POLICY REFORM AND RESEARCH PERFORMANCE IN COUNTRIES IN TRANSITION: A COMPARATIVE CASE STUDY OF LATVIA AND ESTONIA

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Abstract

Several studies have been published postulating the emergence of the post-modern research system, the research system in transition and the new production of knowledge (Cozzens et al. 1990, Rip and van der Meulen 1996, Gibbons et al. 1994). However, these studies have been largely concerned with the gradual transformation of well-established research systems of Western industrialised countries.

The radical transformations of the research systems of Central and Eastern European countries (CEE), following the collapse of the communist regime at the beginning of the 1990s, have attracted a smaller number of scholars (Balazs et al. 1995; Schimank 1995; Radosevic 1999; Dyker and Radosevic 1999, 2000). Prior to this, the developments in scientific organisation have been considered to be either an issue of evolution (in advanced or industrialised countries) or, as in the case of developing countries - a development issue. However, the research/innovation systems of CEE in the 1990s were neither underdeveloped, nor following the pattern of evolution of other industrialised countries, but were forced to change as a consequence of changes in the political and economic order. Furthermore, eighteen years after the fall of the communist regime, the research systems of CEE have developed at different rates, along different trajectories, despite similar preconditions for change.

Taking into account the aforementioned considerations, the study investigates two research systems in transition, those of Latvia and Estonia, which along with the Czech Republic have initiated the most radical reorganisation of their research systems. The choice of countries is based on the realisation that despite, at first glance, similar pre-conditions for change, as well as similar demographic factors, political and economic systems, and institutional structures of scientific organisation (which makes these countries easily comparable); these systems appear to have evolved along different trajectories. Clear differences are seen in terms of total state funding allocated for research, as well as contributions from the private sector, R&D intensity, research output in terms of publication, citation rates and patents, collaborative projects and publications (Kristapsons, Martinson and Dagyte 2003). Based on these indicators, Estonia precedes Latvia on all counts; possible explanations for this are the diversified funding mechanisms available, and the multitude of assessments of research and development on the basis of which policies were formed (Kristapsons, Martinson and Dagyte 2003).

In view of the overall goal of explaining different rates/paths of development of similarly positioned national research systems, the purpose of the study is twofold. Firstly, it attempts to paint a comprehensive picture of the Latvian and Estonian research systems and, secondly, it compares and contrasts them in terms of the reforms initiated and the outputs, outcomes and impacts of these reforms. Methodologically, the study is largely qualitative in nature and it has been deemed appropriate to present the two countries as separate case studies, yet retaining a common analytical frame to gather primary and secondary data. Secondary data has been collected by drawing on the multitude of archival and documentary evidence and statistical databases available; primary data was collected by conducting semi-structured interviews.
Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Chapter I: Introduction

This introductory chapter outlines the main rationale, the context and the scope of this study, as well as the research questions it attempts to answer. Finally, it gives an overview of the overall thesis structure.

Rationale and Problem Statement

The study examines the development and performance of research systems in transition over time by adopting a comparative case study approach. This approach is motivated by two aspects, which are further elaborated in the literature review, namely, the inability of previous research to provide a longer-term perspective on research systems in transition, on the one hand, and the inability of the said body of literature to fully explain the factors affecting research performance. This realisation stems from the fact that the majority of earlier work in the area has been compiled at the outset of the transition period and theoretical frameworks for analysing these systems were in the early stages of development.

The Scope of the Study

The thesis describes, examines and compares the transition and development of the national research systems of two former Soviet republics – Estonia and Latvia. The purpose of this effort is threefold: firstly, to describe the historical and contextual development of the two systems; secondly, to compare their performance against the reforms undertaken in the course of transition, and finally, to determine factors that have affected the development of these systems. In addition, the thesis proposes some avenues for further research.

The assessment of the national research systems of Estonia and Latvia builds on previous studies and is the first attempt to provide a longer-term perspective on the development of these systems. Much of the research on research systems in countries in transition has been conducted throughout the 1990-ies, a period when these countries were in the midst of significant reform. This study, however, will
supplement the historical background with a systematic analysis of more recent events and provide a comprehensive view of the different paths that Estonia and Latvia have chosen, from the radical approach to restructuring their Soviet-style research base to the alignment of their policies with those of the common European Research Area.

