Croatia, Serbia and Slovenia in comparative perspective

Research Policy, Financing and Performance

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Jelena Branković & Norbert Šabić (Eds.)

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Predrag Lažetić

Editor
Martina Vukasović

Reviewers
Vera Dondur
Nicoline Frølich
Srbijanka Turajlić

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Mihajlo Babin, Predrag Lažetić

Belgrade, 2011.

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LIST OF ABBREVIATIONS

A&HCI	Arts & Humanities Citation Index
CPCI-S	Conference Proceedings Citation Index – Science
CPCI-SSH	Conference Proceedings Citation Index – Social Sciences & Humanities
ERA	European Research Area
EU	European Union
GDP	Gross Domestic Product
GERD	Gross expenditure in research and development
ISI	Institute for Scientific Information
IUS	Innovation Union Scoreboard
NSO	National statistics office
OECD	Organisation for Economic Cooperation and Development
PNP	Private non-profit
PPP	Purchasing power parity
R&D	Research and development
S&T	Science and Technology
SCI	Science Citation Index
SCI-Expanded	Science Citation Index Expanded
SFRY	Socialist Federative Republic of Yugoslavia
SME	Small and medium enterprises
SSCI	Social Sciences Citation Index
UIS	UNESCO Institute of Statistics
WoK	ISI Web of Knowledge®
WoS	ISI Web of Science®

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PREFACE

'Research Policy, Financing & Performance: Croatia, Serbia and Slovenia in comparative perspective' has its origin in the ambition to complement earlier research conducted by the Centre for Education Policy on the financing of education and educational institutions at all levels. This study is both a continuation of the 'Financing Higher Education in South-Eastern Europe'[1] and a venture somewhat beyond the domain of educational institutions. The study is part of a broader research project entitled 'Knowledge Economy' supported by the Fund for an Open Society in Serbia and implemented by the Centre for Education Policy.

Initially, the research was designed with the aim to cover Slovenia and the whole of the Western Balkan region. However, early research designs are prone to change during the course of the research itself, and this project was no exception. Though the nature and scope of these changes were mostly the choice of authors and editors, we were also substantially constrained by the availability and accessibility of the required data, and so ultimately chose to both broaden our thematic scope and reduce our number of cases. With this logic, we eventually arrived at the three cases presented in this volume. Broadly speaking, 'Research Policy, Financing & Performance' has two main aims. It strives to contribute both to the ongoing policy debate on the subject in the region and beyond, and to the scholarly debate on the applicability of the principal-agent theory in the context of research policy.

We would like to acknowledge and express our gratitude to those who have been a part of this study in the making. On behalf of the Centre for Education Policy, the research team would like to thank Fund for an Open Society – Serbia for recognising the value of conducting this study and making it possible. The research team is exceptionally grateful to Dr. Nicoline Frølich, Prof. Dr. Srbijanka Turajlić and Prof. Dr. Vera Dondur for giving invaluable comments on the manuscript and for writing the reviews. We would like to thank the informants who were of enormous help in the process of data and information collection in the three countries. We also owe our gratitude to Martina Vukasović for her effort in reading the manuscript and making invaluable

1 Vukasović, M. (Ed.). (2009). Financing Higher Education in South Eastern Europe: Albania, Croatia, Montenegro, Serbia and Slovenia. Belgrade: Centre for Education Policy. Last retrieved on October 12, 2011, from http://cep.edu.rs/en/izdanja/financing-higher-education-south-eastern-europe-albania-croatia-montenegro-slovenia-serbia

comments on its content and organisation. Finally, we thank Lily Lynch for going through the language of the English version of the book.

Last but not least, the editors would like to thank Mihajlo Babin and Predrag Lažetić for their important contributions to this book.

Belgrade, 1. 12.2011 *Jelena Branković and Norbert Šabić*

REVIEW I

A recent study of higher education governance and funding reforms explored the higher education and research policies, policy instruments and performance of 33 European countries. The key question of the study addressed the possible link between governance and funding reforms, as well as the performance of higher education systems with regard to access, educational attainment, mature learners, employability, mobility, research output, capacity to attract funds and cost effectiveness. One general conclusion that emerged from the study is that although many similar reforms have been implemented in European countries over the last few decades, the governance of European higher education is still characterised by its diversity. Nevertheless, these policies have also been characterised by several developments: first, a greater emphasis on the institutional autonomy of higher education institutions, an increased focus on the strategic leadership and institutional management of higher education institutions, and the introduction of measures to improve accountability. Second, the introduction of new policy actors who have entered higher education governance both nationally and at the European level indicate a more networked forms of governance. Third, the introduction of several general funding reforms such as lump sum systems and output-based funding which aim to boost the financial autonomy of higher education institutions; market-based funding systems, with the increasing introduction of tuition fees in many European countries; increasing competition for public funds due to performance-based and contract-based funding, and a rise in the share of competitive funding, particularly in the funding of research. One important finding of the study highlights the difficulty of relating the changes in higher education systems performance to governance and funding reforms in general. Changes in performance are especially difficult to relate to governance reforms. However, improved institutional autonomy, coupled with financial incentives and sufficient funding, seem to enhance performance regarding graduation rates and research output. The general conclusion is that due to the complexity of the reforms and the timing of their implementation, there is a need for a more detailed empirical investigation of these interrelationships.

From this perspective, it is interesting to read the thorough account of research policy, financing and performance in Croatia, Serbia and Slovenia edited by Jelena Branković and Norbert Šabic. The analysis of research policies across the three countries shows that all of the governments are highly receptive to the recommendations of the European Commission. The authors note that the national research systems are unified in a single research area on a European level. According to the policy framework of the three countries, research and development is without exception viewed as a motor of economic growth. At the same time, the authors observe that given the fact that all three are relatively small European countries, they have tended to see their chance for growth in specialisation and have, at least in principle, aimed to focus their public research efforts in a limited number of areas. The authors conclude that the major differences rest within the process of policy implementation – e.g. at the level of choice of instruments and the selection of actors for the implementation of policy.

They point out that Slovenia seems to have implemented research policies in a network delegation mode reflecting the logic behind EU cooperation initiatives, such as the Framework Programme. While the analysis concludes that because Croatia and Serbia are themselves mixtures of the incentive and steady state delegation modes, they are still struggling with the transition from the state control to the state supervision model. The authors also note that westernisation of the state runs parallel with the transition of the role of the state from that of total control to a more supervisory or facilitatory role.

All three countries have introduced intermediary bodies whose roles differ from country to country based on whether they control critical resources such as funds to distribute, monitoring rights and the authority to set priorities. The analysis show that while Slovenia has completely delegated the role of the principal to an independent agency, Croatia has only in part delegated this role, while Serbia still operates under a direct policy maker – research provider mode of communication.

The authors also reflect on several reasons why the government fails to be consistent in its implementation of set goals. Historically, academic and research organisations have enjoyed a great deal of autonomy. According to the authors, attempts by the state to introduce steering mechanisms (either financial or regulative) based explicitly on political interests may fail if they are perceived as a violation of this autonomy. According to the analysis, a lack of control may indicate a high degree of trust between the actors, or the failure of the policy framework to provide an accurate indicator for measuring performance. The authors argue that if performance measurement isn't provided adequately, it becomes difficult to steer agents through funding mechanisms, which can undermine the national effort to meet certain policy goals related to qualitative improvement.

The analysis also concludes that the relationship between a certain research policy, the regulatory and financial instruments it employs, and research output is almost never perfectly attuned. According to the analysis, regulating the institutional environment, creating incentives and predicting the behaviour of researchers and their organisations often seems an unattainable goal.

Finally, the authors summarize their findings by stating that the previous decade of scientific research in Croatia, Serbia and Slovenia followed a convergent trajectory with regard to their major policy lines. According to the authors, this is primarily a result of European integration and an increasing adoption of EU-level policy goals, but also a result of the growing recognition of the role of science in economic growth. Nevertheless, when it comes to the regulatory framework, the authors observe a more diverse picture, which they describe as a combination of the Yugoslav socialist legacy and experimentation with new solutions, arrived at as a result of domestic or international policy learning. Financial instruments are also diverse, with Serbia and Croatia still extracting most of their resources from the government and higher education sector, while in Slovenia these resources are derived from the dominant business sector. In terms of output, the authors report that research productivity in terms of bibliometric indicators and number of projects in all three countries is rising. They assume this is partly due both to rising investments and to increased pressure on researchers as a result of changes in local regulation on quality and funding and from internationalisation processes.

The analysis is thorough and interesting, and if I were to suggest a few next steps for this team, they would include two new comparative projects: one which would situate the development of these three countries in the broader European context, and another which would look in greater detail at the governance and funding of higher education institutions from the perspective of a single higher education institution.

Nicoline Frølich
Research Professor
NIFU Nordic Institute for Studies in Innovation, Research and Education

REVIEW II
SCIENTIFIC RESEARCH: FROM ‘PLEASURE OF DISCOVERY’ TO ‘PRIME RESOURCE RESPONSIBLE FOR DEVELOPMENT OF THE SOCIETY’

It is said that science is a personal activity. History has shown us that with very few exceptions, scientific inquiry was not motivated by a lust for glory or other perceived benefits, but by sheer curiosity about the way the world works. Some have even taken this to such extremes that they have kept their discoveries to themselves, happy with the knowledge that they had found a solution to a particular question.[1] Yet none of this happened in isolation. Each scientist, or to be more precise, all scientific research, clearly reflects the context of the time in which it took place. It has always applied contemporary technology to existing results to further accumulate knowledge. Each and every discovery can be considered a single piece of a gigantic puzzle depicting the entire universe. Yet it has almost always been motivated by some particular problem people faced: time and date keeping, finding directions, healing wounds, conquering new territories, or establishing peace and order.

Aside from having a certain goal, research has always required two additional preconditions: a location where it can be organised and funding to support the researchers and the necessary equipment. Only when these conditions have been met has science flourished. In addition, because knowledge has always been at the heart of economic growth and the rise of social well-being it seems almost natural that every society has had to concern itself with its ability to produce knowledge. Consequently, the question of the role science plays or should play in society has been debated throughout the history of mankind. Yet this debate is gaining new momentum in present day society. The reason for this lies in the unprecedented acceleration of the pace at which contemporary knowledge is created and accumulated. This has had a significant influence on scientific and technological progress of a type that has in turn, induced a sharp change in the economy. The term “knowledge-based economy” was coined to denote this new stage that societies are now entering.

Science and research have come to be viewed as the primary resources driving a society’s development, substituting for the role previously played by natural resources. This new role put science under the microscope in every society whose goal was to keep pace in a globalised world. Suddenly, there

1 Gribbin, J. (2003). *The Scientists: A History of Science Told Through the Lives of Its Greatest Inventors* (1st ed.). p. 613. New York: Random House.

was no more space for theoretical debates on the freedom of research topic choice and whether the strongest motive for research should simply be the ‘pleasure of discovery’. Scientific research was given a clear objective: to create new knowledge and ideas and to apply them to innovation that can be commercialised. Public funds that used to be allocated to science for mostly historical and cultural reasons are now given a clear purpose. Consequently, governments are faced with the need to define a coherent science policy to assure that sufficient resources are allocated towards research that can contribute significantly to economic growth and social welfare.

It is from this point of view that this publication attempts to highlight the main issues that can help (or hinder) countries in transition to become successful players in a knowledge-based economy. The authors have decided to focus on the three countries that share a common historical legacy in establishing research but have developed differently within the last twenty years, and are presently at three different stages with regard to EU membership. Slovenia has six years of full membership experience, Croatia is about to be granted membership and has several years of experience in successful negotiations and reform, and Serbia is still struggling to become a candidate country. An analysis of these three countries offers the possibility to explore the consequences that different policies and instruments yield.

Bearing in mind that this publication will be introduced to readers in a region that is accustomed to ad hoc solutions in research funding, where this funding was seldom (if ever) granted as a result of a comprehensive policy, the authors rightfully spent some time on methodological issues. Clarification of the notions of the policy development cycle, implementation and evaluation, the introduction of the principal-agent theory, highlighting the state as a principal, research organisation as an agent, linking research output with legislation and financing and policy goals, all might be very helpful in setting the framework for future research policy development.

By introducing readers to the notion of the knowledge society, the authors offer a brief historical overview of the environment in which scientific research has taken place. Mischaracterising the Renaissance as the point in time when scientific research began rather than the point at which it was imported to Europe seems to be a common error in the Western world. The decision to leave out research activities that took place elsewhere can be justified in light of the authors’ stated objectives. However, it is difficult to overlook the role ancient Greek, Chinese, Hindu and Islamic scientists and philosophers played in keeping the quest for knowledge alive during a period in European history referred to as the Dark or Middle Ages (see for example Lyons[2], or Seife[3]). Though their long forgotten research policies may not be relevant to this analysis, once the

2 Lyons, J. (2010). *The house of wisdom: how the Arabs transformed Western civilization*. London: Bloomsbury Publishing.

3 Seife, C. (2000). *Zéro: the biography of a dangerous idea*. New York: Penguin Books.

Western world accepts the fact that it does not possess sole ownership of the research legacy it may be in a better position to understand and even foresee global development trends.

The historical perspective of the role of universities in the development of Western science could be seen as more controversial than it is presented in this publication. Porter's claim, quoted by the authors,[4] that 'not only were universities educating scientists of the time, they were also employing them and provided them with resources: libraries, instruments, materials' undoubtedly holds true for certain European universities, but the fact that the scientific revolution gave birth to a number of academies and societies 'shows that the idea of a learned society independent of the university must have satisfied a real need in contemporary society.'[5]

Leaving aside the controversy about the role of universities in the scientific revolution, it is important to note that universities generally failed to be its prime site until the post French Revolutionary reforms. This implies that prior to entering the so-called Mode 1 of scientific discovery characterised by Humboldtian universities as its main agents, knowledge production underwent a different, less structured, but extremely productive phase. Even though the socio-economic environment during the scientific revolution bears no similarity to the present environment, the mere fact that different models of research organisation existed at that time is an indication that the Humboldtian concept of university is not the ultimate model for all knowledge and science discourse. While it may be too early to set a new paradigm, the authors rightfully conclude that it is worth examining emerging models like Mode 2 and Triple Helix. In presenting these concepts, the authors offer fairly balanced 'pros et contras' with a special emphasis on their applicability in the context of science and research in transitional social systems. The authors' precautions about 'emulating the EU level legislation' in the process of Europeanisation of research and science policy, with an insufficient regard for the particular socio-cultural environment, must not be overlooked.

The study assumes that there is a general trend of sense. In the literature, this phenomenon is referred to as isomorphism and can be defined as 'a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions.'

'Economic historians point out that nowadays disparities in the productivity and growth of different countries have far less to do with their abundance (or lack) of natural resources than with the capacity to improve the

4 Porter, R. (2003). The Scientific Revolution and Universities. In H. de Ridder-Symoens (Ed.), *A History of the University in Europe: Universities in Early Modern Europe (1500–1800)* (Vols. 1– 4, Vol. 2, pp. 531–562). Cambridge: Cambridge University Press.

5 Pedersen, O. (2003), Tradition and Innovation, In H. de Ridder-Symoens (Ed.), *A History of the University in Europe: Universities in Early Modern Europe (1500–1800)* (Vols. 1–4, Vol. 2, pp. 531–562). Cambridge: Cambridge University Press.

quality of human capital and factors of production: in other words to create new knowledge and ideas and incorporate them in equipment and people.’[6] Having this in mind, it is unsurprising that the EU, which certainly cannot be considered ‘abundant in natural resources’ has set the goal ‘to become by 2010 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.’ Though achieving this goal will not depend solely upon scientific production and diffusion, it will still constitute an important aspect of it. Consequently, significant effort had been put into developing new policies concerning research and development, and inventing instruments for their implementation. Yet, the set goal was not achieved and had to be reiterated and reset for 2020.

This publication specifically scrutinises financing as a key instrument in the policy implementation process. It points out that in spite of the fact that investments in R&D have increased significantly, they are still far from the set percentage. The authors rightly identify the limited authority of Brussels over the research activity in the EU as a major obstacle. Indeed, even by taking the substantial disparity between the richest and poorest states in the EU out of the equation, a common goal is difficult to attain with 27 sovereign national research policies.

There is, however, another question that deserves attention. It concerns national targets. By only focusing on overall financing, it may be concluded that every country is expected to adjust its policy in accordance with the EU policy and to contribute proportionally towards its implementation. If this is true then the EU can be regarded as a sum of its parts that similarly distribute the same percentage of their GDP. Aside from the fact that it will be a while until (if ever) all the member states achieve the same level of development, the rationality of this approach is questionable. The real strength of the EU (or when it comes to research issues, its larger community known as ERA) lies in its potential to identify which regions are particularly suitable for different research areas. It is from this perspective that the Green Paper argues that ‘European countries and regions may build on their strengths by progressively developing specialisation in certain fields.’[7] This is further supported by the fact that recent reports on ERA development concentrate on regional analysis rather than analysis by country. Finally, based on these results, the European Commission proposes that in order for the efforts to produce long lasting effects, the Community’s framework programme should aim at changing the organisation of research in Europe, rather than at simply adding up resources. Only such a holistic approach can lead to Europe’s success in a highly competitive global market.

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6 David, P. A., & Foray, D. (2003). Economic Fundamentals of the Knowledge Society. Policy Futures in Education, 1(1), 20.

7 European Commission. (2007). The European Research Area: New Perspectives (Green Paper) (COM(2007) 161 final).

While the authors indicate that the fragmented nature of the European research system, with its significant differences between member states in terms of research policy, funding and performance is hampering this progress, some light might have also been shed upon the differences in their defined targets and respective investment structure. Namely, while some member countries have suited their targets to their perceived potentials, others demonstrate a tendency to simply copy the meta-policy, stretching their already scarce resources to cover every area.

Having covered the general framework, the authors turn their attention towards research policies and regulative frameworks in the three countries under study: Croatia, Serbia and Slovenia. Taking the assumption that the public policy in each of these countries is designed to improve the well-being of society as its starting point, this publication focuses on the normative framework that should provide for the successful implementation of these policies. Upon meticulous analysis of the relevant laws and by-laws, as well as their accompanying strategies, the authors conclude that all three countries reveal 'several common points of departure in the way research policies are constructed and reasoned.' They further emphasise 'that while research policy in the countries under study has a common root and grow towards very similar objectives ... the national specificities becomes visible only in the way policies are being implemented and in terms of the instrument used.'

The extensive and informative presentation of the activities in all three countries adds a few additional points of interest. The first concerns the presumption that a scientific and research policy should contribute to the overall development of a country. Therefore, it must be preceded by a National Development Strategy. The fact that in Serbia these two strategic documents were adopted in reverse order calls the nature and coherence of their objectives into question.

The second point is related to the apparent differences in the instruments used to select and monitor research activities. Slovenia has introduced an intermediary public agency as a principal, a model that is now being followed by Croatia, while Serbia has decided to entrust the distribution of finances to the responsible ministry. It might have been interesting to look for the underlying rationale which governed these choices, or to put it more clearly, why they thought that a particular choice was more suitable than another. Since it is still too early to expect any of these countries to have analysed the efficiency of its implemented instruments, their choice must have been motivated by something else.

Another point arises from the fact that all three countries carry out their R&D within the context of the ERA, where progress is monitored through common indicators collected and published by ERAWATCH. Consequently, these same indicators should be used to establish the starting position from which the defined objectives are to be attained. While it is reasonable to assume that Slovenia and Croatia based their strategy and instruments upon ERAWATCH data, it is unclear whether Serbia, which is not a member of ERAWATCH, was able to gather the appropriate information. The authors' claim that 'many of (these) objectives seem to be a reproduction of the objectives of the Lisbon strategy or the Europe 2020' emphasises the question of the existence or nonexistence of the relevant data.

It should certainly be highlighted that the data presented in this publication compensates for the lack of data from Serbia in the ERAWATCH. It is one of the first (if not the very first) systemic presentations of ERA relevant data. The variety of the presented indicators, beginning with the volume of funding through allocation mechanisms to research performance, provides an important base for strategy reshaping.

It should be noted, however, that while for some diagrams (like GERD% by source or by sector of performance), comparison with the EU average (EU27) is indicated, there also exist diagrams where the EU average is not relevant. This is true for all indicators for which a uniform distribution among the countries is not expected, but rather a joint contribution to the set EU-targeted value. This is, for example, the case with GERD% distribution by type of R&D activity. There is no doubt that some countries will have more potential and resources for basic research, while others will recognise that their potential lies in applied research or experimental development. Consequently, it is unlikely that any single country will exhibit similar potentials to the potential of the EU as a whole. Hence their distribution diagrams cannot be compared to the EU average. A relevant comparison would only be with other countries within ERA that are similar in size, resources and policy. In that sense, the three countries under study are comparable to some extent. It would also have been interesting if the rationale behind their differences had been examined.

Nevertheless, the presented data clearly shows that all three countries suffer from insufficient resources, though to varying extents. Whether the distribution of those relatively scarce resources is in accordance with the set objectives remains unclear.

Allocation mechanisms are probably the most contested issue among researchers, who always seek more money for their work and more autonomy to decide upon the subject of research. Whatever the mechanism, researchers will always argue that it is biased, discouraging, wastes time, reduces autonomy or is negative in some other way.[8] In light of rising research costs, there seem to be no resource or mechanism that could satisfy researchers. Yet the government has to find some way to distribute public funds.

In order to facilitate further discussion, this publication presents a review of the most commonly used allocation models, highlighting their advantages and disadvantages. In their effort to relate these models to the allocation

8 Martin, B. (2000). Research grants: problems and options. Australian Universities' Review,48(2), 17–22.

mechanisms in the countries under study, the authors rightly concluded that the corresponding legislative documents regulating allocation do not reveal the complete picture. Therefore, they sought additional information from academics, researchers and ministry representatives.

Two points deserve special attention in this context. The first concerns the blind delegation model, which provides core funding for existing research institutions. Unlike Croatia, Serbia has not formally introduced this model into its science policy. Yet since research institutions in Serbia cannot be left without funding, it is inevitably present when decisions are made about project proposals. It therefore distorts the proclaimed allocation mechanism. Since all three countries inherited a number of research institutions, it may have been useful if the authors had examined whether Slovenia and Croatia had reorganised their network of research institutions, or simply continued to provide core funding to the existing one. This might have been helpful for Serbia, which will have to decide about how to deal with this issue at some point in the future.

The second point is related to the allocation of resources in the higher education sector. While in Slovenia and Croatia the universities are the sole recipients of research funds, in Serbia most of the resources go directly to the faculties. Though the authors did not explicitly highlight this point, it is almost inevitable that this scheme would lead to the overlapping and reduced efficiency of these investments.

It should be noted however, that regardless of certain shortcomings in their policies, all three countries have exhibited a rise in research performance. The authors stipulate that this might be ‘partly due to rising investments and partly due to more pressure on researchers, which come from changes in local regulation on quality and funding, changes in the higher education regulation on promotions and from the increasing number of cross-border research ventures.’ Yet from the numerous facts and ideas presented in this publication, it may be concluded that the reconsideration of particular science policies and their accompanying instruments may certainly lead to an even sharper increase in research performance.

Srbijanka Turajlić
Holder of the UNESCO Chair in Development of Education:
Research and Institution Building

Jelena Branković & Norbert Šabić

Chapter 1
INTRODUCTION

The rationale behind researching research

This study aims to examine the current policies, financing, and performance with respect to scientific research in the three countries which were once part of the former Socialist Federative Republic of Yugoslavia (SFRY): Croatia, Slovenia and Serbia. The study strives to analyse research policy, financing and performance in comparative perspective. Based on this topic, the work attempts to address a number of the most relevant questions, e.g. what motivates certain policy goals, to what extent do national policies incorporate EU-level recommendations, what is the allocation mechanism for public funding, how does national research performance compare, and so on. Even though the research looks into research policy, financing and output, the main idea is to identify the extent to which financing as a policy instrument is conducive to the development of research, and therefore whether it furthers economic growth and improves the international standing of the selected countries. Hence, both research policy and performance are examined through the prism of the financing mechanism. Importantly, the goal here is not to focus on scientific research as such, but to analyse the conditions in which it takes place and to deduce whether these conditions support the potential of scientific research to contribute to the economic growth of the respective countries. The study offers empirical data on research policy, funding and performance, which can (a) be of use for future policymaking in the three countries, as well as useful for (b) international institutions and organisations approaching or seeking to enhance their understanding of the research systems under study. Last but not least, the study provides the reader with an analytical tool for examining the major issues and dynamics of research policy implementation.

The project is based on the idea that effective governance requires recognition and utilisation of the linkages and networks that exist between policy actors (Veiga & Amaral, p. 133). In this sense, when implementing a certain policy, both financial and regulatory instruments are to be employed. From a reverse perspective, in order to prevent policy failure or an inefficient use of resources, these instruments need to be adjusted. Beyond the analysis of policy framework, legislation and finance regulations on one hand and research performance on the other, the study will also attempt to explore the extent to which these countries follow European and global trends in research. One of these trends is related to the rise of so-called 'Mode 2' knowledge production: the transfer of the bulk of research activity from its traditional setting in universities (Mode 1) to independent research centres and industry, coupled with a decrease in support for basic or fundamental research in favour of support for applied research (Gibbons, Limoges, & Nowotny, 1997). Most EU strategies and policies, including the focus on the 'knowledge triangle', resonate with this shift from Mode 1 to Mode 2 knowledge production. Another external force is linked to the Europeanisation of research policies process, and the growing effort mobilised in the name of building the 'knowledge economy.' This is tightly linked with a third force: the intensification of policy entrepreneurship activity at the European level in the domain of science and innovation, and hence the interaction between national and supranational policymakers. Furthermore, the growing recognition of the relevance of scientific activity for economic growth and prosperity is another factor that undoubtedly affects national policy dynamics.

On the other hand, features specific to the region are also expected to play a role, beginning with the common institutional and political framework of the past. The choice of these countries was motivated primarily by their shared characteristics. Until two decades ago, all three countries had been part of one federative system. The legislative and ideological elements of this federation can still be found across the region to a varying extent, including in the domain of scientific research. Second, the economic and political stability of the selected countries varies, which is assumed to be of relevance to the governments' approach to science and knowledge production policy. Given the differences in the countries' socio-economic development, the political recognition of scientific progress as vital to the progress of other sectors in the country is expected to vary. Finally, the selected countries are all in different stages concerning the EU accession process. Slovenia is already an EU member (since 2005), Croatia is a candidate member, while Serbia is categorised as a potential candidate. In other words, all three countries are inevitably affected by the EU policy arena.

In general, the special features of the countries of former Yugoslavia (i.e. fragmentation, transition and integration) already make the case interesting enough to study research funding practices in these countries. Performing a comparative study of the main components of the Croatian, Serbian and Slovenian research systems may reveal regional policy trends and highlight their weaknesses and strengths compared with each other. The study will focus on the main features of the funding systems at hand, which will include an analysis of funding sources, funding instruments and the criteria for funding established to support research activities in these countries. Given the countries' official commitment to EU membership, the question of to what extent they are capable of following key EU strategies in the area of knowledge production, research and innovation (both the previous Lisbon Strategy and the new Europe 2020) is certainly a highly relevant one.

What is scientific research?

Though we focus on the conditions surrounding the research activity rather than on the science in the narrow sense, in order to begin the analysis, we need to begin by defining the core object of study.

The understanding of scientific research or research in pursuit of science and its value and purpose have constantly evolved throughout history. Even today there are many different ways scientific research is understood. The term might be best explained bit by bit. According to Encyclopædia Britannica ('science', 2011), the term 'science' (from Latin *scientia*, meaning 'knowledge') stands for 'any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation.' Building on this definition, we can identify scientific research as the advancement of this type of interconnected knowledge within distinctive areas of human life. Moreover, 'research' can be understood as a systematic investigation into establish facts, while scientific research is a narrower concept and is inevitably tied to the use of the *scientific method* (Gower, 1997). Hence, and according to Nelson (1959), scientific research is the human activity directed towards the advancement of knowledge. This activity, as a rule, implies a systematic, controlled, empirical, and critical investigation of hypothetical propositions about the presumed relations among natural phenomena (Kerlinger, 1986).

Though it is generally acknowledged that science has greatly contributed to shaping society as we know it, appreciation and support for this human intellectual activity has not always been encouraging for those involved in its pursuit. In fact, countless protagonists throughout history have been rather unsympathetic towards it. With the rise of the nation state at the beginning of the 19th century, scientific research entered less threatening waters than those of the early modern period of the Scientific Revolution. The prospects science offered to the newly formed states were soon recognised and lead to more stable and generous support for the pursuit of knowledge.

With the accumulation of knowledge and technological advancement in the 20th century, scientific research gained an impetus unknown to it before. This, accompanied by societal development at a more general level, created new dynamics in the relationship between scientific research and the state, now its leading Maecenas. The question 'what kind of knowledge for what kind of society?' has not only become a question that troubles many, but has also resulted in a reconsideration of the traditional social contract between the state and the protagonist of this book – scientific research. This tension has been fuelled by an evolution of the very concept of knowledge itself, a reaction to a wider evolution of society now reassessing the value of knowledge and arguably ascribing greater value to its application.

Conceptual framework

The way research policy is approached and analysed here is based on conceptual premises found in the literature on policy analysis and economic theory. This is accompanied by a number of working assumptions on the three main themes covered here – research policy, financing and performance.

First, these three phenomena are interlinked and are all subject to both mutual influencing and to influence from external factors, some of which have been listed in the first section of this chapter. The interconnectedness of the main elements is easily illustrated by the fact that research organisations respond to incentives coming from financing mechanisms, while the mechanism is often instrumentalised in the name of certain policy goals. Yet research performance can also respond to trends and developments in a particular disciplinary field, a change in the organisational setting, or a wide range of other formal and informal rules and practices. At the same time, policy goals are often based on the situation with regard to performance at a given point in time, i.e. it is always to some extent reactive.

Second, in the policy implementation cycle, financing is considered a policy instrument, that is, it serves the wider policy goal. Nonetheless, due to their history and already established patterns of functioning, financing mechanisms are rarely completely reconfigured to align with policy objectives. Moreover, the financial mechanism can sometimes produce undesired results, going against the set policy goals.

Third, policy and financing are considered input variables, while performance is an output variable. Following this logic, a change in policy and financing is expected to trigger a response in performance. Yet this does not always have to be the case. Last but not least, a distinction is made between an output and an outcome, the latter being taken as synonymous with a policy goal in the context of research policy.

