in the Future and Emerging Technologies programme and the European Research Council grants – and in the Industrial Leadership pillar in the fields of ICT, biotechnology, advanced materials, advanced manufacturing. Transport is the most successful societal challenge for German scientists. Turkey achieves good results in biotechnology, food and environmental research and the social sciences and humanities. Turkish SMEs also perform better than the Turkish average success rate. Hungary performs well in the research infrastructures programme, in the societal challenges food, transport and social sciences and humanities. Hungarian SMEs also obtain good results. Hungary was the

[75] eCORDA is an external database of proposals, evaluation and grant management data of European framework programmes for Research, Development and Innovation, which is not publicly accessible.

most successful EU13 country in the teaming programme of Horizon 2020 targeted at widening the participation of new member states.

Table 39: Types of institutions carrying out research in Austria, Germany, Turkey and Hungary (in %)

	Austria	**Germany**	**Turkey**	**Hungary**	**EU**
Higher Education	29	30	35	25	33
Business enterprises	38	37	34	39	34
Research centres	21	28	14	21	22
Public bodies	6	3	14	11	6
Other	5	3	4	6	5

Source: eCORDA data of 31. May 2017.

Results can also be analysed based on the type of institutions that carry out the research. Apparently, higher education institutions are the strongest players in Turkey, research is mainly carried out at large universities rather than at research centres. The active involvement of TÜBITAK in Turkey in international scientific cooperation explains the high ratio of public bodies for Turkey in the table. Business enterprises are very active in Hungary – their participation is the highest among all the countries examined. This ratio is still relatively low compared to the share of business financed R&D in Hungary, which is more than 50% of GERD (see Figure 3 on page 79). Compared to the other three countries research centres are significant players in Germany – research institutes of the Fraunhofer Society or the Max Planck Society are among the most successful players in the whole framework programme.

If we look at proposals which were submitted by a consortium with joint participation of Hungary and one of its partners here taken into consideration – Austria, Germany or Turkey – we can identify the most successful fields of cooperation. Such areas are also helpful when identifying key priority areas for bilateral programmes. Obviously, there is correlation between the individual niche-strengths of the countries involved and the main fields of cooperation in joint projects.

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Table 40: Joint participation of Hungarian and Austrian researchers in Horizon 2020

	Received funding in million €; Number of participants				
Area of cooperation	**Austria**		**Hungary**		Participants **AT+HU**
Smart, green and integrated transport	11 €	39	2.6 €	27	66
Information and Communication Technologies	8.8 €	28	4 €	16	44
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	2.5 €	15	2.5 €	17	32
Secure, clean and efficient energy	5.5 €	16	1.6 €	13	29
Research infrastructures	1.8 €	14	1.1 €	13	27
Climate action, environment, resource efficiency and raw materials	2.7 €	10	1.1 €	13	23
Health, demographic change and wellbeing	9.2 €	13	2.2 €	9	22
Future and Emerging Technologies	4.8 €	10	1.5 €	7	17
Europe in a changing world - inclusive, innovative and reflective Societies	3.5 €	9	0.8 €	7	16
Secure societies - Protecting freedom and security of Europe and its citizens	1.4 €	5	0.5 €	5	10

Source: eCORDA data of 31 May 2017.

Transport, ICT and agriculture are the most successful areas for cooperation in terms of the number of participants with Austria. If we look at the budget received, health research ranks above agriculture. The latter one is the only field with balanced results both in terms of participants and budget received. Otherwise the Austrian budget always exceeds the Hungarian one.

Table 41: Joint participation of Hungarian and German researchers in Horizon 2020

	Received funding in million €; Number of participants				
Area of cooperation	**Germany**		**Hungary**		Participants **DE+HU**
Information and Communication Technologies	58.9 €	105	15.9 €	54	159
Smart, green and integrated transport	40.2 €	91	9.9 €	55	146
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	41 €	62	15 €	59	121
Research infrastructures	26.4 €	77	5.2 €	30	107
Health, demographic change and wellbeing	25.2 €	54	8.2 €	31	85

Climate action, environment, resource efficiency and raw materials	19.5 €	48	6.2 €	29	77
Secure, clean and efficient energy	17.4 €	36	7 €	33	69
Future and Emerging Technologies	34.5 €	52	3.6 €	10	62
Euratom	18.9 €	36	2.2 €	16	52

Source: eCORDA data as of 31. May 2017.

We see similar results on the first few areas of cooperation if we have a look at joint projects with Germany. ICT, transport and agriculture rank first, again closely followed by health research. The difference in budget is typically two times larger than the difference in terms of the number of participants, which is in line with the results shown in previous tables. Food and energy are the areas of cooperation where the ratio between budget and number of participants is best matched. In absolute numbers, Hungarian scientists have the largest number of joint projects with German institutions. The total number of participants in joint projects is 1181 who altogether received more than 462 million euro. The collaborative link[76] between Hungary and Germany is 939, a number ranking above the link with the UK (632) in the second, or France (588) in the third position.

Table 42: Joint participation of Hungarian and Turkish researchers in Horizon 2020

	Received funding in million €; Number of participants				
Area of cooperation	**Turkey**		**Hungary**		Participants **TR+HU**
Research infrastructures	1.2 €	9	1.1 €	8	17
Climate action, environment, resource efficiency and raw materials	2.5 €	8	0.5 €	5	13
Europe in a changing world - inclusive, innovative and reflective Societies	0.6 €	5	0.8 €	5	10
Future and Emerging Technologies	1.3 €	4	1.1 €	5	9
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	0.4 €	3	0.9 €	5	8
Information and Communication Technologies	0.08 €	2	0.8 €	5	7
Secure, clean and efficient energy	5 €	5	0.2 €	1	6
Smart, green and integrated transport	0.5 €	3	0.6 €	3	6

[76] A collaborative link is assumed to exist between each pair of participants in each contract. The number of collaborative links created by a project is calculated in the following way:
(a) When there are n participants from a given country in a project, the number of collaborative links between participants from the given country formed as a result of the project is assumed to be n*(n-1)/2.
(b) When there are m participants from one country and p from another country in a project, the number of collaborative links created between the two countries as a result of the project is assumed to be m*p.

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Space	0.03 €	2	0.1 €	2	4
Health, demographic change and wellbeing	0.7 €	2	0.2 €	2	4

Source: eCORDA data as of 31. May 2017.

The ranking and the order of magnitude is quite different in joint projects with Turkey. The total number of participants in joint projects is 93 with a funding of 21 million euro. When looking at the number of participants environment, social sciences and research infrastructures rank first. These areas of cooperation in Horizon 2020 were taken into consideration in defining priority areas for the bilateral call for proposals between the two countries.

V.4.6. Supporting Participation in Framework Programmes

87% of H2020 funds are allocated to the old member states, the so called EU15 countries, while altogether 4.8% of funds are granted to the new member states, the EU13 countries (EC, 2018, p. 18). In order to close this funding gap, EU13 countries are encouraged to use the amounts they receive from the European Structural and Investment Funds (ESIF) on research, development and innovation in an efficient and synergetic way. By using ESIF, they can improve their research capacities, infrastructures and competitiveness and reach a level of excellence that will enable them to become more successful players in European framework programmes.

The amount of ESIF that EU13 countries can allocate to R&D priorities is significant: while Austria spends 282 million, and Germany 4.3 billion euro on R&D, Hungary plans to spend 2.2 billion euro on R&D between 2014-2020 from ESIF[77] (EC, European Structural and Investment Funds data, 2019). The difference is even more remarkable if we compare these numbers to the yearly GERD of these countries: Austria has spent 15 billion euro, Germany 131 billion euro and Hungary only 3.8 billion euro on R&D in 2017. (OECD, 2018)

ESIF can be spent in line with the priorities of the country's Smart Specialisation Strategies. When setting out such strategies, in addition to regional priorities and comparative advantages, possible synergies with European framework programme instruments have to be taken into account.

[77] The spending of ESIF had to be planned for seven years (2014-2020), so it is only possible to compare the plans instead of the actual spending at the moment. ESIF funds need to be topped-up by national funds. I only showed the European part in the main text as it better shows the magnitude of ESIF funds spent on R&D. For the full picture: Austria plans to top-up the 282 million Euro by 525 million Euro, Germany plans to add 2.4 billion Euro to the 4.3 billion Euro, while Hungary plans to add a mere 392 million Euro national funds to the 2.2 billion Euro ESIF funds.

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Synergies might be either dynamic – occurring consistently on the long-term – strategic – resulting from policy – or operational. Serial operational synergies occur when one initiative is supported either by ESIF or by the framework programme and that initiative has an effect on the other programme. Parallel operational synergies occur if complementary interactions are happening simultaneously. Most of the synergies occur rather randomly and rarely follow from an intentional design (Gonzalo, Guy, Acheson, Nauwelaers, & Tsipouri, 2018, p. 6). Dynamic synergies can only be achieved when a synergy-friendly environment has been out in place, and this calls for political commitment and changes in both governance structures and mind-sets. Strategic synergies can result from mature Smart Specialisation Strategies. A typical example for serial operational synergies is the Seal of Excellence scheme. With the help of this scheme, highly evaluated but below available budget proposals are entitled to national funding, which can be ensured by the use of ESIF. An example for the parallel operational synergies is the use of structural funds for co-financing joint European-national initiatives, like ERA-NET Co-fund projects and other European joint programmes and initiatives (e.g. Joint Technology Initiatives, Public-Private Partnerships, Knowledge and Innovation Communities, etc.). In addition to scientific matchmaking, these initiatives often serve as discussion and proposal-making fora with significant lobby power, which can influence programming and decision making on the European level. Hungary would do wise to take better advantage of such opportunities for strategic synergies.

There are also other ways of supporting the national science community to become more successful in European framework programmes. *Austria* has commissioned an evaluation of the Austrian support system in 2010 (Arnold, et al., 2010). This analysis emphasised the importance of tailor-made advice, the need of experienced applicants to get access to strategic information, understanding the changes in the Framework Programme and the unwritten rules of international cooperation, and having a say over parts of the Work programmes (Arnold, et al., 2010, p. 256). General information about rules and regulations is no longer needed by experienced applicants, it is rather appreciated by new-comers and is provided by the so called FFG-Academy programme.[78] Following the recommendations of this analysis a previously used proposal grant – that was used to support the participation of Austrian scientists in framework programmes – was discontinued as

[78] FFG-Academy programme is a training programme of the Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft - FFG) for consultants and applicants.

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it mainly attracted free riders, who would have submitted their applications also without the support received.

The prevalent form of support in *Turkey* and *Hungary* are grants for writing proposals and other financial instruments. Both countries have a similar portfolio of support programmes, they both operate a scheme to facilitate networking activities for scientists by financing costs of mobility and the organisation of events. Project coordinators can apply for larger amounts. There is a scheme to encourage the participation of SMEs in the SME instrument of Horizon 2020, and programmes to increase the number of successful ERC applications (Seal of Excellence type of funding). Differences between the programmes of the two countries exist, but overall the principle is the same: researchers and innovative companies both need financial incentives to spend budget, time and effort to apply for grants in Horizon 2020, which carry a high rate of failure. High-quality but unsuccessful proposals receive a kind of budgetary compensation for their efforts, so as to facilitate conducting at least part of the research set up in the rejected proposals.

Last but not least: how can bilateral cooperation facilitate joint participation in framework programmes? Generally speaking, any type of bilateral activity with countries enjoying a high success rate – like Austria or Germany – increases the chances of Hungarian participants to become successful. As a first step, Hungarian researchers should try to become a member in a European consortium coordinated by Western European countries with a high success rate. If they prove to be reliable partners and make substantive contributions to the research involved they will receive more trust and can then play a more important role in the consortium. As a next step, by using the already existing network, Hungarian researchers can consider taking on the role of project coordination themselves. This requires a larger work load, but it allows for more room in designing the research and also brings with it a larger share of budget.

Bilateral cooperation should both rely on the results of joint cooperation in European schemes and facilitate further multilateral cooperation possibilities. The last bilateral mobility call with *Austria* launched in 2017 identified a number of priority areas: health, agriculture, technical sciences (e.g. ICT), biotechnology, environmental research and energy. These areas are also potentially successful areas for cooperation in Horizon 2020. Applicants for the mobility call with the intention to submit proposals to Horizon 2020 enjoy preferential treatment. Such measures of preferential

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treatment can potentially lead to an increased participation of Hungarian and Austrian researchers in Horizon 2020 and other joint European initiatives.

The recently planned bilateral *German*-Hungarian programme in the framework of the EUREKA network primarily builds on previous cooperative projects within the network. The three most successful areas in EUREKA have been ICT, production technologies and biotechnology. ICT also ranks first in Horizon 2020, so a special bilateral programme supporting this field might further increase the participation of German-Hungarian researchers in European framework programmes.

Turkey presents yet another picture. It is an associated member of Horizon 2020, so joint participation in framework programmes is a definite aim for both Hungary and Turkey. Because Turkey is not a member state of the European Union, Hungary also considers Turkey as a third country when planning joint cooperation activities. The recently planned call for research proposals reflects this dual approach[79]. One of the priority fields is environmental research, which is also the most successful thematic area of cooperation in Horizon 2020. The two other fields, ICT and health research, are also listed among the most successful areas in Horizon 2020, but they were mainly selected for joint support because of their national strategic importance.

V.5. Three Ways of Bilateral Cooperation

As we have seen, S&T Agreements set the general framework for cooperation, but the content is decided upon by the partner countries on a case by case basis. I will describe the bilateral scientific cooperation of Hungary with three countries: Austria, Germany and Turkey in this chapter. I have selected these three countries because of the following reasons: Austria, Hungary's Western neighbouring country with a similar sized territory and ditto population, but with an above-average performance in European Union programmes, could serve as a model for Hungary. Hungary's traditional good cooperation on the bilateral level with Austria could lead to better performance of Hungarian scientists in multilateral schemes. Germany is the number one economic and scientific partner of Hungary with the largest number of successful applications in European framework programmes together with Hungarian scientists. Turkey has a special status: since it has not yet

[79] See: https://nkfih.gov.hu/palyazoknak/magyar-torok/tubitak-nkfi-hivatal

achieved the full membership of the European Union but is an associated member in the framework programmes, it can be regarded both as a European country and a third country at the same time.

V.5.1. Looking for European Frameworks for Cooperation – The German Example

Research cooperation between Germany and Hungary has a long tradition. As indicated in the previous chapter, today's bilateral cooperation in science and technology is based on an agreement on scientific and technological cooperation that was concluded between the governments of the Federal Republic of Germany and the Republic of Hungary in 1987. Increased cooperation in the field of research and technology was agreed in a joint declaration made by the ministries responsible for research in Budapest in 2004.

The main governmental partner of the Hungarian National Research, Development and Innovation Office is the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF). BMBF is responsible for policy and strategy as well as for financing education, research and science in Germany. The main executive agency for bilateral scientific and technological activities is the International Office (Internationales Büro, IB) of the Project Management Agency at the German Aerospace Centre (Projektträger im Deutschen Zentrum für Luft- und Raumfahrt, PT-DLR) located in Bonn.

Financing mobility of scientists has been the main form of bilateral S&T cooperation between the two countries for several years. New calls for bilateral mobility were launched every second year and a high number of researchers took part in each of these. When Hungary joined the European Union in 2004, Germany changed its bilateral policy not only towards Hungary but towards the whole Central and Eastern European region. New cooperation activities were initiated either on the institutional or on the regional, European level. BMBF facilitated funding of projects primarily in the following areas: environmental research, health research, production technologies, and information and communication technologies (IB, 2017).

On top of Germany's interest in regional programmes and European framework programmes, BMBF was willing to join two Hungarian initiatives on financing researchers' mobility. The predecessors of NRDIO and BMBF published a call to strengthen science and technology cooperation in competence areas of mutual interest, including the life sciences, agricultural sciences, environment and technical sciences. After the second round of this call, German and Hungarian scientists were cooperating in 15 jointly funded projects until the end of 2016.

New ways of cooperation were planned and confirmed in the Protocol signed during the 9th meeting of the German-Hungarian Joint Committee in 2004 in Budapest, which was the last classical Joint Committee meeting between the two countries.[80] Both sides agreed that modernisation and further improvement of previous ways of cooperation was necessary, because of Hungary's accession to the EU. The Protocol goes so far as to declare that traditional ways of mobility financing should be replaced by a more substantial use of European mobility schemes.