**Underlying Theoretical Assumptions**

The rationale and scope of the study necessitate the positioning of the study in a theoretical framework conductive of investigating countries in transition. This thesis supports and argues for a broad systemic perspective on analysing the national research base (Rip and van der Meulen 1996), at the same time acknowledging the benefits and drawbacks of existing approaches of national innovation systems (Freeman 1987; Nelson 1987, 1993; Lundvall 1992; Edquist 1997), the triple helix of university, government and industry links (Etzkowitz and Leydesdorff 1997, 2000) and the new production of knowledge (Gibbons et al. 1994).

Existing frameworks have predominantly focused on either the broad aspects of national research systems or on the innovation capabilities of the nation state. They have enumerated the various characteristics of established research and innovation systems, and stressed the importance of systemic characteristics, such as the institutional set-up, the principal actors and the relationships between these actors (Lundvall 1992, Edquist 1997), as well as national peculiarities (Nelson 1987). On the other hand, these frameworks do not fully accommodate the particular conditions research systems in transition are facing, such as emerging governance structures and actors, and the reconfiguration of existing relationships. Hence, emerging frameworks for studying research systems in transition must be explored.

Much of the academic literature on research systems in transition has been compiled at the early stages of transition and has been valuable in illustrating the circumstances the research systems in Central and Eastern Europe have found themselves in at the start of the 1990-ies (Balazs, Faulkener and Schimank 1995; Schimank 1995; Mayntz, Schimank and Weingart 1998). However, most of these
studies have been undertaken at the early stages of transition, and none of them have provided a thorough theoretical framework for the study of research systems in transition, or the ability to grasp the full extent of the transition. Furthermore, this literature is largely descriptive and methodologically – exploratory. Therefore, this thesis attempts to fill this knowledge gap by studying research systems in transition over a longer period of time and by utilising all available data sources to assess the transition in the light of the reforms that have taken place and against the resulting performance.

Research Approach

The subsequent study adopts a comparative case study approach, which utilises secondary documentary evidence, bibliometric and statistical indicators, as well as semi-structured interviews to examine the research problem outlined above. Furthermore, it proposes to structure the cases along the various reforms that these systems in transition have undergone, to elaborate similarities and differences but also to ascertain whether intricate implementation mechanisms play a role in determining the developments of seemingly similar research systems.

This approach allows for a thorough investigation of the phenomenon and enables the construction of a variety of factors that not only allow for an exploratory investigation but provide some explanatory power.

Structure of the Thesis

The thesis proceeds in the following fashion. Chapter II outlines the main existing frameworks for facilitating the study of research systems and rationalizes the need for a systems approach. The main works of knowledge production and its organisational setting form the departure of the study, which then proceeds to studies on research systems in transition, and, finally, examines previous work on the particular countries of interest.
The literature of research systems in transition is highly relevant due to the recognition that research systems of Central and Eastern Europe differ from established research systems in context, as well as in the drivers that propel transition.

Chapter III goes to the root of the study and spells out the rationale behind undertaking such a study and identifies its place in the wider context of studies on research systems. Furthermore, it poses a number of research questions that the study aims to answer in the course of this analysis and defines the main concepts and variables of interest. Finally, it outlines the methods by which the research questions will be answered.

Chapter IV briefly examines the legacy of the research system of the USSR and sets the scene for the analysis of the two research systems in transition. Chapters V and VI depict the two research systems in transition setting them in the methodological context of case studies. The case studies are bounded by the historical context (reiterating the multitude of developments in the framework of various reforms), by the quantitative observations of the resulting outputs (outlined separately in Chapter VII), as well as by stakeholder testimonies. Analogously and collectively, they present the outcome of the employment of the following data collection methods i.e. archival and documentary analysis, quantitative data analysis, and semi-structured interviews.