Within the scope of policy, it is understood that the state has legitimate reasons to intervene in societal processes in order to ensure maximum welfare for society at large. This intervention takes place in the form of public policy and normally contains the form and extent of intervention, usually presented as objectives and measures (policy formulation). It is expected that the objectives will be achieved through the implementation of various regulative and financial instruments (policy implementation), while the effects of these instruments on societal processes form the basis for judging achievements and reassessing the set objectives (policy evaluation). (Figure 1.1)

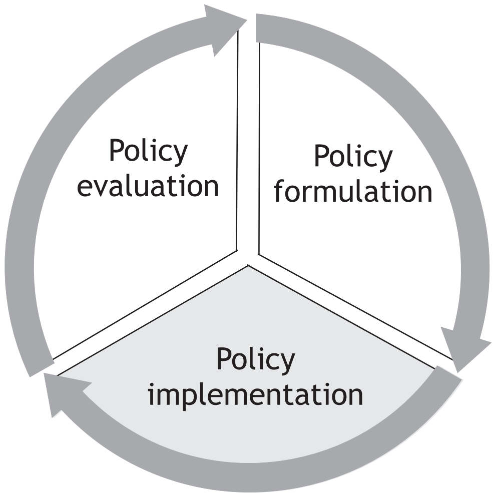

Figure 1.1 Policy cycle

With respect to the application of the cycle illustrated above, in the context of our study it is important to note that the research analyses policy implementation practices in a comparative manner. Therefore, it largely ignores the processes of the policy formulation and evaluation phases. In other words, it does not seek to compare the method, actors, and power relationships that exist during the process of policy formulation, nor does address the question of how policy results are assessed and used for further improvement. Instead, policy implementation and the related questions of how and which instruments are used to implement them are in the foreground of this study.

The analytical framework employed by this study relies on the premises of the principal–agent theory, in which the state plays the role of the principal, and research organisations play the role of the agent. The principal–agent theory, sometimes referred to as a model, was developed within the new institutional economics (Williamson, 2000), and shares its fundamental postulations with the family of economic theories, including rational choice theory, game theory and others. It rests on certain assumptions, such as actors' rationality in making choices, the focus on the maximization of benefits producing consequences, the ascription of little importance to contextual factors, etc. (e.g. see Coleman, 1994). These assumptions have been subjected to extensive criticism by scholars, most notably by March and Olsen (1996), who reject the rationality premise, and argue in favour of bounded rationality (March & Heath, 1994). Hence, this principal-agent relationship suffers from a congenital problem, which stems from the assumption that both the principal and the agent are guided by self-interest and are therefore rational.

The principal-agent theory has proven not to be ideal and perfectly instrumental in every context, which is why it has undergone adaptations to fit a number of different contexts (e.g. Morris, 2003). Yet its applicability in analysing the relationship between the two has been demonstrated by some authors (see e.g. Van der Meulen, 1998; Shove, 2003). At the same time, there are alternative frameworks and theories for addressing policy implementation that may enrich our approach to analysing research policy, financing and performance as well, yet taken on their own offer only a limited perspective to our problem. For instance, the resource dependence theory (Pfeffer & Salancik, 1978; Pfeffer, 1982) assumes that organisations are constantly struggling to increase their own independence from external control by seeking to influence the environment, in particular the flow of resources within it. Though the resource-dependence approach does not exclude the premises on which the principal-agent theory rests, it focuses largely on organisations and their interaction with the environment, while it tells us little about the policy implementation process and the actors within it.

We assume that the state (principal) distributes certain resources and/or duties to actors of the specific policy area (agents), in our case scientists and/or their organisations (generally referred to as 'research providers'), to provide a specific service which is necessary to achieve the set policy objectives. In the context of research *policy*, the theory dictates that the state is the principal, and the researchers and their organisations as the providers of research output are the agents of the policy. The role of the agent is therefore to fulfil the tasks delegated by the principal, normally within a certain policy framework. From another angle, the state as a provider of research funding seeks to steer what researchers do. In this sense, the fundamental steering instrument can normally be found in the mode of delegation or the funding model that the state has chosen to implement. In other words, if the state wants to achieve a certain policy goal, it will look into ways of effectively employing financial instruments in its attempt to influence the behaviour of researchers and their organisations through financing. Alongside the 'power of the purse', the state normally engages its authority (legal power), and organisational capacities and information. In Hood's words, this is 'the property of being in the middle of an information or social network' (1983, p. 21), which enables it to accumulate information unavailable to others and decide upon sending it out.

As one may expect, the principal-agent approach to the object of study is not without its problems. Most notably, the rationality of the principal and the agent is bounded by the information asymmetry, characteristic of the principal-agent problem. The information asymmetry can lead to adverse selection and moral hazard, the often unwanted but always unavoidable by-products of the principal-agent interaction. While the concept of adverse selection refers to any information hidden by the agent in order to misguide the principal in the selection process, moral hazard refers to the situation in which the principal assigns a task to the agent even though it does not have complete information about an agent's behaviour or motives. In these cases, the agent may have an incentive to act against the interests of the principal if its own interests are not aligned with them. Again, we assume here that both the agent and the principal seek to maximize their own benefit from the transaction. As these concepts lie at the core of the transaction-cost economics, it is important to be aware of them. They can occur in any principal-agent relationship, including those located in the science and research sector.

For example, the distinction between the principal and the agent is not always clear-cut. Particularly in the case of research policy, the role of the principal does not exclusively pertain to the state, and the role of agent does not always fall to the research providers. Alternative scenarios are expected to take place in the case of research programmes and research agencies, who, in acting as buffers between the state and the research providers, can act as an agent to the state and a principal to the researchers (as illustrated by the box shared by a principal and an agent in the Figure 1.2) (Shove, 2003). Moreover, a group or consortium of agents can act together for a principal, as is often the case with research programmes (as illustrated by the circle shared by agents G, H, I in the Figure 1.2). At the same time, the state and research providers are typically not engaged in an exclusive relationship, i.e. the state as a principal can have more than one agent, as much as a research provider can play the role of an agent to more than one principal. This multiple principals – multiple agents model is illustrated in the image below.

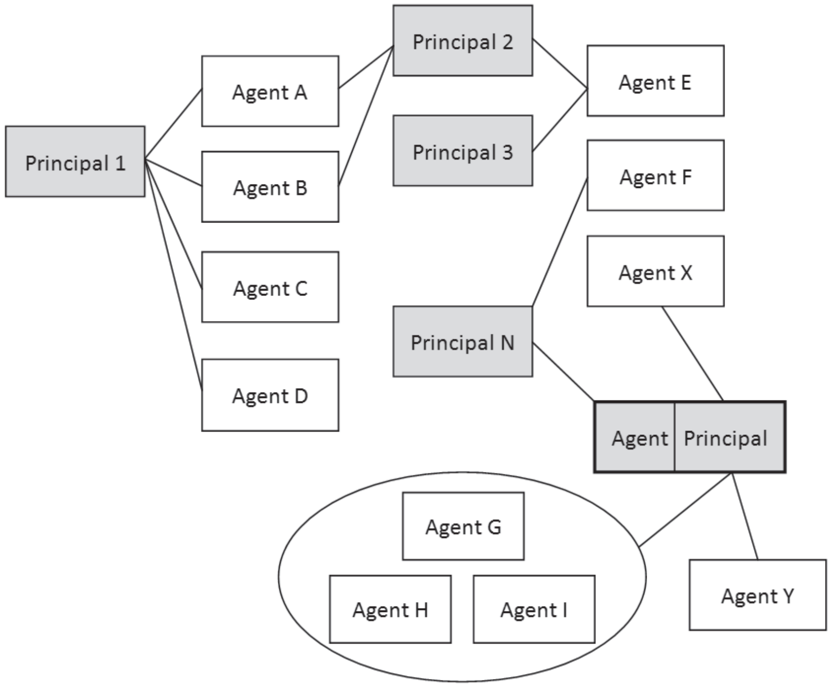

Figure 1.2 Principal-agent model[1]

1 Adapted from Shove, 2003

Moreover, Morris (2003) argues that in the science policy context, the roles of principal and the agent can be reversed if one assumes the main resource to be scientific knowledge and not funds. Instead of the conventional scenario in which 'funds call the tune, and skills (knowledge) must comply', the reverse is the case, which 'turns principal-agent model on its head' (2003, p. 361). In other words, because the state is the user of the scientific output, it becomes the agent, while the scientist, as the creator of scientific knowledge with which the balance of power lies, is the principal. This idea is particularly interesting in the context of research conducted at universities. Higher education institutions are often difficult to steer in the desired direction due to their institutional autonomy and the academic freedom claimed and exercised by the academic staff. Moreover, as they strive to nurture a specific set of values, they show loyalty to their disciplines rather than their governments. With these conflicting goals (Clark, 1983), academics are expected to be prone to moral hazard when placed in the role of the state's agent. Though they operate in markets and share some similarities with businesses, higher education institutions are different (Winston, 1997). Moreover, the academics populating them tend to react to a different set of incentives than their fellow researchers in companies, and this can affect their research performance (e.g. see Li & Ou-Yang, 2010).

As our focus here is on funding and policy rather than knowledge creation and its diffusion, we have opted for the conventional view of the state and its auxiliary bodies as principal, and research providers as agents. Furthermore, we assume the centrality of these two roles and the position of the policy cycle relative to them. Within this context, the state is the one in charge of policymaking, enforcing regulation, setting rules for public funding, the provision of public funding, and monitoring and evaluation, while the role of research providers is to produce research output that is expected to lead to a policy outcome (policy goal), such as economic growth.

In constructing our analysis, we will begin by deploying a historical analysis of science policy, as we deem this relevant to the process of mapping the current state and posing the basic question – what does the present mean, given what has happened in the past? This approach is based on the rationale found in historical institutionalism and 'path dependence' approaches to change, or as Pierson put it simply (2000, p. 252) 'we cannot understand the significance of a particular social variable without understanding "how it got there" – the path it took.' This effect that history has on the present and therefore future, or as Pierson put it, the 'causal relevance of preceding stages in a temporal sequence' is referred to as path dependence and it lies at the core of historical institutionalism (Hall & Taylor, 1996).

Since the principal-agent theory tends to be rather simplistic and thus downplays the role of context, drawing on the concepts of historical institutionalism and making sense of the behavioural patterns that do not fit well within the principal-agent theory could be of some assistance. First of all, historical institutionalism has offered two plausible explanations for how institutions affect the behaviour of individuals (Hall & Taylor, 1996, p. 7). The so-called calculus approach assumes that agents behave in a rational manner, meaning that they will always seek to maximise their attainment consistent with their preferences. Correspondingly, the principal would aim to enact rules that enforce mechanisms for agreement and penalties for defection (Hall & Taylor, 1996, p. 7). Moreover, this approach implies that agents would respond to incentives, which are introduced by the principal to achieve a given policy goal. In contrast to the calculus approach, the cultural approach describes behaviour as not entirely strategic in nature, but bounded by the agents' and principals' worldview. This means that the chosen course of action will depend on the interpretation of the situation, which cannot be done without taking into account the historical development.

The historical account is followed by an outline of a wider political context – the European Union, given its political relevance for all the three countries, as well as for the entire region of the Western Balkans. Once these 'time' and 'space' factors have been mapped out, we will proceed with a comparative analysis of the three case countries, followed by a description of the financing mechanisms employed and finally, research output. It is at this point that the analytical framework *stricto sensu* is introduced and places the three subjects – policy, financing and performance – into a coherent whole. It is of great importance to note that policy, financing and performance are treated as being in a constant state of flux and mapping them as part of a single logical whole at a specific point in time would be undesirable as it could lead to false conclusions about their relationship. It is for this reason that they are treated separately at this point and are cautiously put together in the final chapter of the book. Figure 1.3 is an illustration of the three core elements covered in our analysis and their assumed sequence.

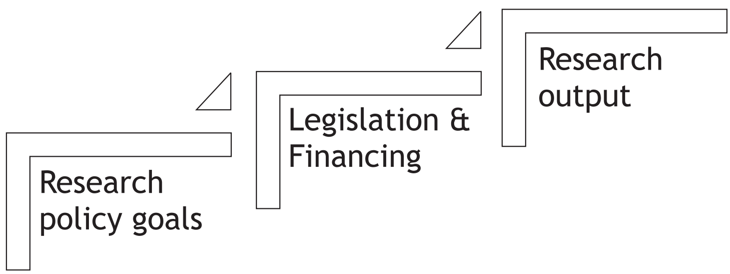

Figure 1.3 Analytical framework core elements

The framework itself runs on two levels. First, it looks into each of the three countries and explores the extent to which financing as a policy instrument is conducive to the implementation of polices targeting research.

Second, it employs a comparative approach that enables the authors to identify the trends to which the countries subscribe and, albeit to a limited degree, places them in a wider European context. All of this is somewhat limited by the data available, yet the authors claim that relevant conclusions can be drawn. Finally, all of the conclusions drawn are put together and as such, are taken a step further.

A note on methodology and data sources

With regard to methodology and data, the study employs a combined qualitative and quantitative approach, based on both the documentary analysis and the analysis of quantitative data. The qualitative data was obtained through the analysis of regulative frameworks, strategies, official statements, and other documents adopted or issued by the state authorities or research institutions, as well as those of the EU institutions and other international organisations. The quantitative data was obtained from the Thomson Reuters Web of Science database by means of data generation commands given by the researchers of this project. The secondary quantitative data used for this study was mostly collected from the UNESCO Institute for Statistics, Eurostat, World Bank databank, and national statistics offices in the countries under study. The way these were used for the purposes of this study, as well as the scope of usage, is described in the respective chapters.

The subject of analysis is scientific research (as it was defined in the previously) conducted within the public sector. Even though applied research is taken into consideration, this study approaches scientific research separately from its application. Nonetheless, as national policies and available data normally focus on both research and development and sometimes science and technology (S&T), these are also included to some extent.

It is important to emphasize that drawing a line between all of these concepts is often very difficult as it is tightly linked with current trends with regard to knowledge production and its appreciation. In order to avoid conceptual overlaps due to vague distinctions between a number of essentially distinct terms such as science, research, development, innovation and technology, we have compiled a glossary that provides definitions for these terms (see Glossary). The purpose of providing a glossary of relevant terms and their explanations is to ensure a consistent approach to a variety of frequently used terms relevant for and related to the topic of study. In order to avoid misinterpretation of the data used, the definitions given here are mainly aligned with the leading manuals used in R&D data collection and analysis, such as the OECD Frascati Manual for R&D (OECD, 2002), or the OECD/Eurostat Oslo manual for innovation (OECD/Eurostat, 2005). That said, the researchers are aware of the limitations of the aforementioned manuals (e.g. see Lepori, 2006), as most of their data was not collected directly by the researchers, but by organisations such as governmental statistics agencies, which, in the case of R&D, normally follow international standards promoted by the OECD. Therefore, in our understanding, ignoring these manuals would mean ignoring important elements of the data background. Similarly, the definitions specific to the Thomson Reuters databases are also taken from this web-based source ("WoK," 2011). With regard to the rest of the definitions, unless otherwise specified, the definition given by the authors is included in the glossary at the end of the book.

Outline of the book

Roughly speaking, the outline of this publication follows the design of the conducted research and its analytical framework. Chapter 1 presents the aims, rationale and research problems, followed by research design, analytical framework, methodology, data, and limitations. Chapter 2 provides a brief historical overview of the development of science, followed by the role the nation state in supporting and advancing it, the evolution of knowledge production, and the emergence of the knowledge society. In Chapter 3 we move on to the broader political context and discuss recent developments in the European Union with respect to science policy. Chapter 4 discusses policy and regulatory frameworks in Serbia, Croatia and Slovenia, focusing on the major strategic and supporting legal documents. In Chapter 5 we shift our focus to financing and place emphasis on the volume of funding and its distribution across sectors, as well as on human resources in scientific research. The second part of the chapter is dedicated to the allocation mechanism for public funding, which we assume to be a major instrument employed by the state in implementing its research policy. Research output, mostly in terms of bibliometric data, is the topic of Chapter 7, which aims to illustrate a trend in the three countries' research performance in the previous decade. This is followed by Chapter 7 in which the authors discuss their findings and place them in a wider analytical framework, while placing the patterns identified in these countries in a broader European context. The discussion is followed by our concluding remarks.

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Jelena Branković, Predrag Lažetić, Norbert Šabić

Chapter 2
TOWARDS A KNOWLEDGE SOCIETY

In fairly broad terms, the core subject of this study is scientific research as a phenomenon encompassing not only those who are directly involved in it, but also those who benefit from it and those who support it. On a more specific level, this study addresses the relationship between the state as a patron of science, and researchers and their organisations as providers of science. The aspect of this relationship under observation in this study is its resource-based dimension, namely the support scientists and research organisations enjoy from their particular environment and especially the state for the purposes of increasing the overall knowledge base of their scientific discipline, or to contribute to the growth of the economy or the wellbeing of society.

The arrangement of research systems and their defining characteristics have been largely shaped by historical momentum. Distinct national systems have emerged as a consequence of past conflicts over political and economic interests (Hall & Taylor, 1996). Thus the power relations between the agent and the principal are conditioned by moments in history that must be emphasized. When building on the principal-agent theory, institutions, whether formal or informal, become the primary sources for structuring the behaviour of researchers. The rules, norms, and procedures distinguish agents not just across national systems, but also across periods of time.

In this chapter we are going to begin with a condensed historical overview of the scientific activity and its institutionalisation. The second part of the chapter is dedicated to the relationship between the state as a formal political institution and the ‘science providers’, as well as to the reflection on the current debate on the changing nature of knowledge. From yet a different angle, the remainder of this chapter is dedicated to two aspects of scientific research. The aspect of research we have chosen to name *external* examines how science has been handled by societies throughout history, and eventually by present-day society and its institutions. The other aspect is the *internal* face of scientific research, that is, the knowledge it is set out to generate. It is this evolving understanding of its nature and purpose that we attempt to analyse later.

Scientific research: a historical overview

Since ancient times, discovering the inner workings of nature has been one of mankind's greatest concerns. Whether for purely existential reasons or due to the sheer curiosity of individuals, humans have always looked for answers to fundamental questions that preoccupied them. Though the approach has varied across place and time, humanity has always managed to find its way to those 'truths' which had been long sought after, regardless of the permanence, fallibility or method by which it was performed, or of which paradigm it was a part. 'The method', as it is known today, has not always been as meticulous or empirical as we like to think of the scientific method today, in fact, quite the contrary. As for paradigms (provided they do exist), in most Kuhnian terms, they have long been proven to be in a constant state of waiting to be replaced by newer paradigms (Kuhn, 1996).

Yet it was not until the 17th century that a profound epistemological transformation took place, today commonly known as 'the Scientific Revolution'. Although according to the aforementioned Kuhn every shift in paradigm is a Scientific Revolution *per se*, the 17th century developments have been regarded as by far the most radical paradigm shift in pre-twentieth century history. Though this 'revolution' triggers thoughts of the major developments in the natural sciences of the late 16th and 17th centuries (discoveries in mathematics and physics primarily through astronomy, and in medicine primarily through the study of the human body), the Scientific Revolution has its roots in earlier developments; in the work of Copernicus in the 16th century, or even in the rediscovery of Aristotle in Europe in the 12th and 13th centuries. Still, it was not until the 17th century and the work of Galileo that the scientific method was born (Chalmers, 1999). Importantly, the Scientific Revolution was part of a more profound phenomenon that eventually led to the Age of Enlightenment. Arguably, it was part of a major change in human experience and the understanding of existence, which was followed by the rise of a more critical and sceptical way of thinking. Further, it resulted in such developments as the Renaissance, Reformation, the discovery and exploration of the 'New World', and major inventions such as the telescope and microscope, just to name a few. For the future of scientific activity, the Scientific Revolution meant 'fundamental reconceptualisations in scientific theory, the overturning of old orthodoxies, the establishment of new and enduring scientific concepts' (Porter, 2003, p. 539).

During the Scientific Revolution, universities played a significant role, particularly in the development of science (Grendler, 2004; Porter, 2003). As Porter has noted, only a small percentage of the leading figures of the Scientific Revolution did not get their education at universities or equivalent colleges. Not only were universities educating the scientists of the time, they were also employing them and provided them with resources: libraries, instruments, and materials (Porter, 2003). Of course, as Porter adds, there were those who were employed as court astronomers, physicians or astrologers, but they were rather exceptions than a rule.

Yet even at the beginning of the 17th century, the university was still a largely medieval institution. It was highly dependent on the church, kings, and local authorities, and in principle focused only on theology, arts, medicine, and law as the four ‘universal’ fields of teaching and studying. This ‘universalism’ of the institution of higher learning was also linked to the common practice of migrating students and scholars, who studied and taught at more than one university during their lifetime. This relative unity was broken somewhat with the advent of the Reformation, which divided the Europe of the time into Catholic and Protestant, with direct consequences for the universities located in the respective areas (Porter, 2003). Later on, with the rise of the modern nation state, this universalism was further reduced to the advantage of the state bureaucracy and its functional demands. This made the map of European universities more fragmented in terms of their curriculum, practices or, more simply, purpose and role in the new environment they were a part of. However, the university was not the only benefactor of science, as ‘scientists’ of the day could also rely on other sources of support for their work, such as kings or emperors (e.g. in the case of Johannes Kepler).

As it is well known, these times were marked by the rule of Christian doctrine, with the church as the single dominant institution setting boundaries on human curiosity with regard to scientific and philosophical inquiry, or, as Porter referred to it, as ‘the watchdog of intellectual orthodoxy’ (Porter, 2003, p. 537). Universities were not exempt from this, and were perhaps even more affected by it given the fact that many scholars were also members of the clergy and were actively involved in church affairs. However, it was precisely in these circles that the first systematic questioning of the ‘truths’ of the day took place. Nicolaus Copernicus, Andreas Vesalius, Galileo Galilei, Isaac Newton, Francis Bacon and many others were among those who today are revered for their great contributions to the progress of humanity. Yet during their lifetime, their achievements were not always welcome and were sometimes actually frowned upon if they happened to challenge the well-established beliefs of the time. Given the conditions of the time, this often presented a severe threat, not only to the work of these individuals, but also their lives and well-being.

While the universities were important for the Scientific Revolution, their importance in the development of science was somewhat diminished later on (Porter, 2003). In the 17th and 18th centuries and during the Age of Enlightenment, scientific and philosophical activity largely took place outside of universities, in the academies of science, various scholarly circles, learned journals, etc., as a reaction against universities, which were now regarded as medieval institutions, belonging to *l’ancient regime* and therefore an inappropriate environment for the academic activities of the late 18th century.

Therefore, it was not until the 19th century and the rise of the nation state that the university became institutionalized as the 'home' of science. By and large, historians of the university agree on the idea that the notion of autonomous institutions of higher learning can be traced back to the beginning of the 19th century. The founding of the University of Berlin by the Prussian educational reformer Wilhelm von Humboldt in 1809 is generally considered the event that marked the rise of the Modern German University, in contrast to the Medieval University (Ben-David, 1971). This so-called *Humboldtian* university model also represents the ideological root of most of the universities in continental Europe and beyond. Its main dimensions, to a great extent novel to the institution of higher learning until that time, can be grouped along the following lines: (a) autonomy from the State and the concept of academic freedom; (b) the organic unity of all scholarship, next to the German concept of *Wissenschaft* as philosophically-informed scholarship; (c) *Bildung* as the aim of education, which essentially refers to personal growth through the acquisition of culture; (d) the pursuit of truth as an endless process. In other words, the university finally became the institution with the integrated functions of knowledge production and knowledge transmission.

All four dimensions outlined above have been essential to the development of science from that point onwards, and in particular to the role of university in the future of scientific inquiry. Another important novelty was the emergence of the centralised state. Not only had the state (gradually and eventually) finally replaced the role of the church in university affairs, owing to its recognition of the value of the university to state's objectives, the state also became its main sponsor. Hence the university's increasing dependence on both its ideological and financial support.

According to Anderson, there were two main contributions of the Humboldtian legacy to science (2004, p. 55). The first contribution was making research the primary purpose of the university, with teaching as its 'supplementary' purpose. The second contribution was phrased in the following way: 'Universities must be protected from outside interference if they are to carry out their true task. The state must supply the organisational framework and resources necessary for the practice of science and scholarship, but must also adhere to a deep conviction that if the universities attain their highest ends, they will also realise the state ends too' (Anderson, 2004, p. 58).

Nonetheless, not all states perceived the role of the university in the same manner the Germans did. The case of France is often mentioned as a contrast to Germany, which saw the main role of universities as professional schools for training state bureaucracy, while scientific activity was dislocated from universities altogether. The more utilitarian approach was also adopted in northern Europe (e.g. Denmark) and other protestant countries. On the other hand, universities in the United States of America were highly autonomous from the state (unlike those in France), and were more often seen as an instrument to strengthen the economy of the newly founded country and contribute to nation-building. In all three cases (Germany, France and USA) the state acted as a major benefactor of science.

The involvement of the state in funding scientific activities increased significantly both during and in the aftermath of World War II. The increase in funding was the result of a more explicit recognition of the contribution of science to the social and economic development of modern nation states. Public money has been vital for scientific research ever since.

Science and the state

The relationship between science and the state was not always as we know it to be today. One could argue that in the decades following World War II, this relationship was defined by its agreement with the state's perceptions of science and innovation as the main drivers behind economic growth, and on its expectation that knowledge institutions would enhance the international competitiveness of national economies. The focus shifted towards the output of research activities rather than on the way of doing research (Brew, 2006, p. 19). This utility-oriented view of science has undoubtedly shaped the expectations imposed on scientific research, in particular from the side of those who provide resources for its functioning and advancement.

As much as Europe was a role model for research at the turn of the 19th century, the US became the role model after the world wars. At the beginning of the 20th century, research was still considered a 'charismatic activity that could be successfully pursued only by an inspired few' (Ben-David, 1971, p. 140). Between the two world wars, the US managed to professionalise research, that is to say, to create the so-called researcher career. The researchers' qualification called *Ph.D.* meant that all who possessed it were obliged to adhere to a certain scientific ethos. They were then employed by the presidents and boards of trustees of various universities to do research (Ben-David, 1971, p. 155).

The professionalisation of research helped the United States slowly emerge as a scientific leader in the post-war world. Following World War II and especially during the 1960's, large amounts of federal funds were invested into scientific research activities. The federal government became the 'principal consumer' of research, seeking outcomes according to its own mission (Geiger, 2004, p. 2). Increased financial resources boosted the prestige of US research universities and inevitably its ability to attract the best scientists from all over the world. Consequently, the term 'brain drain' became a term to describe the increasing emigration of top scientists to the US.

After falling behind during the 60's and 70's, criticism of the Humboldtian model arose in Europe. Political leaders in particular started describing it as profoundly individualistic and elitist. It was argued that it lead to inward oriented research and failed to produce socially valuable outcomes (Geiger, 1985, p. 65). A series of OECD studies entitled The Research System (1972–1974), noted that Europe's research sector should 'organise and direct its efforts more efficiently [in order to] serve society more directly, more massively, and more immediately' and that this could be achieved by 'choosing carefully' rather than increasing spending (Geiger, 1985). United States National Science Foundation (NSF) contributed to the debate with a report entitled 'Science Indicators, 1972', which ambitiously presented the overall state of US science. This 'fruitful dialectic exchange between NSF and the OECD' (Delanghe, Sloan, & Muldur, 2010, p. 539) on the one hand, and the debate about Europe lagging behind the US on the other, constituted a shift in the way scientific performance is measured and compared. In other words, input indicators ceased to be the dominant means of measuring science, setting the stage for output indicators. Finally, the already well-established science data collection and systematization manual the OECD Frascati Manual, gave more attention to output indicators in its subsequent editions, 1981 and 2002 (Delanghe et al., 2010) a fact that had a direct effect on national level data collection, and an indirect effect on science policy discussions at the national level. Later on, from the 1990s, the European Commission 'became increasingly active in the development and use of various S&T output indicators, including not only bibliometric data, but also data on patents, technology alliances, innovation and high-tech trade' (Delanghe et al., 2010).

The US success presented an opportunity to achieve better results in European research. Policy-wise, these developments led to European leaders urging for better collaboration and cooperation between national research initiatives in order to compete more efficiently with the US, and increasingly, Japan. Several research programmes have been set up for that reason. Among them, we should highlight the European Coal and Steel Community (ESCS) research fund, which has supported research in the coal and steel sector since the end of the 1950s. There was also the establishment of the Joint Research Centre (1957), with a focus on nuclear research. In 1983, the ESPRIT programme (European Strategic Program on Research in Information Technology) launched and was immediately followed by the First Framework Programme (1984) and the EUREKA initiative to support industry-related research activities. In 1987, the Single European Act came into effect with the aim to set up the European single market by 1992. It was the first treaty to establish research objectives on a European scale. The act stressed the aim 'to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level.'[1] Additionally, it provided a background for the implementation of the framework programmes. In 1993, with the adoption

1 *The Single European Act*, last retrieved on October 12, 2011, from http://europa.eu/legislation_summaries/institutional_affairs/treaties/treaties_singleact_en.htm

of the Treaty of Maastricht, the importance of science for the future of Europe was highlighted again. All of these initiatives marked the beginning of the European Research Area, indicating that the European community had begun to take a more active role in the development of policy for science in Europe.

The new millennium brought about the European knowledge society discourse, which was clearly linked to the Lisbon agenda set forth by the 2000 spring European Council. This strategy defined the ambitious goal to make Europe the most competitive knowledge-based economy in the world by 2010. The strategy covers a range of areas, including the economy, scientific research, education, social cohesion, and environmental protection and sustainability. It also builds on the view that the industrial economy is transforming into a so-called post-industrial or knowledge-based economy. This term should not be confused with the so-called ‘knowledge economy’ which refers to the tendency to use knowledge as a commodity to trade in various markets. The knowledge-based economy perceives knowledge as the engine of economic development. That is to say, during the industrial age, the economy was established for the purpose of manufacturing, while in a knowledge-based economy, the main objective is not to organise production, but to generate innovations through the utilisation of knowledge. Therefore, it has been anticipated that the future of high wage economies will be critically dependant on their ability to create new markets though product and service innovation (Röpke, 1998, p. 1).

In light of this principle, and in accordance with the ongoing integration process, the EU presented the idea of a common European Research Area (ERA). The political concept was formulated first at the European Council meeting in Lisbon, with the expressed purpose to overcome national fragmentation in research activities. That is to say, the ERA aims to ensure a better management of national R&D resources, increase the mobility of researchers, stimulate excellence through benchmarking, improve the flow of knowledge between research institutions, and lead to better coordination of national research policies (European Council, 2000). This last aspect is especially important owing to the common policy challenges EU member states encounter concerning research. In order to realize their goal of an ERA by 2010, the European Union identified several areas that needed to be addressed. These included their goal to increase the percentage of expenditure on R&D activities to 3% of the GDP (1% public and, 2% private investment), regenerate the research infrastructure, ensure a supply of highly trained R&D personnel and to guarantee the transfer of knowledge from the public sector to the private sector (“ERAWATCH,” 2011). Many of these challenges persist even today, and have been identified as priorities for the EU strategy in the coming decade – Europe 2020. Moreover, to intensify the role of innovation within ERA, the term ‘Innovation Union’ has been introduced, in which innovation is defined as the human activity directed towards the creation of new and improved practical products and processes (European Commission, 2010, p. 3).