The two countries shared the view that the targets of the Lisbon Strategy, the Barcelona objectives, and the development of the European Research Area, are not only shared challenges but also offer new opportunities for cooperation. Bilateral cooperation can be a first step in the joint preparation and submission of proposals to EU framework programmes. All this shows that Germany immediately responded positively to Hungary's new status as an EU member state. Germany also recommended concrete opportunities to cooperate on a European-level, such as exchange of experience and best practices, cooperation between National Contact Points, joint participation in ERA-NET projects, and setting up short term support schemes to facilitate the submission of joint proposals to EU framework programmes.

The 2004 Protocol identified concrete inter-institutional cooperations as the only cooperation activities outside of the European framework. Out of the four project ideas of the so called "German-Hungarian Research Base" two were realised. The first result of this initiative was the establishment of the Robert Bosch Department for Mechatronics at the University of Miskolc in 2004. The other example of inter-institutional cooperation was the establishment of the first Fraunhofer-type institute in Hungary, the so called Fraunhofer Project Centre for Production Management and Informatics (Fraunhofer PMI) at the premises of the Institute of Computer Science and Control of the Hungarian Academy of Sciences (SZTAKI) in 2010. The new Centre was the result of the long-lasting and successful cooperation between SZTAKI and the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) of Stuttgart.

[80] Ungarisch-Deutsche wissenschaftliche und technologische Zusammenarbeit, Protokoll der 9. Sitzung der Gemischten Kommission vom 28.-29.04.2004 in Budapest

The European Union launched the programme "Spreading Excellence and Widening Participation" in Horizon 2020, with the explicit aim to increase the participation of the EU 13[81] countries in the framework programme. The concept of widening is put into actual practice along three main action lines, *viz.* Teaming, Twinning[82] and ERA Chairs[83]. The main aim of Teaming projects is to create centres of excellence in widening countries by coupling their national institution(s) with a leading scientific institution in the old member states.

In the first call for proposals for Teaming projects in 2015 Hungary performed very well. Hungarian institutions were involved in three out of the thirty-one successful EU teaming projects in the 1st phase, all of which also included German partners: two Fraunhofer Association institutes, the Urban Software Institute and the European Molecular Biology Laboratory (EMBL) located in Heidelberg. Two of these projects – "Smartpolis" in the area of Smart Cities, and HU-MOLMEDEX in the field of molecular medicine – were designed exclusively with Hungarian and German partners.[84] An Austrian partner and the Budapest University of Technology and Economics also participate in the EPIC project in the field of Cyber-Physical Production Systems. Two projects – HU-MOLMEDEX and EPIC – were also submitted in the 2nd phase of the teaming call and both of them were successful. Hungary was the most successful EU 13 country in the programme in that it coordinated two programmes out of ten in the second call that received funding on the European level. The involvement of excellent German research centres was a necessary condition for success, and the involvement of these research centres was greatly facilitated by the long-lasting relationship that existed between all the institutions involved.

Germany, as a founding father of the European Union, considers European framework programmes as the main arena for cooperation with other European countries. Furthermore, Germany holds that the cooperation with Central-Eastern and South-Eastern European countries should happen in the

[81] EU member states that joined the European Union in and after 2004: Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia.

[82] Twinning strengthens a specific field of research in a research institution of a widening country. It links the institution with at least two internationally leading partner institutions in Europe by the help of staff exchanges, expert visits, trainings, workshops etc.

[83] ERA Chairs projects bring outstanding academics to universities and research institutions in widening countries. They intend to attract high quality human resources and implement structural changes necessary to achieve excellence on a sustainable basis.

[84] HU-MOLMEDEX project has four Hungarian partners: the Biological Research Centre of the Hungarian Academy of Sciences, University of Szeged, University of Debrecen and Semmelweis University. The project is coordinated by NRDI Office.

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framework of the European Research Area and the Innovation Union after the accession of these countries to the EU. Germany is committed to support further European integration of these countries by supporting joint research and technology projects. A special focus is given to the cooperation with the Danube region. Germany was an active partner in the international cooperation programme DanubeINCO.Net, and actively supports the so called EU-Danube Strategy (BMBF, 2017a, p. 55). As a concrete result of this commitment, Germany started to launch regional calls for proposals instead of the traditional bilateral schemes. Two new calls, to be set out below, were open for the countries of the Central-Eastern and South-Eastern European region and the Danube region. Both calls encouraged the joint participation in European framework programmes and other European schemes.

One of the regional calls for concrete inter-institutional cooperations was called "Integration of the Central, Eastern and South Eastern European Region in the European Research Area"[85]. The programme has a long history – it was already mentioned in the Protocol of the 9th German-Hungarian Joint Committee meeting signed in 2004 as an excellent tool to facilitate the joint participation in European framework programmes. The initiative also shows the commitment of Germany not only towards the new EU member states but also towards the integration of Western Balkan countries into the European Research Area.

This programme provides financial resources for projects to prepare proposals and applications for funding under the thematic priorities of the EU Framework Programme for Research and Innovation Horizon 2020 and other research-relevant EU programmes. Funding is only provided for proposals that have high potential for realization and success (BMBF, July 2016).

Between 2005 and 2014 Hungary performed well in this type of regional call. As the table below shows, Hungary ranked third both in terms of submitted and successful proposals. After 2014 the share of Hungarian scientists dropped, it ranked only 8th in the list of participating countries. Especially the number of successful proposals with Hungarian participation has diminished. However, it is also true that the success rate has generally decreased.

[85] The programme was called "International Cooperation in Education and Research – The Central, Eastern and South Eastern European Region" until 2017, this is why I also refer to this name in table 43.

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Table 43: Participation in the Call: "International Cooperation in Education and Research – The Central, Eastern and South Eastern European Region"

2005-2014		**Rank 1**	**Rank 2**	**Rank 3**	**Rank 4**	**Rank 5**
Country	Total	Poland	Romania	Hungary	Bulgaria	Czech R.
Proposal	334	78	45	39	33	20
Approval	217	60	21	20	20	17

2014-2017		**Rank 1**	**Rank 2**	**Rank 3**	**…**	**Rank 8**
Country	Total	Poland	Czech Rep.	Romania		Hungary
Proposal	121	59	31	26		14
Approval	49	28	13	10		5

Source: Data was provided by the International Office of PT-DLR, data of 31.05.2017

The other regional initiative for concrete inter-institutional cooperations of Germany endorsed by Hungarian researchers was BMBF's announcement for an initiative on the Danube Region. This initiative was underpinned by the same core idea of establishing project partnerships and submitting joint proposals to EU schemes, similar to the other regional call targeted at Central, Eastern and South Eastern European countries. Hungary, as a member of the first call announcement in 2013, was the most sought-after partner country of the whole region. In thirty-nine out of a total of sixty-seven submitted project proposals partner organisations from Hungary were involved. Hungarian partners were present in nineteen out of the thirty-one approved projects. About three quarters of the finalized projects were entering the second phase, the phase of preparing for subsequent applications primarily at EU level (IB, 2017).

In the second call announcement for the Danube region in 2015, Hungary was one of the few countries actively participating in funding project cooperation via a co-financing commitment. After the international evaluation six projects with Hungarian participants were selected for funding, out of the total of fifteen supported consortia.

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Germany is mainly interested in using already existing European structures, and hence Hungary recommended using the EUREKA programme to further enhance bilateral cooperation in 2017.[86] Both Germany and Hungary are active member states of the network. Germany has already started a similar bilateral programme with the Check Republic in the field of Industry 4.0[87] with positive results. The German side supported the initiative as these small scale projects can potentially lead to jointly submitted Horizon 2020 proposals. Most of the previous EUREKA projects in which Germany and Hungary participated were conducted in the fields of production technologies, ICT and biotechnology. Hungary recommended these areas as priority areas for this bilateral initiative, and the proposal was accepted by the German side.

As we can, see both present-day and future cooperation initiatives with Germany are either based on institutional contacts, or are carried out in a regional or European framework. Classical bilateral forms of cooperation are no longer a characteristic feature of cooperative activities between the two countries, since Hungary joined the European Union in 2004. This new approach was mainly initiated and supported by Germany, whereas Hungary would also have continued cooperation on a bilateral level. Nevertheless, Germany is also interested in bilateral schemes with a potential of leading to successful cooperation on the European level (e.g. the EUREKA scheme). Hungary's success rate in regional schemes, launched by Germany, could also be increased by dedicated support schemes on the Hungarian side. Such schemes are meant to facilitate the preparation of joint application to framework programme calls, and would be likely to increase Hungary's participation in European programmes.

V.5.2. Financing Researchers' Mobility – the Austrian Example

Hungary's EU membership also changed the direction of the bilateral cooperation activities with Austria. The Austrian Federal Government launched its Strategy for Research, Technology and

[86] EUREKA is an intergovernmental network to promote market-oriented international RDI project generation, to develop new products, technologies or processes. It is open for any fields of technology; companies are free to decide about the topic of their RDI projects (bottom-up approach). The minimum requirement for support is the cooperation of institutions from at least two partner countries.
[87] Industry 4.0 is the trend towards automation and data exchange in manufacturing technologies and processes.

Innovation for the period 2010-2020 in 2011. In it, Austria listed the following objectives in the area of its international position (Austrian Federal Government, 2011, p. 41):

- Developing a fine-tuned international science and research foreign policy by bundling existing measures to support internationalisation and by creating appropriate institutional structures;
- Shaping and formulation of an overall European policy on research, technology and innovation;
- Striving for increased Austrian participation in European funding programmes to further increase the return ratio;
- Setting up a selective global cooperation and expanding this with innovation front runners such as the USA, selected Asian countries, and the rising BRIC countries;
- Further enhancing cooperation with Central, Eastern and Southeastern European countries.

In order to substantiate the Austrian Federal Government's RTI Strategy, a Task Force was set up with the objective of developing proposals for measures for further implementing the Strategy. Several inter-ministerial Working Groups supported the Task Force. The two groups working on internationalization published their final reports in 2013. One of the reports – Austrian EU Action Plan (Austrian Federal Government, 2013a) – was focusing on cooperation in the framework of the European Research Area; the other report – Beyond Europe (Austrian Federal Government, 2013b) – was written about cooperation opportunities with third countries.

The Austrian EU Action Plan considers the European Union as a single whole, which justifies the fact of dedicating a single policy measure to Central Europe as a region. In this policy measure a targeted approach to regions in Central, Eastern and Southern Europe is set out, in which Austria's active participation in the Danube Region Strategy of the European Union is clearly marked out (Austrian Federal Government, 2013a, p. 21). In the document Beyond Europe, the cooperation with neighbouring countries, like the Danube region and South-eastern Europe is mentioned as a priority (Austrian Federal Government, 2013b, p. 14).

The Austrian Federal Government's RTI Strategy lists three target groups of countries: the first group comprises the most important potential partner countries for Austria, such as the US, China, Russia, and India. The second group of target countries comprises important countries with high STI potential such as South-Korea, Brazil, South-Africa, Israel, Canada, Turkey, Singapore,

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Malaysia, Australia, and Japan. Nominating specialised S&T diplomats in these countries is encouraged. The third group covers Africa, Latin-America, the Gulf countries and ASEAN countries.

On top of these three target groups of countries, Central, Eastern and South-eastern European countries are regarded as a separate group, a group with which cooperation has to be continued and extended in bilateral, multilateral and European schemes (Austrian Federal Government, 2013b, pp. 16-21). Establishing new offices and attaché positions in third countries is to an increasing extent prioritized in Austria but Austria has no intention to set up similar positions in European countries. This strategic policy is similar to the Hungarian approach.

In 2017, Austria had 15 active intergovernmental STI Agreements with partner countries. These countries can roughly be divided into four groups: old EU member states, new EU member states, "classical European partners" like Russia and the Ukraine, and non-European third countries. With most of these countries, the Austrian government has running bilateral mobility projects. In case of non-European countries mobility calls are put to use as "door openers", since they provide a cost-effective solution[88] for establishing new contacts. With European countries, schemes to intensify already existing networks seem more appropriate because bilateral projects can also serve as a stepping-stone to multilateral schemes.

The bilateral intergovernmental Scientific and Technological Agreement between Hungary and Austria was signed in 1969. The partner of the Hungarian National Research, Development and Innovation Office is the Austrian Federal Ministry of Science, Research and Economy (Bundesministerium für Wissenschaft, Forschung und Wirtschaft (BMWFW)). Project implementation in all its practical aspects is delegated to the Austrian Exchange Service (Österreichischer Austauschdienst (ÖAD)). A Joint Committee set up to manage the activities under the umbrella of this agreement sat together almost annually between 2000 and 2012 and made decisions about jointly funded mobility projects. After a short break, a call for proposals was launched in 2015.

The content and structure of bilateral calls between Hungary and Austria has not changed considerably over time. Funding calls still predominantly cover mobility costs of researchers. In

[88] Because of the low amounts of individual grants the relative administrative cost is high, but this scheme is still the least expensive possibility for starting new cooperation.

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terms of content these are relatively uncomplicated schemes that only ask for a short description of the planned joint scientific activities and the participating scientists, and number and length of visits. Mobility costs are fully covered, but the research activity itself and scientists' salaries are not reimbursed by the grant.

In 2009 an on-line survey was conducted among Austrian project coordinators about the correlation between participation in bilateral mobility projects and submitting proposals to the European Framework Programmes. The on-line questionnaire was sent to 1653 project coordinators, the response rate was 10%. The Austrian coordinators participated in bilateral projects with Western-European countries, Central European countries and non-European third countries (Schuch, Wagner, & Dall, 2011, pp. 164-165). The old EU member state group was characterized by competitive research capability and experience in FP participation. Central European countries were still in a transition phase, struggling with problems of modernisation and insufficient FP-participation. Nevertheless, the analysis of the survey mentioned Hungary (and Slovenia) as positive examples in submitting applications compared to the size of their scientific community (Schuch, Wagner, & Dall, 2011, p. 180).

The 2009 survey concluded that cooperation in bilateral schemes had a significant impact on the willingness of the partners to submit proposals to EU project calls. Cooperation with "old" member states definitely showed higher submission rates. This was mainly due to their previous experience in Framework Programmes. Austrian coordinators of bilateral projects from universities generally perceived a higher satisfaction than their colleagues outside of universities, as a result of which the scheme was used far more by them than by scientists from other sectors. However, it was interesting to see that university-participants were less likely to opt in favour of FP funded projects than scientists working at public research institutes, mainly because universities were provided with sufficient funds for research. They rather continued cooperation using their own funds than by applying for EU funds.

Those who submitted an FP proposal after having been in a mobility scheme had a much higher success rate (around 45%) than the average success rates in FP7.[89] The survey concluded that such bilateral programmes should be made more attractive and inclusive for non-university research

[89] FP7 was the running Framework Programme when the study was published. Average success rates in FP7 were around 20%.

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institutions as they clearly revealed a higher affinity for continuing cooperation by submitting joint proposals to European Framework Programmes (Schuch, Wagner, & Dall, 2011, pp. 177-179).

Personal learning effects from such scientific and technological cooperation projects were rated as very high or at least adequately high by more than 90% of the respondents. The level of quality of the delivered results (publications, applications etc.) was also very high (Schuch, Wagner, & Dall, 2011, p. 184).

Certain barriers to submit FP proposals on the back of existing mobility cooperation also exist. The difference in complexity of a relatively uncomplicated bilateral mobility project and a complicated FP project is significant, and so in some cases the transition from a mobility project to an FP project is fraught with difficulties. Partners, who aim at cooperating in FP projects and have not been a member in project consortia, often lack necessary project management skills. The 2009 survey concludes that if the transition from mobility to FP projects is an important objective, broadening of bilateral projects to multilateral ones with a concomitant increase of financial support would be an appropriate in-between step. This would involve a more focussed application and elaborate project management procedures, which would ease the transition between the various levels of complexity between the various types of applications (Schuch, Wagner, & Dall, 2011, pp. 187-188).

However, multilateral calls have their own idiosyncratic difficulties. Governments tend to be wary of mobilising additional funds for new types of cooperation if they are not convinced of the added value. Submission and evaluation deadlines and procedures have to be harmonised by more partners, giving rise to more cumbersome administrative procedures. The likelihood for any of the participating countries to either under-perform or not perform at all increases, and eventually jeopardizes the over-all success of the initiative. As against projects on a European level, where a single body, the European Commission is ultimately responsible for launching and managing the applications and the subsequent successful projects, in multilateral calls several bodies are responsible for these procedures, and they tend to have and maintain their own set of different rules and procedures. This makes harmonization of rules and procedures a tall order indeed.