Chapter VIII offers an analytical comparison of the two research systems in view of the contextual aspects identified in the two case studies in Chapters V and VI; thus, effectively carrying out the triangulation of data to answer the research questions formulated at the outset of the thesis. Chapter IX concludes the thesis, summarising the main findings and identifies potential areas of future inquiry.

The thesis argues that differences in research performance are closely linked to policy reform; however, it is the implementation of these reforms (or the capability thereof) that ultimately determines the subsequent effects. The investigation between funding levels, manpower and research output (i.e. publications) does not show that any particular of these two factors is solely responsible for adequate output.
However, it is proposed that the existence of adequate funding and administration capabilities, as well as the institution of appropriate evaluation mechanisms is key to boosting research performance and achieving the rationales of the reforms undertaken.
Chapter II: Theoretical Background

The following chapter reviews the existing body of literature and positions the thesis topic in the wider area of research of science and technology policy in a national context. It argues for a systemic perspective on analysing the national research base, examining the commonalities and differences of the frameworks of national research and innovation systems. Furthermore, it investigates the application of these frameworks in studies of countries in transition with the aim, firstly, to enumerate a set of characteristics that are applicable to all systems, and secondly, to determine the peculiarities of research systems in transition that necessitate further investigation. Finally, the chapter presents a summary of previous research directly related to the two countries of interest.

Introduction

Numerous attempts have been made to explain the organisational aspects of science and technology in a national setting, from heuristic frameworks of national research systems (Cozzens et al. 1990; OECD 1972, 1997, 1999; Rip and van der Meulen 1996) and national systems of innovation (Freeman 1987; Nelson 1987, 1993; Lundvall 1992; Edquist 1997; and Mietinen 2002), via modes of knowledge production (Gibbons et al. 1994) to the triple helix structure of government, university and industry links (Etzkowitz and Leydesdorff 1997, 2000). At the same time, these frameworks have been constructed from a multitude of observations of established research and innovation systems. Only recently a more substantial body of literature on research and, particularly, on innovation systems in developing countries has emerged (Metcalfe and Ramlogan 2008), looking into the developments of research and innovation in small Asian economies (Lundvall, Intarakumnerd, and Vang 2006, Edquist and Hommen 2008) and South America (Alcorta and Peres 1998, Cimoli 2000).

The earlier frameworks would have been fairly suitable for analysing the research system of the former Soviet Union; however, the collapse of this superpower and the
political and economic implications of this historical event have created a need for a new conceptualisation to accommodate a specific set of circumstances, namely, the collapse of a functioning research system and a construction of a new one, involving limited resources and experience at such an undertaking.

This unique set of circumstances characterising the transition (Kornai 2006) has not only provided the reformers of the former communist research systems with a challenging task, it has also provoked the interest of a small number of scholars (Balazs, Faulkner, and Schimank 1995; Dyker and Radosevic 1999, 2000; Mayntz, Schimank and Weingart 1998; Meske 1998a, 1998b, 2000; Meske et al. 1998, Radosevic 1995, 1998, 1999, 2003), who have attempted to provide, first and foremost, a description of the transition and its main drivers, and, secondly, a preliminary framework for analysing this transformation. Overall, the literature on the latter had been rather limited, with research focusing more on the exploratory aspects of the phenomenon. Therefore, the existence of a knowledge gap in the current literature on research systems in transition necessitates a more systemic and deeper investigation into the problem.

The resulting review of existing literature is structured along the lines of the wider systems theory. It begins with the realisation that a systems approach is necessary for framing the research problem and builds on previous research in the general area of established science and technology systems. It also relies on the assumption that not only established research systems provide a good start for sketching out the general features of all research systems but that they possess some characteristics that are common with characteristics of systems in transition, in general, as well as with the features of the systems that exist in Estonia and Latvia.