Within the ERA, universities and other higher education institutions are expected to contribute considerably to their countries' economic development. They host some of the best researchers and possess the necessary research equipment for producing innovations. This fact has not escaped the policy makers in Europe. Moreover, we observe a strong political pressure to submit university research activities to the needs of the knowledge-based economy. Scientific research in higher education institutions has increasingly been coupled with innovations. The underlying argument is that the quest for new knowledge should be guided by utilitarian values and measured by its profitability on the market. However, for scholars, these developments raise several questions: what kind of knowledge will be needed in the future, how should it be managed, in what manner and under what conditions should research activities be conducted, how far should universities go concerning knowledge capitalisation, and what form should their cooperation take with the industry? Importantly, these questions are not only relevant, but also controversial.

Even though today most research funding in Europe (esp. applied) is spent within the private sector (63,02%), research activities that take place in the higher education sector are still far from undermined (22,91%).[2] Not only does it cover a significant portion of overall research activity, but also contributes to the research and development happening in the private industrial sector (Cohen, Nelson, & Walsh, 2002; Metcalfe, 2008). Within the context of the triple helix, which weaves together the business sector, government and higher education institutions, technology-intensive companies apply and commercialise the newly created knowledge or technology developed by university staff and students more often today than in the past. In addition, universities increasingly establish spin-off firms with an aim to develop technologies or advance research in areas that can be of economic benefit (Mowery & Shane, 2002).

The concept of knowledge society and the paradigm shift in the social field of knowledge and science

One of the most relevant concepts used to illustrate the growing importance of knowledge and its creation, utilisation, distribution and more recently, ownership within society, is the concept of 'Knowledge Society'. Together with related conceptualisations, e.g. information society, the knowledge-based economy attempts to make a diagnosis ('Zeitdiagnose') for the current phase of modernity. The concept is used on different levels. First, it is used as an intellectual device among theorists of society with the aim to describe a new reality in which information and knowledge production have become defining features of relationships within and among societies, organisations, industrial production and human lives. With this Zeitdiagnose, the creation of

2 Last retrieved on October 12, 2011 from Eurostat http://epp.eurostat.ec.europa.eu

a modern social theory of knowledge that can illuminate the clear and growing role of knowledge in economy, culture and politics in postmodern societies can be attempted (see Välimaa & Hoffman, 2008, p. 271). Once introduced, this kind of concept and diagnosis tend to have a life of their own, and the intuitive nature of this intellectual device allows a wide range of actors in the various domains of society (economics, politics, media and research) to introduce their own definitions of the concept (Välimaa & Hoffman, 2008). The broad and active employment of the concept of knowledge society in variety of social arenas sparked the creation of its second nature – knowledge society as a discourse. As a discourse, knowledge society tends to create an imaginary social space (Välimaa & Hoffman, 2008, p. 266) in which everything related to knowledge and knowledge production can be included and interrelated regardless of whether the discourse concerns individuals, organisations, business enterprises, or entire societies. In this sense, knowledge society has a double-sided nature. It represents the diagnosis of the social reality, but at the same time also represents the prognosis of for future social development – social fiction (see Bittlingmayer, 2005, p. 33). The second prognostic nature of the discourse endorsed by the political actors opened a space for the third nature of the knowledge society concept – its nature as a political goal. A multi-level analysis of the political usage of the term 'knowledge society' (see e.g. Välimaa & Hoffman, 2008; Bittlingmayer, 2005) demonstrates that the transformation of society into a knowledge-based society is increasingly politically instrumentalised. The process is presented as evolutionary, as it inevitably develops in a specific direction. It is also seen as quasi-ontological due to the fact that this directed process of modernisation is usually described as a background process without any mention of the actors standing behind it. Finally, this kind of treatment generally gives the process a touch of existential independence. Simply put, it is presented politically as a process that can be observed but cannot be regulated or turned in another direction. Seen politically, the process of society's transformation into a knowledge society happens on its own and appears self-directed. As a consequence, it is understood as political destiny (see Bittlingmayer, 2005, p. 52).

The concept of knowledge society implies interconnected shifts and analytical observations about three main social fields concerned with knowledge society discourse (economic, political and knowledge/science social field). The central thesis of knowledge society is the increased interconnectedness between the scientific, political and economic fields, in which the borders between the three tend to fade and old autonomies tend to disappear.

Undoubtedly, the field of knowledge and science itself has been changing in the context of the knowledge society discourse. One general assumption is the extension of the social field of knowledge and science to the overall society. This phenomenon usually makes itself visible in the increasing presence and relevance of scientific and technological knowledge in almost every domain of life. It makes itself visible to an even greater extent in the widening of borders in the system of sciences, and through the growing rule of experts (see Bittlingmayer, 2005, p. 136). However, the aspect of change most frequently mentioned in the social field of knowledge and science within the context of knowledge society discourse is the change in the production of new knowledge itself.

The most well-known thesis about the emergence of this new production of knowledge is the thesis about so-called 'Mode 2' knowledge production. Mode 2 is a form of knowledge production marked by its reflexivity and heterogeneity (Nowotny, Scott, & Gibbons, 2003), in contrast to the old paradigm of scientific discovery (Mode 1) which was characterised by the hegemony of theoretical or experimental science, an internally-driven taxonomy of disciplines, the autonomy of scientists and their host institutions, the universities (Nowotny et al., 2003, p. 179). The new Mode 2 is seen as a form of production that is socially distributed, application-oriented, trans-disciplinary and subject to multiple accountabilities (Nowotny et al., 2003, p. 179).

Within Mode 1, problems are set and solved by a small group of scientists and generally within an academic disciplinary community, with the university as the primary site of research and dissemination of knowledge. Mode 2 represents a shift towards the production of knowledge in the context of its application, which is often found outside the university. In Mode 1, knowledge is disciplinary, hierarchical, homogenous and relatively autonomous, while in Mode 2 it is trans-disciplinary, fluid, heterogeneous, and allegedly more socially accountable and reflexive (see Delanty, 2001, p. 109).

The thesis about the new mode of knowledge production is usually supported by observations about the changing nature of the research environment with regard to several significant tendencies. The first is the tendency to steer research priorities mostly through dominant funding schemes (e.g. European Community Framework Programmes, national research funding schemes etc.). The second tendency relates to the commercialisation of research that is observable through the increasing presence of alternative sources of funding and the increasing importance of intellectual property generated by research. The third tendency in the transformation of research is the growing emphasis placed upon the management and evaluation of the effectiveness of research (the most famous example being the Research Assessment Exercise conducted in the UK) (Nowotny et al., 2003).

As a result of these and other trends, the authors claim that the fundamental research is now a minority activity of most researchers and research institutions. This has lead to the decline of the status of research from a public good to intellectual property which is produced, accumulated and trades like other goods and services (Nowotny et al., 2003).

Moreover, this conceptualisation of the new knowledge production is located in yet another big metaphor of knowledge society discourse –

triple helix or the model of new knowledge dynamics. This implies that the previously isolated institutional, social domains of university, government and industry have become increasingly interlinked and interdependent (Välimaa & Hoffman, 2008). Although these conceptualisations (Mode 2 and triple helix) offer seemingly clear-cut definitions of reality, there are many critical views that offer relevant counterpoints. These criticisms cite the fact that these conceptualisations focus on relatively small, albeit significant models, and that the diverse landscape of science is a dramatically shifting domain. In addition, critics charge that these models represent more ideal types than empirical models, or that these models have ideological connections to neoliberalism (Välimaa & Hoffman, 2008). In addition, new developments in the mode of the production of knowledge which place more and more emphasis on the context of use and application, connected with the retreat of the state from the role of sole provider of research funding, coupled with an attendant shifting of activity from the university to a range of non-university institutions, has prompted some sociologists to declare the so-called 'end of knowledge' (see Fuller & Collier, 2004). These sociologists predict negative scenarios for the university in knowledge society, in which it loses its privileged autonomy as a result of competition, and is faced with the contestation of the legitimacy of academic science and knowledge (see Delanty, 2001, p. 104).

Although the conceptualisations of a new mode of knowledge production offer provocative statements about postmodern research production, the applicability of these concepts in the context of science and research in transitional social systems is questionable (see Prpić, 2007, p. 488). Prpić identifies two reasons for this. The first concerns the clear demarcation of the traditional and new mode of scientific production in the models, as well as their insufficient theoretical elaboration. Some of their hypotheses are tested indirectly rather than directly. In fact, the reality usually shows a combination of old and new knowledge production modes (Prpić, 2007, p. 488). The second and even more important reason that these models are inappropriate for analysing transitional societies concerns the nature of the social context in which these changes in knowledge production were identified. This context was the world's most developed countries with powerful economies and technological and scientific potential, massive investments in R&D and competitive research systems. In contrast, the post-socialist countries of central and eastern Europe, which despite their social and historical differences, all underwent deep political, economic and social transformation during the 1990s (Korovitsyina, 2004, in Prpić, 2007).

In the case of Croatia, for instance, Prpić (2007) argues convincingly that the transformation of the Croatian research system began in extremely unfavourable social conditions which were made even worse in comparison to other transition countries by the destruction of war, a dramatic erosion of economic activities, socially problematic and insensitive privatisation, and the formally democratic political system whose level of democratisation was nonetheless insufficient. With regard to the research system, it had some of the characteristics of former socialist countries, but also differed from them to some extent. It was not based on the Soviet organisational model of research and development, and was less expansive due to the significantly lower level of research funding. Yet it was also less centralised and much more open to international scientific communication (Prpić, 2007, p. 489). In Croatia and similarly, in Serbia, the reduced R&D funding also led to structural changes in the research system, primarily to the downsising of the industrial research sector. However, the overall reduction in the number of researchers in Croatia was of a comparatively smaller scale than in some other transitional countries. In contrast to the decentralisation of east and central European scientific systems, the Croatian system was, unfortunately, subject to extreme centralisation of decision-making in science (Flego, 2002, quoted in Prpić, 2007).

Furthermore, in support of this thesis, Prpić (2007) refers to large cross-national studies of scientific productivity (covering 95 countries), which undoubtedly demonstrate the significance of the effect of the socio-cultural environment on national scientific output (see Cole & Phelan, 1999 as cited in Prpić, 2007). These studies have not only determined that GDP is the strongest predictor of national knowledge production, but that cultural and structural variables (religion and characteristics of the research system) are also significant factors.

Although the borrowed analytical thesis about a completely new mode of knowledge production certainly cannot be made convincingly outside of the leading technologically and scientifically societies, it is not without political relevance for post-socialist countries; especially keeping in mind the policy emulation tendencies in the Europeanisation process of research and science policy. The concepts of Mode 2 production of knowledge and the triple helix of new knowledge dynamics are becoming increasingly visible in the rhetoric of EU integration and are coming to function as a self-fulfilling prophecy.

Conclusion

It is evident that that both the external and internal aspects of science have been shaped throughout history. Starting out as a marginal social activity, pursued only by a chosen few, science became institutionalised within higher education institutions. By taking just a surface look at the current trends, we can expect that it will most likely transcend even these (Vincent-Lancrin, 2006) as it continues to become embedded within the business sector and multi-actor networks. Governments increased public expenditure on research activities, especially after World War II, primarily to achieve scientific and technological superiority within an emerging global world. But with increased funding came increased expectations. Within the realm of these expectations, the concept of ‘science for the sake of science’ was challenged more and more.

One can assume that the state will strive to attach conditions to the funding provided for research activities in order to secure its own interests. Therefore the relationship between policy-makers and scientists has become a relationship of delegation, where the policy-makers ask the scientists to do something for them they cannot do themselves (Braun, 2003, p. 310). This argument underpins the choice of principal-agent theory as a guiding tool for analysing research funding. This conditioning is primarily achieved through an attempt on behalf of the principal to modify the institutional context in which the agents operate, and by its strategic use of available policy tools to affect their performance. Therefore, it is reasonable to believe that funding instruments and allocation models directly represent the interests of the government. They can be perceived as the apparatus for guiding an agent's activities within the research system, and as a remedy for the pitfalls of the principal-agent relationship, such as moral hazard and adverse selection.

The role of history should not be underestimated in grasping the nature of the relationship between the state and the scientific community, as it sets important road signs for future developments. Looking through the prism of historical institutionalism introduced in the previous chapter, we could argue that the agents in the knowledge 'industry' might not relate well to structured conditioning. This comes from the notion that scientific inquiry has enjoyed a high level of autonomy throughout history compared to other sectors of the public sphere, and may thus be less resilient to compromise in that domain. Given the fact that this autonomy was predicated on the long established mutual trust between the principal and the agent, perhaps even more so. Now, as the trust seems to be on the wane, the 'loyalty' could soon follow. This may account for examples in which principals fail to act in accordance with the calculus approach due to the resistance coming from the research community. On the other hand, the high level of trust the state nurtures towards agents might lead to its hesitation in enacting conditioning to its full potential as it would do in some other sector of society, where such trust had not built up throughout history. This may offer an explanation for the cases of adverse selection taking place as well.

It is not only a matter of whether the state can enact its policies over researchers. What lies at the core of this 'business' is *knowledge* production, which raises the question of who is the ultimate authority to evaluate both the process and its outcome, the state or the experts. We could therefore argue that the shift from Mode 1 to Mode 2 knowledge places the state in a more comfortable role, as Mode 2, being more applied in its nature, is more tangible from the perspective of the state and therefore less challenging to measure. Finally, as this knowledge lies further away from the knowledge production and diffusion practices found in traditional universities, its inherent value is less likely to be embraced by the academic community. This may increase the likelihood of moral hazard on the side of the agents as well.

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Jelena Branković & Norbert Šabić

Chapter 3
RESEARCH IN THE EUROPEAN CONTEXT

It is generally accepted that the demand for knowledge with high applicability and transfer potential is still on the rise. As suggested in the previous chapter, the knowledge recognised as 'needed' is that whose production attracts the most investment from those who provide financial and other resources. This includes the state in particular, but also big industries and international organisations. Simultaneously, as our part of the world recognises the future in ideas such as 'knowledge-based economy', 'knowledge society' or 'knowledge generation', knowledge production and its transmission instantly become a 'core business', cutting through a range of other societal, political or economic domains and thus, is of key importance for development and global competitiveness. This has been facilitated and sparked by technological development and increasing access to digital technologies. They play an increasingly important role in global communication, information exchange, and knowledge circulation. All of this, above all, motivates policy makers, both at national and supranational levels, to develop more effective and 'smarter' policies targeting scientific production and diffusion.

As financing is expected to follow policy closely, i.e. to be actively employed as a key instrument in the policy implementation process, the aforementioned policy trend can be more or less roughly traced to the domain of financing. According to the UNESCO Science Report (Schneegans, 2010), the number of graduates in science and engineering on the global level is growing rapidly, while economies worldwide are dedicating a rising percentage of their resources to scientific capacity building and production, both in universities and outside of them. This is particularly evident in the world's emerging developing countries, such as China, India, Brazil, South Africa and others. As an illustration, India is reported to have opted to establish 30 new universities by 2012 in order to increase total enrolment from 15 million in 2007 to 21 million by 2012 (Schneegans, 2010). In a similar fashion, Russia and Eastern and Central European countries have also increased their R&D expenditures, which decreased drastically after the dissolution of the Soviet Union.

When it comes to the investment in science, the United States still holds the top place though its share at the global level has been decreasing, mostly due to the rising investments in other parts of the world. Between 2002 and

2007, the share of EU investments in global research has dropped from 26.1 in 2002 to 23.1 in 2007, in the same manner as US and Japan. On the other hand, India, Brazil, China, Republic of Korea and some other countries have increased their share (Schneegans, 2010). Still, in 2007, the EU and US alone held a little over 50% of the world share of GERD (23.1% and 32.6%, respectively), followed by Japan (12.9%) and China (8.9%).

The EU's GERD as percentage of GDP in 2009 was 2.01%, with the average annual growth rate of 0.81 between 2000 and 2009 ("Eurostat," 2011).[3] If it is to achieve the 2020 target of 3%, the EU needs to boost its GERD growth rate. Therefore, the European Union has visibly increased the community budget expenditure on research, primarily through the Framework Programme, Europe's main funding instrument for research activities. At the same time, Brussels is urging member states to do the same. The EU budget for 2012–2020, adopted at the end of June 2011, foresees the allocation of €80 billion Euros during the period 2014–2020 for the coming 'Horizon 2020: Common Strategic Framework for Research and Innovation' programme. Considering that the Seventh Framework Programme operated with a budget of approximately 50 million Euros, this represents a more than 60% increase in funds for research and development activities (Commission, 2011). This funding, as the European Commission proposed, will be complemented by EU Structural Funds support for research and innovation. However, because the percentage of total GERD coming from resources other than national resources (to which the spending from Community Programmes also belongs) accounts for less than 10% of the total R&D expenditure in an average EU country, the EU level funding is still a mere supplement. Consequently, national allocation to science, in terms of both scale and mode, remains vital.

On the other hand, the EU itself currently accommodates 27 national research policies and allocation mechanisms for public research (Reichert, 2006). Even though new member states are catching up, there is a substantial disparity between the richest and the poorest states (frequently coinciding with the most and least populous). To illustrate, out of the aforementioned 23.1% of the world share pertaining to the EU, only Germany, France, United Kingdom and Italy alone contributed with no less than 15.3% of the world share of GERD in 2007 (Schneegans, 2010). Apart from the diverse landscape among the member states with regard to population, economic development or history within the Union, another reason for the diversity is the limited authority Brussels has over research activity in the EU. The sovereign rule of national governments over the research infrastructure is accompanied by even more sovereign rule over institutions of higher education, where a great deal of the research still is taking place. Even though there is considerable research investment from the community budget, this cannot be compared to national sources (Reichert, 2006).

3 Table: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsc00001&plugin=1, last retrieved on October 12, 2011.

Finally, with regard to research performance, when it comes to scientific production, the EU is 'the undisputed world leader for publications recorded in the SCI' (Schneegans, 2010, p. 19). However, diversity is an issue here as well, with Germany being one of the world leaders in number of publications, while some smaller or newer EU members are severely lagging behind and struggling to catch up. At the same time, the US is leading the game in innovation. Shelton and Leydesdorff (2011) find the source of funding of key relevance to the fact that both Europe and US are leaders – though not in the same domains. By analysing bibliometric and patenting evidence, the authors conclude that government funding and spending in the higher education sector appears to encourage publications, while industrial funding and spending in the business sector encourage patenting (Shelton & Leydesdorff, 2011). While the latter is a trait of the US research system, the former is typical of Europe. In 2007, 67,3% of total US GERD came from the business enterprise sector (Schneegans, 2010), while in Europe the business sector contributed about 55% ("Eurostat," 2011). Or, as mentioned in the Innovation Union Scoreboard 2011, the EU27 is 'outperforming the US in public R&D expenditures and knowledge-intensive services exports' (*IUS Report 2010*, 2011, p. 16).

EU-level policy documents that recognise science, research and development and innovation[4] as the motor for growth are numerous, in particular in the aftermath of the 2000 Lisbon European Council. Apart from the aforementioned increase in the EU budget, the relevance assigned to science is increasingly evident through the number and scope of activities and structures at the European level (e.g. European Science Foundation, European Institute of Innovation and Technology, European Research Council). In addition, a growing number of diverse funding opportunities facilitated through Community Programmes focusing on research, development and innovation, aim to boost the activity of research institutions, universities, businesses and other potential contributors to the scientific and technological progress of the continent.

Still, the way the European Commission presented the current situation of the EU's R&D was alarming:

> *We are facing a situation of 'innovation emergency.' Europe is spending 0.8% of GDP less than the US and 1.5% less than Japan every year on Research & Development (R&D). Thousands of our best researchers and innovators have moved to countries where conditions are more favourable. Although the EU market is the largest in the world, it remains fragmented and not innovation-friendly enough. And other countries like China and South Korea are catching up fast.*[5]

4 Science, research and development and innovation are distinct phenomena and should not be discussed interchangeably. However, in a policy context they are regarded as interlinked concepts.

5 Innovation Union. Last retrieved on October 12, 2011, from http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=why

Having failed to reach the 3% of GDP investment in R&D by 2010 as had been ambitiously set on the occasion of the Lisbon European Council in 2000, the EU has decided to set the same target for 2020. It is estimated that achieving this target could create 3.7 million jobs, and increase annual GDP by 800 billion Euros by 2025 (European Commission, 2010). While some countries such as Finland or Sweden are cited as role models,[6] most other EU members are being urged to catch up. At the same time, the EU's ambitions seem to be hampered by the often slow response of member states' to supranational initiatives, which is, if not unhurried in all the 27 cases, then without a doubt diverse or even dissonant. Moreover, the political will of the countries is unlikely to be the (key) factor that creates this distortion, but rather their economic and institutional capacities to increase and absorb investments allocated to research and development, in particular in the aftermath of the 2008 financial crisis and cuts in the public sector. Still, the global competition seems harsh and the EU is not keen on stepping down. Perhaps a particularly EU way of dealing with its internal diversity is the encouragement given to research organisations across countries to engage in joint collaboration projects and thus directly contribute to the levelling of individual national performance. In addition, the EU funding policy is also directed towards interdisciplinary ventures, inter-institutional cooperation and public-private partnerships.

The funding of research and development has become vital in terms of economic progress. The European Union is still second considering its share of world GERD, trailing the US even though GDP-wise it is the largest economy in the world. However, in order to maintain this position and improve it further, it has to increase its current level of investment in R&D, both from national budgets and the EU budget. This objective has been clearly identified in all key European policy documents. Reaching the target of 3% of GDP investment in R&D remains crucial. After failing to attain this goal during the first decade of this century, a second attempt is being made. This surely puts an even greater pressure on political structures not to fail to meet the same objective a second time.

Swift overall progress on a European scale remains unlikely given the fragmented nature of the research system in which outstanding differences between member states in the areas of research policy, funding and performance are persistent (European Commission, 2010). This is why the Council of the European Union has promoted the necessity of coordinating the research and technological development activities of the Member States: to ensure that national policies and those of the Community are mutually consistent (The Council of the European Union, 2008, p. 3). Consequently, collaboration remains a central theme of research funding at the EU level. Joint ventures across borders and different sectors are strongly encouraged and viewed as indispensable within the European Research Area.

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6 Last retrieved on October 12, 2011, from Eurostat: http://epp.eurostat.ec.europa.eu.

In sum, funding from the European Union remains undersized compared to national expenditures, without dismissing the positive contribution of these funds to the development of ERA, we should note that relying on them alone will not be enough to achieve the set level of investment into R&D. National level initiatives become crucial for success. Yet it remains disputable whether national governments are willing and able to devote more resources to R&D. According to the European Commission, in order for the efforts to produce long-lasting effects, the Community's Framework Programme should aim to change the organisation of research in Europe rather than to simply add resources (Breschi & Cusmano, 2004, p. 4). That is to say it is expected to create the conditions for greater public and private investment into R&D. It remains to be seen to what extent this has affected and will continue to affect the dynamics of research systems in Croatia, Serbia and Slovenia.

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Norbert Šabić

Chapter 4
NATIONAL RESEARCH POLICIES AND REGULATIVE FRAMEWORKS IN CROATIA, SERBIA AND SLOVENIA

Introduction

In this chapter, we will describe and compare the research policies of the countries under study. The policy analysis is primarily based on the assumption that public policy is determined, implemented and enforced by governmental institutions in order to improve the wellbeing of society. Consequently, we will include normative comparisons of policy priorities and policy measures of individual countries to obtain a holistic and meaningful picture of the developments in research sector. The analysis will not focus on policy formulation (the political process which lead to the definition of the policy), but rather on policy content analysis.

Policy content analysis encompasses an investigation of the underlying assumptions and normative frameworks, and it requires the analysis to be delivered according to a set of characteristics, e.g. problems, objectives, instruments, linkages (Gornitzka, 1999, p. 19). First and foremost, two types of documents will serve as data sources for the analysis. On the one hand, we will look at laws and bylaws, which are to regulate the actors' behaviour, and on the other strategies, which provide a sense of direction for the sectors' development.

Due to the EU integration processes to which all three countries subscribe, and to the harmonisation of policies taking place within the EU (even within the area of research), it is expected that there would be a general trend of emulating the EU level legislation. In the literature, this phenomenon is referred to as isomorphism, and can be defined as 'a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions' (Hawley, 1968 in DiMaggio & Powell, 1983, p. 149). As identified by DiMaggio and Powell (1983) there are three forms of institutional isomorphism, namely, coercive, mimetic and normative isomorphism. Coercive isomorphism takes place through the mechanism of political influence and power, normative isomorphism refers to the adoption of similar rules and forms, while the mimetic one refers to the cases in which organisations copy on another, often due to the uncertainty and lack of any clear idea of what they should do or how. In light of this argument, the analysis will start by presenting Slovenia, which is supposed to harbour a policy environment that is, of the three, the most aligned with the European Union. The analysis then continues with Croatia, which is a candidate country and supposedly has a less harmonised policy environment with the EU. The last country for examination is Serbia, which due to its status in relation to the EU, has just begun the process of policy harmonisation.

Defining research policy

Before we move on to the analysis, it is important to define what a policy is and what constitutes it. In theory, one can define policy as a public statement of an objective and the kind of instruments that will be used to achieve it. A common criterion for an action or activity to be called policy is that there is a stated objective attached to it (Gornitzka, 1999, p. 178). A policy objective might be to increase the enrolment rate in higher education, or simply to rationalise the elementary school network. In order to achieve the stated objectives governments employ different instruments, like regulatory adjustments or budgetary decisions on funds allocation. In any case, policies are subject to a legislative decision-making process, which usually takes place in the national parliament or governmental bodies, and thus becomes embedded in legislative documents and/or strategies. Consequently, a research policy can be defined as a set of policies (including science, technology and innovation policy) at various levels that concern the mission, support, management and translation of research (Metcalfe, 2008, p. 241).

Traditionally, higher education and research are regarded as closely related to one another. In practice however, they are often handled and regulated separately. Still, this does not lead to two isolated policy areas. Higher education policy can encompass parts of research policy, especially when it concerns the training of scientists and those working in the science field (Metcalfe, 2008, p. 254). On the other hand, research policies can have a significant effect on the functioning of academic institutions as well, especially on those that are research-intensive (Metcalfe, 2008). The apparent overlap is likely the result of the fact that research organisations such as universities perform both the function of higher education and research.

Research policies not only address academic research, but national laboratories, independent scientists, industrial science, and international cooperatives beyond the university sector as well. Also, the number of policies that touch upon issues related to research and development has increased with time. Nowadays, examples of research policy areas include (though are not limited to): the funding and regulation of scientific research, intellectual property management (patenting, licensing, copyright), medical experimentation, small and medium enterprises (SME) development, resource conservation, and energy production (Metcalfe, 2008, p. 254). Thus, it is obvious that research policies do not operate separately from other policy areas. With innovations coming to the foreground of economic progress, policy makers tend to shift research policies towards the furthering of economic goals. On the other hand, it becomes very difficult to speak about economic policy without touching upon research and development.

Nevertheless, research policy is often marginalised when we speak about higher education, even though it is a central activity of many colleges and universities. In our case, only Croatia has an integrated research and higher education act that regulates both activities simultaneously. Slovenia and Serbia have both adopted a single law on research and another for higher education. A similar design is visible on the European level, where research and higher education objectives are channelled into the detached concepts of ERA and the EHEA (Mantl et al., 2009, p. 57).

As was mentioned earlier, the principal focus of the study is on research policies. In this regard, it is important to make a distinction between science policy, technology policy and innovation policy. All three policies are part of this review because they influence the way research is understood and handled. However, as differences exist among them, they will be clarified here.

Science policy belongs to the post-war era because the idea of science as a productive force was rarely emphasized before World War II. Before the war, national governments were funding university research and the training of scientists primarily for historical and cultural reasons. The Bernal (1939) and Bush (1945) reports emphasised the potential economic impact of investments in science, and science policy soon came to the foreground in many developed countries, especially during the Cold War (Lundvall & Borrás, 2006). The major issues in science policy are about allocating sufficient resources to science and distributing them wisely between activities in order to ensure that resources are used efficiently and contribute to social welfare. Second, *technology policy* refers to policies that focus on technologies and sectors. It sees science-based technologies, such as nuclear power, space technology, computers, drugs and genetic engineering, at the very core of economic growth. These policies tend to identify strategic technologies and arrange funding priorities accordingly (Lundvall & Borrás, 2006). Finally, the focus of *innovation policy* moves from universities and technological sectors, towards all parts of the economy that have an impact on innovation processes. The main objective of innovation policy is economic growth and international competitiveness. There are two approaches to this. One puts the emphasis on non-interventionism and signals that the focus should be on 'framework conditions' rather than on specific sectors or technologies. The second perspective implies that most major policy fields need to be considered in the light of how they contribute to innovation. Therefore, a fundamental function of innovation policy becomes to review and redesign the linkages between the parts of the system (Lundvall & Borrás, 2006).

These three types of policies deal with slightly different questions. Science policy addresses questions about the way science should be utilised for economic progress, or how utilisation affects academic freedom and autonomy. Technology policy focuses on the question of which field of science should be supported, while innovation policy looks at how the institutional context should be changed in order to promote innovation. The three policy types exist simultaneously in the present political discourse, and sometimes it is almost impossible to make a clear distinction between them.

Simultaneously, a clear distinction has to be made between the concepts of governance and policy. In the majority of cases, governance is about operating the system, while policy is about changing it (Radó, 2010, p. 292). That is to say, a necessary condition for public policy intervention would be a failure in the functioning of the system to produce an expected outcome. Therefore, the actual characteristics of governance determine the context within which policies are developed and implemented. Bearing in mind that this analysis also involves the review of the selected countries' regulative frameworks, it is expected to describe and discuss the existing governance structures. However, analyzing governance should not be taken as the focal point of this chapter.

Policies become embedded in various governmental documents. In this study, we will direct our attention to the analysis of major policy documents and regulatory acts (i.e. strategies and acts) but will not go into a presentation of the numerous action plans that have been developed on the basis of these strategies. That is to say, we will not go into the manner in which these objectives are translated into concrete measures. First, the policy documents will be analysed one by one, followed by a comparison of their specific characteristics.

Derived from the legal frameworks, the study will also describe the basic governmental structure of the research system in each country. This presentation is not central to our analysis, however, as it will provide a framework in which we can position and better understand certain governmental actions and decisions. Moreover, it is useful to make a distinction between the principal, the intermediary bodies and the agents. Hence, in each country, this chapter identifies the actor(s) responsible for policy formation (principal), and those responsible for policy implementation (intermediary bodies).

Research policy in Slovenia

Slovenia is the most advanced country among the former Yugoslav republics with respect to research and innovation (see chapters 5 & 6). It is also the only country among the former Yugoslav republics categorised as an innovation follower according to the Innovation Union Scoreboard 2010 (*IUS Report 2010*, 2011). As stated by the scoreboard, the country's relative strengths lie in its highly skilled and educated workforce and in the results of the private sector's innovation activities, while its weaknesses are in its low level of private sector investment in R&D activities and lack of intellectual assets, which is the number of generated intellectual property rights (*IUS Report 2010*, 2011). Slovenia is also described as a growth leader with an average annual growth rate above 5%. Certainly, being categorised as an innovation follower and a growth leader in innovation requires Slovenian policy makers to address the relative weaknesses in their national research and innovation systems more systematically to produce above average results.