For a concrete attempt in this direction of multilateral calls, we can look at a regional call Austria launched in 2016 for countries in the Danube-region. This call merely asked for a reallocation of

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bilateral mobility funds, so any need to find new financial sources of support for mobility purposes was waived.

As part of a comprehensive report, another survey was carried out in 2013 to evaluate the STI cooperation programmes and agreements in Austria (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013). The 2013 report concluded that a bilateral mobility project is typically coordinated by a university professor, whose research field belongs to the natural sciences and who uses the project to improve his already established partnership especially by high-quality publications. University based coordinators appreciate simple management and administrative procedures. Based on the responses of the survey, mobility projects are less appropriate tools to bring scientific results to the market or to reap any economic benefits from the results.

Based on this 2013 report, 89% of partners in such bilateral projects cooperate further after the end of their mobility grant. They continue to publish and occasionally submit other joint proposals. The likelihood of a more long-standing and sustainable cooperation is larger if the partnership already existed before the mobility project started, if both partners were satisfied with the results of the project, if the publication output was higher than the average, and if the partner of Austrian scientists was coming from an EU-15 country[90] (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013, pp. 10-11).

The remark on the cooperation with EU-15 countries can be interpreted in two ways from a Hungarian point of view. On the one hand, as Hungary is not part of this group, the preference of Austria for EU-15 countries is a tell-tale sign that Hungary is not amongst the countries most attractive for cooperation for Austria. On the other hand, for Hungary the cooperation with EU-15 countries – like Austria – can be more beneficial if Hungary transfers mobility projects into Horizon 2020 proposals.

The report also provides the following recommendations for Austrian policymakers, which are equally relevant for Hungary.

[90] The first 15 countries that joined the European Union: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

1. Similarly to the concluding remarks of the 2009 survey, the 2013 report is in favour of introducing a new type of call for proposals that is midway between relatively simple bilateral mobility calls on the one hand, and complicated Horizon 2020 calls with large consortia on the other. This novel type of call can be either bi- or multilateral, and it can support joint projects or joint laboratories. Without such an in-between stage, the divide between the two alternative options can hardly be bridged.
2. When new agreements are signed, these should preferably take the form of Memoranda of Understanding, because this is a more flexible form of cooperation, which can also be discontinued more easily.
3. It is necessary to harmonize evaluation criteria between partner countries to avoid widely diverging ranking orders. When different sets of criteria are being used, giving very different evaluation results, the final decision will be based on ad-hoc compromises instead of any objective ranking.
4. New agreements should only be signed if there is strong political commitment, strategic interest, or high STI capacities in the potential new partner country. New calls for mobility proposals should only be launched if without mobility financing no new STI cooperation would come off the ground.
5. The 2013 report also concludes that the cooperation with neighbouring countries should be slowly phased out. The arguments for this conclusion are that, on the one hand, universities ought to be able to bear the relatively small costs of mobility schemes themselves, and, on the other hand, cooperation should be carried out on a higher and more complex level, preferably in the more extended context of European Framework Programmes, COST or EUREKA. Because this last recommendation is not in line with the 2011 Strategy for Research, Technology and Innovation of the Austrian government, reducing cooperation with Central and Eastern European countries is not likely to happen.

I have designed a questionnaire[91] to provide important additional information to the second 2013 Austrian survey at the beginning of 2016. My questionnaire consisted of ten questions about the usefulness, advantages and disadvantages of the Hungarian-Austrian bilateral STI calls for

[91] The original questions and results – in Hungarian – of this questionnaire is to be found in Annex II of the thesis.

proposals. The questionnaire was sent to 101 Hungarian scientists who have submitted proposals to one of the recent bilateral calls with Austria. 46 researchers have responded, which amounts to a response rate of 46%. This response rate was due to the fact that bilateral calls for proposals have been recently launched after a longer break in 2015. Out of the 46 respondents two did not have any bilateral proposal that was awarded – neither with Austria nor with any other country –, so they could not properly fill in the questionnaire. Most of the respondents (60%) were coordinators of bilateral Hungarian-Austrian projects. 21% were coordinators of projects with other countries. 8% participated in bilateral projects with Austria, 2 scientists participated in bilateral projects with other countries.

Similarly to the Austrian results in their 2013 survey, in most of the cases scientists working at higher education institutions make use of this type of bilateral cooperation. 26 questionnaires were sent back by university professors (56%). The rest, 18 responses, came from institutes of the Hungarian Academy of Sciences, which are also important actors in such bilateral calls. There was only one business enterprise and one state-funded non-profit research organisation among the respondents. We can conclude that this type of calls is almost exclusively used by higher education and state-funded academic institutions in Hungary.

I expected similar or even more positive answers than the ones given by Austrian scientists concerning the usefulness of the scheme. In Hungary research institutes and universities have limited funds to cover travel expenses, making such a support scheme even more indispensable for Hungarian researchers than for their colleagues in Austria. It is also good to bear in mind that the position of Austria in the European framework programmes is an outstanding one. This makes cooperation with Austrian counterparts an outstanding opportunity for Hungarian scientists to become partners in consortia submitting calls for proposals to European framework programmes. So Hungarian scientists are more keen to keep up their cooperation with their Austrian counterparts.

As table 44 shows, overlap occurs between the scientific fields in which researchers are working in Austria and Hungary. Natural sciences drew the most responses, heading the list with 30, followed by engineering and technical sciences with 11 responses. Health (including veterinary sciences) proposals take a third place with a mere four responses. There was one applicant from

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the field of agriculture.[92] The social sciences and the humanities have not recently been supported by this type of call, the reason why these areas gave no response.

Table 44: Scientific fields of the submitted proposals

Scientific field	**Percentage of submitted proposals** In Hungary	In Austria
Natural sciences	65.1	61.2
Engineering	24	18.1
Health (including veterinary sciences)	8.7	5.6
Agriculture	2.2	3.2
Social sciences	0	5.1
Humanities	0	5.5
Interdisciplinary project	0	1.3

Source: Bilateral Mobility Questionnaire (annex II), (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013)

To the question: “What would have happened if the proposal would not have been supported?”, twelve scientists did not respond at all because they got their proposal awarded, and they did not consider this question relevant. Most of the other respondents would have tried to find another source of funding (15). Thirteen scientists would not have implemented the project because of lack of funding. Only six researchers would have implemented the project from their own funds. So we can draw the conclusion that in most of the cases external funds are necessary for project implementation.

Table 45: Responses to the question: What would have happened if the proposal would not have been supported?

	Hungarian response (%)	**Austrian response (%)**
The project would have been implemented from own resources	17.6	21
I would have looked for other funding possibilities	44.1	23.4
The project would not have been implemented due to lack of funding	38.3	
No funding alternative would have been available		55.6

Source: Bilateral Mobility Questionnaire (annex II), (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013)

[92] In the last years the number of applications in the field of agriculture has increased considerably. Institutions of the National Agricultural Research and Innovation Centre are very active in submitting proposals.

Hungarian scientists seem to be more positive about their chances of obtaining other sources for funding than their Austrian colleagues. When there are no funds available, Austrian researchers are less often aware of or interested in finding any alternatives.

The next question was about the motivation for submitting a proposal. Respondents were allowed to give more than one answer. Most of the Hungarian applicants (21-21) marked two answers to this question: they submitted a proposal because of a lack of institutional resources, and because no alternative national funding schemes were available. This latter answer contradicts the answers given to the previous question, in which a large number of respondents announced they would have been looking for other resources. We can conclude that due to the lack of alternative funding possibilities a number of mobility projects would simply have not come off the ground.

18 respondents considered simple project structure an advantage, 15 others mentioned uncomplicated management and implementation as an appealing feature. Application forms for mobility projects are easier to fill in, to submit, to implement, and to report than other, larger-scale projects. However, if we compare the amount of funding[93] with the amount of work, the picture is less positive. Especially if we take into consideration the constantly changing call texts and submission programmes, the costs of this funding scheme – in terms of time and energy – are relatively high.

Table 46: Responses to the question: Why was the bilateral STI project submitted?

Reason	**In Hungary**	**In Austria**
	In percentage (100% = all the answers given)	
High success rate	5.4	18.6
Simple administration and implementation	16.3	26.7
Own institutional fund is not available	22.8	29.1
No alternative support scheme available	22.8	9.7
Request of the foreign partner	13	0.9
Simple scheme*	19.7	-
Co-financing of another national/international project*	-	14.3
Interesting cooperation possibility*	-	0.7

*These options were different in the two questionnaires

Source: Bilateral Mobility Questionnaire (annex II), (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013)

[93] The maximum amount of funding per project is 2 million HUF for two years.

Hungarian scientists do not seem to be interested in high success rates as much as their Austrian counterparts, or at least they are more motivated by other factors. Both the Hungarian and Austrian responses about available alternative resources, funding schemes contradict the answers given to the previous question. On the one hand, Hungarian scientists seem to be less optimistic about finding alternative funding, and on the other hand, Austrian scientists do not seem to find this a decisive factor any more. Austrian scientists are more active in initiating cooperation: Hungarian scientists often submit proposals based on the request of their partners – this hardly ever happens in the case of Austrian scientists. This kind of active approach on the part of the Austrians is also reflected in the high number of Austrian coordinators in Framework Programmes.

Question six consisted of two parts: in the first part I was interested in the usefulness of bilateral mobility projects in certain aspects; in the second part I wanted to know how these aspects could be realised by project implementation. In most of the cases realisation met expectations about the usefulness of the projects. Researchers were asked to evaluate the usefulness and realisation of various aspects of mobility projects on a rising scale between “0” and “4”.

Table 47: Usefulness and main results of S&T mobility projects (average)

Aspect	**Usefulness**		**Realisation**
	In Hungary	In Austria	In Hungary
Establishing new contacts	3.16	2.87	3.17
Improving existing contacts	3.71	3.58	3.74
Preparation of other joint proposals	3.39	3.32	3.39
Economic exploitation of scientific results	2.32	1.72	1.98
Preparation of joint publications	3.52	3.03	3.48
Joint publication	3.57	2.79	3.57
Extending scientific network	3.4	3.16	3.12
Contacts with science-policy makers in the partner country	1.98	1.87	1.7
Access to research infrastructures	3	2.54	2.88
Supporting young researchers	3.57	3.32	3.49
Supporting female researchers	2.84	2.91	2.8
Development of intercultural and language skills	2.81	2.37	2.82

*The Austrian survey used different types of data for the usefulness (average of the answers) and realisation (percentages of the answers) of bilateral projects so only usefulness could be compared with the Hungarian results

Source: Bilateral Mobility Questionnaire (annex II), (Schuch, Smoliner, Wagner, Degelsegger, & E., 2013)

Generally speaking, Austrians were less prone to give high marks when evaluating the usefulness and results of the mobility scheme – their scores are typically lower than the Hungarian rating. Similar to the results of the Austrian survey, Hungarian scientists also appreciate the improvements to and extension of existing results as the main advantage of bilateral proposals. This answer was also first on the list of results of mobility projects. Making contacts with science-policy makers in the partner country was low on the list in both countries, it was considered neither as useful nor as a clear result by scientists. Economic applicability of results also received a very low ranking in both countries. The answers given by Hungarian researchers to the question of economic applicability viewed from the perspectives of usefulness and realisation were at the most extreme ends of the rating scale. Austrian researchers are even more negative about economic exploitation of results than their Hungarian colleagues.

Both the preparation of joint publications and joint publication itself were activities that many scientists engaged in, as reflected in the high number of joint publications mentioned by researchers in their answers to the seventh question. Almost all the respondents published jointly during or after their mobility project. In cases in which partners had a long-lasting cooperation the number of joint publications was over 20. Austrian researchers seemed to find mobility projects more suitable for the preparation of joint publications than for publishing itself.

Although the preparation of further joint proposals was also highly evaluated, this is reflected to a lesser extent in the number of joint applications. Although some applications were submitted to European framework programmes, none of the Hungarian respondents could report any awarded FP proposal. They rather submitted new applications to the national R&D support system, and most of the scientists applied for OTKA funds. 50% of Austrian project partners have submitted new applications – in- or outside of the European framework programmes – to continue the cooperation with their partners.

The mobility scheme was assessed as a suitable tool for establishing new contacts, for extending the scientific network, and for supporting young scientists by both countries. Access to research infrastructures in the partner country does not seem to be the main motivation when applying for mobility support, nor does the development of intercultural and language skills. Opinion varies between of Austrian and Hungarian respondents when it comes to the importance of involvement of female researchers in mobility proposals. Its importance is ranked higher in Austria than in Hungary. This is mainly due to the fact that proposals involving female researchers enjoy preference in Austria during project evaluation, which is clearly stated in the call text.

All in all we might conclude that based on the scientists' judgement the main advantages of bilateral mobility projects are the improvement of existing scientific contacts, the high number of joint publications and the involvement of young scientists.

Hungarian scientists were also asked if they were in favour of maintaining the current mobility scheme. Scientists were allowed to mark more answers. Altogether 45 scientists have given one or more answers to this question.

Table 48: Hungarian responses to the question: Shall the bilateral mobility scheme be preserved?

Answer	Number of responses
Yes, because it helps to establish international contacts	41
Yes, because it is a good tool to motivate young scientists	37
Yes, because it facilitates co-publishing and joint applications	31
Yes, because there is no institutional funding for supporting mobility	30
Yes, if grants can be spent in a more flexible way	16
Yes, if administrative burdens will be reduced	14
No, because administrative costs are too high compared to the size of support	3
No, because other support schemes should be developed	3
No, because travel expenses to Austria are low anyway	1
No, because international cooperation materializes anyway	0

Source: Bilateral Mobility Questionnaire (annex II)

As we can see most of the respondents find the S&T mobility scheme even in its current form something to be continued. They mainly support it because it helps to establish international contacts, but it is also considered a good tool to motivate young scientists. Joint publishing and the lack of institutional funding for traveling were also mentioned by the majority of scientists. Around one third of respondents would keep the scheme but would be in favour of some modifications. In certain cases administrative burdens are so high compared to the amount of support that it deters some researchers from further applications.

There were only three scientists, who marked the answer: "No, because other support schemes should be developed", but two more added a remark about the necessity of additional forms of funding research. These researchers do not want to annul the current mobility scheme, they would either expand it further or they would launch calls for funding research additionally.

When travel expenses are not covered by institutional funding, the short distance to the partner country does not seem to help Hungarian scientists to maintain their international partnerships without external financial support. This is an argument against financing mobility schemes that is often used, to the effect that excellent scientists should be in a position to engage in international contacts without national funding. The scientific community itself does not seem to espouse this argument. None of the respondents thought the scheme unnecessary only because international cooperation would materialize even without any support.

The last question was about the willingness of the scientists to submit a new application for mobility support. There were 8 scientists who would not apply again (18% of respondents). Some of them found administrative burdens for application too high. Mobility programmes used to be more simple in Hungary than the current calls for proposals. The text of the last Hungarian Austrian call and guidelines was altogether 37 pages. The same in Austria is four pages. Submission of proposals is also more complicated in Hungary and submission programmes change frequently. Nevertheless 82% of scientists would apply again, slightly more than half of them (20 scientists) with Austria, the rest (17 scientists) with another country.

In Austria 88.7 % of project coordinators continued their cooperation after the end of their mobility projects, and almost half of them exclusively from institutional funds, a third of them by applying for new support, the rest using both institutional funding and support schemes.

As the above responses show the appreciation of the mobility scheme is quite similar both in Hungary and in Austria. Scientists in both countries also agree about the main advantages of mobility financing. However, Hungarian scientists seem to use their mobility network to a lesser degree to submit other joint proposals than their Austrian counterparts.

The possible future of calls supporting the mobility of scientists can be described using a variety of scenarios. Different scenarios serve different objectives and are supported by different arguments.

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Negative scenario: discontinuation of the current mobility programme without developing any new bilateral scheme.