National Research Systems and the Need for a Systemic Approach

It has been recognised that there are many similarities amongst the research systems of the former Soviet countries, notably due to their common structural heritage and their shared past (Balazs, Faulkner, and Schimank 1995, p. 615). However, their development, although denoted by a set of common transformations i.e. decrease in
labour and capital for research, institutional reorganisation and fundamental changes in the reward system, has led to the adoption of different strategies, which this study aims to investigate. Furthermore, it is this level of analysis that has been called for to explore research systems in more detail:

*Analysis of long-term developments of systems, combined with synchronic analysis of functioning of systems allows diagnosis at a deeper level* (Rip and van der Meulen 1996, p. 343).

The use of the concept dates back to the 1970s, when the Organisation for Economic Co-Operation and Development (OECD) published a series of reports on the organisation and financing of fundamental research (OECD, 1972). An indication of why a systems approach to the study of research within a particular country is useful is presented:

*If scientific research is examined as a continuous system, defined by a chain of formal and informal links between different institutions, the process is more easily understandable* (OECD 1972, p.16).

Furthermore, whilst the focus of the OECD study is on fundamental research, several properties of research systems are referred to. Firstly, the need for studying research as a system arises from the recognition that research is conducted within a specific institutional context that can be characterised by the entities and relationships within this context (OECD 1972). And secondly, the report identifies some traits of research systems, that have become commonplace in studies of current research systems i.e. interdisciplinarity in terms of the proximity of basic research and applied research, the emergence of new institutional frameworks, and the impact political and economic factors have on science (OECD 1972). Recently, the OECD has published several documents that have built on the original idea and furthered the systems approach as a tool for developing science, technology and innovation policy, which allow the operationalisation of the most important facets of the systems (OECD 1997, 1999).
In turn, having recognised the need for an elaborate conceptualisation of the term *research system* and the descriptive nature of previous studies of research systems, Rip and van der Meulen (1996) have produced a more comprehensive view of the modern research system, which can be described as the most inclusive definition of the term. The authors are critical of the OECD definition, recognising the limitations in applying the term:

*These studies pursued their descriptive and diagnostic goals without explicit conceptualisation of what a ‘research system’ would be* (Rip and van der Meulen 1996, p. 343).

In their article, the authors also develop a definition of modern research systems, which states:

*(National) research systems consist of research performers (individuals, groups, institutions), other organisations and institutions, interactions, processes and procedures. Their systemic character, as mutual interdependency systems is predicated on the collective character of the scientific endeavour and on the role of the modern state, which has created the ‘national’ character of these systems’* (ibid. p. 345).

Furthermore, the authors ascribe the following properties to the system:

- increasing heterogeneity of actors and their functions within the system, heterogeneity of knowledge and networks;
- multiple levels of aggregation – organisational, institutional, sectoral and national;
- mutual interdependency between institutions and actors as a common denominator of entities belonging to the system;
- increasing interdisciplinarity of research and recombination of various forms of knowledge produced;
- diversification of the functionality of organisations with respect to their traditional roles;
- the emergence of new generators of knowledge and broader networks (ibid., 1996).
However, on the aggregate level, two systemic properties, that of steering and aggregation, are identified. The former refers to the ability and extent of the nation state to determine the priorities of science and technology policy, the latter – to the agenda-building of the various institutions within the system, whereby the authors are clearly in favour of the latter in order to accommodate the aforementioned characteristics of what they identify as the post-modern research system. In the authors’ view, a post-modern research system is a system that is, firstly, characterised by augmented aggregation, in view of increasing heterogeneity of the system. Secondly, it exhibits a decrease in the importance and the role of the nation state, which is, to some extent, replaced by other actors (such as the private sector), thereby creating a more varied landscape and new interdependencies. And, finally, the post-modern research system poses new challenges to coordination at the system level. In brief, a post modern research system is “the idea of a transition path branching out to a viable position, which offers an alternative to typically modern research systems” (ibid. 1996, p. 349).

However, a number of issues emerge, when contemplating the applicability of this approach. Firstly, the concept of steering fails to take account of the developments in European science and technology policy, promoted by the European Commission, where the role of the state is diminishing (giving way to increasing steering at the supranational level), but also decreasing the bargaining power of the states and the institutions taking part in the aggregation process. Secondly, the authors openly state that the interplay of these two dimensions does not allow for normative judgements of the said “viable position” of the national research system, and further investigation is both necessary and possible at the systems level (ibid. 1996).