The development of research policy in Slovenia is shared between several governmental bodies. It is the responsibility of the Ministry of Higher Education, Science and Technology, the Ministry of Economy, the Government Office for Development and European Affairs and the Government Office for Local Self-Government and Regional Policy ("Raziskovalna in inovacijska strategija Slovenije 2011–2020," 2010, p. 5). In addition, there are two advisory bodies of the government to facilitate research policymaking: the Science and Technology Council (created in 2005) and the Competitiveness Council (created in 2008). The latter strives to strengthen cooperation and joint ventures within the triple helix and to promote technological development within selected narrow areas of research. The Science and Technology Council, on the other hand, has a more general role. Its members are nominated from the research community, higher education institutions, the business community and the government. The council provides an opinion on the research and innovation strategy, gives guidelines for policy implementation, monitors the results and effects of implementation, and conducts other tasks if foreseen by the law or other regulations ("Research and Development Act," 2002, p. 9).

The above-mentioned structures can be considered the key stakeholders of the Slovenian research policy area, with different levels of power in decision making. The implementation of the policy, however, lies mainly in the hands of public agencies. That is to say, the Ministry of Higher Education, Science and Technology delegates the implementation of its policies to the Slovenian Research Agency (SRA) and to the Public Agency for Technology of the Republic of Slovenia (TIA). SRA is responsible for the execution of public research financing on a competitive basis to selected research projects, and for conducting their monitoring. TIA is in charge of programmes promoting innovation and technological development within the business sector (Bucar, 2009, p. 12). Similarly, the Ministry of Economy also directs the implementation of its entrepreneurship and innovation programmes to the Public Agency of the Republic of Slovenia for Entrepreneurship and Foreign Investments, the Slovene Enterprise Fund and to TIA ("Raziskovalna in inovacijska strategija Slovenije 2011–2020", 2010, p. 5).

Based on the information above, it is obvious that the implementation of research policy is shared by two dominant governmental sectors. The first group is lead by the Ministry of Higher Education, Science and Technology, and the other by the Ministry of Economy, whose policy measures are also relevant for R&D, especially because they cover business innovations. Both groups have a legitimate interest in research activities, especially the latter group of organisations whose involvement was gradually intensified as R&D activities became the driving engine of economies. Furthermore, the Ministry of Defence has begun to show an increased interest in research and development, and has become more engaged in financing R&D. So far, it has launched two major programmes, one with SRA (Knowledge for peace), and one with TIA (Technologies for peace) (Bucar, 2009, p. 12). However, due to the nature of this study, we will first consider those regulations that relate to research activities within the academic field, and will to a lesser extent analyse laws, bylaws and strategies which refer to competitiveness and innovation in the business or other sector.

Slovenia's Development Strategy

In 2005, Slovenia adopted the national development strategy. It demonstrates the country's commitment to implementing the Lisbon strategy of the EU, and sets a corresponding vision and set of objectives for Slovenia's development. Four strategic objectives are outlined in this document:

– The economic development objective is to exceed the average level of EU's economic development (GDP per capita) and to increase employment;
– The social objective is to improve the quality of life (human development index, social risk and social cohesion) and the welfare of all individuals;
– The sustainable development objective is to enforce sustainability as the fundamental measure of quality;
– The international environment objective is to become a recognised and distinguished country around the world.

("Slovenia's Development Strategy," 2005, p. 7)

The central policy problem is that with regard to economic standards, Slovenia is lagging behind in comparison to other European countries. Therefore, the ambitious goal was set to increase economic growth from 3.7% to 5%. One of the measures for reaching this goal was to increase investment in R&D to up to 3% of GDP. Even though the impact of the financial crisis and the changed economic environment was not yet fully taken into account at the time the document was written, it can be safely assumed that the majority of identified objectives are still valid even today. Moreover, after the adoption of Slovenia's so-called 'crisis package', the National Reform Programme 2008–2010, the allocation of public resources for technology development in business R&D has increased with an additional €48 million for 2009 (Bucar, 2009, p. 17). This could imply that research and innovation actually gained in importance after the crisis as key areas for policy intervention, but this could just as well be a coincidence resulting from timely budgeting.

Research and Development Act

The Research and Development Act, adopted in 2006, regulates research activities in Slovenia. It is a comprehensive law that defines how research should be organised and carried out in order to transform Slovenia into a knowledge-based society ("Research and Development Act," 2002, p. 1). That is to say, it sets the basic principles and objectives of research and development activities, the organisation of funding and the governance of the system. In this respect, the Law portrays a clear management structure, with apparent hierarchies and task divisions between governmental bodies, councils, agencies and research organisations and individual researchers. In addition, it sets a stabile basis for the successful implementation of the coming Research and Innovation Strategy of Slovenia.

The overall goal of the Research and Development Act is to establish the regulative framework and determine conditions for funding research and development. The purpose of this is to create new knowledge and understanding, generate capacity for social and technological progress, as well as to increase the individual and collective quality of life and strengthen national identity ("Research and Development Act," 2002, p. 3).

Furthermore, the act aims to develop a polycentric model of organisation, to link science, education, and industry more closely together, to establish conditions for autonomous and independent guidance, evaluation and monitoring of research and development activities, to develop centres in selected areas that can be the basis for long-term economic and social development, and to promote further investment in research and development ("Research and Development Act," 2002, p. 4). The underlying assumption, however, is that research results should be transferable and usable to generate economic benefits in order to increase the overall social welfare in Slovenia. Therefore, much emphasis has been placed on linking research institutions with the industry and on providing a foundation for selective research funding that will be capable of taking into account the set economic and social goals.

According to the Law, the funding of research activities has to follow two basic principles. One is efficiency, which ensures maximum benefits for the public, and the other is transparency, which is to ensure access to data and information on spending public money on research activities ("Research and Development Act," 2002, p. 2). In addition, we could say that the Law is well harmonized with the Slovenian Research and Innovation Strategy, because it highlights the importance of the strategy with regards to defining the long-term aims for development. The strategy is supposed to mark out the specific goals, means of funding, and the indicators for measuring efficiency and effectiveness

("Research and Development Act," 2002, p. 7). Therefore, the Law foresees that the organisation of funding should be consistent with the strategy and the measures identified in it. From the period 2006 to 2010, funding was carried out through the National Research and Development Programme of Slovenia, which will be replaced by the coming Slovenian Research and Innovation Strategy. The document is currently in development and will cover the period 2011–2020.

National Research and Development Programme

The third document under the loop is the National Research and Development Programme (NRDP). The NRDP is based on Slovenia's Development Strategy, and should be considered the principal policy document defining the country's research policy. It was developed by the Ministry of Higher Education, Science and Technology and was adopted by the Slovenian Parliament in December 2005 for the period 2006–2010. The NRDP set the aim to improve the quality and excellence of knowledge production in Slovenia, and in order to do so, it sets the following objectives: to stimulate R&D cooperation between companies and the public research sphere, to increase investment into R&D and correspondingly enhance its quality, to strengthen human resources in R&D and develop a supportive environment for it, and finally, to increase the number of high-tech and innovative companies in the country.

To achieve the set objectives, the following measures have been outlined by the policy document:

- Annually increase public spending for research by approximately 0.1% of GDP (26 million Euros);
- Change the structure of R&D investment (expand the share of applied research and change from programme to project financing);
- Introduce expert systems for project evaluations;
- Significantly improve the supervision of the implementation of the NRDP and financed research projects;
- Increase efficiency of national research institutes by clearly defining their vision, mission, responsibilities and duties, by standardising and simplifying their operations, and enhancing their management practices and competencies;
- To adopt legislations which provide space for establishing spin-off companies at universities and research institutes, a flexible and attractive labour market in the area of R&D, and the employment of foreign professors and researchers at Slovenian universities and research institutions;
- To adopt legislation which stimulates investment in research, development and human resources and the circulation of professionals among universities, research institutions and enterprises.

One of the key elements of the programme is to identify research priorities that have the greatest potential for increasing the economic competitiveness and productivity of the country ("National research and development programme for the 2006–2010 period," 2005, p. 3). New institutions and organisations have already begun being set up in these areas (e.g. clusters, centres of excellence, technology networks, etc.), and increased funding is expected to follow. NRDP also highlights the importance of those fields (within humanities and social sciences), which are not directly linked to Slovenia's economic competitiveness, but contribute to the nation building, strengthening of democracy and public governance. However, the programme fails to name these research areas; therefore, we can assume that their role is symbolic in the overall strategy. The priority areas are:

- Information and communication technologies,
- Advanced synthetic metal and non-metal materials and nanotechnology,
- Complex systems and innovative technologies,
- Technologies for a sustainable economy (energy and environmental protection,
- Health and life sciences.

The NRDP employs several policy instruments, such as financial stimulations (increased funding), selective funding (focusing on priority areas), easing administrative procedures, upgrading evaluation procedures of research projects and strengthening monitoring procedures. Moreover, funding is increasingly linked to the ability of research organisations to cooperate with industrial partners and produce socially/economically valuable outputs. NRDP also favours technological development over scientific research conducted in the public sector, as it states the goal to gradually expand the share of applied research ("National research and development programme for the 2006–2010 period," 2005, p. 4). It is believed that businesses are much more oriented towards applied and development projects, while public R&D remains too concentrated in basic sciences. Hence, it is expected that favouring business R&D will bring around the planned restructuring of research from a more general to a more targeted one (Bucar, 2009, p. 30).

Three documents have been presented here that concern research activities in Slovenia. The first was Slovenia's Development Strategy, which is the prime policy document on which all the other national policies are supposed to be built. The second one was the Research and Development Act, which provides the regulative framework for research activities in the country. Finally, some of the features of the National Research and Development Programme have been revealed. It is important to mention, however, that the NRDP will be succeeded by the Slovenian Research and Innovation Strategy soon. Because the policy was still in the public debate phase at the moment this study was being produced, it was not taken as a point of departure.

Looking at the broader policy context, it becomes obvious that the major policy question for Slovenia is how to become an above average country within the context of the European Union. The development challenge that the country faces is that, considering most of the social and economic indicators, Slovenia scores either at average level or slightly beneath it. In order to position itself among the leading countries of the EU, Slovenia has recognised that research and development is a crucial activity capable of generating outstanding economic results and welfare for all of its citizens. Consequently, the country has taken steps in the past decade to advance its R&D activities.

Like most European countries, Slovenia is also moving towards establishing a separate and recognisable research and innovation system ("Raziskovalna in inovacijska strategija Slovenije 2011–2020," 2010, p. 4). It has adopted a unified research policy that clearly aims to contribute to the broader Lisbon goals. It aspires to stimulate cooperation among governmental, business and higher education institutions ("National research and development programme for the 2006–2010 period," 2005, p. 2), especially by bringing public R&D closer to the needs of the business sector. Finally, it portrays a shifting model from basic non-targeted research to targeted applied research (Bucar, 2009, p. 27).

Research policy in Croatia

Croatia is an EU candidate country and therefore is in the process of harmonising its national policies with those of the EU. Hence, we can expect that its research policy has changed during the last ten years. The changes that have taken place have mainly been inspired by the Lisbon guidelines, the availability of European research funds and, of course, the country's full membership in the European Research Area (ERA) (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 17). Moreover, during the last ten years, Croatia has progressively supported the development of research. The budget for research has increased by 52% between 2002 and 2007, and 1400 jobs have been created in science. Out of those, 1280 were solely for new junior researchers (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 2).

Still, on the European scale, Croatia's research performance is lagging behind most Western European countries. When looking at the innovation scoreboard, Croatia belongs to the group of countries that are categorised as moderate innovators (*IUS Report 2010*, 2011, p. 14). This means that Croatia's research performance is below the European average. The country's relative strength lies in the availability of a highly skilled and educated workforce, and the number of firms that have introduced innovations into the market or within their organisations. Relative weaknesses are found in the international competitiveness of the science base and in the number of intellectual property rights generated (*IUS Report 2010*, 2011, p. 51).

At the central state level, the Ministry of Science, Education and Sports (MSES) coordinates the research system in Croatia. The Ministry is the principal administrative and executive body responsible for planning, funding and monitoring the entire science and education system (*ERAWATCH Research Inventory Report for: Croatia*, 2010). However, the basic guidelines of higher education and research policy are determined by the Croatian parliament. The parliament has elected two separate expert bodies to be in charge of policy development. One of them is the National Council for Science, which is also the highest body that addresses the development and quality assurance of research in Croatia. It defines research priorities and strategies, suggests measures on monitoring and evaluating research organisations, proposes the budget for research funding, conducts the evaluation of research projects and programmes, and so forth (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 42). Its twin organisation, the National Council for Higher Education, regulates and monitors the development of the higher education system. Both councils are assisted in matters of budget planning by the Higher Education and Science Funding Council. Concerning administrative and expert tasks, the councils are supported by the Agency for Higher Education and Science, especially in the area of quality assurance.

Alongside the Agency for Higher Education and Science, several other bodies are involved in policy implementation, including the Business Innovation Centre of Croatia (BICRO) which implements technology development and innovation support programmes especially within the context of science-industry cooperation, and the Croatian Institute of Technology (HIT), which supports the development of Croatian R&D activities, provides assistance in the protection of intellectual property rights, and enhances participation in the EU research projects. The fourth body to be involved in policy implementation is the Croatian Science Foundation (CSF). It is one of the oldest bodies established by the national parliament of Croatia to support scientific, higher education and technological programmes and projects. It also aims, to strengthen links between research and economy and to foster international cooperation. In recent years, it has been identified as the main body that should be the responsible for the allocation of public funding in Croatian public research.

In 2008, the Croatian government established two new high-level government bodies for science and technology development: the Strategic Council for Science and Technology (SVEZNATE) and the National Innovation System Council of the Ministry of Science, Education and Sports (VNIS) (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 37). SVEZNATE brings together high governmental officials, including the president of the Croatian government, while VNIS encompasses the representatives of the researchers' society. These two bodies are supposed to jointly coordinate and enhance policy implementation with regard to the establishment of the Croatian Innovation System.

The chief strategic document in Croatia is the Strategic Development Framework 2006–2013. It defines 10 priority areas for the forthcoming period, and among them, knowledge, science, education, and IT technology have a prominent role (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 2).

Research activities in Croatia are regulated by the Act on Scientific Activity and Higher Education, which was adopted in 2003. Since then, the act has been supplemented by four strategic policy documents to reform research and development in Croatia. These are the Science and Technology Policy 2006–2010, its Action Plan for the period 2007–2010, and the Action Plan for Increasing the investment in research and development. In addition, in 2008, the Ministry of Science, Education and Sports launched the Action Plan to strengthen the capacity of research organisations for participation in the Framework Programme (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 17). Even though some of these strategies and action plans passed, there has not been any new policy document adopted in Croatia regarding research and development.

Strategic Development Framework 2006–2013

On its way to becoming a full member state of the European Union, Croatia developed a strategy which should increase its competitiveness on a European scale. The aim has been set to establish a competitive market economy and at the same time, ensure that the important social goals are met. The strategy uses a prosperity circle to depict the crucial areas for intervention in order to achieve the aims set. The circle encompasses the main issues that hinder development, the required cohesive elements, and the foundations of development. As one of the main problems the document refers to is Croatia's insufficient foundations for development, the ability to util research and development for the sake of economic development is listed as one of the three actions to strengthen this foundation ("Strategic Development Framework 2006–2013," 2006, p. 8). Consequently, research and development becomes a key policy area for intervention.

In this regard, the strategy identified the following objectives:

- To establish well equipped and flexible research centres where groups of researchers will work on targeted projects;
- To increase the capacity of Croatian research organisations to attract European projects;
- Increase the investment into research and development, especially private ones;
- To concentrate public research funding for the benefit of knowledge transfer and economic development;
- To reorganise public research organisations and universities;

– To enable the transfer of knowledge and technologies into Croatian entrepreneurial initiatives;
– To support a polycentric development of research in Croatia,

The strategy also highlights the weaknesses of the present research system. It states that R&D is very much isolated from the private sector, which is illustrated by the notion that 90% of all researchers works in public institutions ("Strategic Development Framework 2006–2013," 2006, p. 19). It also outlines the fact that Croatia is underperforming with regard to its number of researchers, level of investment in R&D, and age structure of researchers in that it too few are young researchers. In order to tackle these problems, the strategy outlines the importance of developing the national research area with the virtues of excellence, openness, and the evaluation of results according to the best international standards ("Strategic Development Framework 2006–2013," 2006).

Act on Scientific Activity and Higher Education

The act is the most important document to regulate Croatia's research and higher education system. It was adopted in 2003 by the Croatian parliament, and represents an integrated approach to manage both sectors. Even though the focal purpose of the act was to establish a framework for the implementation of the Bologna process, it also affected the way research was carried out. It did so primarily through the modernisation of organisation, management and financing of research (*ERAWATCH Research Inventory Report for: Croatia*, 2010).

The law recognises two core types of entities that perform research activities within a common research and higher education sector. One of those is the university, which conducts scientific, artistic and developmental research, and, based on the results of these activities, organs undergraduate, graduate and postgraduate education. Another is the research institute, which primarily conducts research in areas of strategic interest for the country ("Zakon o znanstvenoj djelatnosti i visokom obrazovanju," 2003, p. 2). In addition, the law also mentions the Croatian Academy of Science and Arts and the Miroslav Krleža Institute of Lexicography as important actors in the Croatian science sector, but leaves the regulation of their work to a separate law.

The law also introduces three new elements into the existing research system. First of all, it introduces collaborative research programmes, which should increase the number of interdisciplinary research projects. Secondly, it defines the title of Research Centre of Excellence, which can be gained by any research institution that from a global perspective, has outstanding performance within its disciplinary field. Third, a new organisation, the Science-Technology Park has been introduced. It is defined as a commercial organisation that seeks to exploit the results of research on the market.

However, the most noticeable change brought on by the law was the reorganisation of research funding. It introduced lump sum funding for research activities at universities and research institutes in order to enable autonomy and support their integration (*ERAWATCH Research Inventory Report for: Croatia*, 2010). The individual amounts are proposed by the national council for science and the national council for higher education, and are adopted by the Croatian Government. Additional research grants are to be provided on a competitive basis through projects. Moreover, in order to increase private investment in R&D, the law also introduced tax exemptions for companies willing to engage in R&D, and requires research institutions to generate a certain portion of their budget through economic activities ("Zakon o znanstvenoj djelatnosti i visokom obrazovanju," 2003, pp. 43–44).

Science and Technology Policy of the Republic of Croatia 2006–2010

In 2006, the Croatian Ministry of Science, Education and Sports produced a comprehensive policy paper for research and development. It was adopted by the government the same year, and since then, it has been the most important policy document in the field. This document was produced on the basis of another policy document called the *Development strategy of the Republic of Croatia* 'Croatia in the 21st Century– Science,' which dates back to the year 2004. The majority of reform ideas in that document have been carried out, and many of them can be considered logical responses to the Lisbon agenda and its objectives. The policy clearly follows the directions set at the EU level. It aims to reform the research sector primarily by increasing both public and private investment in research, providing guidance for research activities, strengthening partnership between government, research organisations and the industry, supporting young researchers, modernizing the research infrastructure, and encouraging entrepreneurship and the emergence of an innovative industry ("Znanstvena i tehnologijska politika Republike Hrvatske 2006–2010," 2006, p. 12).

The Science and Technology Policy of the Republic of Croatia stresses four concrete objectives listed below.

(1) To increase investment in R&D

This objective is further operationalised as the refinement of the structure of the existing funds' use by focusing investments in the most prominent research; annually increase funds for R&D at the rate of at least 25% (0.3 annually); establish expert evaluation of research projects and funding transparency; introduce financial and tax regulations which enhance investment in R&D.

(2) To restructure Croatia's science system

This objective is foreseen to be implemented through the introduction of programmes which raise public awareness about the significance and importance of R&D; the establishment of centres of excellence which integrate existing scientific projects in their field; the reform of the existing doctoral studies into efficient 3rd circle research studies.

(3) Strengthen the cooperation between science, government and the industry

Cooperation enhancement hereby demands the development of financial instruments which would encourage collaboration between research organisations and business firms; the creation of a flexible and appealing science labour market which is also capable to attract Croatian scientists from abroad; the introduction of incentives for the increase of R&D personnel in the industry and public administration

(4) Increase Croatia's participation in the European Framework Programme

This objective is to be operationalised through the introduction of measures for co-financing and stimulating participation in the EU programmes; the establishment of an agency for helping institutions to participate in the EU programmes.

The policy paper also describes the tools that the Ministry will employ in order to support the implementation of the strategic objectives. Among them, it outlines the existing funding instruments of research and presents how they fit the purpose to foster excellence in research and guide research efforts towards national priority areas. In addition to utilising the financial instruments, the policy describes the Ministry's plan to organise an awareness-raising campaign. The purpose of the campaign will be to communicate the benefits of S&T for society to the wider public, and to encourage young people to take up a scientific career. Moreover, the policy encourages the Ministry to support the involvement of S&T in the political decision making process, primarily through establishing advisory groups alongside the ministries.

Besides science, the document also covers areas of the innovation system. That is to say, there is a strong interest in establishing a structure that will allow for innovations to flow in all sectors of the economy. So far the Croatian government has been the dominant financier of research activities. In order to set up an efficient innovation system, the ratio of private-public investment in R&D should be adjusted to a ratio of 1:1 ("Znanstvena i tehnologijska politika Republike Hrvatske 2006–2010," 2006, p. 24). In this respect the following objectives have been set:

- Promote the creation and growth of knowledge-based enterprises;
- Create technology infrastructure to support knowledge-based SME's and technology based start-ups;
- Stimulate demand for R&D from business;
- Manage intellectual property;
- Diversify funding sources for R&D, attract private sector investments and create risk-capital industry;
- Promote public confidence in science and innovation awareness.

These objectives are to be met through the Croatian Programme for Innovative Technological Development (HITRA). The programme has been created with the purpose to support the establishment of the Croatian Innovation system, and is implemented through two sub-programmes, the TEST and RAZUM. TEST provides funding for academia and research organisations that want to conduct research projects with a possible industry application. RAZUM on the other hand supports the development of knowledge-based companies ("Znanstvena i tehnologijska politika Republike Hrvatske 2006–2010," 2006, p. 30). These two programmes can be considered the pillars upon which Croatia's innovation system should be built.

The Science and Technology Policy was soon supplemented with several action plans to ensure that the objectives of the policy will be fulfilled. In 2007, the Croatian government adopted the Action plan for the Implementation of the Science and Technology Policy 2007–2010. In 2008, it was followed by the Action plan to increase the level of investment in science and research, and shortly later by the Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the FP7 in the Period 2009–2010.

One of the common messages appearing throughout the analysed documents is that resources for R&D in Croatia are not sufficient to enable progressive moves in science. Therefore, they push for increased investments (both public and private) in R&D. A strategic area in which to improve this is to support the participation of Croatia in the EU Framework Programme. The Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the FP7 is the first document that systematically describes and analyses the participation of Croatia in the FP and provides a range of recommendations for strengthening the absorptive capacities of Croatian scientific organisations (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 19). In addition, the broadening of the 'pure scientific' policy along with the innovation policy represents another remarkable development. It is an attempt to strengthen and connect research and education with technology and business as a means to enable the transition of Croatia to a knowledge-based economy (*ERAWATCH Research Inventory Report for: Croatia*, 2010, p. 21).

The documents outlined above demonstrate that Croatia's research system is prepared for integration with the European Research Area. The majority of the Lisbon goals, as well as the corresponding targets regarding research and development have been included in the national research policy. That said, the Strategic Development Framework 2006–2013, which outlines Croatia's main development policy, brings research to the top of the list of areas that need to be addressed and improved upon. The Croatian Act on Scientific Activity and Higher Education is by no means less relevant for its progressive attempt to provide a framework for increased private investment in R&D. The third policy document to be analyzed was the Science and Technology Policy of the Republic of Croatia 2006–2010. Though its timeframe has already expired, the objectives and instruments that it introduced remain the basic building blocks of Croatia's research and innovation system. At this time, no announcements have been made regarding the development of a follow-up strategic framework for Science and Technology.

Research policy in Serbia

Serbia's R&D activities have significantly decreased since the beginning of the Yugoslav wars in 1991. According to the Statistical Office of the Republic of Serbia, the number of research organisations (including institutes, faculties and research units) during the period between 1990 and 2001 dropped steadily, from 297 to 189.[1] Currently, Serbia is working intensively on becoming an EU member state, though the formal accession process has not yet started. That said, this does not put the country in a drastically disadvantaged position concerning its participation in the European Research Area. In 2007, a Memorandum of understanding was signed between the Republic of Serbia and the European Commission, allowing Serbia to participate as an associate member in the Framework Programme, one of the main EU-level instruments employed to support the development of ERA.

Serbia currently invests only 0.3% of its GDP in research activities ("Focus and Partner," 2010, p. 7), which according to the European Agency for Reconstruction demonstrates an innovation capacity ten times lower than the EU (Žarković, 2006, p. 1). However, this would only be true if the EU was at 3%, rather than stagnant at 1.84%.

In order to increase its capacity for innovation, Serbia is expected to take advantage of its strengths and improve on its weaknesses. When looking at the Innovation Union Scoreboard 2010, Serbia is categorised as a modest innovator, with a below average performance. The country's strong points are its human resources, which include the availability of highly skilled and educated workforce, its internationally competitive science base, and in firms' results in innovation activities. On the other hand, its relative weaknesses are in its intellectual assets, which stand for the different forms of intellectual property rights generated through the innovation process, and the lack of firms and other organisations that have introduced innovations onto the market (*IUS Report 2010*, 2011, p. 56).

The main national research policy actor in Serbia is the Ministry of Education and Science. Not too long ago, these two areas, education and science, were governed by two distinctive ministries. Following the reorganisation of the government in 2011, they were merged into a single ministry. Aside from

1 Statistical Office of the Republic of Serbia, last retrieved on October 12, 2011, from http://webrzs.stat.gov.rs/WebSite/

the ministry, the Act on Scientific Research Activity oversaw the establishment of the National Council for Scientific and Technological Development, which is supposed to be the highest advisory and expert body within Serbia's research system ("Zakon o naučnoistraživačkoj delatnosti," 2005). It was constituted in 2010, which makes it a very 'young' body. Its mandate lasts for five years, during which time the main purpose of the council is to establish a quality assurance system for research activities and to give recommendations on the future development of science and technology in Serbia.

Serbia has a rather simple governance structure for research, with only two bodies involved in policy development. The same is true in the case of policy implementation. The execution of measures foreseen by the research policy falls solely to the Ministry of Education and Science and its expert working groups, as no public agency has been set up for such purposes.

In addition to the Ministry of Education and Science, the Ministry of Economy has taken an interest in R&D activities, particularly because this ministry aspires to become a catalyst for the development of small and medium enterprises. Consequently, the ministry took a proactive role in encouraging cooperation between educational, research and business organisations, which is elaborated on within the Strategy for Small and Medium Enterprises. The most obvious example of this can be found on a political level, where collaboration between the national Agency for Small and Medium Enterprises, the Ministry of Economy, and the Ministry of Education and Science is strongly encouraged ("A Strategy for the Development of Small and Medium-Sized Enterprises and Entrepreneurship in the Republic of Serbia 2003–2008," 2003, p. 11). As foreseen by this strategy, the result of this cooperation is the establishment of business incubators and science parks across the country, which are to represent the main source of training of future entrepreneurs and creation of SME ("Programme for Business Incubators and Clusters Development in the Republic of Serbia 2007–2010," 2007, pp. 21–26).

Serbia 2020

Closely following the aims and content of the European Union's growth strategy Europe 2020, Serbia has put together its own national development strategy called Serbia 2020. Until now, there has been no comprehensive development strategy in Serbia. Therefore, the present document represents the first of its kind in this direction. Though it has yet to be adopted by the Serbian government (and it is unknown whether it ever will be in the present form), we will take it as a point of departure for analysis. As a result, it will be possible to have three comparable policy analyses in all the countries that were looked at in this study.

Serbia 2020 attempts to define the basic elements and direction of the socio-economic development of the country. In addition, it names research and development as one of its five main areas of development. In this respect, the strategy sets the target to increase investment in R&D to 2% of the national GDP, out of which 50% should be covered by the private sector ("Srbija 2020. Koncept razvoja Republike Srbije do 2020. godine," 2010, p. 9). The central argument for increased investment into R&D is the outdated research infrastructure, which hinders outstanding performance. Moreover, to encourage the private sector to increase its investment in R&D, the strategy supports the idea of strengthening cooperation between the economic and the scientific,sectors, and the introduction of stimulatory measures, such as tax deductions.

As the strategy further elaborates on its set targets, it asserts the necessity of developing a separate strategy for Serbia's scientific and technological development for the period 2010 to 2015, and even further, to 2020 ("Srbija 2020. Koncept razvoja Republike Srbije do 2020. godine," 2010). Considering that Serbia 2020 was developed after the Strategy for Scientific and Technological development was adopted, it is expected that many measures from the latter document will have been carried out by Serbia 2020. Accordingly, the strategy sets the following measures:

- Focusing on national scientific priorities,
- Rationalising the network of research organisations,
- Developing and preserving human capital in science,
- Strengthening the scientific literacy of the society,
- Linking science and industry,
- Establishing a fund for supporting innovations, which are directly linked with the development of new products, processes and services,
- Including the capacities of the scientific diaspora into national research activities,
- Encouraging networking with the international scientific community,
- Ensuring the active role of science in the national infrastructural and other projects of national importance.

Act on Scientific Research Activity

In 2005, the Serbian parliament adopted the Act on Scientific Research Activity ("Zakon o naučnoistraživačkoj delatnosti," 2005). According to the act, three types of institutions are eligible to conduct research in Serbia. One of them is the Serbian Academy of Science and Arts. The academy was founded at the end of the 19th century and represented an open forum of eminent scholars from various disciplines (Mantl et al., 2009, p. 157). It currently operates 10 research institutes dedicated to both the humanities and natural sciences. The second type of institution is a cultural-scientific institute called 'Matica Srpska.' Beyond its expressed purpose to preserve the cultural heritage of the country, it also conducts research on Serbian history, culture, literacy and similar fields. These two organisations played and are still playing a major role in the nation building process, and it is for this reason that they are also referred to as 'institutions of national importance' ("Zakon o naučnoistraživačkoj delatnosti," 2005, p. 13). The third type of organisation eligible to conduct research is the research organisation. Research organisations can be institutes or entire faculties, and they can be either part of the university or independent.

Based on the act, we can deduce that there is a high level of political awareness about the importance of research for the economic development of the country. This is also evident looking at the aims of scientific and research activities. The act places economic interests in a prominent position, and says that research activities should enhance both economic development and national productivity, as well as raise the standard and quality of living ("Zakon o naučnoistraživačkoj delatnosti," 2005, p. 2).

The act is also the basis for the establishment of the national quality assurance system for research activities, and provides the legal basis for the establishment of several expert bodies. Among these expert bodies are the National Council for Scientific and Technological Development, the Committee for the Accreditation of Research Organisations, the Commission for Obtaining Scientific Titles, a number of thematic scientific committees, and the Institutes Community of Serbia. In addition, the act implies the necessity of producing a national science and technology strategy, which would describe in detail the development objectives of the research system.