Arguments in favour of this scenario:

- Mobility programmes only finance travel costs of researchers, they do not have any real added value.
- Joint research is not monitored at all, not even in the final accounting phase.
- International cooperation for scientists is a must, it should be financed by the institutions or the scientists themselves.
- The relative cost – in terms of the time and energy of scientists and administrators – of the scheme is too high.
- The Austrian report also recommends to slowly phase out this kind of cooperation in our region.

No change scenario: the current programme would continue without any significant change or improvement

Arguments in favour of this scenario:

- It is a scheme well-known by scientists who are still interested in applying for it, having been in operation for a longer period of time.
- Despite the increasing administrative burden in Hungary, it is still a relatively uncomplicated scheme.
- It is a good and very cost-effective tool to improve existing bilateral contacts, to publish together and to involve and motivate young scientists. Results of my survey show that institutions and scientists often do not possess necessary funds for travelling. A considerable number of contacts would not have been established or would not have been sustained if mobility funding was not available.

In case of loss of interest on the part of the research community or in case of any further increase of administrative burdens, the no-change scenario might shift in the direction of the negative scenario. It might also be developed further in which case it would transform into the *improved scheme scenario*.

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Improved scheme scenario: in this scenario the current mobility scheme would be developed further, but the improvements made to it would not be such that it would change beyond all recognition. The modifications to the mobility scheme can be made in various ways. The programme can be simplified both in terms of administration and financial accountability, which would reduce the amount of time scientists are obliged to spend on filling in forms and would, in all likelihood, increase the number of applications.

The issues of monitoring and high management costs directly follows on the attitude of the authorities in charge of these procedures. In Hungary, instead of a process of simplification, calls for proposals are getting more complicated, rules for participation are getting stricter, which results in an increase of non-scientific work both for the scientists submitting the proposal, and idem for administrators working on and assessing these proposals.

This is a classical principal-agent problem. If available funds are low, the agent is not trusted at all, and the costs for the principal are very high. In such a principal-agent game, the principal should trust the agent instead of monitoring, but this is not the case in Hungary. The Austrian system is simpler and monitoring is solved by a peer-review process: reports of project coordinators are available to be assessed by other scientists of the same field. Professional control by colleagues is scientifically more objective than monitoring by administrators not or insufficiently involved in the relevant scientific field. However, if the principal has not enough trust in the agent this type of improvement is not likely to occur.

A possible stabilisation of the game could occur when a number of concrete and easy-to-control indicators and requirements would be set and monitored that are in line with the principal's objectives (e.g. an increased number of joint applications in European framework programmes) and that would reduce administration. If these objectives are also acceptable for the agents, they will be willing to go along with the principal's objectives rather than considering not applying at all. In this case, both principal and agents would be in a win-win situation.

New scheme scenario: it is also possible to introduce a completely novel scheme to replace the existing one. Introducing new schemes can be made to happen in different ways. One of the ways of introducing a completely new scheme is to extend the bilateral mobility scheme into a regional one. Such a new scheme has already been initiated and set up by BMWFW with countries of the Danube region. The advantage of a regional scheme is that it brings together a higher number of research groups, and that these groups united in a research consortium in the regional scheme, can then more easily apply for European framework programmes. A regional scheme also requires more advanced skills to manage the project and harmonise procedures, quality and other requirements, which is beneficial for successful applications in more complex funding schemes.

Another way to introduce a new scheme is to finance joint research projects instead of mere mobility schemes. Writing a joint research proposal will acquire additional skills in terms of planning joint research activities and setting up budget that is realistic. If the structure of the call and the proposal are in line with EU standards, this would be one more step down the road to successful application in European framework programmes. The main drawback of funding joint research projects, however, is the increased cost of such a scheme, both in terms of budgetary requirements and administration.

V.5.3. Joint Research Projects – The Turkish Example

The performance of the Turkish economy over the past decade has been rather impressive, judged both by its own historical standards and by the performance of the region as a whole (Öniş & Kutlay, 2013, p. 1415). In 2016, with a total GDP of 857.7 billion USD, Turkish economy ranked 17th in the list of world economies (Worldbank, The World Bank Data, 2017). Vision 2023 (Republic of Turkey, 2004), a policy document published in 2004 for the 100th Anniversary of the Turkish Republic, has set the target for Turkey to become one of the 10 largest economies in the world. In order to reach this goal Vision 2023 has formulated recommendations in the fields of economy, health, energy, tourism, as well as research. To increase economic competitiveness, the technological and innovative capacity of the country, Vision 2023 has formulated the R&D targets in such a way that they raise GERD/GDP to 3%, and BERD/GDP to 2% by 2023. The number of FTE of researchers should increase to 300 000, 180 000 of them should work in the private sector. GERD/GDP currently stands at around 1%, but with an impressive average yearly growth of 17% between 2003 and 2013. The current level of BERD is 0.45%, which is also a far cry from the 2% national BERD goal. The number of researchers has just exceeded 100 000, half of them working for the business sector (OECD, 2016).

If we look at the R&D-innovation objectives of the Europe 2020 strategy (EC, 2010a) – the EU's agenda for growth and jobs for the current decade – we can see similarities with Vision 2023 goals. The target of reaching 3% of GERD/GDP to be invested in R&D and innovation clearly leaps to the eye. Compared to the employment target of 75% of the 20-64 year-olds in Europe, Turkey is less ambitious, since they aim to achieve an employment rate of 55%. However, Turkey's aim is to reduce the unemployment rate to 5%. As for the climate change and energy priority, while Europe aims at 20% of energy from renewables, Turkey intends to reach the 30% level; both Turkey and Europe want to increase their energy efficiency by 20%. Although not mentioned in Vision 2023, it is interesting to see that the current drop-out rate in higher education in Europe is 12.8% - Europe 2020 target is 10% - while this number in Turkey is almost 40%. There is also a huge difference in the enrolment to tertiary education: in the EU the current level of enrolment is 35.8% and has a target of 40% for 2020. Turkey currently has a level of 18% (Dávid & Szigetvári, 2017, pp. 144-145).

In spite of similar agendas and strategic targets, the relations between Turkey and the European Union are rife with controversies. Since the creation of the Republic of Turkey in 1923, the country was keen to be part of Europe. Constitutional, political and economic reforms have been adopted to be able to start accession negotiations with the EU. Turkey has been linked to the EU by an Association Agreement since 1964. A customs union was established in 1995. The European Council granted the status of a candidate country to Turkey in December 1999, and accession negotiations were opened in October 2005. At the EU-Turkey Summit in 2015, the two parties decided to deepen their relations in all key areas of joint interest (EC, 2016c, p. 4).

Turkey's eagerness to be involved in the integration process with the EU in the 1960s was rather prompted by political reasons. The reluctance of Europe to take up Turkey is reflected in very long, protracted accession negotiations. For a long time, the main arguments against Turkish accession were summarized as too big, too poor and too Muslim (Dávid & Szigetvári, 2017, p. 142).

Turkish response to the attempted coup of 15 July 2016 has provoked negative reactions on the part of the EU, and, as a consequence, the accession negotiation process stalled. Although the EU acknowledged that the coup represented a frontal attack on democracy in Turkey, and the EU expressed its solidarity to the Turkish democratic institutions, it could not accept the scale and collective nature of measures taken against the alleged perpetrators of the coup attempt. Based on the Screening Report of 2016, an overall backsliding occurred not only in the case of political chapters but also in the case of economic ones. Turkey is only well advanced in the areas of company law, trans-European networks and science and research (EC, 2016c, p. 8). This last chapter, chapter 25, on science and research happens to be the only temporarily closed chapter. It was already closed in 2006, only one year after the negotiations started. This shows that in the area of science and technology Turkey is on a par with European countries.

The last Progress Report of 2016 indicates that Turkey is making good progress when it comes to preparations in the area of science and research. Although Turkey should still prepare a National ERA Roadmap and a National Research Infrastructure Roadmap, progress has been made on its integration into the European Research Area. Turkey has taken action to encourage technology transfer, and there are measures to support innovation and cooperation between academia and industry. However, the role of universities in organizing research and innovation should be further encouraged, in particular by stepping up cooperation with industry and SMEs (EC, 2016c, p. 85).

Turkey participates in the EU's research and innovation programme Horizon 2020 as an associated country, so it enjoys all the benefits of the programme just like any other EU member state. Turkey has a network of national contact points in place, and has representatives in all Horizon 2020 programme committees. Participation statistics show recent improvements, but there is still room for even better results, in the area of scientific excellence (pillar one), and in the area of societal challenges (pillar three). Based on the Innovation Union Scoreboard for 2016, Turkey is a „moderate innovator", and so it is in the same bracket as Hungary (EC, 2016c, pp. 85-86).

Despite several controversies around Turkey's accession to the European Union, the EU is still the best partner for Turkey to reach the goals set by its Vision 2023. Turkey is well integrated in the European Research Area. It is an associated member of the R&D framework programmes since 2002, it participated in and coordinated various scientific projects, policy-coordination actions, mobility programmes, and won grants for excellent researchers. In addition to increased participation in framework programmes, Turkish priorities are to some extent in line with Societal Challenges listed in Horizon 2020: in the Turkish national STI strategy[94] the three vertical and six

[94] In Turkey, the last accepted STI strategy, the National Science, Technology and Innovation Strategy (2011-16) (UBTYS) aimed at strengthening national R&D and innovation capacities in order to upgrade the industrial structure towards high-technology industries. UBTYS targeted competitive sectors with strong STI potential and areas of global demand (energy, water, food, security and space).

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horizontal axes consisted of various scientific areas like ICT, energy, defence, water, food, which have also been set as priority areas in the European H2020 programme (Dávid & Szigetvári, 2017, pp. 149-152).

Both EU member states and associated countries of the framework programmes foster the successful participation of their scientific community in Horizon 2020 by providing various support mechanisms. There are three major types of support structures. Countries can align their own national support system with EU priorities and funding schemes, they can provide professional advice and support during the application procedure, or the national government provides funds to motivate researchers to apply in programmes of Horizon 2020. The Turkish government provides a mixture of these three mechanisms. National Contact Points under the Scientific and Technical Research Council of Turkey (TÜBITAK) are mainly responsible for giving information and advice during proposal preparation. As excellence remained an important pillar of Horizon 2020, and both OECD and the Innovation Union have criticized Turkey because of its low performance on innovation and excellent research, some new policy tools have been developed to achieve better results in the area of excellent science. TÜBITAK facilitates applicants to participate in ERC grants and Marie Skłodowska-Curie (MSC) Actions by providing support and training facilities to enhance the quality of actual project-proposal writing, pre-evaluation and interviewing. In this way Turkey hopes to make the project-preparation phase more successful. An award with the name *Above Threshold Award* provides financial support for proposals that rank high in the final evaluation, but are nevertheless not selected for financing. Turkey in this way attempts to alleviate the efforts it takes to apply, and increase the chance for financial support from national funds. The *ERC Success Awards* top up ERC grants with additional national budget. The *Success and Above-Threshold Award* is also made available to participants and coordinators of any type of Horizon 2020 projects to motivate them to re-submit their proposals. There are Turkish mobility schemes, which are developed in line with MSC Actions. These mainly facilitate the reintegration of Turkish scientists, or offer a possibility to visiting scientists from abroad to carry out research in Turkey.

The Horizon 2020 priority areas of Future and Emerging Technologies, Enabling and Industrial Technologies, as well as the thematic fields of Horizon 2020's Societal Challenges, are all taken into due consideration in the national priorities of Turkish science policy documents. Turkey is not only a member country of ESFRI, the European Strategy Forum on Research Infrastructures, but

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Turkey also takes its national decisions on new infrastructures in accordance with the guidelines of the Forum.

TÜBITAK 1512, a support programme for individual entrepreneurs, was developed to facilitate the successful participation of Turkish enterprises in the SME instrument of Horizon 2020. The phases and the structure of the two programmes are the same: in the first phase a feasibility study has to be developed and submitted, which is then followed in a second phase by the realisation of the innovative project idea and the development of a prototype. Commercialisation is facilitated in the last, third phase. The Turkish model can be a good test bed for local SMEs to get acquainted with the more robust competition on EU level.

TÜBITAK is also keen on using its bilateral cooperation agreements and programmes to facilitate the participation of Turkish researchers in European programmes by using the same evaluation and selection criteria, defining similar policy objectives, and developing comparable application forms to the ones used in the framework programmes. The new type of call for proposals that was launched together with Hungary in 2017 follows the same structure.

In order to show the development of the bilateral cooperation between Hungary and Turkey, the main milestones of the cooperation will be introduced in the following paragraphs. The intergovernmental Agreement on Scientific and Technical Cooperation between the government of the Hungarian People's Republic and the government of the Republic of Turkey was signed on 5 June 1989 in Ankara. This agreement provided the general framework for scientific cooperation between the two countries. As an executive document of the general agreement, a Protocol on Cooperation in Science and Technology was signed by the Scientific and Technical Research Council of Turkey (TÜBITAK) and the National Office for Research and Technology (NKTH) of Hungary in 2005. This Protocol regulated the manner of cooperation between the two countries, which was mainly limited to funding the mobility of scientists at the time the document was signed.

After signing the Protocol[95] calls were regularly launched for mobility proposals, every second year in 2006, 2008 and 2010. The total amount of funding decreased by every call – in 2006 the available amount for the call was 50 million HUF, in 2008 it decreased by 10 million to 40 million

[95] There were also similar calls for proposals before the new protocol was signed but I only focus my analysis on the calls after 2005.

HUF, and in 2010 the allocated fund for the call was only 20 million HUF.[96] The number of supported projects has also decreased from eight to three. However, funding per project has increased from 4 million to 5 million HUF by 2008. Due to internal reorganisation processes in Hungary the proposals submitted in the last call in 2010 were only evaluated in 2012. The reorganisation resulted in a longer gap in the bilateral cooperation, the next open call was only launched in 2015.

The calls between 2006 and 2010 laid due emphasis on joining larger international consortia and building up international networks. However, there was no indication to the participation in European programmes, although both Hungary and Turkey had already joined the framework programmes by that time. Bilateral cooperation and multilateral cooperation in European schemes were more separate worlds in those years.

After the establishment of the National Research, Development and Innovation Office in 2015 the bilateral cooperation with Turkey re-started. The scheme did not change much on the Hungarian side: the funds allocated to bilateral cooperation was 30 million HUF[97] and mainly mobility-related costs were eligible for funding. However, TÜBITAK altered the scheme considerably: Turkish scientists were allowed to receive funding not only for costs for mobility, but for research activities as well. Raising the amount of funding on the Turkish side resulted in strict evaluation procedures and a low success rate: only one out of the twenty eligible proposals was recommended for funding.[98]

After these results Hungary and Turkey decided to switch from mobility financing to project funding at the end of 2016, during the Joint Committee meeting between NRDIO and TÜBITAK. In order to avoid different evaluation results, the two partners agreed about developing a joint call text, application forms and evaluation criteria. The structure and content of the new application form as well as evaluation criteria were harmonised with the structure and content of European programmes, with the aim of encouraging scientists to jointly submit projects to framework programmes as a next step.

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[96] Due to the changing exchange rates the amounts in Euro slightly differ: the amount of dedicated support in 2006 was about 190 000 Euro, in 2008 160 000 Euro and in 2010 only 72 500 Euro.
[97] 30 million HUF is around 100 000 Euro.
[98] The Hungarian evaluators would have supported 10 proposals.

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Scientific priorities of the call, Health, ICT and Environment, were partly determined by joint participation in previous framework programmes. Environment related research has ranked first in projects with Turkish-Hungarian participation in Horizon 2020 (see table 42). The other two areas were defined based on co-publication analysis: Health and medical sciences produced the second most co-publications with Turkish-Hungarian authors, while the number of co-published articles in the field ICT/engineering ranks third.[99]

The importance of European framework programmes in international cooperation has grown in tandem with the funding available in these programmes. As we have seen in this chapter, this steadily increasing importance is also reflected in the recent history of Hungarian-Turkish bilateral R&D cooperation. The simple mobility scheme of 2006-2010 was first changed into a joint mobility programme that favoured proposals with a potential for later H2020 funding. The current programme was developed in such a way that applications can be easily submitted with the same content to Horizon 2020.[100]

Bilateral scientific cooperation with Turkey is a special case. On the one hand, Turkey is not an EU member state, so it can be considered as a third country. In Hungary there is a trend that prefers research funding over mobility funding, but there are such open calls only with third countries and not with European countries. So launching a call with Turkey that covers the costs of research was in line with this policy. On the other hand, Turkey is an associated country of Horizon 2020, it enjoys the same rights as ordinary member states, so it can be considered as a European country in this regard. This was also the reason for the development of a new type of call for proposal between the two countries, which was very much in line with European schemes.