**National Systems of Innovation**

Much of the work of Rip and van der Meulen (1996) originates from comparing national research systems to national systems of innovation. Studies of national innovation systems first emerged in the late 1980s and were the focus of such

There are similarities between the definition of national research systems given by Rip and van der Meulen (1996) and the definition of national innovation systems by Lundvall, especially in the emphasis of elements and relationships, where:

A system of innovation is constituted by elements and relationships, which interact in the production, diffusion and use of new, and economically useful, knowledge and that a national system encompasses elements and relationships, either located within or rooted inside the borders of a nation state (1992, p.2); and, more specifically, all parts and aspects of the economic structure and the institutional set-up affecting learning, searching and exploring (1992, p. 12).

Furthermore, Lundvall (1992) argues that institutions are guide-posts for action and change and can be either supportive i.e. reinforcing change or unsupportive i.e. blocking processes of learning.

Institutions in this regard are considered as “sets of habits, routines, rules, norms and laws, which regulate the relations between people and shape human action” (Johnson 1992, p. 26), which can be either formal or informal. These also fulfil certain functions, such as: provide information, reduce uncertainty, condition the use of knowledge, mediate conflict and provide incentive systems and stability for reproduction. On the other hand, this does not mean that institutions are efficient (Johnson 1992).

Several criticisms of this approach have been raised; however, the most comprehensive can be found in Miettinen (2002). In his book National Innovation System: Scientific Concept or Political Rhetoric, the author states the following conceptual and methodological drawbacks of the framework. Firstly, the appropriateness of the level of analysis is questioned due to the lack of studies investigating the underlying dynamics at micro level (i.e. user-producer relationships). In addition, the framework outlines the various ways of learning, such
as searching and exploring, yet these are general references that have not been subjected to in-depth study in the context of innovation at the micro level or the national level. Secondly, while the process of innovation can be studied in terms of interactive learning, “the acceptance of the idea of interactive explanation does not presuppose the acceptance of a systems approach” (p.40).

Methodologically, Miettinen (2002) distinguishes between two approaches or attitudes to studying national systems of innovation: the holistic scientistic attitude and the more moderate, comparative attitude. The author categorises the interactive learning systems approach as modern scientism, which he objects to on two counts:

First, it seems to be based on the old idea of linear causality: the determinants ‘determine’ the development of the system. Second, the creation of a reasonable theory of all essential factors that influence innovations seems an unrealistic project because the innovative activity of a nation is complex and multifaceted, heterogeneous and ever-changing set of phenomena for which we do not even have satisfactory definitions (ibid. p. 47).

Furthermore, the scientistic attitude to national innovation systems studies implies that if the determinants of change are investigated, the system can be influenced to at least attempt to achieve desirable policy outcomes. Miettinen (2002) challenges this presupposition claiming that while it is possible to study interactive processes historically, the findings cannot be used for future planning.

**Nelson’s Comparative Approach to National Innovation Systems**

A different approach to the study of national systems of innovation is provided by Nelson (1993) in an edited volume entitled *National Innovation Systems*, which describes fifteen countries in terms of their national innovative performance.

In the introductory chapter, the editor states that the aims of the study are to describe the institutions and interactions that support technical innovation, to illustrate
similarities and differences and possible reasons for these, as well as to attempt to discuss how these differences are pertinent to the development of national innovative activity (Nelson 1993).

The author states his awareness of the lack of a “well articulated and verified analytical framework”, and defines the study as descriptive rather than an “attempt to prove or calibrate a theory” (Nelson 1993, p.4). In addition, the concepts of innovation and system are used in their broadest sense. The concept of innovation is not restricted to new products and processes but those that are new to the firm, and not necessarily new to the market (contrary to, for example, in the most widely accepted definition of Freeman and Soete, 1997). Finally, a system according to Nelson (1993) is a set of institutions and actors that are contributing to innovation as a process, which in no way presumes that it is a conscious and systemically organised process. Furthermore, the author recognises the increasing translational activity of institutions, as well as the variance of involvement of institutions and actors in different industries (Nelson 1993).