Furthermore, several programmes for research activities have been identified by the act,. These programmes constitute the primary instruments for the implementation of the research policy and they are:

- Programme for basic research;
- Programme in the area of technological development;
- Programme for knowledge transfer and stimulation of the application of research results;
- Programme for the scientific work of the Serbian Academy of Science and Arts and Matica Srpska;
- Programme for the centres of excellence;
- Programme for acquiring and maintaining research equipment and space;
- Programme for international cooperation with national importance for Serbia;
- Programme for the development of information society;
- Programme for additional education of scientists and researchers;
- Programme for acquiring scientific and professional literature and access to international journals and databases;

- Programme for scientific publishing and organisation of scientific conferences;
- Programme for enhancing the activities of scientific and professional organisations who are engaged in the advancement of scientific work, promotion and the popularization of science and technology, and the preservation of scientific and technological heritage.

With the exception of the forth programme listed above, all the others are determined by the Ministry of Education and Science based on the recommendation of the National Council for Scientific and Technological Development. The content of the fourth programme is set according to the recommendations of the Serbian Academy of Science and Arts and by the Matica Srpska ("Zakon o naučnoistraživačkoj delatnosti," 2005, p. 4). Taking into account budgetary allocations, the top two programmes listed represent the major financial channels through which research projects are funded.

Strategy for Scientific and Technological Development of the Republic of Serbia for the period 2010 to 2015

The primary policy document in the area of research and development is the Strategy for Scientific and Technological Development of the Republic of Serbia for the period 2010 to 2015. It was developed by the former Ministry of Science and Technological Development (now the Ministry of Education and Science) and adopted by the Serbian Government in 2009. It sets forth the vision of creating an innovative Serbia in which scientists attain European standards, contribute to society's overall level of knowledge, and further the technological knowledge of the economy ("Focus and Partner," 2010, p. 3).

The strategy defends the position that enhanced economic development is only possible if the country increases its present level of investment in research and development. Moreover, it defines the establishment of an integrated innovation system as its ultimate purpose. The system would enable the integration of research organisations, private companies and governmental institutions for the sake of knowledge and technology diffusion.

In terms of research capacity development, the strategy intends to stimulate the training of future PhD students, increase the number of research programmes, and expand investments in R&D up to 1% of national GDP until 2015. The strategy also aims to establish a clearer focus when it comes to funding research activities. It aims to favour applied research over basic research by introducing utilitarian and pragmatic criteria for grant allocation ("Focus and Partner," 2010, p. 51) and sets national priorities regarding research areas. These priorities have been identified according to their potentials and include biomedicine, new materials and nanotechnology, environmental studies and climate change, energy and energy efficiency, agriculture and food, informatics and telecommunication, and policy development, together with the affirmation of national identity ("Focus and Partner," 2010, pp. 25–26). These areas represent the research themes and measures subsequently identified as 'top'.

In addition to the theme-specific measures, the strategy also identifies the following areas as those of national priority: the development and preservation of human capital in science, the harmonisation of research funding with the identified priority areas, student enrolments in higher education, the rationalisation of the number of research organisations, the enhancement of intellectual property protection, and international scientific cooperation.

Therefore, it seems that Serbia has finally drafted an exit plan out of almost 20 years of recession in terms of research and development. Serbia's main strategic document, Serbia 2020, sets the goal of reaching 2% level of investment in R&D (of GDP). Though this objective is considerably more modest in comparison to the Lisbon agenda and the Europe 2020 strategy, it is also considerably more realistic, if one takes into account the current level of investment in this sector. The core regulatory document of the sector is the Act on Scientific Research Activity. It foresees a simple governance structure for Serbia's research system and introduces structural developments like quality assurance through accreditation and the identification of programmes through which research funding is allocated. The third policy document is the Strategy for Scientific and Technological Development of the Republic of Serbia for the period 2010 to 2015. The strategy provides a very clear and concrete direction for the development of the research sector. It manages to identify those scientific areas that could yield the biggest 'economic' benefit for the country's development and intends to change the current patterns of research funding to fit the needs of these priority areas.

It should be noted that during the same year the Act on Scientific Research Activity was adopted, the Serbian Government also put forward a separate act for regulating innovation activities. This act clearly defines the participants in the county's innovation system, including organisations that provide infrastructural support for innovation activities (i.e. business incubators and science and technology parks). Moreover, it closely regulates the funding criteria of innovation activities, and serves as the basis for establishing the Innovation Activities Fund ("Zakon o inovacionoj delatnosti," 2005, p. 11). Certainly, having two independent acts regulating scientific research and innovation activities is an approach that is unmatched in the region.

Discussion and conclusion

In this chapter we have presented the research policy contexts of Slovenia, Croatia and Serbia. All three countries are in a different stage of development, a fact that is anchored in their different rankings according to the Innovation

Union Scoreboard 2010. Though they are at different stages in the European Union integration process, all three are equal in terms of participation in the European Research Area, meaning that all three are part of the European Research Area and can participate in the Framework Programme.

A short summary of the main policy documents and chief policy actors is shown in the table below (4.1).

Table 4.1 Legal frameworks and governance structures for R&D in Croatia, Serbia and Slovenia

	Slovenia	Croatia	Serbia
Legal framework	[2002] Research and Development Act	[2003] Act on Scientific Activity and Higher Education	[2005] Act on Scientific Research Activity [2005] Act on Innovation Activity
Research policy documents	[2006] Resolution on National Research and Development Programme 2006–2010 Research and Innovation Strategy of Slovenia 2011–2020[2]	[2004] Development strategy of the Republic of Croatia 'Croatia in the 21st Century-Science' [2007] Science and Technology Policy of the Republic of Croatia 2006–2010	[2009] Strategy on the Scientific and Technological Development of the Republic of Serbia in the period from 2010 to 2015. Focus and Partnership
Related policy documents	[2005] Slovenian Development Strategy	[2005] Strategic Development Framework 2006–2013	Serbia 2020[3]
Responsible Ministries	Ministry of Higher Education, Science and Technology	Ministry of Science Education and Sport	Ministry of Education and Sport
Other bodies	Slovenian Research Agency Science and Technology Council Public Agency for Technology	National Council for Science Agency for Higher Education and Science Business Innovation Centre of Croatia Croatian Institute of Technology Croatian Science Foundation	National Council for Science and Technological Development

A comparison of the policy documents reveals that there are several common features in the way research policies are constructed and reasoned across these countries. First of all, it should be noted that all of the countries

2 In the consultation process.

3 In the consultation process.

have developed a general growth strategy, which is very much aligned with the European Union's Lisbon strategy. Serbia, which has the youngest such strategy, has taken Europe 2020 as a point of departure, instead of the Lisbon strategy. Usually, these strategies tend to identify those areas and related objectives that are expected to become the driving force behind future policy making. With relation to policy problems, insufficient investment into R&D activities and an inadequate utilisation of its potential were identified as a major problem in all three cases. Therefore it is unsurprising that national growth strategies have called for the development of separate national R&D policies through which governments could address these challenges in a more focused manner.

In more concrete terms, it appears that research and development is being foregrounded in national development strategies. One of the main reasons for this lies in the promise it holds for economic growth. It is perceived as the area that most needs to be enhanced in order to ensure international competitiveness within the European context and beyond. This line of argumentation forms the basis of all three research policy documents that were looked at for this study.

As such, all of the research policies were directly linked to economic objectives, and they all correspondingly stressed the necessity of fostering cooperation between the public research sector and the business sector. This is also most likely the reason why the ministries responsible for the economy are increasingly becoming more important in implementing research and innovation policies in all three countries.

Considering that knowledge has become a *sine qua non* for economic growth, all three countries seem to push for allocating more resources to R&D activities. Hence, their research policies have foreseen the increase of financial resources devoted to research and development. However, the level and pace of this increase differs from case to case. As the regional leader in R&D, Slovenia predictably set a slow pace of increase from year to year, while Croatia and Serbia, who are lagging behind significantly, predict a much more progressive increase in the level of investment in R&D. Hence the latter two appear more ambitious in their goals and, perhaps, less realistic. It remains to be seen to what extent they will be able to meet the objectives set.

In addition to increased investment, the national research policies also call for a prioritisation in areas of research and an aligned system of research funding to those areas. Therefore, investments should favour those fields that could be considered as the countries' strength in terms of R&D. In this respect, Serbia has shown the most progress, as it not only outlines the 'top' research areas, but also systematically analyses Serbia's research potential in them and suggests specific research priorities within those areas.

The Slovenian regulatory framework favours selective funding and establishes two sorts of programmes (research programmes and infrastructural programmes) which can provide funding to research organisations on a project basis. Consequently, these programmes are supposed to run according to selective criteria in order to provide guidance to research activities. The selection and monitoring of a research project should be performed by the agencies responsible for research and technological development ("Research and Development Act," 2002, par. 20, 21, p. 9, 10). Additionally, the act states that the basis for directing and determining the scope of public research funding will be provided through a national research and innovation strategy ("Research and Development Act," 2002, par. 7, p. 3).

In Croatia, we encountered a slightly different picture. The Croatian Act on Scientific Activity and Higher Education does not stipulate any suggestions on selective research funding through programmes, but does introduce centres of excellence. This is not to say that the act fails to provide any opportunities for project funding, but rather that it fails to identify specific program areas that would enable the government to become more selective in funding research activities. The act establishes so-called collaborative projects too, but gives the right to decide upon funding criteria to the National Research Council. That is to say, it puts it in the hands of the agents (Zakon o znanstvenoj djelatnosti i visokom obrazovanju," 2003, par. 111, p. 44). With these limitations, it is easy to assume that Croatia has less space for introducing selective funding. It does, however, foresee the possibility of selecting centres of excellence in outstanding research areas based on the recommendation of the National Research Council. These centres of excellence receive special rights and obligations; however, they are not enlisted ("Zakon o znanstvenoj djelatnosti i visokom obrazovanju," par. 29, p. 12). Though the act fails to highlight the fact that these centres have access to additional public research funds, in most cases they do.

With regard to Serbia, we can see that its Act on Scientific Research Activity defines both centres of excellence and programmes for project funding. The Act has introduced 13 programmes with slightly different targets. This certainly enables the government to channel financial resources into those areas that are of special interest at a given time. The list of programmes can be supplemented with additional programmes in the event that the strategy for research calls for it ("Zakon o naučnoistraživačkoj delatnosti," 2005, par. 10, p. 5). Centres of excellence are another means for the government to enforce selective funding, especially since a separate programme has been created to support them. However, the criteria for selecting and funding these centres are to be defined by the National Research Council, which, as in Croatia, limits the government's power as the principal ("Zakon o naučnoistraživačkoj delatnosti," 2005, par. 14, p. 8).

With the exception of the Croatian Act on Scientific Activity and Higher Education, all of the policies emphasise the importance of developing a national research strategy that will provide a more concrete direction to research activities, as well as to the funding of research activities.

The integration of public research organisations, private companies and governmental institutions into a common innovation system is another highly anticipated outcome of research policies. In Slovenia, both public and private entities can organise themselves as research organisations, enabling knowledge intensive companies to establish them ("Research and Development Act," 2002, par. 5, p. 3). Moreover, the Slovenian Research and Development Act sets out a special organisation, called Organisation acting in the public interest' ("Research and Development Act," 2002, par. 22, p. 10). This organisational form can be employed by any organisation conducting research and development work for the benefit of society at large. In addition, the agency for technological advancement is responsible for providing support for knowledge transfer and networking between academic institutions and the industry. However, the act does not specify the means by which this should be carried out.

The Croatian Act on Scientific Activity and Higher Education foresees the possible initiation of collaborative research projects between universities and public research institutes, but fails to identify private companies as possible partners on these projects ("Zakon o znanstvenoj djelatnosti i visokom obrazovanju," 2003, par. 28, p.12). As such, it somewhat hinders cooperation between private entities and public research organisations in executing collaborative research projects. The act also introduces science-technology parks, which have the status of a limited liability company and also enjoy tax exemption benefits in line with their mission and objectives. Though the act does not specify how these parks should link public research institutions and private companies, we can still anticipate that they will be crucial for the generation of innovations and their commercialisation.

The Serbian Act on Scientific Research Activity states that research institutes may be state owned, private or mixed in terms of the origin of their capital ("Zakon o naučnoistraživačkoj delatnosti," 2005, par. 41, p.23). As such, it not only enables private investment in research and development, but also permits the development of a collaborative organisational form in which the capital is provided both by public and private entities. Moreover, research institutes can be established as public institutions or companies, which allows a greater flexibility in terms of attracting research funds and promoting knowledge capitalization. Institutes can also establish technology transfer centres, innovation centres, business and technology incubators, and science and technology parks in compliance with the act.

The research acts of all three countries permit the establishment of private research organisations that would allow knowledge-intensive companies to create separate branches for their R&D activities and, depending on the case, also attract public support for them. Both the Slovenian and Croatian acts failed to provide for the possibility of establishing mixed organisational forms, which would enable public research organisations, private companies and government institutions to work as one organisational entity. Therefore, we possess limited opportunities for joint research ventures across sectors within the Slovenian and Croatian legal environment.

Moreover, national R&D investment policies imply that all three countries need to secure additional funds from the European Union as well if they are in need of collaborative research ventures. Therefore, participation in the Framework Programme and other similar programmes of the EU is a heavily stressed objective in the research policies of all three countries. Croatia certainly stands out in this regard as it has also developed a specific action plan to help its research institutes absorb more funding from EU sources, especially the Framework Programme. On the other hand, Slovenia and Serbia have active local units promoting and supporting FP7 implementation. Therefore, we can safely conclude that all three countries recognise the relevance of European cooperation in research and the value of the European Research Area.

With the general policy context of Croatia, Serbia and Slovenia in mind, and the problems they address in particular, we can observe a number of similarities in both the direction they have undertaken and the content itself. In general, they have all identified the need to increase investment in R&D, to link research to the needs of the national economy, and to set priorities concerning research funding. At the same time, many of these objectives seem to be a reproduction of the objectives of the Lisbon strategy or Europe 2020, which is likely due in part to uncertainty, and thus qualifies as mimetic isomorphism, of relatively high confidence governments across the region in EU research policy. In addition, this is also likely due to the shared ambition to be competitive within the European Research Area. Therefore, it is evident that the countries in question have undergone an intense policy harmonisation process. Looking at the general policy level only, we could not identify any country as lagging behind in policy harmonisation, which may have been predicted by a country's phase of EU accession. Points of divergence only become visible when examining the areas of emphasis with regard to the set objectives. Consequently, we can conclude that the research policy in the countries under study has a common root and points in the direction of very similar objectives. National specificities only become visible when looking at the instruments that are used and the way policies are implemented.

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Jelena Branković & Mihajlo Babin

Chapter 5
INVESTING IN RESEARCH

> *In the course of funding history, a large variety of political answers have been given. These have moved from one end of the paradox — complete freedom of scientific institutions — to the other — complete planning of scientific activities. I contend, nevertheless, that today we have entered a new period of dealing with the paradox, offering in many ways different answers from before.*
>
> *(Braun, 2003, p. 309)*

The research or science systems of European countries have been introduced into the spotlight of broader discussions on economic development and growth. Given the knowledge economy discourse at the European level, the increasing relevance of knowledge creation and diffusion across national policy arenas is expected, and can have a direct impact on budgetary allocations for science.

This chapter is dedicated to two main aspects of investing in science. The first is the volume of investment and its distribution across sectors, fields, and sources. Within this context, we pay particular attention to human resources. The other aspect analysed here is the funding mode in the public sector, or, as we also refer to it, the allocation mechanism of public funds, i.e. the way governments distribute financial resources to research providers. While in the first case we look into the entire R&D system (including both the public and private sector), the second is dedicated solely to the public sector.

With regard to the first aspect, the authors have used the data obtained through national statistics agencies, the UNESCO Institute of Statistics, and the World Bank. However, we must emphasise that though we relied heavily on the methodology of these institutions, a certain level of caution is needed. The rationale for this lies with the notion that the data collected by the official statistics offices are in effect the aggregated claims of research organisations themselves.

As for the other aspect, we relied on legislative documents and informal conversations with ministry representatives, university professors and researchers as our basic sources of data and information. The purpose of speaking with professionals was primarily to enhance our understanding of the workings of the allocation mechanism beyond the information found in the documents. Moreover, not all of the documents could be accessed, which is why theses insights were even more important.

Funding in figures

There are a number of aspects with regard to investments in science we must to consider. These are namely the total expenditure, expenditure by source, sector, and field of science, and investments in human resources in R&D. This chapter illustrates the above-mentioned trends, starting from 2000 and ending with 2008 and 2009, the most recent years for which data is currently available.

The analysis has been conducted in comparative perspective. Wherever possible and in accordance with the available data, it compares the three countries and the European Union average in a fairly descriptive manner. The data used for this purpose was taken from the UNESCO Institute for Statistics (UIS) online database,[1] which was crosschecked with the data from the national statistics offices (NSOs) of the countries under study. Both UIS and NSO data are as a rule collected by the national statistics offices. Therefore, in all three countries, the statistics offices use recommendations given by the OECD Frascati Manual for most of the indicators pertaining to the statistical field in question.

It is also important to note that both research and development were covered and there are three reasons for this. First, research and development taken together at the aggregate level offers a more complete picture of research activity, regardless of what takes place in a research-specific institution or, for example, in the industrial sector. Second, having in mind the policy discourse pertaining to this subject area, R&D is more likely to be addressed by policy makers than research without development. This goes both for policy makers at the EU and the national level, a fact which becomes evident once one takes a surface look at any policy document of major relevance. The third reason is a more pragmatic one. In the course of this research, we discovered that the aggregated data covering both research and development is more readily available than data on research only. Often, once an indicator for R&D is identified in the data, it is difficult to disentangle research from development, as the data collection method is not always clearly described. Even when

1 For explanation on categorisation of data obtained through UNESCO Institute for Statistics, please consult ‘Instruction Manual for Completing the Questionnaire on Statistics of Science and Technology (S&T)’, to be found at the UIS web page http://www.uis.unesco.org/UISQuestionnaires/Documents/UIS_ST_2010M_EN.pdf, last retrieved on December 12, 2011.

the data method collection is clear, separating figures from research and development is not possible. A similar logic follows Science and Technology (S&T) collocation.

R&D expenditure

Back in 2000, the investment R&D as percentage of GDP in Croatia, Serbia and Slovenia was 1.06%, 0.93% and 1.39%, respectively. While Slovenia experienced a slight upwards trend in the last decade, Croatia and, in particular, Serbia did not follow the same pattern. The case of Serbia could even be perceived as reverse, having experienced a slight downwards trend during this period, only to recover slightly at the end of the decade. The figure below (5.1) shows these countries together with the EU average gross domestic expenditure on R&D (GERD), as well as the EU 2020 target for R&D expenditure.

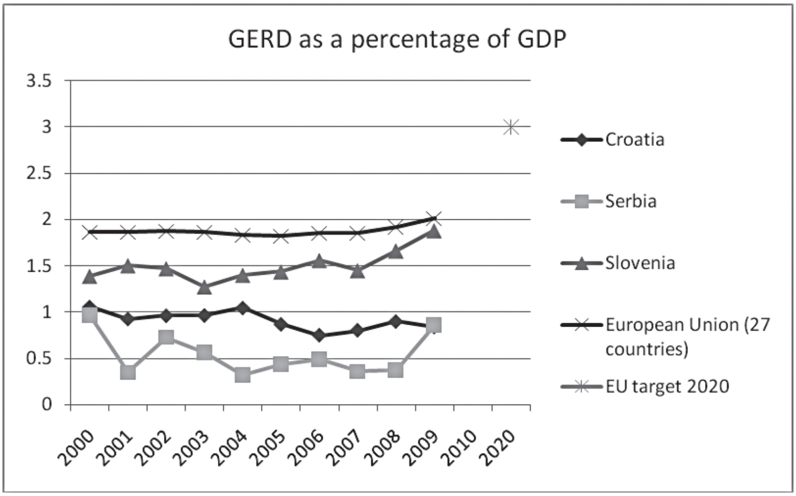

Figure 5.1 GERD as percentage of GDP in selected countries, 2000–2010 (incl. EU 2020 target)

Source: UNESCO

In the period 2000–2009, the average annual growth rate of GERD as percentage of GDP in the EU was 0.81, while Slovenia achieved a growth of 3.57. A more modest growth over the period was marked by Croatia, 1.11, while Serbia experienced a decrease of 2.06. Placed in an absolute category, the trend in the GERD per capita growth in the three countries (Figure 5.2) confirms the trend in terms relative to the GDP.

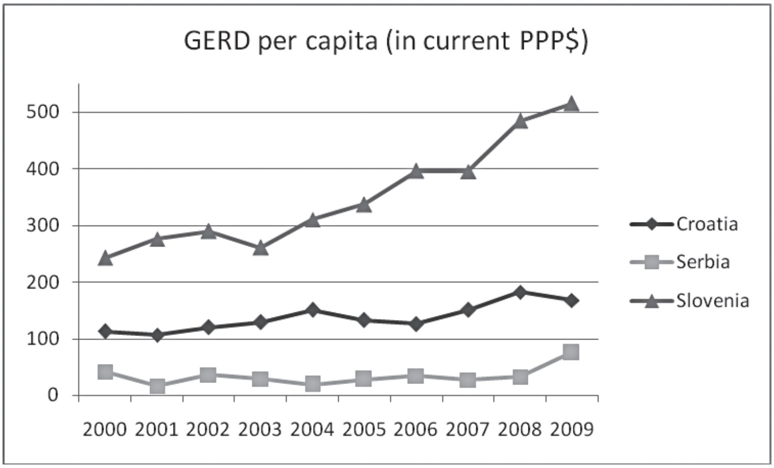

Figure 5.2 GDP per capita in selected countries, 2000–2008 (in current PPP$)

Source: UNESCO

If we take a better look at the R&D expenditure by focusing on the source of financing, a more striking difference can be observed. While in the previous decade Slovenia's business sector dominated in terms of R&D investment (with 58% of total GERD in 2009), over governmental contributions (35.7% in 2009) and that of higher education (0.3% in 2009), the situation in Croatia was somewhat reversed, as the government was contributing with 51.2% of total GERD. (Table 5.1)

While the EU and Slovenia derive most of their R&D funds from the business sector, Croatia and Serbia are still dependant mostly upon the contributions of government, though this is more the case with Serbia than Croatia (where the business sector contribution has been steady at about 40% during the past decade). What is also striking here is the difference between the relative contribution to R&D coming from higher education – 0.3% in Slovenia, about 2% in Croatia, about 1% in the EU, and slightly above 20% in Serbia. Though it is tempting to conclude that universities in Serbia are far more scientifically oriented than those in the average EU country (especially in the allocation of their own revenues), it is extremely important to take these figures with a grain of salt. Namely, we must emphasise again that we relied on the data collected by the official statistics office, which is essentially the aggregated claims of institutions themselves. These figures are even more striking when one learns of the financial hardship many of the higher education institutions in Serbia undergo, and that they often resort to raising tuition fees in order to make ends meet. Nonetheless, even if it were that higher education sector in Serbia invested in science as much as an average EU country, it would still mean that the government sector was the dominating one when it comes to the source of R&D funding.

In a paper analysing variables predicting research output, when measured by bibliographic data or patents, Shelton and Leydersdorff (2011) identify the origin of financial resources for R&D as the best predictor. Higher contribution from business enterprises trigger more patents, while more resources from the higher education sector or government yield more books and articles.

Table 5.1: GERD by source for selected countries, 2009 (%)

	Croatia	Serbia	Slovenia	EU*
Abroad	7.0	7.2	6.0	8.7
Business enterprise	39.8	8.3	58.0	54.7
Government	51.2	62.9	35.7	33.9
Higher education	1.9	20.9	0.3	0.9
Private non-profit	0.1	0.8	-	1.7

Source: UNESCO

*average based on the EU countries with data available at the moment of producing the table

Looking into GERD by sector where R&D is performed (Figure 5.3), it can be noted that Croatia and Slovenia have their R&D activities mostly concentrated in business enterprises (and for that matter, EU countries on average as well). On the other hand, in 2009, Serbia directed most of its R&D investments into the higher education sector (54.8%), followed by the government sector (30.9%) and finally by the business sector (14.3%). On the other end of the spectrum we have Slovenia (in the same manner as an average EU country), where business enterprises contribute more than 60% of national GERD, in Croatia about 40%, while in Serbia only slightly more than 10%.

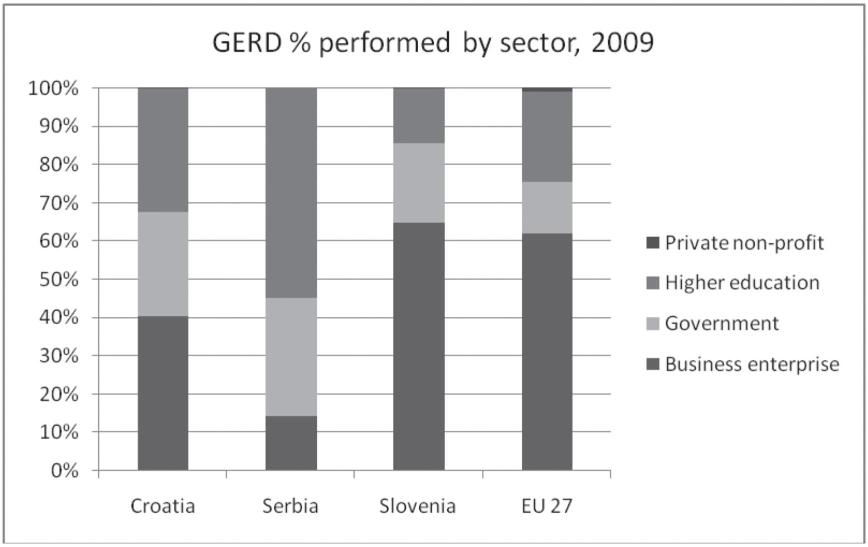

Figure 5.3 GERD by sector of performance for selected countries, 2009 (%)

Source: UNESCO

The patterns found in the distribution of expenditure by sector of performance normally coincide with the patterns seen in the distributions of type of R&D activity: basic research, applied research and experimental development. While in the case of Croatia and Serbia the situation is rather balanced between the three, Slovenia has about 69.5% of its total GERD channelled into applied research, 8.5% into experimental development and only about 12% into basic research (Figure 5.4). In the previous decade, Slovenia's GERD for applied research increased from about 53% (2000) to almost 70% (2008), mostly at the expense of basic research (24% in 2000; 12% in 2008). An opposite trend was noted in Serbia, where basic research overall increased between 2005 (30%) and 2009 (42%). No significant fluctuations were noted for Croatia during the same period.

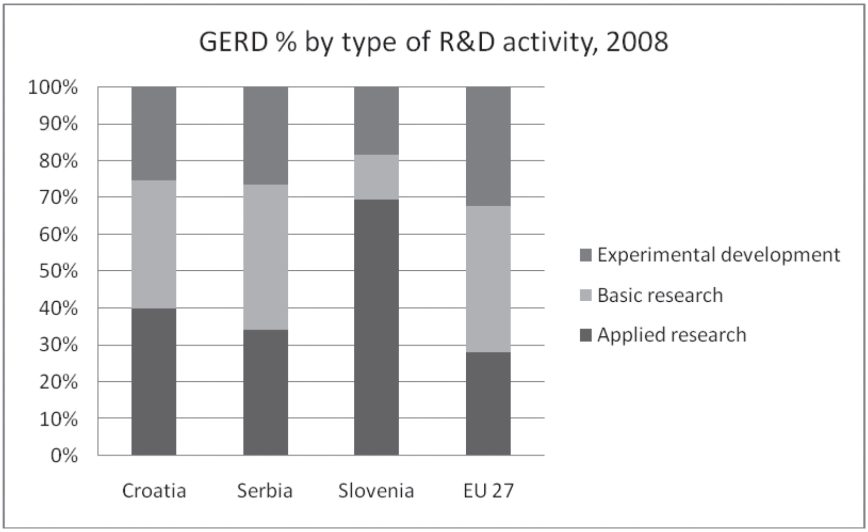

Figure 5.4 GERD by type of R&D activity for selected countries, 2008 (%) (EU average is authors' estimation based on the data from 18 member states)

Source: UNESCO

In the field of science, natural sciences and engineering and technology dominated the spectrum of GERD in 2009, accounting for more than 85% in the case of Slovenia, 67% in Serbia and 54% Croatia. A similar situation exists in 13 EU countries with data available through UNESCO (Table 5.2). Between 2000 and 2007, Slovenia allocated on average about 24% of its GERD to medical and health sciences, which fell to about 3% in 2008, the same year natural sciences were entrusted with about 13% more funds in comparison to 2007 (in total about 17% of GERD).

Table 5.2 GERD by field of science for selected countries, 2008 (%)

	Croatia	Serbia	Slovenia	EU*
Agricultural sciences	8.4	-	1.3	7.3
Engineering and technology	32.5	37.9	45.7	36.6
Humanities	11.5	9.0	3.3	5.3
Medical and health sciences	16.4	5.0	3.3	8.6
Natural sciences	21.5	28.5	40.4	28.7
Social sciences	9.6	9.7	5.9	8.1
Not specified	-	9.9	-	-

Source: UNESCO

*average based on the EU countries with data available at the moment of producing the table

Human Resources

When it comes to human resources in research and development, in principle, R&D staff fall into three categories: researchers, technicians, and other supporting staff.

There are two ways to count researchers and other staff. One is by counting the absolute number of people regardless of the type of contract they have and the percentage of their working week they spend on R&D (as opposed, for instance, to teaching or other professional engagements), while the other is counting the total number of full-time equivalent employees. The first method is normally indicated as HC (head count), while the latter as FTE (full-time equivalent). Here we will use FTE whenever looking into aspects of relevance to research intensity, unless no FTE figures are available. Normally, HC is used when looking into attributes of researchers, such as gender, education and social background, which are of secondary interest to us here.

During the past decade, the ratio between FTE and HC of R&D personnel in these three countries has been rather stable. This is particularly the case in Slovenia, where this ratio was between 69% and 73% from 2000 to 2008. In Croatia, the fluctuation was slightly higher, starting from about 75% of FTE in total HC in 2000, dropping to about 53% in 2003, only to climb slowly to about 60% in 2008. Meanwhile, in Serbia, in 2007, 2008 and 2009, the FTE – HC ratio was stable at about 90%, which is considerably high compared to the other two countries (“UIS,” 2011). In practice, this could imply that the employment policy for R&D staff (or employment policy in general) either offers no incentives for part-time employment, or is rather rigid.