As we have seen science and research is the strongest link of Turkey to Europe. Turkey is motivated to further strengthen this link as much as possible. The combination of research funding with

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[99] Most articles are co-published in the field of physics and astronomy, but the joint call favoured project ideas with an applied science character, and most of the articles on physics were related to basic research. Co-publication data was presented by Hakan Karatas, Director for International Cooperation at TÜBITAK in December 2016 in Budapest. TÜBITAK used SciVal Database of 2016 during their analysis.

[100] There is a need for a larger consortium and a matching call for proposals for successful applications in Horizon 2020.

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European-type call schemes will hopefully result in jointly prepared and submitted proposals that can be successful on the European level, which is the interest of both Hungary and Turkey.

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VI. Conclusions

VI.1. Setting the Agenda of International Science Policy in Hungary and in Europe

This thesis has set out in some detail all the institutional turbulences and their effects on the Hungarian scientific environment up to 2018. In spite of all the efforts at modernisation and reorganisation, both the institutional landscape and the programme portfolio of responsible organisations have hardly changed after the systemic change. However, constant uncertainty, lack of stable funding, frequent change of rules and regulations have had a detrimental effect on the scientific environment, especially on international cooperation, an area in which partners from abroad have in their turn also been subjected to national reorganisations. Hence, long-term stability, and a reliable institutional and funding environment would be amongst the most important conditions for improving the efficiency and impact of Hungary's scientific actors.

As of June 2018, when I finished collecting data for this thesis, the main organisation responsible for science policy in Hungary was the National Research, Development and Innovation Office (NRDIO). It was the main government institution responsible for setting the science policy agenda in Hungary. NRDIO conforms to the ideal public model as described by the OECD (Henriques & Larédo, 2013) in that it is responsible for planning, priority-setting, budgeting and administration, and in that it launches and manages scientific calls for proposals in line with the priorities set by itself, which are financed by NRDIO's own budget. The main advantage of such a powerful institution is the efficient way in which it can control all the processes involved in science policy making and managing. The main disadvantage is the lack of any external scientific control mechanism.

The Hungarian R&D landscape represents a less than ideal picture if we analyse it using the ideas of the post-modern research system described by Rip and van der Meulen (Rip & Van der Meulen, 1997). In their view, a post-modern research system should be based on the principles of dialogue, cooperation and trust between government and scientists, and not on the principles of mere controllability, efficiency and interest. On top of this, learning and adaptation, a minimum of intervention and a maximum of flexibility should also be key elements of such a research system.

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In it, the role of the central government should be restricted to the creation of necessary conditions for cooperation and to the distribution of funds to finance research after due negotiations with the scientific community. However, the current mechanism of operation of NRDIO is rather characterised by very detailed and strict regulations, strong intervention and tight control and supervision.

From the point of view of the principal-agent game theory (Rip, 1994), the Hungarian case can be considered as a double principal-agent game. In the first game the Hungarian government is the principal, whilst NRDIO is the agent that is monitored by the Prime Minister's Office. In the Hungarian case the principal is interested in evidence based planning, effective management and payments according to tight time-tables. The agent has to comply with these requirements put down by the principal, because its mere existence is not independent of the principal. This first principal-agent relationship also has an impact on the second game in Hungary's double principal-agent game model.

In this second game, in which NRDIO is the principal and the Hungarian research communities represent the agents, NRDIO as the principal has a clear preference for monitoring over trust, and compliance with its rules over bending its regulations. In this game scientists have to compete for scarce resources, whereas the cost of monitoring and reporting is very high both for the principal and for the agents. Lowering the costs of the monitoring process, and stabilizing the game could be achieved by moving towards the more customary peer-review system as a way of quality control. However, NRDIO has opted in favour of a monitoring process carried out by civil servants, a process which is both expensive and is perhaps in some cases insufficient in terms of the scientific content brought to bear on the quality assessment procedures. Strict monitoring by civil servants tends to result in complicated and rigid procedures and regulations, which in turn make flexible responses and reasonable adaptations to requests on the part of the scientific community next to impossible. The principal-agent game could also be stabilised by setting the objectives in a joint manner, involving scientists in such a way that the objectives are accepted both by the agent and the principal alike. In this context, attempts at stakeholder consultation and regular dialogue between civil servants and scientists have been made, but due to the rigidity of the system, any results coming out of these negotiation processes rarely are implemented in policy documents. By far the largest number of the attempts at flexibility in joint priority-setting are scuppered by the existing institutional practices. It seems that the Hungarian R&D system is characterized by strong path dependency.

Scientific cooperation in the European arena can also be described as a principal-agent game, in which the European Union is the principal, and members of the European scientific community are the agents. Similar to the Hungarian case in itself, the EU favours competition and strict compliance to rules, and it is also well known that tight bureaucratic control on the part of the Commission is very much a characteristic of the system. European science and technology policy often adds to the political and institutional complexity of science and technology policy-making without actually helping to decrease the problem-solving capacity of the member states. Nevertheless, there is a clear European added value of collaborative projects and various types of partnerships initiated and supported by European framework programmes in order to tackle global challenges.

EU science policy has a substantive impact on national science policies. It does so in various ways. First, in centrally planned, managed and funded European framework programmes, the EU plays the role of a policy entrepreneur by setting the research agenda. This role of the EU as policy entrepreneur has been increasing in tandem with the growing importance of international cooperation and the increasing amount of funds allocated to framework programmes.

Secondly, in countries such as Hungary the importance of financial resources deriving from the European Structural and Investment Funds (ESIF) is crucial. Only less developed regions, often with lower absorption capacities, are entitled to benefit from ESIF. Most of the excellent research institutes, universities and innovative companies are located in the more developed Central Hungarian region, which is not entitled to support from ESIF. If the government wants to guarantee equal treatment and possibilities for all regions, they need to finance the developments in Central Hungary by national funds. This all goes to show that national programmes and national budgets are also to a large extent determined by the agenda setting on the European level by European institutions. This impact on agenda setting of national programmes on the part of the European Union is further increased by the potential synergies between European framework programmes and Structural Funds, a synergy that is encouraged by the European Commission.

The conclusion of this overall situation is that the impact of European international science policy in actual fact is very substantive, more or less obliging national science policies and programmes to be brought in line with European science policy, and to complement the policies coming from the European Union. Seen from the opposite perspective, this situation severely restricts the impact any national agenda-setting can exert on the international R&D agenda.

Several clear cases in the history of Hungarian science policy has brought to light that limited resources can only be spent in an efficient way if they are targeted towards those scientific fields in which Hungary already excels. Be this as it may, the deeply entrenched and diverse interests of existing research institutes turn the allocation of limited available funds into a very complicated matter for policy makers. The pressure to give financial support to scientific centres of excellence on the one hand, and the pressure to take due account of the political goals of equitable distribution and capacity-building on the other hand, always continues to give rise and maintain uncomfortable tensions between the various stakeholders involved in the management of the distribution of the available funds, be they coming from the European Union or the national government.

These limitations put on the scope of international agenda-setting for national governments can to a certain extent be overcome by building coalitions and joint priority-setting. In the case of Hungary, it is clear that Hungary on its own lacks the gravitas to successfully put an issue on the European research agenda if it is not backed up by other countries. For this reason Hungary seeks to broaden its sphere of influence by actively looking for scientific challenges that enjoy shared support within the wider region. This mechanism justifies the cooperation with EU13 countries. Over and beyond regional alliances, good contacts with traditional partner countries in Western Europe, like Austria and Germany, are also expected to increase the likelihood for Hungary to open up windows of opportunity, to put themes on the research agenda, and to mobilise the necessary political goodwill and financial resources in order to facilitate the practical implementation of items on the research agenda.

The network of Hungarian science attachés abroad also plays an important role in supporting bilateral cooperation, establishing new contacts, representing the interest of Hungary and Hungarian scientists in partner countries. Nevertheless, the potential of the network is not used in an optimal way: in recent years science attachés miss clear guidance and professional advice from their home departments (e.g. NRDIO, MFAT). The role of the network of science attachés is also changing considerably. On the one hand more emphasis is put on their role in science for diplomacy

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over diplomacy for science, whilst on the other hand innovation and industry-related activities are growing in importance.

VI.2. Impact of International Political Events on Scientific Cooperation

The history of Hungarian science policy over the past centuries has provided sufficient evidence that significant international political events have a major impact not only on national but also on international science policy issues of the country. International political events set the general backdrop against which any national science policy must inevitably be filled out. It is incumbent on the science policy makers living in these political state of affairs and changes to turn challenges into advantages.

The following brisk overview of political events having had a major impact on Hungary's science policy, discussed in more detail in the main body of this thesis, will provide a picture of the way policymakers have turned potential negative impacts of political events on science policy into more positive opportunities.

After the tremendously negative impact of the treaty of Trianon in the 1920s, it was because of the resilience and the efforts of Kuno Klebelsberg and Zoltán Magyary that a network of Hungarian research centres and Hungarian faculties were established in the most important European capitals. The strong governmental support given to international scientific cooperation shifted the balance from what to all intents and purposes seemed a traumatic political event in favour of a positive approach to science policy. The stamina of both these Hungarians turned the period after the treaty of Trianon into a veritable Golden Age for research in Hungary. The institutions that were established in this period were managed by excellent scientists and science diplomats, who enhanced both the reputation of Hungarian science and of Hungary in general.

After WWII the communist regime had a considerable impact on the scientific landscape in Hungary. The Hungarian Academy of Sciences was substantially reorganised to fit the regime's needs, new institutions were established, universities were forbidden to carry out research, and all scientific output was planned and controlled by the Communist Party. By 1956, most of the scientific contacts with non-socialist countries were severed, and international cooperation was

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almost completely limited to bilateral cooperation with the Soviet Union. This dire situation changed during the 1960s, a period of opening up in which international cooperation was encouraged, even with capitalist countries, and in which the first bilateral intergovernmental scientific cooperation agreements were signed.

Framework conditions for international scientific cooperation significantly altered after the systemic change. In the 1990s new bilateral agreements were signed, Hungary joined international research organisations. Hungarian scientists already participated in the 4th Framework Programme of the European Union in 1994, 10 years before Hungary's accession to the European Union.

After 2004, framework conditions for international scientific cooperation again took another turn. Hungary was promoted from the status of an underdeveloped and poor transition country into a Member State, i.e. an equal partner with equal status, rights and obligations as the other Member States. Hungary and Hungarian researchers lost their preferential access to funds, and they had to compete in European framework programmes on an equal footing as all the other Member States of the European Union. Joining the EU also had a major impact on bilateral cooperation with other Member States. For international cooperation many European countries give preference of employing existing European schemes, mainly framework programmes, over bilateral schemes. Extant bilateral and regional programmes mainly aim at joint participation in larger schemes such as the framework programmes, too. Although the European budget for R&D is still relatively modest in comparison to national budgets, its weight and importance in international scientific cooperation inside of Europe has proven to be significant.

Being a Member State of the European Union also affects national science policy decisions via European-wide strategies, initiatives and programmes, which directly or indirectly have an effect on international cooperation. The European Research Area, more concretely its implementation document, the ERA Roadmap 2015-2020 encourages Member States to develop and implement National Action Plans, which – because of the sixth priority of the ERA concept – also refer to international cooperation. Although Hungary has not developed its National Roadmap yet, but the six ERA priorities are integrated in national strategy making. The research and development target of the Europe 2020 strategy, namely reaching an average 3% GERD/GDP level in Europe resulted in the national target of 1.8% GERD/GDP in Hungary. Such an increase of public expenditure on R&D could positively influence the whole scientific landscape in Hungary. The national Smart

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Specialisation Strategy, influencing national and international calls alike, was developed as a precondition for European Regional Development Fund (ERDF) allocation. A high percentage of open calls are funded by ERDF in Hungary.

Following from this it is fair to say that Hungary's membership in the European Union not only has an impact on its science policy development and objectives, including bilateral and multilateral scientific cooperation of researchers, but also on budgetary decisions.

VI.3. Modalities of Scientific Cooperation

Bilateral scientific cooperation is typically based on intergovernmental agreements or Memoranda of Understanding. Such agreements provide a very general framework for cooperation. The details of implementation are fully dependent on the interests of the two partner signatories. On the national governmental level, Hungary is involved in bilateral mobility financing, bilateral research funding, and regional cooperation programmes.

The lack of an international S&T strategy with clear national priorities makes it unlikely that Hungary is in a position to initiate novel ways of cooperation. Instead of which Hungary as a rule is joining successful programmes, proposed by its partner countries, or it makes use of already established forms of cooperation. The general framework for cooperation is thus set either by the European Commission or by individual partner countries, in which latter case the areas of cooperation and rules for participation are jointly agreed upon by the partners involved. This phenomenon very well reveals that even a strong, centralised institution, such as NRDIO, is not in the position to have a substantive impact on bilateral relations if it does not cleave to a clear and well-thought out strategy. As long as international cooperation activities are backed up by ad-hoc measures instead of well-defined long-term priorities, it cannot realistically be expected that the participation of Hungary in European programmes will be increased.

If we want to summarize developments in Hungarian international science policy in recent years we might conclude that complicated and time-consuming intergovernmental agreements are generally replaced by inter-institutional forms of cooperation, bilateral schemes are often substituted by multilateral, regional programmes, and that funding joint research projects are

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preferred over financing mobility schemes. As a next step, many of the nationally financed schemes of scientific cooperation aim at an increased participation in larger – typically Europe-wide – programmes. Furthermore, there is a trend for bilateral cooperation to be replaced by participation in European programmes. However, bilateral scientific cooperation also has advantages of its own that justifies its existence even between European countries over and above larger multilateral European programmes. Single countries will have their own idiosyncratic priority areas, challenges and interests, other than those identified on the European level. It can potentially be far more efficient and substantially more simple to set common targets and to agree about joint priorities only based on the scientific interest and preferences of the scientific communities in the two countries involved. The task of science policy makers, to represent the national interest and to create favourable conditions for cooperation on selected priority areas, is easier on a bilateral than on a multilateral level. So bilateral scientific cooperation in its traditional forms also prevails.

Although providing financial support for the mobility of researchers is often criticized by policy makers, it remains a modality of funding well-favoured by scientists themselves, who frequently apply for it. It is considered to be an effective and relatively inexpensive tool to improve existing bilateral contacts, to write joint publications, and to involve and motivate young scientists. The necessary national funds for travelling are as a rule not available to Hungarian institutions and scientists, so a considerable number of contacts would not have been established or sustained if funding for the mobility of researchers on the basis of memoranda of understanding had not been available.

The relatively heavy administrative burden and costs of such mobility schemes could be decreased by an overall simplification of the rules and regulations. The efficiency of such schemes could be enhanced by a more clearly targeted approach and follow-up (e.g. supporting young scientists, developing more elaborate R&D indicators, encouraging the further cooperation in European framework programmes).

A possible way to extend bilateral mobility schemes is to turn them into regional schemes, e.g. for Hungary with countries of the Danube region. The advantage of a regional call is that it brings together a number of research groups, who can jointly submit a proposal to European framework programmes as members of an already existing research consortium. Participation in regional calls also requires advanced skills to manage and harmonise procedures, which is an added benefit when it comes to successful applying for more complex funding schemes. Submitting research proposals to European programmes is therefore often a requirement of such regional calls for proposals.

Another way of international scientific cooperation is the joint funding of research projects, which is typically a form of cooperation with third countries, i.e. countries outside of Europe. Partners need special skills to write complicated research proposals, plan timelines of activities and budgets, which can be seen as a preparation for the participation in more complex schemes. Another advantage of such programmes is that thematic fields are defined by the partners based on their mutual interests and existing cooperation. This increases the likelihood of obtaining sound and excellent scientific results, which is beneficial for both countries involved. The main drawback is the high cost of participating in such schemes both in terms of matching budgets and administrative burdens.