The primary focus of the study is the innovative processes taking place in firms, and more broadly, in industries and how these vary on a country to country basis. At the same time, the importance of other organisations, such as the organisations of professional science, regulatory and funding bodies is acknowledged. However, according to Nelson, it is important to distinguish the different rationales that guide these organisations:

\begin{quote}
It is important not to confuse the highly valued autonomy of the individual scientist, in shaping his or her own research agenda with the determination of research-funding agencies to commit resources to those areas of scientific research that appear to offer the most attractive future returns. Public and private institutions may well be expected to define future returns rather differently, but neither is likely to be indifferent to the size of these returns (Nelson 1993, p. 9).
\end{quote}

Miettinen (2002) characterises Nelson’s framework as a methodologically moderate, comparative approach and praises the author’s acknowledgement of the difficulties
of application of the national systems of innovation approach and his avoidance in “formulating recommendations of ‘a right kind of innovation system’” (p. 49). At the same time, no definition of boundaries, essential elements, or factors is given. Furthermore, the dynamics, in terms of interactions between the different institutions are not analysed at the micro-level. And finally, there is a lack of a verified framework that enables the study of effects of institutional arrangement on economic and technological performance (Miettinen 2002).

**Freeman’s Framework of Techno-Economic Paradigms**

The most influential work of Freeman in the field of national innovation systems is his study of Japan (Freeman 1987). Freeman’s theory is inspired by the work of Kondratiev on waves of economic activity and Schumpeter’s dynamic analysis of technological change. At the heart of the framework is the importance of technology, which can be classified and progresses from incremental to radical innovation, to changes in technological systems, to changes in the techno-economic paradigm. Freeman argues that change occurs when radical technological developments call for a new socio-institutional paradigm, which in turn is influenced by the nation state (McKelvey 1991). Nation states are then studied in terms of how well they are able to adjust to technological change.

Freeman’s definition of national innovation systems is similar to other definitions; however, the author places greater emphasis on technology:

*The network of institutions in the public and private sectors, whose activities and interactions initiate, import, modify and diffuse new technologies* (Freeman 1987).

Given this definition, and taking as an example the Japanese case, the study focuses on four features of the system:

- the role of the government in supporting innovation through the provision of appropriate incentives;
- the role of the corporate R&D in creating new technologies;
- the role of education and training to facilitate learning and knowledge transfer; and
- the general structure of industry, in terms of industrial capabilities within a national context.

However, these factors, as the author points out, can vary across countries (ibid. 1987). Furthermore, McKelvey (1991) lists some drawbacks of the theory. Firstly, its focus is on radical technological change as the driving force within nations but there is very little emphasis on the development process of technology by the author. Secondly, Freeman (1987) stresses the importance of networks of institutions but gives no indication of how processes of social adjustment take place and what role is played by the individual actors. Furthermore, the emphasis is placed on structures, but more importantly, on the cost structures, on the basis of which evaluation takes place. This makes the study highly focused on economic indicators and quantitative variables, which make the justification of the impact of the three former features of the system cumbersome.

**Common Characteristics of the Systems Approach to Innovation**

All of the aforementioned works on innovation systems have focused on the importance of the nation state in accommodating innovative activities, yet these studies have looked at the systems from different angles, emphasising different aspects. Most of the studies (except Lundvall 1992) were case studies of different countries i.e. the United States and Japan, or comparative studies of a larger set of countries (Nelson 1993).

There are several aspects of these studies that are significant in conceptual terms, as well as methodological terms. Firstly, the emphasis of actors and relationships is common to most studies on national innovation systems, which allows the investigation of the function of actors in the production of knowledge, as well as the transmission of this knowledge through user-producer relations. Furthermore, the broad definition of the concept permits the analysis of scientific and technological performance, taking account of the peculiarities of the national system and the wider
socio-economic context. On the other hand, a significant drawback of these studies is the lack of research that has examined the interaction of the various actors/elements of the system at the micro level. Moreover, some studies have focused on the firm and industry level as the main actor in the process of innovation and economic growth. Nevertheless, it is these aspects of the national innovation systems framework that enable the illumination of the differences between the concept of national innovation systems and national research systems.