On a more general level, the total number of R&D personnel (FTE) in Slovenia (12,410) and Croatia (11,015) reached about the same level in 2009, both having fewer R&D personnel in total than Serbia (18,107). (Figure 5.5)

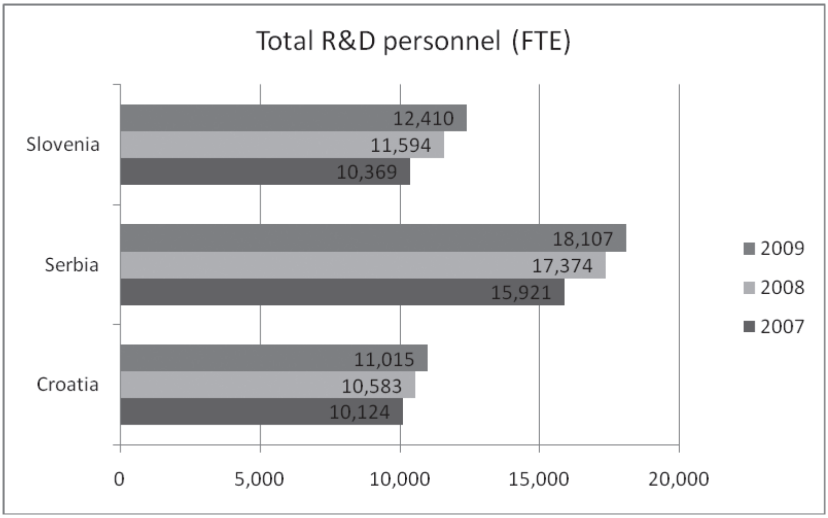

Figure 5.5 Total R&D personnel (FTE) for selected countries, 2007–2009
Source: UNESCO

With regard to the percentage of female R&D personnel, Croatia and Serbia show a steady 50% (+/-2) between 2002 and 2008, while the percentage in Slovenia kept at about 40% in the same period. As for the percentage of female researchers, during the same period, the research core of R&D personnel in Croatia and Serbia was about 40% female, while in Slovenia this number was even lower – about 35%. Strikingly, throughout the period 2000–2008, only about 30% of researchers in the EU were females, among which only Latvia and Lithuania had more than 50% in 2008, 54.7 and 51.4, respectively (Figure 5.6).

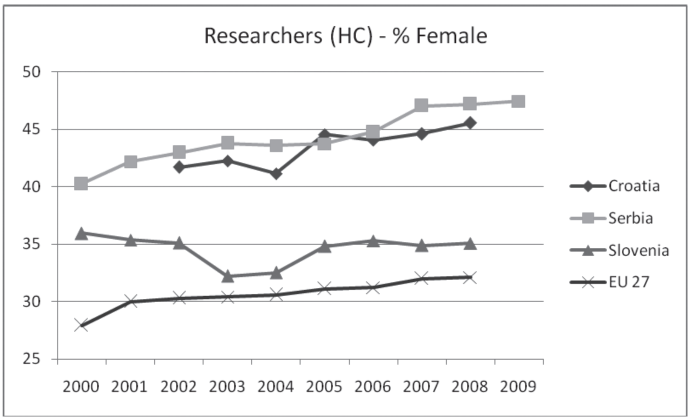

Figure 5.6 Female percentage of total researchers (HC) for selected countries, 2000–2009 (%)
Source: UNESCO, Eurostat for EU

On the other hand, looking into the sectors where the personnel is located, the majority of Slovenian R&D staff was in business enterprises in 2009 (55%), while about the same percentage of Serbian (59%) and 40% of Croatian R&D personnel was in higher education. The Slovenian higher education sector employs less than 20% of all R&D human resources in Slovenia.

Between 2000 and 2009, the total number of FTE researchers in R&D was rather stable in the three countries, with the exception of Slovenia as of 2004, when a more noticeable growth in FTEs began. This growth reached Croatia's level in 2006 and finally surpassed it in 2008. The average annual growth rate of the total number of Slovenian researchers (FTE) in this period was 7.2. The number of researchers in Serbia increased between 2007 and 2009, with an average annual growth rate of 6.2 (Figure 5.7).

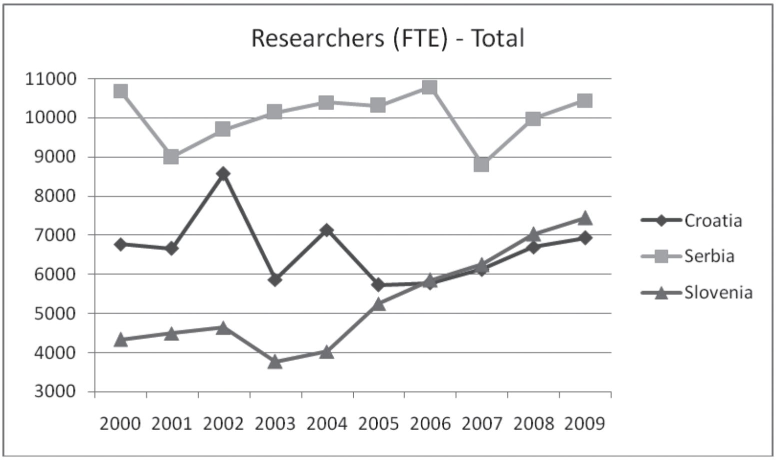

Figure 5.7 Total researchers (FTE) for selected countries, 2000–2009 (figures for Serbia for 2000–2006 are estimated)

Source: UNESCO

Still, all three countries are significantly below the EU average in terms of the human resources they employ in R&D, simply because they are relatively small countries. As an illustration, an average EU country had slightly below 60,000 full-time researchers in 2009. However, the average annual growth rate for the EU during the period 2000–2009 was 4.2, starting with a little above 40,000 researchers in 2000. The EU country that was identified as having most intensified their labour force during this period was Portugal, whose number of researchers almost tripled by reaching more than 45,000 in 2009. On the other hand, in the period 2000–2009, the relatively lower average annual growth rates in Spain and France still meant a total of more than 50,000 and 100,000 new researchers respectively.

Importantly, these figures should not simply be taken in absolute terms, but as relative with regard to size of the country, number of active research institutions, total workforce and other indicators that could be indicative of the place of human resource investment with respect to R&D. In this light, we could look at the number of researchers relative to the total population of the country. If we take this as an indicator of the research-intensity of a country, Slovenia was by far increasingly more research-intensive in the past decade, while Serbia and Croatia share a position similar to one another and are still far behind. In concrete figures, the number of researchers per million of inhabitants in Croatia and Serbia in 2009 was about 1500, while in Slovenia this number was more than 3500. In the same period, the average EU country experienced a decline in its share of researchers. In other words, while the number of researchers in absolute terms was rising at an average annual growth rate of 4.2, the number of researchers relative to the total population was declining at an annual growth rate of 2.7.

A similar pattern can be observed when looking at the number of researchers per thousand total employments. Though there is no data from the same source for Serbia in this instance, we could reasonably expect a similar pattern in this case (Figure 5.8).

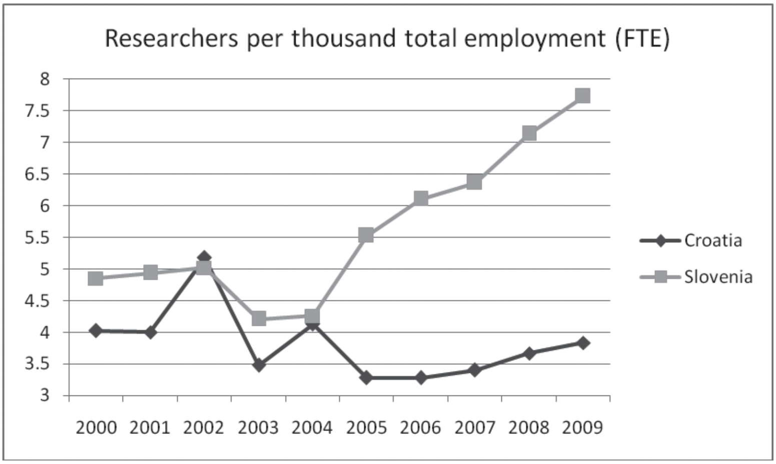

Figure 5.8 Researchers (FTE) per thousand total employment for selected countries, 2000–2009

Source: World Bank

When we move on and look into the sector that employs researchers (Figure 5.9), a slightly different distribution is observed from those of GERD distribution between sectors (Figure 5.3) and the distribution of personnel between sectors. Relatively speaking, the business enterprise sector absorbs a higher percentage of total financial resources than human resources, in a situation opposite to that of higher education (the government sector gets more or less the same share for both GERD and total researchers). This is, of course, unsurprising as R&D performed in the business sector tends to be more applied in nature, cover hard disciplines and as such, is more expensive. Finally, 'development' in R&D is also more likely to be concentrated in that area. With respect to the countries we have looked at, the Slovenian case concentrates more of its researchers in the business sector compared to other sectors, and also more than Croatia and Serbia do. The latter two seem to give priority to higher education, followed by the government sector, and finally the business sector. Research time in the average EU countries is, interestingly, equally distributed between the business and higher education sector, while government and private non-profits account for about 15% of the total research labour force.

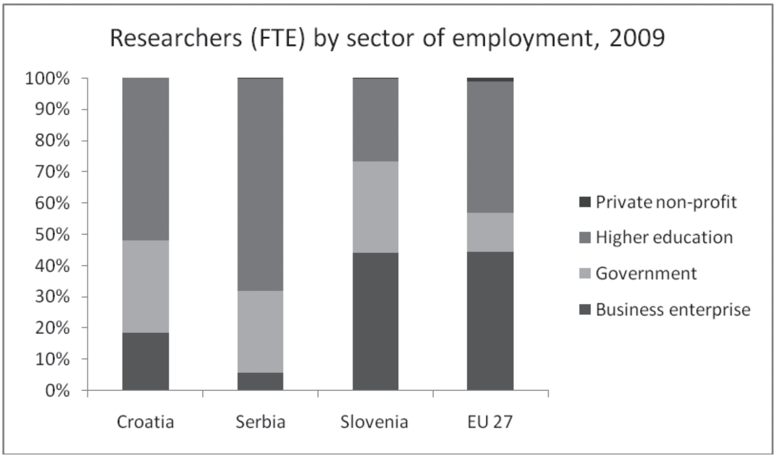

Figure 5.9 Researchers (FTE) by sector of employment for selected countries, 2009 (%)

Source: UNESCO

The figures given here are for 2009, though they represent the entire period from 2000 to 2009 as only minor fluctuations in the distribution are noted, in relative terms. For instance, the percentage of Serbian researchers in business enterprises rose from 1% in 2007 to 6% in 2009. Still, in terms of FTEs, this number was about 100 in 2007 and about 600 in 2009, which is, when compared to the other two countries, alarmingly low (Figure 5.10).

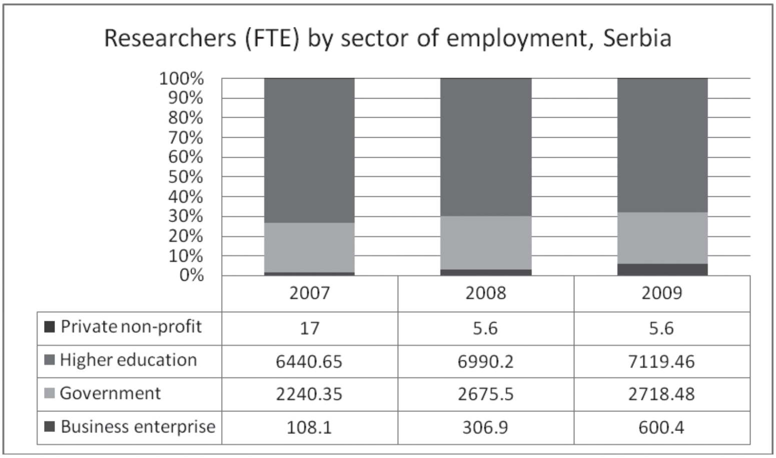

Figure 5.10 Researchers (FTE) per sector of employment for Serbia, 2007–2009 (%)

Source: UNESCO

Taken from a disciplinary point of view, and roughly in line with the dominance of the business sector in Slovenia, the majority of researchers (about 76% in 2008) are engaged in research activities in either the natural sciences or business and technology (Table 5.3). These two fields of science account for less than 50% of research in both Serbia and Croatia. On the other hand, engineering and technology, followed by the natural sciences, employ a considerable percentage of researchers in all three countries, the main exception being Croatia, which directed about 20% of its human research resources into medical and health sciences. A similar situation exists in Serbia though in the field of social sciences, with medicine at some 12%. In conclusion, Serbia and Croatia do have a more diversified researcher landscape field-wise, while Slovenia appears to be more focused.

Table 5.3 Researchers (FTE) by field of science for selected countries, 2008

	Croatia	Serbia	Slovenia
Natural sciences	1,257	1,860	2,365
Engineering and technology	1,707	2,673	2,952
Medical and health sciences	1,516	1,260	502
Agricultural sciences	567	1,131	201
Social sciences	889	1,906	633
Humanities	759	921	379
Not specified		227	

Source: UNESCO

With respect to the higher education sector and the disciplinary distribution of researchers, a more balanced picture can be observed. Still, even within this sector, engineering and technology were leading in all cases in 2008, though most substantially in Slovenia. This pattern is observable throughout the period 2000–2009, with slight shrinkages of some fields (most notably, agricultural sciences in Slovenia) and widening of others (agricultural sciences in Serbia).

Meanwhile, governments concentrated most of their researchers in natural sciences in all three countries (about 40% Croatia and Serbia, more than 50% Slovenia). Only in Serbia did engineering and technology account for more than 10% of researchers in the governmental sector (in 2007 this was at some 25%). Interestingly, social sciences in all three cases account for between 10% and 15%, while in Croatia humanities within governmental institutions employ about 20% of the total number of researchers (FTE), displaying a growth curve since 2002 (12%).

Public Research Funding in Croatia, Serbia and Slovenia

While the previous section was dedicated to the volume of funding, in this section we look into the allocation mechanism for public funding in Serbia, Croatia and Slovenia, chiefly through the lens of the principal-agent approach. Unlike the previous section, in which we analysed the volume of funding, i.e. the question of 'the how much', here we will analyse the manner in which public money is allocated, i.e. 'the how' of research investment. In other words, here we will examine the predefined 'rules' and the dynamics these rules create in the given systems.

In a broad sense, the 'allocation mechanism' refers to a set of regulations prescribed by the state or other funding authority with regard to the distribution of the public budget earmarked for science. In principle, the allocation mechanism is intended to serve a policy goal, i.e. to steer research providers to behave in a particular way that would maximise their chance of attaining a desired outcome. Therefore, the allocation mechanism is based on an intended plan and should ideally follow the will of the policy maker. It can also be seen as a specific framework for distributing funds, and as a mixture of values, goals, incentives, and disincentives.

From a historical point of view, the interest in modes of allocation first emerged in the 1970s and 1980s (Lepori et al., 2007) for two main reasons. The first reason was the stagnation in research funding (as measured as percentage of GDP), which was linked to the second reason, the new policy rationale for an efficient use of public funding through competitive allocation mechanisms (Geuna, 2001). While the first is focused on the macro level and the ratio of research funding to GDP, the second is concentrated on the improvement of efficiency through allocation mechanisms. Nonetheless, both aspects are of primary importance to the analysis of allocation mechanisms for research funding. From the perspective of policy makers, the basic assumption is that providing financial resources to scientific activity is an investment in the future. Consequently, as economists would attest, it is reasonable to increase budgetary deficits, take a loan, and invest in science. However, this reasoning is not without problems. The first problem is the well-known economic story of returns on investment. *Will the returns from science investment be high enough to pay off and how do we measure this?*

Three important categories emerge when one is to analyse this issue:

– Inputs (e.g. number of researchers, number of scientific institutions),
– Outputs (e.g. journal articles, monographs, patents),
– Outcomes (e.g. improvement of living conditions, stronger economic growth).

If the increase of inputs leads to the increase in outputs and outcomes, then it is said that these variables positively correlate and the state should increase investment in science. However, this is not always the case. The investment in science is often only explained as an increase in inputs, but this guarantees neither the outputs, nor the outcomes. The increase in inputs does not generally lead to an increase in enablers or outputs (the number of articles published or the number of patents) and often the hardest task is to determine whether the increase in inputs that creates a rise in outputs has any impact on the outcomes (e.g. whether a patent has been used in production, whether some procedure or rule has been changed and improved due to research published in some article or scientific publication, or whether the increase in scientific investment has enhanced economic growth or the quality of life in a country). Creating an environment that will stimulate the maximisation of research potential is always a challenge for policy makers.

In some studies (e.g. Lepori, 2006), the solution to these problems is sought by means of the introduction of a new generation of indicators, the so-called positioning indicators. These indicators would focus on an analysis of the financial fluxes between research funders, intermediaries, and performers. The enhancement of the allocation mechanism is also possible through a combination of input indicators with the different types of output indicators – mainly bibliographic indicators (e.g. Moed et al., 2005). Another important idea is to develop economic indicators that can assess performance or the productivity of research units of entire countries. Also, some efforts have been taken to measure the impact of R&D activities on economic growth (e.g. Debackere et al., 2004).

According to Potì and Reale (2007), public research funding and the way it changes over time can be analysed from a number of perspectives, including through the *volume of funding*, the *instruments* used in determining and channelling this funding, or through the *structures* installed for the purpose of allocating these funds. Braun (2006) suggests that the evolution of funding policies can be analysed in terms of delegation modes whose aim is 'to guarantee maximum welfare benefits, without violating the independence of scientists and their organisation' (Potì & Reale, 2007, p. 418). In other words, both sides need to recognise their mutual interest in 'doing business' together, despite being two distinct systems in pursuit of different goals, resting on different values, and operating by a different set of rules. Naturally, trust is of vital importance here, putting the sustainability of 'the common agenda' of the science and policy systems to the test.

According to Braun, research policy belongs to the distributive policy arena, in the sense that within the framework of a policy, the government distributes money to some groups to perform certain tasks (Braun, 2006). This can be direct distribution to research providers, or to independent structures such as funding agencies, a common practice across Europe and beyond. Money is given to research providers on the basis of a promise for future performance (Braun, 2006). It can be compared to paying for a service well in advance with a high level of risk, little guarantee that anything will be achieved (esp. in natural sciences), zero knowledge about the extent of that achievement, its application or any eventual return on the initial investment. However, as research policies are undertaken with this degree of risk, in order to reduce the risk of not getting 'value for money', the principal needs to have some assurance mechanisms from the agent (Coleman in Braun, 2006) such as previous results, information on capacity and conditions, etc. This relationship of trust is tightly linked to instances of information asymmetry and further with potential moral hazard.

Delegation in which two actors are exchanging resources is an important part of the principal-agent discourse, of which more was said in Chapter 1. As previously described, two problems pertaining to the principal-agent approach are adverse selection and moral hazard, both arising from the actors' rational pursuit of self-interest. In order to minimise the risk of an agent partaking in undesired behaviour Braun (2006) identifies the use of contracts, while van der Meulen (in Braun, 2006) argues that reaching a solid consensus on the objectives to be pursued would diminish either side's motive to conceal information or shirk on responsibilities. Bernal (in Braun, 2006) argues in favour of building ownership over research policy goals, by means of joint research policies between policy makers and research providers. Apart from adverse selection and moral hazard, Braun (2003, p. 310) also identifies the problems of responsiveness ('getting scientists to do what politics want') as well as decision making and priority setting ('knowing what to do').

In the context of funding allocation, the principal-agent relationship becomes more complex because in reality, more than two actors or groups of actors are present. This ultimately means a revision of the conceptual and theoretical premises is required. Intermediary bodies, funding agencies, and research councils all play a double role: they are the agent to the state and the principal to research providers. Braun (2006) refers to them as the intermediaries of trust, i.e. structures which enjoy more trust from the government than direct target groups do (research organisations). Two ways of implementing this are identified. First, *peer review*, through which the principal is given better insight into which agent may better contribute to the desired policy goal, or, as Braun (2006, p. 153) puts it, 'who to trust within the scientific community'. Second, Braun mentions *research institution and university*, which when it is acting as an agent, is a guarantee of the ability to conduct good research and be held accountable for it. The mechanism of trust is the same in both cases: as the principal trusts scientific experts through peer review, it also trusts the university as a scientific institution. The task of determining trustworthiness can also be delegated to finding agencies, which act as intermediaries between the government and the research providers and play the double role of agent to the government and principal to the research organisations. However, the relationship between the intermediary and the government can suffer from weakness of information asymmetry and be at risk for shirking as well.

With regard to the discussion about the allocation mechanisms for public funding and the relationship between the principal and the agent (and, implicitly, the level and nature of trust), we have chosen Braun's (2003) five delegation modes as the analytical prism: *blind delegation*, *the incentive mode*, *austerity delegation*, *contract delegation* and *network delegation*. This categorisation is based on the ways in which policy makers have managed the tension between the research providers who have a natural inclination to seek autonomy and the governments who strive to engage research providers in reaching the desired policy outcome. The classification system also aligns with different periods in the funding history. Table 5.4 gives an overview of the five models, in terms of responsiveness, moral hazard, monitoring costs, performance measure, and decision making costs.

Table 5.4 Delegation models in funding policy (Braun, 2003)

Model	Responsiveness	Moral hazard	Monitoring costs/ performance measure	Decision-making costs
Blind delegation	Low	Low	Low Scientific Publications	Low
Incentive mode	Increasing	High	Increasing Practical solutions presented in research reports and advisory bodies	Increasing
Steady state	Increasing	Very high	Increasing Efficient use of resources and practical solutions	Increasing
Contract mode	High	Decreasing	High Thorough evaluation of output defined and operationalised in contract	High
Networks	High	Low	Decreasing Process-related measures concerning network quality	Low

The blind delegation mode is defined by the very high level of trust the political system has in the science system, and characterised the post-war period until the 1980s. Within this mode, the principal fully trusts the agent who, in turn, behaves as if there were no external demands, and follows the dynamics of its discipline or academic environment in its work. Property rights are delegated to research organisations that have the freedom to direct their research, set internal rules, etc. Publications are therefore the first and foremost indicator of research output. As such, chances for moral hazard are low, and so are the monitoring and decision-making costs.

Later, the incentive mode stepped in (1960s), placing some constraints on the work of scientists but still giving them enough freedom of choice with regard to their work. With the increase in external demands, moral hazard is increasingly present, followed by the principal's increased costs associated with monitoring the agent's activity, leading to decreased trust.

With the arrival of the steady state or austerity mode, we witness a decrease in trust, with an increase in the relevance of the application of research output and the needs of the user. Moreover, this mode is characterised by an increased competition for funds, in particular in the areas of research politically determined to be of priority, which leads to a marginalisation of those deemed less politically relevant. This mode also favours quicker and more flexible research providers who can react quickly and easily adapt to new political priorities, leaving others behind. Hence, Braun views this change in the principal-agent relationship as a 'transformation of funding policy' (2003, p. 313). The steady state mode is also the mode with the highest likelihood of moral hazard, in which agents are more exposed to structural incentives and held more accountable in their use of public funds. Like the previous two modes, the steady state mode did not bring a change in property rights, nor has it interfered with the internal rules of the scientific system (Braun, 2003).

In the 1970s, cuts in public funding brought about the increased presence of programme funding. This was to be further supported by the rise of New Public Management and the increased presence of contract funding, an emphasis on research output, and the ex-post evaluation of scientific work. It was at this stage that organisations rather than individual scientists were entering contract-based relationships with funding providers. As could be expected, contract delegation also became the strictest in terms of output evaluation. However, most important in the institutional context is that 'contracts change the institutional embeddedness of scientists' by delegating property rights to research organisations instead of scientists (Braun, 2003, p. 314), and thus view them as the research provider and the agent. This was the state's reactive measure to address the problem of moral hazard and directly engage research organisations in responding to societal needs.

The fifth mode suggested by Braun is the network delegation. In this delegation, a network of research organisations, private companies and other organisations are supported and funded, and their work is more facilitated by the state than controlled by it. The users of scientific output are also part of the process, which is to ensure the increased responsiveness of science to society. To some extent, the EU's Framework Programme subscribes to this mode. The FP7, for instance also focuses on process and network quality. Network delegation stimulates cooperation, knowledge sharing, reflexivity and indeterminacy (Braun, 2003). Hence, the moral hazard decreases, while the decision making costs are higher. As Braun emphasises (2003), the network delegation should not be understood as the opposite of contract or steady state delegation, but rather as coinciding with them, despite the fact that they have conflicting features. In reality, as Braun explicitly suggests, different modes can and do coexist.

Furthermore, Braun (Potì & Reale 2007) attempts to map project funding instruments (i.e. free projects and grants, programmes and networks*)* to the delegation models above and analyses them using the selection and evaluation procedures they are subjected to during the process of funding allocation. From this, he suggests that free projects naturally correspond to the blind delegation mode, while programmes correspond to the incentive mode. Having analysed these instruments through the prism of evaluation and selection procedures (composition of committee, methodology, criteria, intermediary, *ex post* evaluation, effects and type of instrument) Potì and Reale conclude that, in a number of European countries, the relationship between a delegation mode and the instrument at work depend on a number of additional factors which Braun did not specifically address, including the emergence of international funding schemes and instruments, and the role of intermediary bodies.

The analysis of allocation mechanisms in the remainder of the chapter attempts to shed light on the process of turning inputs into outputs and outcomes. It employs the basic features of Braun's conceptualisation of the modes of principal-agent relationship in its analysis of the funding allocation mechanism in Croatia, Serbia and Slovenia. Thus, the conclusions drawn could provide a hint as to possible reforms of the existing allocation mechanisms.

Public funding in the institutional context

As described in the previous chapter, all three countries have national strategies for research and development that are accompanied by regulatory acts, such as acts and bylaws and calls for application. The acts represent the legal and normative basis for the establishment, functioning and financing of public and private organisations and institutions that engage in research and development. With the exception of Croatia where research is regulated by the same act as higher education, Serbia and Slovenia have legal acts solely regulating scientific research.

At the level of the system, all three governments have a ministry that covers science and simultaneously covers other areas, such as education and sports.[2] Unlike the other two countries, in Serbia, the Ministry is still in charge of decisions on budgetary allocations and the monitoring of spending. In the case of Slovenia, the budgetary allocation decisions are delegated to the SRA, hence we perceive the Agency to be the principal here. As a transition in the role of principal took place between the Ministry and the CSF in the previous decade, we see both as principals, yet not of the same nature.

At the same time, all three countries have national scientific councils that perform an expert role in some aspects of decision-making. Normally, they have a say in policy and strategic development as well as on other science-specific issues, such as criteria for setting up research funding programmes, approving accreditations of research organisations and setting selection criteria for research projects. The councils often set up different working or thematic bodies, i.e. experts in charge of issues specific to different fields of science or areas of work.

Finally, research in these countries is conducted by a range of institutions, organisations and companies. In Croatia and Slovenia, most public funding is absorbed by universities and research institutes. In Serbia and Croatia, this funding is also retained by faculties, as they are recognised by the law as a separate category of public funding users from universities. It is important to emphasise again that Slovenian business enterprises allocate more funds to R&D activities than those in Croatia and Serbia do. In this respect, in 2009, out of the total financial allocation to R&D, Slovenian business enterprises accounted for almost 60%, compared to 40% in Croatia and only 8% in Serbia. On the other hand, the higher education sector in Serbia is the source of 21% of the country's total allocation to R&D, compared to 2% in Croatia and only 0.3% in Slovenia.[3] Most importantly, for the purpose of this analysis, we have narrowed the scope of this section and are exclusively analysing those research activities funded by the government. These represent 63% of total funding in Serbia, 51% in Croatia and 36% in Slovenia. Since this distribution has not changed significantly in the previous decade, we take this as representative of the period. (Source: UNESCO)

Moreover, we have decided to further narrow the scope of our enquiry and to analyse the particular relationship between the principals holding the

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2 Currently, Croatia has the Ministry of Science, Education and Sports, Serbia the Ministry of Education and Science and Slovenia the Ministry of Higher Education, Science and Technology.

3 Although as indicated earlier, it remains unclear what lies behind this sharp difference between the relative contributions to scientific activity in these countries.

public purse (ministries and intermediary bodies) and agents in the public sector – universities and their units and scientific institutes. This choice was made due to the fact that our interest lies primarily in the development of this relationship, given its history and the role it will play in the development of a knowledge-based economy. Therefore, we deliberately do not address bodies such as the Business Innovation Centre of Croatia or the Public Agency for Technology in Slovenia, though we do not underestimate the actual role they play in the system.

In terms of framing the selected segment of research funding systems according to the principal-agent model, we note that the role of the principal belongs to the ministries in Croatia and Serbia, with research organisations as the agents of research policy. In Slovenia, the intermediary body in the guise of the SRA is the principal to the research-providing organisations, in a similar manner as the Croatian Science Foundation is to Croatian research providers. This transition of the role of principal from the Ministry to an independent agency is characteristic of the EU integration process, and is one of Brussels' recommendations under Chapter 25 (Science and Research). Therefore, the aim is for the ministry to be in the role of policy body, and the agency in the role of strategic and funding body, with the latter in direct communication with research organisations.

Public funding allocation mechanism

In analysing the research funding systems of Croatia, Serbia and Slovenia in terms of Braun's (2003) five delegation modes, we will use the criteria set in Table 5.4 and approach the countries from a direct comparative perspective. We will start with the decision making process.

In all three countries, most research activity is financed on a project basis through various programmes and set by the authorities to facilitate the implementation of policy. In Croatia, until several years ago, the Ministry was the principal and the one to announce calls for financing research projects, junior research placements, research infrastructure, and equipment. Within this framework, the Ministry decided on the financing of projects and programmes (a set of at least three related projects), based on the anonymous evaluation given by domestic and international experts selected by the National Research Council. However, the Ministry's role as the main principal is being taken over by the CSF. That institution is seen as suitable not only to allocate financial resources to research providers, but also to fulfil the broader mission to strengthen scientific development, boost international cooperation, and the research potentials of the country. The role of the foundation, similar to that of the SRA, is to secure excellence, European standards and quality in research. Serbia on the other hand has a list of about a dozen research programmes of national interest identified in its research act, within which the

Ministry announces the call for project applications. The most relevant of the programmes are the Basic Research Programme, Research Programme in the Field of Technological Development, Programme for the Co-funding of Integral and Interdisciplinary Research, Programme for Purchase and Maintenance of Research Facilities and Equipment ("Zakon o naučnoistraživačkoj delatnosti," 2005). The criteria for the establishment of these programmes and the selection of projects within them is adopted by the Ministry based upon the National Research Council's opinion. The decision on financing projects is made by the Ministry, based on a specific set of criteria. The criteria are adopted by the Ministry, yet the National Research Council does provide an opinion. Finally, project-based funding is a mechanism in Slovenia as well, and is organised through a set of different types of projects for which the SRA announces public calls, normally once per year. Moreover, through public calls, the SRA can specifically finance and co-finance activities such as the placement of young researchers, visits of foreign researchers, doctoral studies and international cooperation. In Croatia, this role is being gradually undertaken by the Croatian Science Foundation.

These calls typically target specific kinds of research activity and, as a rule, ask the proposals to be explicitly in line with the National Research and Development Programme. Depending on the nature of the call, the projects are either selected by the Agency's Scientific Council, its Management Board, or a commission specially appointed by the Agency Director.