This thesis has described and analysed three countries as examples of the three ways of bilateral cooperation. Austria and Hungary have continued to support the exchange of scientists by funding the costs of mobility of researchers. The scheme is highly appreciated by the scientific communities in both countries as an excellent tool to improve existing bilateral contacts, to publish together, and to involve and motivate young scientists. Both Hungary and Austria are in favour of prioritizing the continuation of mobility projects in larger European projects, a position that is reflected in new call texts. Extending part of the current scheme and jointly participating in a regional programme for Danube-region countries has also been planned in recent years.

Germany decided to stop bilateral mobility financing in 2004, and launched a regional funding scheme for Central-European and Southeast-European countries. Currently Hungarian scientists either cooperate with German colleagues in regional or European schemes on a bilateral basis, or they use existing bilateral inter-institutional and personal ties to jointly apply for funding in European programmes. So in the case of Germany, European programmes have taken the place of dedicated bilateral schemes for cooperation.

Turkey and Hungary have decided to switch from bilateral mobility financing to project funding in 2016. The two partners prepared and launched a new type of call in 2017, which funds research projects in the fields of health, ICT and environment, which priority areas were decided upon based on the results of cooperation in European programmes. The new application form as well as

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evaluation criteria have a similar structure to EU programmes, which encourages scientists to submit projects jointly to framework programmes.

VI.4. Costs and Benefits of International Cooperation

It is a commonplace to state that modern research and global challenges are increasingly complex and demand an ever widening range of skills. Scientists need to cooperate more and more to produce new scientific knowledge that meets the expectations of excellence, impact and applicability. International cooperation has become easier due to various factors such as the growing importance of open access, online publications and databases, new communication tools, an increasing number of scientific conferences and networking events, increased mobility.

A direct advantage of international cooperation is the access to funds provided by international programmes, such as the European framework programmes. International co-publications are not only encouraged by such programmes, but they are the most immediate and measurable results of international cooperation. Because excellence is one of the main evaluation criteria of these programmes, members of collaborative project consortia will have access to the most recent and excellent research results. As the conclusions of the survey about the Austrian-Hungarian mobility scheme have shown, in addition to co-publishing and networking, the motivation of young scientists is another added value of international cooperation. Becoming a highly appreciated member of international scientific networks can guarantee constant knowledge-flow and enhanced funding possibilities. Internationally well embedded, excellent scientists can also serve science for diplomacy purposes. Another indirect benefit of such cooperation might be the dissemination and transfer of acquired knowledge both in the scientific community and in the wider public. Technology transfer might also lead to profitable industrial applications.

The issue of profitability also raises the question as to what extent fundamental research with long-term benefits is to be distinguished from innovation related activities with short-term and immediate results and how these two forms of science should be supported. Benefits from basic research can not be predicted and might only be realised in the longer run. At the same time, real breakthrough innovation is often based on the results of fundamental research activities.

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Controversially enough, risky, long-term basic research needs stable, long-term financing. Curiosity-driven research needs maximum autonomy, so unlike applied research and technological development, it should not be influenced in a top-down manner. Applied research activities might be targeted by thematic calls in order to respond to social and economic needs. Basic research, applied research, technological development and innovation are not contradictory, conflicting concepts, their results should rather contribute to a dynamic knowledge flow.

Nevertheless, research cooperation also has certain additional costs: scientists have to spend their precious time on writing proposals, attending international meetings, do project reporting, instead of spending their time on conducting research. The increasing importance of international cooperation is also reflected in the growth of funds allocated to international collaborative projects. These larger amounts of available funds have resulted in stricter conditions and tighter control, in compulsory reporting, in more complicated evaluation requirements, and in more bureaucratization. The tension between the need for better management and control on the one hand, and the academic culture of intellectual autonomy on the other hand has increased by the emergence of a new, international level cooperation and of subsequent management and control.

In certain cases international cooperation is a conditio sine qua non, but in some cases it is not per se obligatory. Science policy makers and programme managers have to take into consideration both the costs and benefits when taking decisions about the appropriate magnitude and allocation of support for research cooperation. The modalities and key priority areas of cooperation should not be determined by civil servants managing funding programmes, or drafted by policy makers, but by real social needs for which scientific experts know in which direction to look for solutions. And for this to happen it is not always mandatory to work in large international projects, smaller-sized projects can also fit the bill in a better, and less expensive way.

Competition on a global scale for the benefits from international knowledge creation is starting to increase. National efforts are needed to develop favourable research conditions and capabilities in order to make the country an attractive choice for researchers seeking for cooperation. The questions of where the knowledge is created and its result applied are of equal importance. Global knowledge creation is mainly beneficial for the most developed countries, which can offer excellent research infrastructures, laboratories, and the most rewarding and the best publication opportunities for scientists.

For countries like Hungary with a smaller scientific community, limited budget and less developed research infrastructures, the challenge to acquire the knowledge created at the global level and to apply it to specific local needs is of pivotal importance. Open calls for proposals offer equal opportunities for small and large countries because the selection of scientists is mainly based on the criterium of scientific excellence. The necessary preconditions for scientific excellence would be skill development, life-long learning and a strong education system. Based on European Innovation Scoreboard data, Hungary currently performs well below the EU average in these fields, which diminishes the chances of the country to catch up.

Small countries, like Hungary, do not possess the means to become excellent in every scientific field. They have to set priorities based on local needs, resources and national excellence in niche areas. Smart specialisation strategies are intended to serve this goal but the current national smart specialisation strategy of Hungary is far too general in scope, covering all scientific fields, open for any region in the country. The next national smart specialisation strategy should be far more narrowly focused, built on local strengths, niche competences and human resources, and support schemes should be planned along the same priorities. At the same time, international cooperation allows access to a larger, more global knowledge base, ensuring joint scientific activities and technology transfer also in fields outside of any national priorities. A prime example for the necessity of joint efforts and proper prioritisation are large research infrastructures.

If countries like Hungary will not succeed in obtaining a good position in the increasingly competitive playing field of science and science funding, the divide between less and more developed countries will only grow wider. In order to increase the competitiveness and hence the social wellbeing in the country Hungary should create a favourable environment for science. In addition to provide stable framework conditions inside the country, both bilateral and European level cooperation should be enhanced in order to ensure the efficient uptake of the results of technological development and innovation and of the knowledge that is created internationally.

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Összefoglalás

Disszertációm célja a magyar nemzetközi tudománypolitika bemutatása volt, különös tekintettel a 21. század első két évtizedére. Alapvetően három kérdésre kerestem a választ: (1) Mely intézmények és szereplők határozzák meg a nemzetközi tudománypolitikát, s ezek hogyan hatnak egymásra? (2) Hogyan befolyásolják a nemzetközi politikai események – különösen Magyarország európai uniós csatlakozása – a nemzeti tudománypolitikát? (3) Hogyan változott Magyarország kétoldalú együttműködése hazánk európai uniós csatlakozását követően?

A jelenlegi magyarországi *intézményi struktúra* jól leírható a megbízó-ügynök elmélet segítségével: az első játszma a kormány és a Nemzeti Kutatási, Fejlesztési és Innovációs Hivatal (NKFIH), a második az NKFIH és a magyar kutatói közösség között zajlik. Mindkét esetben a viszonyrendszert a bizalom hiánya, erős kontroll és magas monitoring költségek jellemzik. A második játszmát stabilizálhatná, s ezáltal a költségeket csökkenthetné a kutatói közösség erősebb bevonása a prioritások meghatározásába.

A 20. századi magyar tudománypolitika áttekintése több példával is szolgál a jelentős *politikai események*, illetve az adott korszakban élő politikusok nemzeti tudománypolitikára gyakorolt hatására. Mindezek ellenére, az 1989-es rendszerváltást követő időszakot erős útfüggőség jellemzi. Bár számos kísérlet történt új támogatási eszközök bevezetésére, a meglévő intézmények átalakítására, a rendszer végül mindig reprodukálta a korábbi intézményi struktúrát és program-portfóliót. Az átalakulásokat követő állandó bizonytalanság mindeközben kedvezőtlenül hatott a – főként nemzetközi – tudományos kapcsolatokra. Nem túlzás azt állítani, hogy a hosszú távú kiszámítható intézményi és támogatási struktúra lenne az egyik legfontosabb előfeltétele a magyar tudományos élet hatékonyabbá tételének.

Magyarország európai uniós csatlakozása nem csupán a kétoldalú nemzetközi tudományos együttműködésre, de a nemzeti szintű tudománypolitikai döntésekre is *hatás*t gyakorol: az európai uniós kutatási keretprogramokban való részvétel mellett az Európai Strukturális és Beruházási Alapokból érkező, hazai felhasználású források tervezése is európai prioritások mentén valósul meg. Magyarország EU-tagsága hagyományos kétoldalú tudományos együttműködéseit is befolyásolta. Hazánk csatlakozását követően ugyanis a többi tagállam már nem átalakulóban lévő, támogatásra szoruló országként, hanem egyenrangú partnerként tekintett ránk. A tézisben három országpéldán keresztül mutatom be a kétoldalú tudományos együttműködés különböző formáit: a német esettanulmány jól példázza, amikor egy EU-tagállam az európai programokkal helyettesíti a hagyományos kétoldalú együttműködést. Az osztrák példa azt mutatja be, hogy a kutatói mobilitás támogatása hogyan segítheti elő az európai programokban való részvételt. A török példa különlegességét az adja, hogy Törökország nem EU-tagállamként harmadik országnak tekinthető, miközben a keretprogramokhoz társult országként a kutatás területén a tagállamokkal megegyező jogokat élvez. A közös kutatás finanszírozása pedig segíti a sikeres fellépést az európai színtéren.

A nemzetközi tudománypolitikai döntések tervezésekor az európai kutatási keretprogramok pozitívumai – pl. kiválósági hálózatokhoz való hozzáférés – mellett tudatában kell lennünk a kétoldalú együttműködések előnyeivel is. A kétoldalú programok rugalmasabbak, nagyobb teret engednek a prioritások közös meghatározása, a nemzeti érdekek képviselete számára.

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Summary

This dissertation aims to discuss international science policy in Hungary in the beginning of the 21st century up to June 2018. It addresses three main research questions: (1) Which institutions and actors are involved in, responsible for, and interact in setting the agenda of Hungarian and European science policy? (2) In what way do international political events have an impact on national science policy with special regard to Hungary's membership of the European Union? (3) How, after Hungary's accession to the European Union, do the main forms of bilateral scientific cooperation benefit from, adapt to, or are resilient to the European setting?

The current institutional framework in Hungary can be described as a double principal-agent game, one between the Government and the National Research, Development and Innovation Office (NRDIO), and another between NRDIO and the Hungarian scientific community. Both games are characterised by a lack of trust, pervasive control and high monitoring costs. The second game, the one between NRDIO as principal and the scientists as agents, could be stabilised and rendered more cost-effective by actively engaging the scientific community in setting research priorities.

A historical overview of Hungarian science policy since the beginning of the 20th century provides evidence of the impact on national science policy of both political events and the policy makers living in such periods of upheaval. Nevertheless, analysis reveals a strong path dependency of the science policy system in Hungary after the change of regime in 1989. In spite of all the efforts to introduce new instruments and reorganise institutions, the policy process has continued to reproduce more or less the same type of institutional settings and funding portfolios. Even worse, constant reorganisation has provoked an uncertain and unstable policy environment, which has a detrimental effect on the scientific community and its capacity for international cooperation. Long-term stability would benefit the efficiency and impact of Hungary's scientific system.

Hungary's accession to the European Union has had a major impact on its science policy, in that its national science policies have been adjusted to EU schemes: European priorities determine both competition-based participation in European framework programmes as well as participation in national funds shaped on the back of European Structural and Investment Funds. Hungary's EU membership also altered cooperation with its traditional partners in bilateral alliances. Since its accession, Hungary is no longer seen as a country in transition in need of additional support, but instead as a partner on an equal footing with the rest of the EU Member States. Three examples in this thesis unwrap the different forms of bilateral scientific cooperation. The example of Germany shows how some Member States employ European programmes to replace traditional bilateral cooperation. The example of Austria points out how mobility projects can pave the way for participation in European schemes. And the example of Turkey demonstrates how joint research cooperation with a non-EU Member State associated third country can contribute to increasing successful participation in European programmes.

Participation in European framework programmes has its obvious advantages, e.g. access to excellent scientific networks and knowledge, but at the same time there are certain inalienable assets to bilateral cooperation, such as flexibility, setting joint priorities, adapting solutions to local needs, that policy makers would do wise to be sensitive to when planning international science policy on a national level.

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Annex I. Questionnaire with Hungarian Science Attachés

(English translation)

1. When were you a science attaché?
- Before 1990
- Between 1990-2000
- Between 2000-2010
- After 2010

2.a How much time did you spend on the tasks listed below? When answering this question, please also show the relative importance of the tasks! (Possible answers: no time; a bit; quite some; a lot)
2.b What results have you achieved in the fields below?When answering this question, please also show the relative importance of the results! (Possible answers: no result; a bit; quite some; a lot)

- Reporting about the R&D programmes, international relations and important R&D events of the host country;
- Networking, partner search, matchmaking both on the inter-institutional and intergovernmental level (agreements);
- Representation, information, promotion, PR;
- Delegations, organisation of visits, cooperation with scientific stakeholders of the host country;
- Hungarian scientists' network, building up networks of Hungarian scientists living abroad, supporting their reintegration into the Hungarian STI environment;
- Enterprises, supporting Hungarian enterprises, searching for partners and investment opportunities;
- EU Member State, representing Hungary as a Member State of the European Union.

3. Which function in the area of science diplomacy was the most decisive for your work?
- Science in diplomacy: science based policy advise
- Science for diplomacy: using existing good RDI contacts in order to establish other forms of cooperation between the two countries
- Diplomacy for science: using diplomacy for improving scientific cooperation

4. Typically which party initiated the cooperation?
- Hungarian governmental institution
- Hungarian scientific community
- The science attaché
- Foreign partner governmental institution
- Foreign scientific community
- There is a balance between national and foreign initiatives
- Other:

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5. Who/Which institution had the largest impact on your work? Please rank your answers! (1. = least impact, 5. = most impact)
- Ministry of Foreign Affairs and Trade (and predecessors)
- National Research, Development and Innovation Office (and predecessors)
- Ambassador
- Partner ministry
- I am quite independent

6. Has there been any significant change in your tasks during your service/between your various services?
- Yes
- No

7. If yes, what was the cause of these changes?
- Significant external event (e.g. EU accession)
- New ambassador
- New Hungarian STI strategy
- New partner abroad
- New STI strategy in the partner country
- Other:

8. In case you also had innovation and business-related activities, how did these influence your work? If you did not have such tasks, please do not respond!
- Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat
- Such new duties cost too much time and energy
- The importance of such a mixed position is evaluated higher by partners
- It is rather confusing – partners cannot judge if the attaché is an economic or a scientific one
- The additional field of work opens new possibilities for the attaché
- Short-term result oriented economic work affects the negotiating position of the S&T attaché in a negative way
- My work is not significantly affected by innovation related tasks
- Other

9. Please summarize the main benefits of the work of science attachés for Hungary!
10. What do you consider your main personal success?

Answers:

Answers for question 1 follow together with question 5. Question 9 and 10 were open questions. The answers might reveal the respondents, which goes against anonymity, so the answers to these two questions are not listed her.

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2.a How much time did you spend on the tasks listed below? When answering this question, please also show the relative importance of the tasks!

Reporting about the R&D programmes, international relations and important R&D events of the host country	Networking, partner search, matchmaking both on the inter-institutional and intergovernmental level (agreements)	Representation, information, promotion, PR	Delegations, organisation of visits, cooperation with scientific stakeholders of the host country	Building up networks of Hungarian scientists living abroad, supporting their reintegration into the Hungarian STI environment	Enterprises, supporting Hungarian enterprises, searching for partners and investment opportunities	EU Member State, representing Hungary as a Member State of the European Union
A lot	A lot	Quite some	Quite some	Quite some	A bit	
A lot	A lot	Quite some	Quite some	Quite some	A bit	No time
Quite some	A lot	A bit	Quite some	A bit	Quite some	No time
A lot	Quite some	Quite some	A lot	No time	No time	A bit
A lot	A bit	Quite some	Quite some	No time	No time	No time
A lot	A lot	A bit	Quite some	No time	A bit	Quite some
A lot	A lot	Quite some	A bit	Quite some	A bit	Quite some
Quite some	A lot	Quite some	Quite some	A bit	A lot	Quite some
A lot	Quite some	A bit	A bit	A bit	A bit	
A lot	Quite some	Quite some	Quite some	No time	No time	A bit
A lot	Quite some	Quite some	Quite some	A bit	Quite some	A lot
A lot	A lot	Quite some	Quite some	A bit	A bit	A lot
A lot	Quite some	Quite some	A bit	Quite some	A bit	A bit
A lot	Quite some	Quite some	A lot	Quite some	A bit	A bit
Quite some	Quite some	A bit	Quite some	No time	No time	
Quite some	A lot	Quite some	Quite some	A bit	A lot	
A lot	A lot	Quite some	Quite some	A lot	A lot	Quite some
Quite some	Quite some	Quite some	Quite some	A bit	A bit	A bit
A lot	A lot	A lot	A bit	Quite some	A bit	A bit
Quite some	A lot	Quite some	A lot	Quite some	A bit	No time
A lot	Quite some	Quite some	A bit	No time	Quite some	A bit
A lot	A lot	A bit	Quite some	Quite some	A bit	A bit
Quite some	A lot	A lot	Quite some	A bit	Quite some	No time
Quite some	A lot	Quite some	Quite some	A lot	A lot	
Quite some	A lot	A lot	A lot	A lot	A lot	A bit
Quite some	Quite some	A bit	A bit	No time	A bit	No time
No time	Quite some	A lot	A lot	A bit	No time	A lot
Quite some	A bit	A bit	Quite some	Quite some	No time	Quite some
Quite some	Quite some	A bit	Quite some	A bit	Quite some	
Quite some	A lot	Quite some	Quite some	A lot	A bit	A bit

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2.b What results have you achieved in the fields below? When answering this question, please also show the relative importance of the results!

Reporting about the R&D programmes, international relations and important R&D events of the host country	Networking, partner search, matchmaking both on the inter-institutional and intergovernmental level (agreements)	Representation, information, promotion, PR	Delegations, organisation of visits, cooperation with scientific stakeholders of the host country	Building up networks of Hungarian scientists living abroad, supporting their reintegration into the Hungarian STI environment	Enterprises, supporting Hungarian enterprises, searching for partners and investment opportunities	EU Member State, representing Hungary as a Member State of the European Union
A lot	A lot	Quite some	A lot	Quite some	No result	
A lot	A lot	Quite some	Quite some	A lot	Quite some	No result
A lot	Quite some	Quite some	Quite some	No result	Quite some	A bit
A lot	Quite some	A bit	Quite some	No result	No result	A bit
A lot	Quite some	Quite some	A lot	No result	No result	No result
A lot	Quite some	A bit	A bit	No result	A bit	A lot
A lot	A lot	Quite some	Quite some	Quite some	Quite some	Quite some
Quite some	A lot	A lot	Quite some	Quite some	A lot	Quite some
Quite some	Quite some	A bit	A bit	A bit	A bit	
A lot	Quite some	Quite some	Quite some	No result	No result	A bit
A lot	A lot	Quite some	Quite some	Quite some	Quite some	Quite some
Quite some	Quite some	Quite some	Quite some	No result	A bit	A lot
Quite some	A lot	A bit	Quite some	No result	A bit	Quite some
Quite some	Quite some	Quite some	Quite some	A bit	A bit	A bit
Quite some	Quite some	A bit	Quite some	No result	No result	
Quite some	A lot	A bit	A lot	A bit	A lot	
A lot	Quite some	Quite some	Quite some	A lot	Quite some	Quite some
Quite some	Quite some	Quite some	Quite some	No result	A bit	A bit
A lot	A lot	Quite some	Quite some	A bit	A bit	A bit
Quite some	A lot	Quite some	A lot	A lot	A bit	A bit
A lot	A lot	A bit	Quite some	Quite some	A bit	No result
Quite some	A lot	A lot	Quite some	A bit	Quite some	No result
Quite some	A lot	Quite some	Quite some	A lot	A lot	
Quite some	A lot	A lot	A lot	A lot		A bit
Quite some	No result	A bit	A bit	No result	No result	No result
Quite some	Quite some	Quite some	A lot	A bit	No result	A lot
Quite some	A lot	A bit	Quite some	A bit	No result	Quite some
Quite some	A lot	A bit	Quite some	Quite some	Quite some	
Quite some	A lot	Quite some	Quite some	A lot	A bit	A bit

3. Which function in the area of science diplomacy was the most decisive for your work?	4. Typically which party initiated the cooperation?
Diplomacy for science	There is a balance between national and foreign initiatives
Diplomacy for science	Hungarian governmental institution, The science attaché
Science for diplomacy	Hungarian governmental institution, The science attaché, Foreign partner governmental institution
Science for diplomacy	Hungarian governmental institution, The science attaché, Foreign partner governmental institution
Diplomacy for science	The science attaché
Diplomacy for science	Hungarian governmental institution, The science attaché
Diplomacy for science	Other: the number of foreign initiatives is higher but there are also national ones.
Science for diplomacy	Hungarian scientific community, The science attaché, Foreign partner governmental institution
Science for diplomacy	There is a balance between national and foreign initiatives
Diplomacy for science	There is a balance between national and foreign initiatives
Diplomacy for science	Hungarian scientific community, The science attaché, Foreign partner governmental institution
Diplomacy for science	There is a balance between national and foreign initiatives
Science for diplomacy	There is a balance between national and foreign initiatives
Diplomacy for science	Foreign partner governmental institution
Diplomacy for science	The science attaché
	Hungarian scientific community, The science attaché, Foreign partner governmental institution, Foreign scientific community
Diplomacy for science	The science attaché, Foreign scientific community
Science for diplomacy	Hungarian governmental institution, The science attaché
Diplomacy for science	The science attaché, There is a balance between national and foreign initiatives
Diplomacy for science	The science attaché
Diplomacy for science	Hungarian governmental institution, Hungarian scientific community
Diplomacy for science	Hungarian governmental institution, Hungarian scientific community, The science attaché
Diplomacy for science	Hungarian governmental institution, Hungarian scientific community, The science attaché, Other: "best pratice" recommended by other S&T attaché
Science in diplomacy	The science attaché
Diplomacy for science	The science attaché, There is a balance between national and foreign initiatives
Diplomacy for science	Hungarian governmental institution
Diplomacy for science	Hungarian governmental institution, The science attaché
Science for diplomacy	Hungarian governmental institution, Hungarian scientific community, Foreign partner governmental institution
Science for diplomacy	There is a balance between national and foreign initiatives
Diplomacy for science	Hungarian governmental institution, The science attaché

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1. When were you a science attaché?	5. Who/Which institution had the largest impact on your work? Please rank your answers!!				
	Ministry of Foreign Affairs and Trade (and predecessors)	National Research, Development and Innovation Office (and predecessors)	Ambassador	Partner ministry	I am quite independent
Before 1990	3	3	2	4	3
Before 1990, Between 1990-2000, Between 2000-2010	5	4	3	2	3
Before 1990, Between 1990-2000, Between 2000-2010, After 2010	3	5	3	3	2
Between 1990-2000	4	5	3	3	4
Between 1990-2000, Between 2000-2010	2	5	4	4	2
Between 1990-2000, Between 2000-2010	3	5	4	2	2
Between 1990-2000, Between 2000-2010	1	5	1	4	2
Between 1990-2000, Between 2000-2010	2	3	1	3	5
Between 1990-2000, Between 2000-2010	4	5	3	3	4
Between 1990-2000, Between 2000-2010	1	4	3	2	5
Between 1990-2000, After 2010	1	2	1	4	5
Between 2000-2010	4	5	2	3	3
Between 2000-2010	4	5	1	3	2
Between 2000-2010	4	5	3	2	1
Between 2000-2010, After 2010	1	4	3	2	5
Between 2000-2010, After 2010	4	3	5	2	2
Between 2000-2010, After 2010	2	2	1	2	5

Between 2000-2010, After 2010	2	4	4	1	3
Between 2000-2010, After 2010	4	4	3	3	5
After 2010	4	3	5	2	1
After 2010	4	3	5	2	1
After 2010	3	4	4	2	5
After 2010	4	3	4	1	2
After 2010	3	1	3	2	4
After 2010	3	4	2	3	4
After 2010	5	2	4	3	1
After 2010	1	5	2	3	4
After 2010	3	4	1	2	4
After 2010	4	3	4	3	2
Between 2000-2010, After 2010	2	3	5	1	4

6. Has there been any significant change in your tasks during your service/between your various services?	7. If yes, what was the cause of these changes?
Yes	New Hungarian STI strategy
Yes	Significant external event (e.g. EU accession), New Hungarian STI strategy, New STI strategy in the partner country
No	Other: tasks have not changed considerably.
Yes	New ambassador, New Hungarian STI strategy, New partner abroad
Yes	New ambassador, New Hungarian STI strategy
No	
Yes	Significant external event (e.g. EU accession), New Hungarian STI strategy, New STI strategy in the partner country
No	
No	
Yes	Significant external event (e.g. EU accession)
Yes	Significant external event (e.g. EU accession)
Yes	Significant external event (e.g. EU accession), New ambassador
Yes	New Hungarian STI strategy
No	
No	
Yes	New ambassador, New Hungarian STI strategy, Other: New position, new country, new tasks.
No	
No	
No	
No	
	Other: I have not spent enough time here to judge.
No	

Yes	New ambassador, New partner abroad, New STI strategy in the partner country
Yes	New Hungarian STI strategy, New partner abroad, New STI strategy in the partner country
Yes	New Hungarian STI strategy
Yes	New Hungarian STI strategy
Yes	Other: maternity leave of my colleague
No	Other: there have not been any changes in these two months
No	
No	

8. In case you also had innovation and business-related activities, how did these influence your work? If you did not have such tasks, please do not respond!
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; Other: in a good balance mixing the two fields is really beneficial
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; Other: in case of RDI intensive spin-off companies
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.

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Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; Such new duties cost too much time and energy; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners, The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; The importance of such a mixed position is evaluated higher by partners, The additional field of work opens new possibilities for the attaché.
The additional field of work opens new possibilities for the attaché.
Supporting innovation and companies fits into the portfolio of a science attaché, it rather increases the efficiency of the diplomat; Such new duties cost too much time and energy.

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Annex II: Bilateral Mobility Questionnaire

(English translation)

1. What is the type of institution you are working for?
   - Higher Education institution
   - Publicly financed research institute
   - Business enterprise
   - Private non-profit organisation
   - Other:

2. What is your scientific field of research?
   - Natural sciences
   - Engineering
   - Health (including veterinary sciences)
   - Social sciences
   - Humanities
   - Other:

3. Did you/do you have a retained bilateral S&T cooperation proposal?
   - Yes, with Austria, I coordinated
   - Yes, with Austria, I participated
   - Yes, with another country, I coordinated
   - Yes, with another country, I participated
   - No

4. What would have happened if the proposal would not have been supported?
   - The project would have been implemented from own resources
   - I would have looked for other funding possibilities
   - The project would not have been implemented due to lack of funding
   - Other:

5. Why was the bilateral STI project submitted? You can have multiple choices.
   - High success rate
   - Simple administration
   - Simple implementation
   - Own institutional fund is not available
   - No alternative support scheme available
   - Request of the foreign partner
   - Other:

6.a Please evaluate the usefulness of bilateral S&T mobility projects on a scale of 1-4! (1 = not useful 4 = very useful)

6.b Please evaluate how far your bilateral S&T project could be realised on a scale of 1-4! (1 = not realised; 4 = fully realised)

- Establishing new contacts
- Improving existing contacts
- Preparation of other joint proposals
- Economic exploitation of scientific results
- Preparation of joint publications
- Joint publication
- Joint research on the field
- Extending scientific network
- Contacts with science-policy makers in the partner country
- Access to research infrastructures
- Supporting young researchers
- Supporting female researchers
- Development of intercultural and language skills

7. Number of joint publications with the partner. Please mention in your response the number of:
a) Joint publications before the S&T project
b) Joint publications during the project
c) Joint publications after the project

8. Further proposals submitted together with the project partner. Please mention in your response:
a) The number of joint proposals
b) The number of retained proposals
c) Type of proposals (especially EU framework programmes)
d) Size of the grant (Hungarian partner)

9. Shall the bilateral mobility scheme be preserved in its current form?
You can have multiple choices, but please do not give contradictory answers!

- Yes, because there is no institutional funding for supporting mobility
- Yes, because it is a good tool to motivate young scientists
- Yes, because it helps to establish international contacts
- Yes, because it facilitates co-publishing and joint application
- Yes, if administrative burdens will be reduced
- Yes, if grants can be spent in a more flexible way
- No, because international cooperation materializes anyway
- No, because travel expenses to Austria are low anyway
- No, because administrative costs are too high compared to the size of support
- No, because other support schemes should be developed

- Other:

10. Do you plan to submit another S&T mobility proposal?
    - Yes, with Austria
    - Yes, with another country
    - No

Answers:

1. What is the type of institution you are working for?	2. What is your scientific field of research?	3. Did you/do you have a retained bilateral S&T cooperation proposal?
Business enterprise	Engineering	Yes, with another country, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Public non-profit research institute	Engineering	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with Austria, I participated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Publicly financed research institute	Engineering	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Health	Yes, with another country, I participated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	No
Higher Education institution	Engineering	Yes, with another country, I coordinated
Publicly financed research institute	Health	Yes, with Austria, I coordinated
Publicly financed research institute		Yes, with Austria, I coordinated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Publicly financed research institute	Engineering	Yes, with Austria, I participated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Veterinary science	Yes, with Austria, I coordinated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated

Business enterprise	Natural sciences	No
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I participated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with Austria, I participated
Higher Education institution	Engineering	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	No
Higher Education institution	Health	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated
Publicly financed research institute	Natural sciences	Yes, with Austria, I coordinated
Retired from a Higher Education institution	Natural sciences	Yes, with Austria, I participated
Publicly financed research institute	Natural sciences	Yes, with Austria, I coordinated
Publicly financed research institute	Natural sciences	Yes, with another country, I coordinated
Higher Education institution	Agriculture	Yes, with another country, I coordinated
Publicly financed research institute	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with Austria, I coordinated
Higher Education institution	Natural sciences	Yes, with another country, I coordinated
Higher Education institution	Natural sciences	Yes, with another country, I coordinated

4. What would have happened if the proposal would not have been supported?	5. Why was the bilateral STI project submitted?
I would have looked for other funding possibilities	Simple administration, Simple implementation
I would have looked for other funding possibilities	Simple administration, Other: similar research in the neighbouring country
I would have looked for other funding possibilities	No alternative support scheme available
The project would not have been implemented due to lack of funding	High success rate, Simple administration, Simple implementation, Own institutional fund is not available, No alternative support scheme available
The project would have been implemented from own resources	No alternative support scheme available
	Other: it is a helpful tool to increase the intensity of the cooperation, to involve young scientists and to enhance cooperative research possibilities
The project would not have been implemented due to lack of funding	Simple administration, No alternative support scheme available

	High success rate, Own institutional fund is not available, No alternative support scheme available
	Simple administration, Simple implementation, No alternative support scheme available
	Simple administration, Simple implementation, No alternative support scheme available
The project would not have been implemented due to lack of funding	Simple administration, Simple implementation, Own institutional fund is not available, Request of the foreign partner
I would have looked for other funding possibilities	High success rate, Simple administration, Simple implementation
The project would not have been implemented due to lack of funding	Request of the foreign partner
	Own institutional fund is not available, No alternative support scheme available
I would have looked for other funding possibilities	Own institutional fund is not available, No alternative support scheme available, Request of the foreign partner
The project would not have been implemented due to lack of funding	
	Simple administration, Simple implementation
The project would not have been implemented due to lack of funding	Simple administration, Own institutional fund is not available
I would have looked for other funding possibilities	No alternative support scheme available
	Simple implementation, No alternative support scheme available, Request of the foreign partner
The project would have been implemented from own resources	No alternative support scheme available, Request of the foreign partner
	Simple administration, Own institutional fund is not available
I would have looked for other funding possibilities	Simple implementation
	Request of the foreign partner
I would have looked for other funding possibilities	High success rate, Simple administration, Simple implementation, Other: a good tool to prepare and implement bilateral OTKA-FWF proposals
	Simple administration, Simple implementation, Own institutional fund is not available
The project would have been implemented from own resources	Joint work facilitates better results
The project would not have been implemented due to lack of funding	Own institutional fund is not available, No alternative support scheme available, Request of the foreign partner
The project would not have been implemented due to lack of funding	Own institutional fund is not available

The project would not have been implemented due to lack of funding	Simple implementation, Own institutional fund is not available, No alternative support scheme available, Request of the foreign partner
Other: I can not see any alternative at the moment	Own institutional fund is not available, Request of the foreign partner
I would have looked for other funding possibilities	Simple administration, Own institutional fund is not available, No alternative support scheme available
I would have looked for other funding possibilities	High success rate, Simple administration
I would have looked for other funding possibilities	Simple administration, Own institutional fund is not available
The project would have been implemented from own resources	Simple implementation, Own institutional fund is not available, Request of the foreign partner
The project would have been implemented from own resources	Own institutional fund is not available
Other: there has been no proposal submitted yet	
I would have looked for other funding possibilities	No alternative support scheme available
I would have looked for other funding possibilities	Other: why, if it is possible?
I would have looked for other funding possibilities	Request of the foreign partner
The project would not have been implemented due to lack of funding	Simple administration, Simple implementation, Own institutional fund is not available
I would have looked for other funding possibilities	Other: previous cooperation
	Own institutional fund is not available, No alternative support scheme available
	Simple administration, No alternative support scheme available
The project would not have been implemented due to lack of funding	Simple administration, Simple implementation, Own institutional fund is not available, No alternative support scheme available
The project would have been implemented from own resources	No alternative support scheme available, Request of the foreign partner
I would have looked for other funding possibilities	Simple implementation, Own institutional fund is not available, No alternative support scheme available
The project would not have been implemented due to lack of funding	Own institutional fund is not available

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6.a Please evaluate the usefulness of bilateral S&T mobility projects on a scale of 1-4!