In Croatia and Slovenia on the other hand, other running costs such as regular salaries for researchers not associated with any of the research projects are foreseen in the state budget and are allocated as part of a separate funding stream for scientific institutes. This funding is not linked to performance, but to the mere existence of the research institute. Serbia could have also subscribed to this type of blind delegation, but the system was changed several years ago in line with the government's determination to increase the efficiency of the research system. Nevertheless, even though this two-stream funding system is no longer in place in Serbia (not counting higher education institutions), the selection of projects can be described as a balance between the fulfilment of the basic needs of all public scientific institutes (by at least providing them with a minimum of project-based funding in order to survive), and the pursuit of policy goals and focused finding through the setting of priority research areas.

Given the structures involved in setting criteria and deciding on applications, and the number of programmes and funding opportunities provided by the government (including the frequency of opening) it could be concluded that, given the existence of the Agency, these costs would likely be higher in Croatia and Slovenia. Yet, this might not be the case, as the Serbian Ministry maintains a high level of activity and we have not obtained any data on this issue. Once the projects are contracted, the principal is engaged in monitoring their implementation. What we witness in all three countries is the regular monitoring activity described in all relevant documents, conducted directly by the principal, and normally based on both regular reporting (yearly or following the phases of the project) and final reporting. This reporting contains both the technical and financial aspects of the projects as well as its scientific content.

With regard to the measure of performance, all three countries have adopted some kind of research-output criteria to be taken into account when deciding which project to fund. This was pioneered by Slovenia and Croatia, while in Serbia it was introduced only after 2005. The criteria are typically based on previous research results measured in terms of bibliometric indicators or results in technology development, such as patents, products, and processes enhanced. Beginning in 2005, Croatia and Serbia introduced a new criterion for the selection of projects for funding: the previous research output of individual researchers within organisations. Slovenia also values engagement in other international projects, such as the EU Framework Programme, in allocating points to a project's application. With the strengthening of the CSF during the last several years, the internationalisation agenda is increasingly evident in Croatia as well.

All of the countries seem to encourage cooperation with business enterprises, and tend to give higher ratings to projects that include some form of inter sector cooperation. That said, none of the countries evaluate the performance of running projects in terms of concrete research output during the project's lifetime.

Comparing the three research systems in terms of level of regulation of scientific work, the Serbian system seems to be the strictest. The legislative documents tend to be very prescriptive about what kind of behaviour is allowed and preferred. Scientists seemingly have very little room to manoeuvre within the confines of a research project. The state seems to play a very active role in controlling the research sphere by employing an involved principal determined to get the agent to do what it is expected of it. It toys with incentives in order to direct research organisations, yet it is unclear how effective they are. On the other hand, the SRA is also an active principal (and apparently an obedient agent to the state), but more freedom is left to the research organisations to set their own internal work dynamics. A similar situation is observed in Croatia. Yet we can only estimate the extent of moral hazard based on the alignment of the internal goals of research organisations with those of the policy maker. Even with this information, we must keep in mind the space allowed them by the formal and informal rules and the attendant possibilities for shirking.

The above is also related to the agents' responsiveness to state policies and the adopted funding mechanisms. Here we need to consider the types of research organisations we deal with and the resources available to them in the given environment. Given the very tight regulation on behaviour combined with relatively weak incentives, we expect the highest short-term responsiveness in Serbia with regard to commitment to policy goals. The Ministry in Croatia is somewhat similar, yet CSF's entering the stage as the principal is a game-changer, most likely in the direction of what we see happening in Slovenia. The Slovenian state seems to be the most facilitating, the least controlling, and yet offers the strongest incentives. Notably, Slovenian research policy strongly encourages research cooperation, joint ventures, and international engagement. Therefore, it is the closest to the network delegation mode. Moreover, Slovenian universities and institutes have also established cooperation with business enterprises, explicitly stimulated by the Agency (another task to be taken on by the CSF). Finally, the incentives for international cooperation in Serbia seem to be the weakest.

In all three countries, research funding inevitably collides with the funding allocated for universities and their constituent units that perform both teaching and research. The nature of the research funding allocation process within an institution of higher education, as well as details on how such funding reaches its targeted group remains unknown to this study. This is given both the difficulty of disentangling the two functions and the reluctance of these institutions to disclose their internal practices with regard to finances.

Summary and conclusion

This chapter focused on a number of aspects of investment in science. Namely, we have described total expenditure, expenditure by sector and field of science, and investments in terms of human resources. Based on the data provided, the investment in research and development as percentage of GDP in Croatia, Serbia and Slovenia in 2000 was 1.06%, 0.93%, and 1.39%, respectively. While Slovenia experienced a slight upward trend during the last decade, Croatia and, to an even lesser extent, Serbia did not follow this same pattern. The trend in Serbia could even be described as the opposite, as a slight downward trend is observed, with a slight recovery only at the end of the decade.

If we take a better look at the R&D expenditure in Croatia and Slovenia, focusing now on the source of financing, a more striking difference can be observed. While R&D investment in Slovenia was dominated by the business sector during the previous decade (relative to the government and higher education), the situation in Croatia was more or less the opposite, with the government as the biggest contributor. In Serbia we noticed that in 2009, about 21% of the country's investment in science came from the higher education sector, in sharp contrast to Croatia, Slovenia, or the average EU country, in which the higher education sector contributed about 1% on average. The reason for this might be found in the way these institutions report their activities to the statistics offices. Still, we will make no conclusions here, save an assertion of the need for further research. That said, in its distribution of R&D expenditure per type of activity, an average EU member state is more similar to Serbia than to Slovenia.

With respect to the field of science, engineering and technology and the natural sciences dominated the spectrum of GERD in 2009 in Slovenia and Croatia, as well as in roughly half the EU countries with data available through UNESCO. Still, with regard to the sectors employing R&D personnel, Slovenian business enterprises are the employers of slightly more than half of the nation's human resources engaged in R&D. Serbia is in the reverse situation – about half of Serbian R&D personnel in 2009 were in higher education, slightly more than in Croatia. Again, the comparability of figures ultimately depends on the methodology applied by the statistical offices and followed by research organisations. Finally, the distribution of Slovenian R&D personnel by sector reflects the EU average, while Serbia and Croatia stand outside of this picture. Even though the trend of the past decade demonstrates a slight increase in business enterprises' share of Croatia's and Serbia's total R&D staff, the overall pattern has not changed much. A similar conclusion can be drawn for researchers only.

From a disciplinary point of view, and roughly in line with the dominance of the business sector in Slovenia, the majority of researchers in 2008 came from either the natural sciences or business and technology. Conversely, these two fields account for less than 50% of researchers in both Serbia and Croatia. With respect to the higher education sector and the disciplinary distribution of researchers, a more balanced picture can be observed in all of the countries. At the same time, governments concentrated most of their researchers in the natural sciences in all three countries, while Serbia stands out as the only of the three in which more than 10% of researchers employed by the government were employed in engineering and technology.

Seen through the prism of Braun's (2003) five delegation modes, all three countries are indeed a mixture of at least three modes. Yet Slovenia seems to be the closest of the three to the network delegation mode, in terms of the funding criteria's emphasis on research cooperation. It also shows characteristics of the steady state mode, while Serbia is closer to a mixture of the incentive mode and steady state delegation. Croatia seems to be somewhere in between the two, which generally reflects the pace of the EU integration process. On the other hand, the overall mixture and constant shifting of the delegation modes is perfectly understood in the context of transition from the socialist Yugoslav context to one of European integration. As expected, Slovenia is pioneering this process. At the same time, all three countries show elements of blind delegation, given that they predominantly use publications as the performance criteria. Nevertheless, as public scientific institutes in Croatia and Slovenia enjoy support from the state budget regardless of the projects they conduct, project-based funding is supplementary. Though in principle all public institutes in Serbia have to compete for funding in order to continue operating, in practice, all of them get a fair share of the cake at the end of the day.

Interestingly, Croatia and Slovenia could be marked as the cases with a 'double principal.' While their governments allocate funds for running costs and basic salaries through national budgetary provisions and ministries in a rather blind manner, the SRA and the CSF are far less 'blind' in allocating resources. On the other hand, Serbia is still a one-principal research system, though due to the EU integration process, this principal is likely to undergo a separation of the 'policy maker' and 'funding provider' roles currently combined by the Serbian ministry.

Importantly, all three countries have demonstrated awareness about the employment of their research capacities to boost economic growth, not only in policy statements, but in developing smarter allocation mechanisms for public funds. While Slovenia is more advanced in both engaging business enterprises in the process and in cooperation with public research organisations, Croatia and Serbia still need to work in this direction. Nonetheless, over the last eleven years, a tendency to have a larger share of total resources invested in business enterprises (relative to GDP) can be noted in all three countries. Nonetheless, despite these small shifts, the distribution among sectors seems to have been relatively stable over the period. In the case of Slovenia, where more than half of total R&D expenditure comes from and goes to business enterprises, this stability could be seen as a positive feature, given the fact that it signals a strong link between research and economy. On the other hand, Serbian business enterprises are not as research-intensive, given that the largest share of its R&D activity in the last ten years has taken place in the university sector. Croatia is somewhere in between, yet faces the same challenge as Serbia. If it is to become an economy based on knowledge, it needs to strengthen the institutional links between the institution of knowledge and economic activity.

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Jelena Branković

Chapter 6
RESEARCH PERFORMANCE IN CROATIA, SERBIA AND SLOVENIA

Introduction

Measuring research performance and ranking research organisations accordingly has become an oft-visited topic for researchers, analysts, research organisations themselves, and the larger public. The scholarly attention paid to this topic has been particularly significant for those who are interested in science as such, as well as in those interested in economics and organisations, and higher education institutions in particular. This interest has been more pronounced than ever in the aftermath of the launch of the first Academic Ranking of World Universities (ARWU) in 2003 and the Times QS World University Ranking in 2004. Though it is likely that rankings have had an impact on the general understanding of research performance and measurement, it is not our aim to go into the issue of university rankings here. This would take us beyond the scope of our presented research, and has been discussed extensively elsewhere (Dill & Soo, 2005; van Raan, 2005; Shin, Toutkoushian, & Teichler, 2011). It is our aim to take a closer look at research performance in the three countries under study, in order to gain a better understanding of the research systems observed.

Evaluating research performance has become an increasingly debated topic among those who undergo evaluation, those who provide resources to research providers, and those who research and analyse science and research evaluation. In scholarly literature, the state's embrace of this debate is often part of a larger trend coined 'the Rise of the Evaluative State' (Dill, 1998; G. Neave, 1998). This trend is closely related to the occurrence of yet another term, 'New Public Management' (NPM) which, put simply, refers to the adoption of private sector management mechanisms by the public sector and a shift from an input-based system to one that relies on the output of a process. In the context of higher education research, a more elaborate definition could be of use, by which NPM refers to 'the introduction of strategic planning, the setting in place of mechanisms and procedures for institutional self-assessment, and the elaboration of more sophisticated indicators of cost control, performance evaluation, the paraphernalia for estimating academic productivity and institutional efficiency' (Groof, G. R. Neave, & Švec, 1998, p. 59).

In general, evaluation can be conducted during a process or once the process is over, i.e. it can be formative or summative and can be based on qualitative or quantitative methods. Moreover, in line with the trend outlined in the paragraph above, governments often use research evaluation to enhance their policies and justify modes of funding allocation. However, some cases point out that governments adopt evaluative measures towards research organisations for reasons such as '"good housekeeping" of research institutions, rather than as a basis for allocating research funds or assessing goal achievement' (OECD, 1997, p. 30). Nevertheless, the instrumentality of research evaluation or even research output measurement is undisputed in the process of strategic thinking, policy making and designing allocation mechanisms for public funding. However, the question that poses much controversy is *how* research and research organisations are actually evaluated and *by whom*. The latter can be done either by those who engage in research themselves or their peers, or externally, such as by evaluation agencies or government officials. As for the former, the question often boils down to performance indicators and the debate on how these are constructed or which of them are better at evaluating different aspects of research performance. Finally, with regard to the object of evaluation, the method can be applied to an individual researcher, research work or project, research organisation, or an entire research system. In the case of the European Union, evaluation can also be done for the aggregate of 27 countries (and more). As expected, the reasoning behind research evaluation and evaluation practices adopted by countries vary (OECD, 1997).

Bibliographic data is one of several ways of examining the research performance of a country (others include number of collaborative projects, citation reports, number of prizes and medals received and patents applied for). Though the usage of bibliometric methods of measuring research performance for the comparison of institutions and countries is widely disputed by both scholars studying research and science and those directly engaged in the day-to-day research work (e.g. van Raan, 2005), it remains the most popular method for measuring research performance.

Two sources of data indicative of level of research performance have come to our attention during this process. First, the data collected separately by the national statistics offices in Croatia, Serbia and Slovenia, and, second, the data available through the Web of Science (WoS) of the Institute for Scientific Information (ISI) Web of Knowledge, Thomson Reuters' academic citation indexing and search service, widely used in bibliometrics. This was further supported by a number of secondary data sources. Importantly, the bibliographic data from Scopus and Google Scholar, as well as data on innovation activity, such as patent applications, were not used.

In principle, the chosen research approach aspires to be objective (Andreis & Jokić, 2008, p. 264) as we have chosen not to look into perceptions of academic staff or leadership in research organisations, but into the bibliographic traces they left in conducting their research. However, as the data collection method employed by National Statistics Offices (NSOs) is based on the research organisations' self-reporting on their own research activity and productivity, some of the limitations that normally accompany this kind of data may well apply in this case. Importantly, the data available is also limiting in this respect, as going beyond this level would require access to the primary data of statistics offices, as well as some further data collection. Yet the existing figures tell a story that aids in the creation a broader picture, which is what this study aims for, and we will attempt to take a deeper look into what it unveils.

The aim of this chapter is to identify trends and basic patterns in research performance in the three countries. Based on this, we have decided to look into the following data: (a) the number and distribution of research works, projects and publications as available in the statistical yearbooks or NSOs' websites for 2008 (the most recent year available), bearing in mind the methodological and conceptual discrepancies between the countries' NSO; (b) the number and categorization of publications indexed in sources on five WoS databases in the period 2000–2010 – Science Citation Index Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index – Science (CPCI-S) and Conference Proceedings Citation Index – Social Sciences & Humanities (CPCI-SSH); (c) GERD and the number of researchers from UNESCO Institute for Statistics (UIS) for 2000–2009 (the most recent year available), already introduced in the previous chapter. In order to avoid methodological inconsistencies, the data from different sources is addressed separately.

In methodological terms, using WoS data, among others, means several things. First, the data depends directly on what those who published submitted as their home institution, home country, city, funding agency and so on, or on what publications sources – journals and similar – gave them as options. Second, it also means that one who is looking for numbers needs to be careful in defining what they are looking for, i.e. what the software understands as the query. Often some data cleansing is needed, at least in the case of WoS. When it comes to NSOs, this is not an option, as all the data is ready to use as it is given, with all of the limitations in its collection, systematisation and processing, which is, again, not always transparent to an outsider.[1] Importantly, the data from NSOs refers to R&D in general, while WoS does not distinguish among the various types of activities leading to a bibliographically measurable output.

Given the aforementioned information, the data presented here should be taken with extreme caution. Since the focus we have chosen is on trends

1 For methodological clarifications pertaining to national statistics offices, please visit their official web pages: Croatia: http://www.dzs.hr/, Serbia: http://www.stat.rs/, Slovenia: http://www.stat.si/

and patterns in research performance in the countries of interest as seen through the data from the sources mentioned, the working assumption is that the data is suitable for the purpose. Moreover, since in this chapter we are not undertaking an in-depth analysis of research productivity, no normalisation mechanism has been used to correct for a disciplinary field, regarded as a factor of direct relevance to the productivity of a researcher (Leydesdorff & Opthof, 2010; Lundberg, 2007; Waltman, van Eck, van Leeuwen, Visser, & van Raan, 2011).

Research productivity

This section is organised in three parts according to the type and source of data. First, we look into what the NSO data in the three countries tells us about research activity in 2008. Second, we move to the international level, and look into the data obtained from the Web of Science for the period 2000–2010, in which publications in 2010 are analysed in greater depth. Finally, we place the findings against some of the research input variables, such as GERD and number of researchers, in an attempt to locate significant patterns. While the first two parts are descriptive, the third part is analytical in approach.

Bibliographic indicators

With regards to R&D, national statistics offices in principle follow the guidelines given in the OECD Frascati Manual (2002), established almost half a century ago. These guidelines are also embraced by the UNESCO Institute for Statistics and Eurostat, the frequently used international data sources in Europe. However, as indicated in the previous section, the data on R&D given in the official statistical yearbooks or on NSO websites is not always as transparent as we would like it to be, nor is it always directly comparable. The latter is particularly the case with regard to research performance indicators, namely, research projects and publications. For the sake of illustration, the Slovenian Statistical Yearbook of 2010 provides data on finished research projects by sectors of performance, fields of science, types of activities, and subscribers. It also makes a distinction between *finished research projects* and *published research projects*. However, the only related definition found in the methodological explanation is the one defining research works as 'projects that are realised within the framework of scientific-research organisations, R&D organisations and research units, and are the result of finding new and developing existing knowledge and experience and its creative use. Completed research projects are projects finished and reviewed from 1 January through 31 December, irrespective of when they were started.' On the other hand, Serbian NSO offers a similar definition of the research project. However, what we find in its online database is the number of 'R&D works', distributed as basic research, applied research and experimental development, and also by field of science and performing sector.

Though collected in all three countries (as the question exists in the three NSO questionnaires), the number of published articles and monographs is not available to the public. The exception here is Croatia whose Statistical Yearbook contains the number of published research works by type of activity (basic research, applied research and experimental development), by place (works published by researchers' own research organisation, published by other domestic research organisation and published abroad), as well as by performing sector, and field of science. The Slovenian NSO collects data on published journal articles and monographs published in Slovenia or abroad, but we were unable to locate figures organised in these categories on the NSO's website or in the Slovenian Statistical Yearbook.

Still, as the idea is to depict a trend in the research intensity of all three countries over a period of time, nationally collected data by means of self-reporting could be of use. Placed in the same chart with considerable methodological reserve, these three countries show an overall growth curve when it comes to their research activity between 2000 and 2009, measured in terms of *published research works* (Croatia), *number of R&D works* (Serbia) or *published research projects* (Slovenia). Due to the potential methodological inconsistency of the three indicators, the aim is not to compare the three countries' values for the three somewhat similar indicators, but to illustrate a trend in productivity with regard to three measurable indicators of research activity.

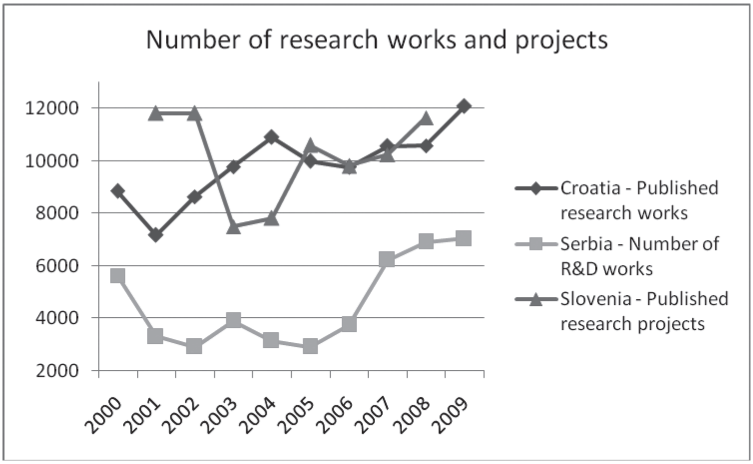

Figure 6.1 Number of published research works in Croatia (2000–2009), finished R&D works in Serbia (2000–2009) and published research projects in Slovenia (2001–2008), total

Source: NSO of Croatia, NSO of Serbia and NSO of Slovenia

Among the three, Croatia has shown the most stable growth curve during the period. We note that as of 2006, none of the three countries experienced a decrease in the number of research works/projects. The sharp decline in Slovenia between 2000 and 2003 may have occurred due to the change in the data collection instrument, as five new questionnaires were introduced by the NSO in 2003.[2] The level of GERD, a common predictor of research performance, also experienced a decrease in the data from 2003, which due to the expected time lag of at least one year between research investment and research output, fails to explain the drop in research output. As a comparison, Slovenian GDP did not experience a decrease and 2003 is the only year between 2000 and 2009 in which GERD did not follow GDP's upwards trend. Finally, Serbia's drop in research output between 2000 and 2002 and a general instability in growth until 2005 probably occurred due to the political changes which took place in 2000 and the fact that it has been the last of the three to recuperate from political and economic instability of the 1990s. Though its GDP per capita (in PPP US$) was rising throughout the decade, its GERD (both in current PPP$ and as % of GDP) was moving in a zigzag.

With regard to Croatia and according to the same source, life sciences and humanities account for about half of all works published as basic research, while social sciences and engineering, again on equal foot, contribute in the same way to the overall applied research works published in 2008. They are closely followed by biomedicine and health works. As for experimental development, again, social sciences and engineering are leading, closely followed by life sciences. When it comes to where publications appear, according to the Croatian NSO, most life sciences, engineering, biomedicine and health works appear in foreign publishing, while the opposite is the case with humanities and the social sciences, in which the highest number appear in the journals or monographs issued by the organisation that conducts the research. With regard to sector, higher education is the most active in terms of published works, followed by government and finally, the business sector. This goes for own publications, as well as other domestic and international ones. On the other hand, with regard to research works published, the government sector is most intensive in the field of basic research, which also goes for the higher education sector.

According to the Serbian Statistical Yearbook 2010 (Milojić, 2010), the number of research papers increased by more than 10% in 2008 compared to 2007, while a particular increase was noticed in the papers that subscribe to applied, rather than basic research. As in Croatia, engineering and technology was the most active field of science in the production of experimental research works in Serbia in 2008, but unlike Croatia, it accounts for roughly half of all experimental development works, which is followed by natural and agricultural

2 (In Slovenian) http://www.stat.si/doc/metod_pojasnila/23–086-MP.htm, last retrieved on August 22, 2011.

sciences with about 12% each. Natural and agricultural sciences are most intensive in basic research (both about 30% in 2008), followed by some 25% of all works contributed by medical and health sciences. Social sciences and humanities are minimally present in this picture, and when they are, are confined mostly to the basic research field, where social sciences accounted for 9% of works signed by a Serbian author in 2008.

As indicated above, Web of Science is Thomson Reuters' online academic citation index, designed to search through a number of databases containing information from thousands of academic journals, books, book series, reports, conferences, and others.[3] There are seven databases in total, three of which are most commonly referred to and analysed, namely, SCI-Expanded, SSCI and A&HCI. In addition, two databases include conference proceedings, and these refer to the literature published within the scope of a recognised conference, symposium, etc., that is, CPCI-S and CPCI-SSH. Finally, the Web of Science includes two chemistry databases, designed to search for chemical compounds and reactions: Index Chemicus (IC) and Current Chemical Reactions (CCR-Expanded).[4]

For the purpose of this chapter, we have conducted a small-scale research of publications coming from authors who, when submitting their publications, reported to be geographically located in Croatia, Serbia or Slovenia, starting from the year 2000. Yet as Serbia was part of first FR Yugoslavia and then Serbia and Montenegro (together with Montenegro, population about 620.000, roughly ten times smaller than Serbia) until 2006, we also included calculations for Yugoslavia and Serbia and Montenegro until 2006. We have run queries covering SCI-Expanded, SSCI and A&HCI, as well as CPCI-S and CPCI-SSH for the period between 2000 and the present (mid July 2011).

With regard to the reliability of the data collected from the Web of Science, it must be stated that errors are not rare and can be caused by a number of factors. Concerning citation counts, Glänzel et al. (2003) distinguish between four main causes, that is, database producer, publication author, journal editor and the user of the bibliographic database. As we have witnessed during our research, these are of relevance in acquiring data from the database for purposes other than citation count. For instance, when it comes to the names of institutions behind a publication or the funding source, it often happens that one institution appears several times under different names. The Slovenian Research Agency can appear as 'ARRS,' 'SRA,' 'Slovenian Agency' or in some other form. University of Zagreb can also be 'Univ Zagreb', 'Sveuciliste Zagreb,' and so on. In addition, an organisational unit that is legally part of a university can sometimes be listed by its own

3 ISI Web of Knowledge. Last retrieved on October 12, 2011, from http://images.isiknowledge.com/WOK45/help/WOK/h_database.html

4 Web of Science quick reference guide. Last retrieved on October 12, 2011, from http://wokinfo.com/media/pdf/qrc/webofscience_qrc_en.pdf

name, and in order to ascribe its publications to a particular university, one needs to be aware of the relationship. Therefore, it is important to state that we have taken as much caution as possible to correct these kinds of errors, and to ensure that no severe miscalculations have taken place. For the sake of precaution, the percentages given here represent the minimum for a certain category of data, i.e. the percentage could be higher but it is highly unlikely that it is lower.

Table 6.1 and its accompanying Figure 6.2 below show the overall increase in the number of publications in the respective databases over the course of 11 years (with the exception of 2011, which is not yet over at the time of writing). The obvious exceptions are Yugoslavia and Serbia and Montenegro from 2004 till 2006, during which Serbia's contribution skyrocketed compared to the 2000–2004 period. Here, we guess that at some point a considerable number of researchers started submitting their works as coming from Serbia rather than Yugoslavia, which can also be inferred from the clear course taken by Serbia once Montenegro became independent in 2006. The overall number of Montenegrin publications is therefore added to the overall picture.

Table 6.1 Web of Science published works in SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH databases by authors from Croatia, Serbia, Slovenia, Montenegro and Yugoslavia, 2000–2011. (results for 2011 are incomplete).

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011***
Croatia	1776	1759	2070	2171	2411	2904	2851	3497	4360	4483	4155	1802
Serbia	35	49	50	66	245	1981	2599	3545	4099	4747	4719	2151
Slovenia	2030	1996	2223	2427	2431	2806	2815	3576	4074	4053	3923	1850
Serbia & Mon.	32	45	49	60	131	1851	927		4	2		
Montenegro					4	2	72	100	131	155	172	91
Yugoslavia	1442	1330	1612	1662	1916	582	7					

*Data incomplete

Source: WoS

For the sake of clarity and due to the relatively modest contribution of Montenegro during the post-2000 Yugoslavia (see Table 6.1), Figure 6.2 does not include data for Montenegro, nor for Serbia and Montenegro.

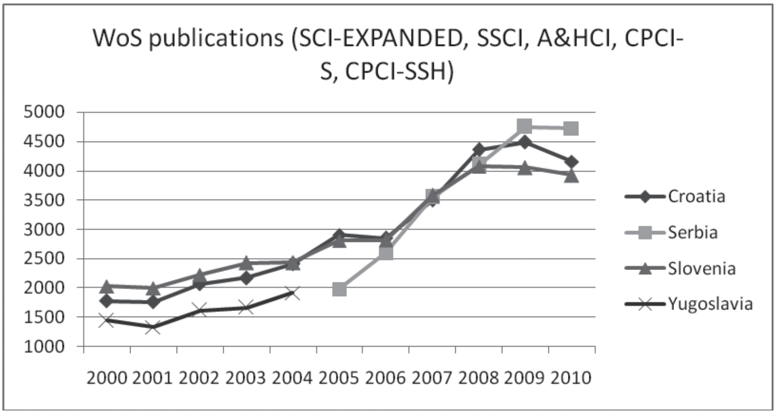

Figure 6.2 Web of Science published works in SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH databases by authors from Croatia, Serbia, Slovenia and Yugoslavia, 2000–2010.

Source: WoS

Two points are worth mentioning here. First, the apparent increase in research publications should not be taken as a direct indicator of the increase in the bibliographic productivity of scientists, due to the changes in the WoS journal coverage during the period, as will be illustrated in the following paragraphs.

Second, while national statistics offices collect their data by means of a number of forms sent to all registered research conducting organisations in a country in which they are to report their activity, Thomson Reuters' databases are tied to the journals that are indexed on the Web of Science. Therefore, a logical step would be to look into the changes that occurred on the WoS with regards to the journal indexed. In an essay entitled 'The Globalization of the Web of Science' published by Thomson Reuters in June 2011 (Figure 6.3), Croatia is listed among the 14 countries that added 40 or more journals to Web of Science between 2005 and 2010 (Testa, 2011). By the end of 2010, 61 Croatian journals were listed on the WoS. Similarly, back in 2005, Slovenia had just 6 indexed journals, only to add 20 more by 2010. In the same fashion, Serbia had no journal coverage back in 2005, and by 2010 had 23. However, as stated in the same source, 'four journals now published in Serbia, for example, were covered in Web of Science before 2005 but originated from different countries (3 were formerly from Yugoslavia and one was published in Germany)' (Testa, 2011, p. 4). As noted some paragraphs above, these journals are those in which a considerable percentage of the publications on the Web of Science attributed to the country in question are located. In this sense, what we see in Figure 6.2 can be taken as an indicator of international visibility of the national scientific activity, which is, as shown, on the rise, rather than as an indicator of increased productivity.

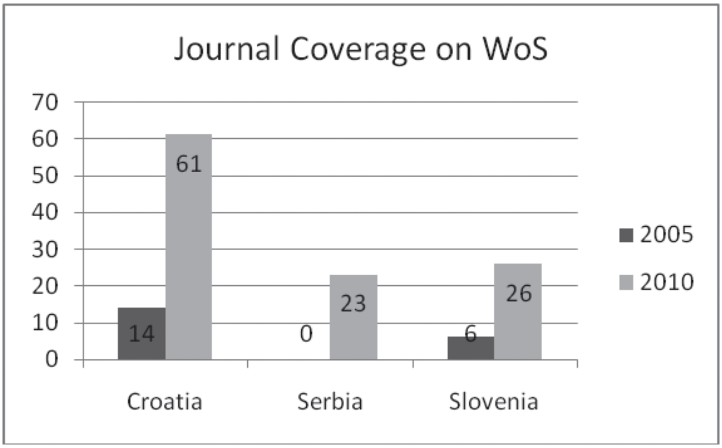

Figure 6.3 Journal coverage on the Web of Science in 2005 and 2010 for selected countries

Source: WoS

Third, with respect to the journal in which articles are published, domestic journals are among the ones with the highest number of articles published by domestic authors. In 2010, out of 30 top journals by number of publications from Croatian authors, there were at least 25 registered in Croatia, taking up to about 25% of all Croatian publications in the Web of Science registered journals. During the same period, in the case of Slovenia this ratio was 19 out of 30, or about 14% of total Slovenian publication number on WoS. Serbia, on the other hand, had only 9 out of 30 of the top journals as registered on its own territory, but still covering about 14%, similar to Slovenia. Despite the apparently high concentration of publication in domestic journals, the majority of publications still go to foreign journals and to a diverse group of them. It is important to mention that a factor largely contributing to this is the number of journal's issues in a year or the number of citeable items (e.g. articles) it publishes in each volume.