Establishing new contacts	2	4	3	2	4		3	4	4	4	3	3	4	3	3		3	4	4	1	4	3		2
Improving existing contacts	2	4	4	4	4	4	4	4	4	4	4	3	3	4	4		3	3	4	4	2	4	4	4
Preparation of other joint proposals	2	2	4	4	4	4	2	4	4	4	4	2	3	4	4		3	4	4	4	4	2		2
Economic exploitation of scientific results	2	2	2	1	1	3	1	3	4	4	3	1	1	3	3		3	2	2	3	1	2		1
Preparation of joint publications	2	4	4	3	3	3	3	4	4	4	4	3	4	4	4		3	4	4	4	3	3		4
Joint publications	2	4	4	4	4	4	4	4	4	4	4	3	2	4	4		3	4	4	4	3	3		4
Joint research on the field	2	4	4	4	4	4	4	4	4	4	4	1		4				4	4	3	3	2		4
Extending scientific network	2	4	3	4	4	4	3	4	4	4	4	2		4	3		3	4	3	3	4	2		2
Contacts with science-policy makers in the partner country	2	1	2	2	2		1	3	3	3	2	1			1		3	1	2	2	1	1		1
Access to research infrastructures	2	3	4	4	3	4	4	3	3	3	4	1	4	4	2		2	2	2	3	3	1		3
Supporting young researchers	2	4	3	4	3	4	3	2	4	4	3	3		4	4		3	4	4	4	4	4	3	3
Supporting female researchers	2	3	2	4	3	3	2	2	3	3	2	1		4	4		1	1	4	4	1	3		1
Development of intercultural and language skills	2	2	2	4	2	3	4	4	2	2	4	1		4	2		1	3	2	3	2	1		2

6.a Please evaluate the usefulness of bilateral S&T mobility projects on a scale of 1-4!

Establishing new contacts	4	4	4	4	4	4		4	2	4	3	1		3	2	4	4	3	2	4	3	4	4	4
Improving existing contacts	4	4	4	4	4	4	4	4	4	4	3	3		4	3	4	4	4	4	4	4	4	4	4
Preparation of other joint proposals	4	3	4	4	4	4	3	4	1	3	2	2		4	3	4	4	4	4	4	4	4	4	4
Economic exploitation of scientific results	3	2	3	3	4	3	3	2	2	3	1	1		2	1	2	4	3	2	3	3	2	4	3
Preparation of joint publications	4	2	4	4	4	3	4	4	2	4	3	3		4	3	4	4	4	4	4	4	3	4	4
Joint publications	4	1	4	4	4	3	4	4	3	4	3	3		4	3	4	4	4	4	4	4	4	3	4
Joint research on the field	4	1	4	4	4	4	4	3	4	4	2	2		4	2	4	4	4	4	4	4	4	3	4
Extending scientific network	4	3	4	4	4	4		4	4	4	4	1		4	2	4	4	3	3	4	4	4	3	4
Contacts with science-policy makers in the partner country	2	1	2		4		2	3	2	3	1	1		2	2	2	4	2	2	3	3	1	3	4
Access to research infrastructures	4	2	2	4	1	4	2	3	4	4	2	3		2	3	4	4	4	3	4	4	4	3	4
Supporting young researchers	4	3	4	4	4	3	3	4	4	4	3	4		4	3	4	4	4	4	4	4	4	4	4

Supporting female researchers	4	3	4	4	4	3	3	3	4	4	1	1		4	2	4	4	3	3	4	3	2	4	4
Development of intercultural and language skills	4	4	4	4	1	4	2	3	3	3	1	2		4	2	3	4	4	4	4	4	4	3	4

6.b Please evaluate how far your bilateral S&T project could be realised on a scale of 1-4!

Establishing new contacts	3	4	3	3	4		4	4	4	4	4	1		2	3		3	4	4	2	3	3		1
Improving existing contacts	3	4	4	4	4	4	4	4	4	4	4	3		4	4		3	4		4	3	4	4	4
Preparation of other joint proposals	3	3	4	4	3	4	4	3	4	4	4	3		4	4		3	4	4	4	2	2		2
Economic exploitation of scientific results	3	2	3	1	2	1	2	2	3	3	2	1		3			3	3	1	3	1	2		1
Preparation of joint publications	3	4	4	4	2	2	4	4	4	4	3	4		4	4		3	4	4	4	3	3		4
Joint publications	3	4	3	4	4	4	4	4	4	4	4	4		4	4		3	4	4	4	2	3		4
Joint research on the field	3	4	3	4	4	4	4	3	4	4	4	4		4				4	3	3	1	2		4
Extending scientific network	3	4	3	4	4	4	3	3	3	3	2	3		3	1		3	4	4	3	3	2		1
Contacts with science-policy makers in the partner country	3	2	1	1	2	1	1	1	3	3	1	1		3	1		3	1	1	2	1	1		1
Access to research infrastructures	3	3	4	4	4	4	4	2	2	2	4	1		4	3		2	1	1	3	2	2		4
Supporting young researchers	3	4	2	4	3	4	2	2	4	4	4	3		4	4		3	4	4	4	4	4	3	4
Supporting female researchers	3	3	1	4	3	4	2	1	3	3	4	1		4	4		1	1	4	4	1	3		4
Development of intercultural and language skills	3	3	2	4	2	3	4	4	2	2	4	1		4			1		2	3	3	1		1

6.b Please evaluate how far your bilateral S&T project could be realised on a scale of 1-4!

Establishing new contacts	4	4	4		4	4	4	3	3	4	3	1		3	1	4	4	4	2	4	3	3	4	4
Improving existing contacts	4	4	4		4	4	3	4	4	4	3	3		4	3	4	4	4	4	4	4	4	4	4
Preparation of other joint proposals	4	3	4		4		3	4	3	3	2	2		4	3	4	4	4	4	4	4	3	4	4
Economic exploitation of scientific results	2	2	2		1	1	2	2	2	3	1	1		1	1	2	4	3	3	3	1	1	4	3
Preparation of joint publications	4	2	4		4	3	4	4	2	4	2	3		4	3	4	4	4	4	4	3	4	4	4
Joint publications	4	2	4		4	1	4	4	4	4	3	3		4	3	4	4	4	4	4	3	4	4	4
Joint research on the field	4	1	4		4	4	4	3	4	4	2	2		4	2	4	4		4	4	4	4	4	4
Extending scientific network	4	3	4		4	4		3	4	4	3	1		4	1	4	4	3	3	4	4	3	4	4
Contacts with science-policy makers in the partner country	1	1	2		4		2	2	2	3	1	1		1	1	2	4	1	3	3	1	1	3	4

Access to research infrastructures	4	1	4		1	4	2	3	4	4	1	3		2	1	4	4	4	4	4	4	4	3	4
Supporting young researchers	4	3	4		4	3	3	4	4	4	1	4		4	3	4	4	3	4	4	4	4	4	4
Supporting female researchers	4	3	4		4	3	3	2	4	4	1	1		3	2	4	4	3	2	4	4	1		4
Development of intercultural and language skills	4	3	4		4	4	2	3	3	3	1	2		3	1	3	4	4	4	4	4	4	3	4

7. Number of joint publications with the partner	8. Further proposals submitted together with the project partner
124	-
(0) none (1) 1 (6) further 5	(a) 1 (b) 1 (c) exchange of young researchers (d) 2 million HUF
Joint research is going on, no publication yet.	We have not found any suitable call yet
No publication before the project. 5 joint publications during the project. 1 publication after the project.	In spite of several attempts, we did not have any.
. U. Onthong, I. Bakó , T. Radnai, . "Ab initio study of the interaction of dimethylsulfoxide with the ions Li+ and I-" Int. J. Mass Spect. 2003, 223, 263 (IF:2.18) I. Bakó, T. Megyes T. Radnai, G. Pálinkás M. Probst Ab Initio Quantum Chemical and Molecular Dynamics Simulation Study of Lithium Iodide in Acetonitrile Z.Phys.Chem 2004, 218, 643 (IF: 0.855) U. Onthong, T. Megyes, I. Bakó, T. Radnai, T. Grósz, K. Hermansson, M. Probst X-ray and Neutron Diffraction Study and Molecular Dynamics Simulations of Liquid DMSO, Phys. Chem. Chem. Phys 2004, 6,2136. (IF: 1.838) U. Onthong, T. Megyes, I. Bakó, T. Radnai, T. Grósz, K. Hermansson, M. Probst, Molecular Dynamics Simulation of Lithium Iodide in Liquid Dimethylsulfoxide, Chem. Phys. Letters 2005, 401, 217 (IF: 2,438) Injan N, Megyes T, Radnai T, I.Bakó: Potential energy surface and molecular dynamics simulation of gold(I) in liquid nitromethane J. Molecular Liquids 2009,147, 64	a. Two ERA proposals – we did not win but have managed to get into the second round
Continuous	a, 3 (OTKA, EUH2020 x2 b, OTKA-ANN 114554 c, basic research d 32.754.000 HUF
1, 2, 5	2, 2, FWF
a) 13: IEEE, Springer, Kluwer, etc. b) 8: IASTED, Springer, Elsevier, IEEE, etc. c) 4: Springer, ACM, IGI Global, etc.	a) 1 b) 1 c) NKTH-OTKA-EU 7. FP "MOBILITÁS" d) 22 million HUF
More than 10 (with South-Africa)	Granted proposals Austria 1, France 2, Spain 2, Malaysia 1, South-Africa 4
Only after finishing the project	a, 2 jointly submitted and granted proposals for 2 PhD-students. b, 0.

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	c, No EU FP yet. d, We have received the amount applied for.
I have coordinated and participated in a number of projects. We published yearly once or twice per project, sometimes also after the project was finished Altogether: 10 conference papers; 8 articles. 3 PhD students also used the results	2, in spite of the good evaluation results, not supported
a) 0 b) 3 articles and 5 conference presentations c) 0	a) 1 (under evaluation) b) 0 c) 0 d) 0
a, 1 b, 2 c, 2	More S&T mobility calls (both coordinator and participant) a, 4 b, 3 c, around 3 million HUF
1 is being published	Jointly submitted proposals have not received funding yet, we plan further applications
a) 0 b) 0 c) 2	a) 3 b) 0 c) - d) -
5 conference papers 2 articles	
a.) 0 b.) 1 (1 conference paper) c.) 3 (1 article, 2 conference paper)	a.) 1 b.) 0 c.) 0 d.) 0
a. 4 b. 2 c.3	a.2 b.0
b) conference presentation	no, but we are still in contact
b)+c) 1 article, 3 conference papers and presentations	
a) Before the project: 1 (2014) b) During the project : 0 c) 2 articles under preparation	ÖAD grant: 2003 exchange of researchers: 2004-5 OTKA-FWF: 2013-16
a) 2 before 2007 b) 6 between 2008-2010 c) 3 after 2010	a) 1 b) not supported c) -
21 joint publications in 12 bilateral S&T mobility projects	2 successful proposals out of 6 submitted ones
a) not before. Our proposal is being evaluated so we can not answer the other two points	Not yet
a:0 b:3 c:2	a:2 b:0 c:0
No joint research before the project. b) Establishment of joint infrastructure during the project. c) No	Not with these partners
a)3 b)2 c)5	

a) 3 b) 6 c) 4	a) 3 b) 2 c) Osztrák K+F, MTA d) 20.000, EUR, 20.000.000, HUF
2 before, 2 during 5 after the project in international journals	3 successful proposals at ÖAAD. 1 million HUF/proposal ERC proposal, not supported. EU FP – not successful.
Before: 0 During: 3 After: 3	-
In 2010 an abstract in Circulation journal (5527) In 2013 an article in Open Access PLOS-ONE journal	No
a) 0 b) 1 c) 2	-
-	-
a: 0 b: 3 c: 3	a: 3 b: 1 c: FWF-OTKA d: 100.000 EUR
3	a) 1 b) not public yet c) national d) not public yet
a) 1 (Surface and Interface Analysis) b) 5 (Surface and Interface Analysis 1; J. Electron Spectros. Rel. Phenom. 1; Thin solid Films 1; Surface Science 2) c) 4 (Surface and Interface Analysis 1; Phys. Rev. Lett. 1; Phys. Rev. B 2)	
1 after the project.	1 proposal was submitted, it was not retained
a) 5 articles and conference papers b) 3 articles and conference papers c) 1 articles and conference papers	a) 2 b) under evaluation c) d)
About 60 joint publications in 20 years (German partner)	3 S&T mobility project with Germany, one with Austria + DAAD, Phare Accord, EUREKA, national funds:OTKA, OMFB, NKTH)
4 c	
5 posters at scientific conferences. 1 article under preparation	No granted proposal
4 high-impact publications. Before 0, during 2, after 2.	No
only Thomson-Reuters, ISI) publications: a) 2. b) 10 c) 10	a) 0 b) 2 c) kb. 20 M HUF

9. Shall the bilateral mobility scheme be preserved in its current form?	10. Do you plan to submit another S&T mobility proposal?

Yes, because it is a good tool to motivate young scientists, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because it helps to establish international contacts	No
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts	No (already retired, can not apply any more)
No, because administrative costs are too high compared to the size of support	No
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if grants can be spent in a more flexible way, Other: it would help if at least other minor costs would be eligible for funding. It would also be positive if more students/researchers could be involved.	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	No
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Other: I also find the funding of research activities necessary	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it helps to establish international contacts, Yes, if grants can be spent in a more flexible way, No, because other support schemes should be developed	Yes, with Austria
	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with Austria

Yes, because there is no institutional funding for supporting mobility, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with Austria
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	No
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, if grants can be spent in a more flexible way, No, because travel expenses to Austria are low anyway, No, because administrative costs are too high compared to the size of support	No
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, if administrative burdens will be reduced	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if grants can be spent in a more flexible way, No, because other support schemes should be developed	Yes, with another country

Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way, No, because administrative costs are too high compared to the size of support, No, because other support schemes should be developed	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts	Yes, with another country
Yes, because it is a good tool to motivate young scientists, Yes, because it facilitates co-publishing and joint application, Yes, if grants can be spent in a more flexible way	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it helps to establish international contacts	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced	Yes, with another country
Other: This type of proposal in itself is not enough to sustain serious cooperation. Funding of research activities is also necessary.	No
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if administrative burdens will be reduced	Yes, with Austria
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Other: personal contacts help further scientific cooperation	No
Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria

Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with another country
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application, Yes, if grants can be spent in a more flexible way	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	No
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with Austria
Yes, because there is no institutional funding for supporting mobility, Yes, because it is a good tool to motivate young scientists, Yes, because it helps to establish international contacts, Yes, because it facilitates co-publishing and joint application	Yes, with another country