With the exception of anthropology, more than 50% of the top 25 subject areas in which publications were submitted by Croatian authors in 2010 came from the fields of medicine, chemistry, and mathematics (Web of Science Categorization). Anthropology was by far the most popular for publishing, as it received 317 publications, or 7.6% of all WoS publications coming from Croatia in 2010. Notably, the most frequently recurring journal on the list of scientific contribution destinations was the Croatian international journal *Collegium Antropologicum*, the official journal of Croatian Anthropological Society.[5] With regard to Serbia, chemistry-related and medical sciences account for about 45%

5 Collegium Antropologicum. Last retrieved on October 12, 2011, from http://www.collantropol.hr/

of all subject areas in the top 25 most frequent areas from the list of those under which Serbian scientists published in 2010. Finally, when it comes to Slovenia, chemistry leads with about 15% in the top 30 subject areas, followed by engineering, physics and mathematics, and medical sciences.

Universities of Zagreb, Split and Rijeka appear signatory to at least[6] 55% of all publications from Croatia, with the University of Zagreb alone to at least 43%. Researchers from the Ruđer Bošković Institute signed at least 12% of all Croatian publications in 2010. Universities of Belgrade, Novi Sad, Niš and Kragujevac were the most active in publishing in Serbia and they account, on their own or in cooperation with other institutions, for at least 62%. Here as well, one university stands out – the University of Belgrade with at least 46%, including Vinča Institute for Nuclear Sciences (at least 5.5% of all publications signed by a Serbian author), part of the university since 2007. Finally, with regard to Slovenian institutions, universities of Ljubljana, Maribor, Primorska and Nova Gorica appear in at least 65% of all publications in 2010, while the University of Ljubljana alone appears in 45%. In the same year, the scientists from Jožef Stefan Institute signed at least 16% of all publications. As in Croatia and Serbia, hospitals, medical centres, and clinics are also very active in publishing. Therefore, when it comes to bibliographic indicators, it could be concluded that with respect to institutional landscape, all three countries are rather centralised and dominated by university research.

With respect to the funding agency behind publications, the Croatian government, and to a far lesser extent the EU, are the most prominent sources of funding for Croatian publications, followed by foreign science foundations, governments, and others. Less than 1% of all Croatian publications in 2010 were affiliated with these, about 3% with the EU[7] and more than 20% with the Croatian government. The Serbian case is similar to Croatia's, with a clear domination of the Serbian government, followed by the EU with a small percentage, though still ahead of other individual funding institutions and organisations. On the other hand, the Slovenian Research Agency was the most noted funding agency of Slovenian authors, followed by the Slovenian ministries and the EU. An interesting comparison between publications sponsored by a national funding agency and the EU shows that the latter are more likely to be a result of international cooperation than the former, more so in Croatia

6 The phrasing 'at least' has been carefully chosen, due to a number of institutions which could not be identified whether they belonged to a certain institution or not. E.g. in Serbia we could see 'Agricultural Faculty' as an institution, without having the university indicated and similar examples. Therefore, the author has aggregated the numbers only for those publications whose origin was known.

7 Note: EU as a source appeared under many 'disguises' in the database, such as EC, European Commission, Commission of the European Communities, EAR, DG SANCO, RTN Network, Minerva, etc. The authors have tried to spot as many of these as possible. See previous footnote.

and Serbia than in Slovenia, where international presence (in terms of total number of foreign authors) is more common even in publications resulting from national funding.

In order to get a better idea of what these numbers tell us about research intensity in each of the three countries, it is necessary to place them in relative perspective. In other words, since these three countries have a significantly different population size, number of research organisations, number of researchers, potential and real resources invested in R&D etc., it is desirable to take at least some of these into consideration.

One of the indicators of research intensity that can be calculated from the existing figures is the researcher (FTE) – publication ratio, i.e. the number of works published on the Web of Science (five databases, i.e. with proceeding papers) in a given year per FTE researcher in the country in the same year. Note that the data from NSO and WoS are not from the same year. Importantly, as this research does not cover innovation activity and patenting, these have not been added to the picture of scientific output measurement, but it does not mean that they are not relevant indicators of research intensity, quite the contrary, particularly in the business sector. The exercise conducted is restricted in this respect and should be taken as such.

On the other hand, when we look at the researcher – research work/ project published or finished (Figure 6.4) ratio for all publications reported to the NSO, not only those on WoS, productivity goes up. Yet even more in Croatia than in Serbia, where an FTE researcher was involved 0.8 times on average in 2008, taking into account all research works/projects published or finished, and in 0.5 publications on the WoS. In Croatia, this ratio in the same year was 1.7 and 0.7, respectively.

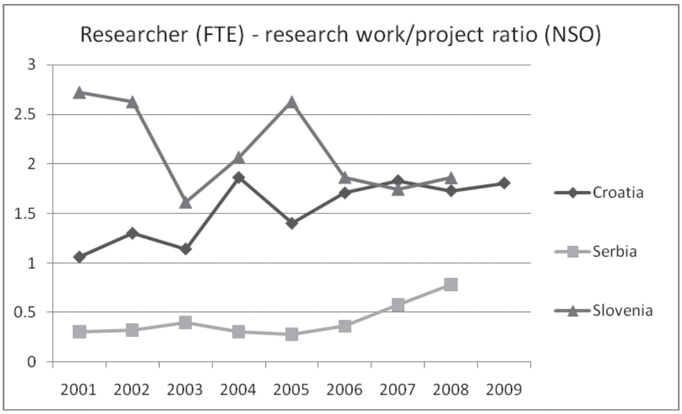

Figure 6.4 Researcher (FTE) – NSO research work/project ratio for selected countries, 2000–2009, 1 year time lag

Source: UNESCO, NSO of Croatia, NSO of Serbia and NSO of Slovenia

Though it is somewhat illustrative of research intensity, Shelton and Leydersdorff (2011) argue that the number of researchers is not a good predictor of research output, which they demonstrated in the referred article. As a far better predictor, they suggest the resources allocated to science from the government or higher education, as these tend to produce incentives for bibliographically measurable scientific production, unlike business enterprise funding, which highly correlates with patenting activity. As this analysis is of a superficial nature, the statement should be taken with a grain of salt until more thorough analyses are available.

Summary

Though the approach to research performance taken in this chapter is admittedly narrow, we can still draw several conclusions in our comparison of the three countries.

First, there appears to be an upward trend in publishing in all three countries, both when looked at through the lens of the national statistics offices and the Web of Science. This trend was steeper in the case of Serbia during the previous decade, most likely due to the later political and economic stabilisation of the country. Currently, all of the countries seem to be at more or less the same level in terms of publication numbers, when it comes to this source. However, it has been demonstrated that the number of publications in the Web of Science databases is not indicative of productivity, but rather of the international visibility of national scientific activity in terms of publications, given the increase in the number of domestic journals indexed by Thomson Reuters between 2005 and 2010.

With the aim of determining whether productivity has indeed increased, further research could, for instance, look into whether the number of publications from these countries' authors has increased in foreign journals at the same time. An explanation for the rising activity in publications are changes in regulation on quality and funding, from the changes in the higher education regulation on promotions, which, as least in the case of Serbia, now impose conditions on obtaining doctoral dissertations or promotion to tenured positions with publishing in specific journals, for instance. Another explanation would be the increased activity in cross-border research collaboration, joint research ventures and similar, which facilitates the internationalisation process.

As seen both from the data obtained from statistical yearbooks and the Web of Science, the higher education sector is by far the most active in publishing in all three countries, followed by the governmental (public research institutes fall in this category) and finally business enterprise sector, which, we could freely assume, is more involved in patenting activity than in publishing. Medical and health sciences, chemistry, physics, mathematics, biology, and related life sciences are top contributors to the world of knowledge in this respect and in almost all countries, are responsible for the majority of both top published and top cited works. As an exception to this rule, anthropology is listed in the WoS database as a very intensive field in Croatia, which, as we have seen, has largely to do with a single journal from Croatia with more than 30 articles per issue.

Slovenian researchers tend to be more likely to have international collaborators on their projects than Croatian and Serbian researchers, even when this is not an EU requirement as the principle funding agency of a research project. Interestingly, citation reports show that publications signed by Slovenian authors are more cited on average than publications signed by authors from Croatia or even more so, Serbia.

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Chapter 7
DISCUSSION AND CONCLUSIONS

The final chapter grants us an opportunity to review, analyse, and discuss some of the main findings of this study. It is structured in such a way that it follows the analytical framework, but also offers some freedom to reflect on certain aspects beyond it. The chapter starts with a summary of the comparative analysis with respect to research policy, research funding, and research performance. It later proceeds with a discussion and presents a number of suggestions for policy implementation.

The analytical framework outlined in the first chapter is based on the premises of the principal – agent problem, supported by a number of assumptions on the framework's major constituent units. The framework places the principal-agent relationship within a broader framework of a policy cycle, more specifically, the implementation of a certain policy provisions by means of regulatory and financing mechanisms. In theory, the principle and the agent are understood as roles, which can be embraced by the state, intermediary bodies, and research organisations, respectively. In practice, the roles can be reversed, or even both accommodated within one structure, such is the case with the Slovenian Research Council and the Croatian Science Foundation.

According to the policy framework of the three countries, research and development is without exception seen as a motor of economic growth. On the other hand, as the public purse is shrinking, especially in the aftermath of the economic crisis of 2008, the key question that many policy makers face in Europe, including Croatia, Serbia and Slovenia, is how to boost private investment into (public) research, and consequently remove the main barrier behind reaching 3% GDP expenditure on R&D activities. The European Commission has already stated that the European level expenditure on research activities should serve the purpose of creating a framework that would boost private investment. Certainly, a similar approach at the national level is highly desirable and, at least in writing, has been addressed in the three countries under study.

The analysis of research policies across the three countries has shown that all the governments are highly receptive to the recommendations of the European Commission. The majority of the objectives identified with regard to research and development in the Lisbon strategy and Europe 2020 have been absorbed into national level policies. Therefore, we could state that the national research systems are drawn into a unified research area on a European level. Consequently, the major differences we encountered rest within the process of policy implementation, as well as within the specific areas these countries decided to specialise in when it comes to R&D.

Bearing in mind that research performance has become a key indicator of global competitiveness, it is not surprising that Croatia, Serbia and Slovenia have adopted policies that aim to improve their national research systems. What can be observed is that this advancement takes place primarily through the transformation of research systems into innovation systems. The new paradigm introduces new research virtues that encourage intersectoral cooperation and Mode 2 knowledge production. Research moves away from being the sole property of university scientists and is increasingly taking place outside of the public sector, which closely follows the increasing presence of the knowledge economy discourse among policymakers. However, the lack of any visible change in the distribution of resources and activities between public and private sector, or, to put it differently, among government, higher education, and business in the last ten years, suggests that knowledge economy discourse has yet to truly penetrated the national policy arenas of these countries. However, it must be noted here that the starting point for the three countries was not the same. With more than half of its research being financed and conducted in the business sector, Slovenia is the most invited of the three to see itself as a knowledge economy, with Croatia lagging behind. Croatia has serious challenges ahead concerning how to engage the business sector to invest more in R&D on one hand, and how to encourage public institutes and universities to engage in cooperation with third parties on the other. Serbia is the furthest away of all when it comes to the share of both R&D investment and activity pertaining to the business sector, and has not even set a rising trend in the previous decade. Even if the higher education contribution to the overall investment in science were smaller (20.9% in 2009), the investment of the business sector would still be relatively more modest than in Croatia and Slovenia, or an average EU country, given the domination of the government sector. This state of affairs poses risks for economies that embrace them to become imitative, rather than innovative and thus further away from knowledge-based. Accordingly, as indicated in Chapter 4, the EU's Innovation Union Scoreboard labels Slovenia as an innovation follower, Croatia as a moderate innovator, and Serbia as a modest innovator, with performance that is below average.

While all three countries are, in a very similar manner, 'EU-aware' when it comes to R&D, its role, and the way it should be further supported, they are at the same time, though to varying extents, self-critical of their achievements to date and hence eager to increase international visibility. They also share ambitions which can probably be encountered in any other European country, and that is to increase the capacity of their research organisations to attract European level funding. At the same time, given that all three are relatively small European countries, they see their chance in specialisation and hence they, at least in principle, strive to focus public research efforts in a limited number of research areas. However, due to rather minor fluctuations in the distribution of resources both among sectors of performance and disciplinary fields throughout the first decade of the century, it is more likely that this apparent specialisation is inherited and inertial, rather than a result of well-considered strategic direction.

The contexts in which policies are defined and implemented across the countries under study have many similarities, mainly stemming from their shared institutional past. The analysis of research policy, financing, and performance has shown that in this domain and with relevance to the agency problem, the similarities that exist in Croatia, Serbia, and Slovenia, whether historical or present, simply cannot be ignored. As it was indicated in Chapter 5, when read in the language of Braun's (2003) five delegation modes, Slovenia seems to be the closest to the network delegation mode, and hence more reflects the logic behind the EU cooperation initiatives, such as the Framework Programme. By introducing actors such as the Business Innovation Centre of Croatia and the Croatian Institute of Technology, Croatia has shown a clear devotion to strengthening the links between the industry and public research, while Serbia is explicit, yet needs to enhance the institutionalisation of public-private cooperation through securing structures with that particular role. These structures could act as facilitators of networks of cooperation in R&D, both in the country and abroad. Apart from being 'just another type of delegation', network delegation is considered the most recent one to emerge, mostly as a reaction to the weaknesses of its predecessors and, most notably, contract delegation (Braun, 2003). That is why the notion that Slovenia is the most progressive of the three is a plausible one. As a mixture of the incentive mode and steady state delegation mode, Serbia is still struggling with the transition from the state control to the state supervision model, a struggle Croatia is slowly leaving behind. Serbia seems to be the country that stands furthest from the blind delegation, yet in practice the state still finds it difficult to fight the path of dependence and attempts to balance between competitive funding allocation and blind support to public institutions. Croatia and Slovenia, on the other hand, embrace blind delegation to some extent, through a separate funding channel of state to public research organisations, alongside the project-based and somewhat more output-based allocation model of their respective intermediary bodies. Finally, with higher education and research activities overlapping within higher education institutions, the state in all three cases indirectly and blindly supports research activities.

Apart from a recognition of its role in economic growth, the extent to which policy makers have embraced Mode 2 knowledge, at least when strategies are in question, is illustrative of the state's diminishing belief that scientists will provide the desired results if only given the resources and autonomy to do so. The shift from solely input-based to partly output-based funding is noted in all three countries, while the particularly favoured output by the policy makers is knowledge which can be measured, transferred, and used. However, at the level of implementation, the countries only partly fulfil this stated goal, some more than others. Slovenia wins again, both in terms of the relatively well-balanced distribution of R&D in the business and public sector, followed by Croatia, which is far more challenged when it comes to knowledge transfer and joint public and private research ventures. Like Serbia, it is aware of the challenge, but unlike Serbia, it has made structural changes in the system in order to better face the challenge.

With regard to the role of the state as a principal in research policy implementation, in the case of all three countries, its role has undergone a transition in the past two decades. Roughly put, this transition could be described as one from a centralised state of a socialist type, to a democratic model of the West. Arguably and quite logically, this westernisation of the state runs parallel with the abovementioned transition from the state's role as a controlling one to a more supervisory or facilitatory one, though the latter process is somewhat less the case if one sees Europeanisation as a type of westernisation.

Observed through the principal-agency theory, the relationship between the state and research organisations shows different patterns across the three cases. These differences can essentially be ascribed to the changing nature and intricacy of the existing relationships within the policy implementation process. Often, this relationship is made more complex by introducing intermediary bodies whose role might differ from country to country, based on whether they control all three critical resources, namely authority to set priorities, funds to distribute and monitoring rights (van der Meulen, 2003, p. 325). While Slovenia has delegated the role of the principal to an independent agency and Croatia is beginning to follow suit, Serbia still operates a direct policy maker – research provider mode of communication. That said, when it comes to the institutional support and support to research through supporting higher education institutions, we still have a direct communication remaining in all three countries, though the mode adopted here is blind. In Serbia, the Ministry has direct linkages to the providers, with no intermediary bodies to facilitate the funding process.

Given that in all three countries the activities of the respective policy makers as well as research organisations have intensified in the previous years (as can be concluded from the policy documents analysed, novelties in the financial mechanism and the scientific output), it is difficult to describe the implementation process as more or less successful. The changes have certainly shaken the existing relationships among the actors, making researchers more aware of the importance of their work for society, signalling that the 'ivory towers' are no longer affordable and that they need to be accountable for the resources they use.

On the other hand, there are obstacles in this process that are inherent to policy implementation as such and these countries are no exception. Naturally, policy implementation is not a smooth process and it takes time, as a plethora of rules and institutions are at work in the system at any given time. Bearing in mind the previous paths and established ways of operating the system, the path dependence theory and historical institutionalism might account for at least part of the explanation. Historically, the agents (i.e. academic and research organisations) used to enjoy a great deal of autonomy. Attempts from the state to introduce steering mechanisms (either financial or regulative) based on interests and justifications not well embraced by the academic community might be perceived as a violation of this autonomy, and hence result in failure. In terms of research policy, the government wants to encourage scientists to contribute more directly to the welfare of society. It devotes resources on a competitive basis to research activities in order to encourage scientists to act on behalf of its own economic interest. However, as implied in Chapter 2 and also as Braun and Guston have noted (2003, p 304), one of the basic shortcomings of applying principal-agent theory to research policy is that treating scientists as agents does not at all imply a hierarchical relationship. Moreover, in most cases scientists act as autonomous agents who manoeuvre between different principals in order to satisfy their own interests and not those of the policymaker. Yet in all three countries we have analysed, the state is still the dominant funding provider in the non-business sector, which makes it very difficult for researchers to avoid being instrumentalised by the principal.

Nonetheless, it should be noted that due to knowledge asymmetry, research policies are frequently formulated and even put forward for adoption by expert bodies, which are made up largely by members of the scientific community. This was also the case concerning all three countries under study. In most cases, research policies were defined primarily by research councils which consisted of the elected representatives of the scientific community, and to a lesser extent, representatives of the government and the industry. Thus, as Morris (2003) puts it, ‘The purity of the [principal-agent] model again suffers from the suspicion of congenital contamination of policy by agents’ agendas’. Though this is expected to increase the scientific community’s ownership relationship with the policies, it does not guarantee that the implementation will be any smoother. However, we argue that the role of the state is as big as the resources coming from it are. The less it directly contributes, while stimulating other potential principals’ entering the stage, the more responsive researchers should become, given that this would intensify their interaction with a diverse set of principals, each one of them having a different agenda.

When it comes to the place of these three countries in the international research arena, we could conclude that they are all increasingly more visible, collaborative and reactive to the existent trends. Here, again, we have to stress that the degree of all three features varies. The number of domestic journals internationally recognised is growing in all of the countries, with Croatia being the most progressive of the three. Joint research ventures resulting in publications are also present, yet here we have Slovenia as the leader of the three, which is further boosted by the government's incentives directed at further supporting this trend, not only within EU cooperation programmes and other foreign funding sources, but also through its own budgetary provisions. In the previous decade, Slovenia and Croatia were leading in terms of absolute number of publications in indexed journals, though Serbia is catching up fast. Research organisations in Serbia got an additional impetus once the competitive funding was introduced to replace the direct institutional support, combined with more relevance to bibliographic indicators for academic promotions. The latter might as well be a reflection of the global trend to pay more attention to the measurable output. However, in relative terms, given the differences in the size of these countries, their GDP, GERD, or number of researchers, Serbia lags behind Croatia, which, again, lags behind Slovenia – the smallest and the most productive.

We could summarise the above-written in the following way. During the previous decade, scientific research in Croatia, Serbia and Slovenia followed a convergence trajectory with regard to their main policy lines. This trend is most notably a result of European integration and an increasing adoption of the EU-level policy goals, but also the increased recognition of the role of science in economic growth. Policy learning through emulation and mimetic mechanisms, as well as adoption of norms and procedures, is also noted, yet mostly within the framework of the EU integration processes. Coercion is by no means a dominant mechanism of policy transfer when Brussels is put in the position of the principal, yet soft low mechanisms are not unheard of in this respect (cf. Radaelli, 2000; Borrás & Jacobsson, 2004).

On the other hand, when it comes to the regulatory framework, a more diverse picture is observed, and could be described as a mixture of the Yugoslav socialist legacy and experimentation with new solutions, yet often still as a result of policy learning, whether domestic or international. Sources of financial support are also diverse, yet not completely different, with Serbia and Croatia still extracting most of their resources from the government and higher education sector and Slovenia from the dominant business sector. A similar pattern is observed when it comes to the sector in which R&D is performed, and here Slovenian businesses are the most research active, while Croatian and, even more so, Serbian businesses, are in this sense lagging behind both Slovenia and the EU average.

Finally, research productivity in all three countries seems to be rising, partly due to rising investments and partly due to more pressure on researchers, coming from changes in local regulation on quality and funding, from the changes in the higher education regulation on promotions, and from the increasing number of cross-border research ventures. Still, bibliometric data is reasonably indicative of research output, but they tell us little about outcomes, i.e. the actual effect scientific research has on countries' economies and their growth. In order for this link to be strengthened, policy makers should address them more directly by bringing knowledge and economic activity closer together and thus fostering growth through knowledge production and its application. A scenario that is not in line with this threatens to render much research activity ineffective or even irrelevant for the development and well-being of the society it is expected to contribute to.

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GLOSSARY

Applied research[1]is an original investigation undertaken in order to acquire new knowledge. It is however, directed primarily towards a specific practical aim or objective.

Basic research[2] is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Bibliographic reference.[3] Standard entry that refers the end user to an original source of information referenced or cited by an author in the main body of the text. A bibliographic reference usually includes title of article, chapter or complete work, author, source, and where appropriate, the volume number, issue number and pagination. ISI indexes these bibliographic references or citations. The use of bibliographic references demonstrates the value of a specific work across a variety of journals and disciplines and through time. By tracking the frequency with which a specific bibliographic reference appears across a wide variety of journals, one is better able to evaluate the importance of that work to a multidisciplinary audience.

Bibliometrics.[4] Study of the quantitative data of the publication patterns of individual articles, journals, and books in order to analyze trends and make comparisons within a body of literature.

Citation is a quotation or reference to a published or unpublished source.

Cited reference.[5] ISI indexes extensive information about each article indexed in its products including the article’s cited reference list (often called its bibliography). This information allows a user to search the citation indexes for articles that cite a known author or work.

Experimental development[6] is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

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1 OECD. (2002). *Frascati Manual 2002*. Paris: OECD.

2 OECD. (2002). *Frascati Manual 2002*. Paris: OECD.

3 Web of Knowledge [v5.3]. (2011).*Thomson Reuters Web of Knowledge*. Database. Retrieved on August 8, 2011, from http://www.isiknowledge.com/

4 Web of Knowledge [v5.3]. (2011).*Thomson Reuters Web of Knowledge*. Database. Retrieved on August 8, 2011, from http://www.isiknowledge.com/

5 Web of Knowledge [v5.3]. (2011).*Thomson Reuters Web of Knowledge*. Database. Retrieved on August 8, 2011, from http://www.isiknowledge.com/

6 OECD. (2002). *Frascati Manual 2002*. Paris: OECD.

Financing is used when referring to any sort of income, while **funding** refers to income from the state budget, i.e. public funds. Along those lines, **core funds** refer to funds obtained from the state, while **own income** refers to income gained through charging various fees or cooperation and contracts with third parties.[7] When macro level is taken as the analytical unit, the term financing is considered roughly synonymous with **total expenditure** or **total allocation**, whereas funding is somewhat synonymous with **total public expenditure** or **total public allocation**. Expenditure is normally expressed in percentage of GDP.

Gross domestic product (GDP)[8] is total market value of the goods and services produced by a nation's economy during a specific period of time. It includes all final goods and services—that is, those that are produced by the economic resources located in that nation regardless of their ownership and that are not resold in any form. GDP differs from **gross national product (GNP)**, which is includes all final goods and services produced by resources owned by that nation's residents, whether located in the nation or elsewhere.

Higher education institution (HEI) refers to an establishment providing tertiary education and recognised by the competent national authority of a participating country as belonging to its system of higher education. The terms **state higher education institution** and **public higher education institution** are used interchangeably, since the legislation in the region does not distinguish between the two, although it should be noted that in most cases the literal translation from the local language would be "state higher education institution".

Impact factor.[9] The number of current citations to articles published in a specific journal in a two year period divided by the total number of articles published in the same journal in the corresponding two year period. ISI stresses that a journal's impact factor is a meaningful indicator only when considered in the context of similar journals covering a single field of investigation or subject discipline.

Industrial research is research activity taking place in an industrial enterprise, often with the aim of creating project or process innovations.

Innovation[10] refers to technological product or process innovation. Technological *product* innovation is the implementation/commercialization of a product with

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7 Vukasović, M. (Ed.). (2009). *Financing Higher Education in South Eastern Europe: Albania, Croatia, Montenegro, Serbia and Slovenia*. Belgrade: Centre for Education Policy. Retrieved on September 18, 2011, from http://cep.edu.rs/en/izdanja/financing-higher-education-south-eastern-europe-albania-croatia-montenegro-slovenia-serbia

8 gross domestic product. (2011). *Encyclopedia Britannica Online*. Retrieved on August 28, 2011, from http://www.britannica.com/EBchecked/topic/246647/gross-domestic-product-GDP

9 Web of Knowledge [v5.3]. (2011).*Thomson Reuters Web of Knowledge*. Database. Retrieved on August 8, 2011, from http://www.isiknowledge.com/

10 OECD/Eurostat, L. (2005). *Oslo Manual* (3rd ed.). Paris: OECD.

improved performance characteristics, while a technological *process* innovation is the implementation/adoption of new or significantly improved production or delivery methods.

Invention[11] is the act of bringing ideas or objects together in a novel way to create something that did not exist before.

Knowledge[12] refers to (i) facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject; (ii) awareness or familiarity gained by experience of a fact or situation. Relevant to the subject of this study, Gibbons et al. (1997)[13] distinguishes between Mode 1 and Mode 2 knowledge. **Mode 1** is the knowledge generated in universities and is considered the traditional mode, while **Mode 2** is the knowledge which is generated in practice and whose significance has been increasing in the recent years.

Knowledge-based economy is an expression coined to refer to the rising importance of knowledge in the economic growth.

Patent[14] is a government grant to an inventor of the right to exclude others from making, using, or selling an invention, usually for a limited period.

Publication is a published original empirical or theoretical work in the natural and social sciences.

Research and development (R&D)[15] includes creative work carried out on a systematic basis in order to increase the stock of knowledge of man, culture and society, and the use of this knowledge to develop new applications. The term R&D covers three activities: basic research, applied research and experimental development.

Research institute refers to an organisation whose primary interest lies in conducting basic or applied research. Institutes normally operate within higher education institutions, industrial enterprises, or might be independent, or have other organisational arrangements. By structure of ownership, research institutes can be public, private or mixed.

Science Citation Index (SCI) is a citation index owned by Thomson Reuters, the world's most referred and often considered the leading index of journals of science and technology.

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11 invention. (2011). *Encyclopedia Britannica Online*. Retrieved on August 28, 2011 from http://www.britannica.com/EBchecked/topic/292272/invention

12 knowledge. (2011). *Oxford English Dictionary Online*. Oxford: Oxford University Press. Retrieved on August 8, 2011, from http://oxforddictionaries.com/definition/knowledge

13 Gibbons, M., Limoges, C., & Nowotny, H. (1997). *The new production of knowledge: the dynamics of science and research in contemporary societies*. London: Sage.

14 patent. (2011). *Encyclopædia Britannica Online*. Retrieved on August 28, 2011, from http://www.britannica.com/EBchecked/topic/446287/patent

15 OECD. (2002). *Frascati Manual 2002*. Paris: OECD.

Science[16] refers to any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation. In general, a science involves a pursuit of knowledge covering general truths or the operations of fundamental laws. It is this pursuit of knowledge that we refer to as **scientific research**.

Scientific fields can be broadly divided in two large groups: **natural sciences**, studying natural phenomena and the biological world, and **social sciences**, covering human behaviour and societies. However, the data obtained from UNESCO suggests OECD field of science classification and hence a distinction made natural sciences, engineering and technology, medical and health sciences, agricultural sciences, social sciences and humanities.[17] The latter will be referred to in the secondary data analysis.

Scientometrics.[18] The quantitative study of the disciplines of science based on published literature and communications. This could include identifying emerging areas of scientific research, examining the development of research over time, or geographic and organisational distributions of research.

Technology refers to the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment. **Technology transfer** refers to sharing of technologies between different parties.

16 science. (2011). *Encyclopedia Britannica Online*. Retrieved from http://www.britannica.com/EBchecked/topic/528756/science

17 Working Party of National Experts on Science and Technology Indicators. (2007). Revised field of science and technology (fos) classification in the frascati manual. OECD. Retrieved on August 28, 2011, from http://www.oecd.org/dataoecd/36/44/38235147.pdf

18 Web of Knowledge [v5.3]. (2011). *Thomson Reuters Web of Knowledge*. Database, Retrieved August 8, 2011, from http://www.isiknowledge.com/

CONTRIBUTORS

MIHAJLO BABIN has graduated from the University of Novi Sad Law Faculty and has obtained a M.Sc. from the Faculty of Economics, Finance and Administration (FEFA), Singidunum University. Currently, he is a teaching assistant at FEFA and the World Bank consultant for financing of pre-university education in Serbia. His main research topics are education financing and governance. He has contributed to several research projects and has published studies and articles in national scientific journals.

JELENA BRANKOVIĆ is a researcher at the Centre for Education Policy in Belgrade, focusing her work primarily on higher education policy and governance. She has graduated from the Master Programme in Higher Education jointly offered by the University of Oslo (Norway), the University of Tampere (Finland), and the University of Aveiro (Portugal). Prior to enrolment in the master programme she held the position of the National Coordinator for the EC TEMPUS Programme in Serbia.

PREDRAG LAŽETIĆ is the Director and researcher at the Centre for Education Policy. He obtained a masters degree in higher education at the University of Kassel – International Centre for Higher Education Research (INCHER) and was involved with the European Students' Union (ESU, former ESIB) for several years. His principle areas of research interest are funding and governance of education systems, policy monitoring and evaluation as well as the relationship between higher education and the world of work.

NORBERT ŠABIĆ is a Probationary Doctoral Candidate at the Doctoral School of Political Science, Public Policy, and International Relations at the Central European University in Budapest, Hungary. Norbert obtained a Bachelor of Science with a major in Education from the University of Jönköping (Sweden), and received a joint European Master degree in Higher Education policy and management studies from the University of Olso (Norway), the University of Tampere (Finland), and the University of Aveiro (Portugal). After his studies, Norbert moved back to Serbia, where he worked for two years as a technical manager at Subotica Tech – College of Applied Sciences. Norbert is also affiliated with the Centre of Education Policy in Serbia, where he conducts research in the field of higher education. Norbert's research interests concern higher education and innovation policies. In addition, he has extensively explored the topics of academic rankings, representation of minorities in higher education, and R&D policies in some of the Western Balkan countries.

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