National Innovation Systems versus National Research Systems

In terms of conceptualisation, national research systems and national innovation systems share a common understanding of the importance of systemic features and the role of the nation state. Yet, the focus and purposefulness of the systems are elucidated by the differences in research in general and innovation in particular.

National systems of innovation, as the abovementioned definition implies are focused on the study of the creation of knowledge that will benefit the economy. Although, here, it should be pointed out that the different elements of the system are not purposefully geared to such a predisposition (Rip and van der Meulen 1996). The national research system, on the other hand, predominantly sees its main aim as the creation of new knowledge irrespective of its present or future applicability (in the strictly economic sense), i.e. the creation of new knowledge for the sake of the advancement of science, in the first instance, where the extent of its application to novel products and processes is a positive and welcome development, but not the primary goal. Furthermore, this aim is historically inherent in the set up of the system, albeit the fact that not all elements are exclusively devoted to this process.

Having established the overall inclination of the study of these two systems, the attention needs to be turned to the more specific properties of the two kinds of systems. Firstly, the importance of institutional set-up has been emphasised by authors concerned with the study of both systems (Rip and van der Meulen 1996, Lundvall 1992, Nelson 1992, Johnson 1992), yet the importance of actors within the different systems varies, which is understandable given the purpose of the two
systems being different. Studies of national systems of innovation repeatedly stress the importance of the firm, as the main producer and diffuser of marketable knowledge; national research systems, on the other hand, see the role of public research institutions as crucial to the production of new knowledge. At the same time, both approaches stress the importance of the relationships among these key players and between these players and other institutions, notably the public sector, as well as the importance of the historical and cultural context in which they operate.

Another differentiating aspect is the importance of the kind of knowledge generated. National research systems are producers of fundamental research and applied research, whereby these areas, albeit prioritised one over another, are equally important in the long run. National innovation systems are mostly concerned with economically useful knowledge, which originates from applied research and, hence, are more concerned with the interplay of science and technology, rather than the research process as such. Finally, these differences can also be highlighted in terms of codified and tacit knowledge, whereby the former is more valued in research systems, and the latter in innovation systems.

**On the New Production of Knowledge**

A key feature of national research systems and national innovation systems is the process of knowledge production. One of the most prominent studies on the production of knowledge (Gibbons et al. 1994) postulates the emergence of a new trend of knowledge production, entitled Mode II. It is this mode of knowledge creation that has replaced the former mode (i.e. Mode I) by moving from generating knowledge in a specific setting with broad interests i.e. academia to an application-bound method of solving problems, by bringing together different disciplines and organisational structures rather than being bound to a particular institutional framework, and by increasingly taking into account the various actors upon which the outcomes of new knowledge will be exercised (Gibbons et al. 1994, pp. 3-8).

Whilst receiving wide recognition and being described as a *charter document* and a *group manifesto* (Shinn 2002, p. 601), the work of Gibbons et al. (1994) has also
received considerable criticism. A number of issues are brought forward by the critics, notably, the lack of a methodological framework and theoretical underpinnings, as well as the absence of empirical data in support of the wide range of generalisations expressed (Shinn 2002, pp. 603-604). In addition, one of the main disagreements regarding this theory is the sharp distinction that is drawn between Mode I and Mode II knowledge production:

*The result is the appearance of deep rupture where there is none. Ironically, the illusion is maintained because, despite talking a ‘hard-headed’ policy relevant line, the Modists systematically ignore salient features of the institutionalisation of inquiry* (Fuller 2000, p. 80).

The objections to the use of the Mode I and Mode II terminology raised by Boden et al. (2004) are similar to those of Shinn (2002); however, the authors go further as to suggest the practicalities involved of adopting such a concept, notably, with reference to the New Production of Knowledge and its use to policymakers (Boden et al. 2004, p. 11). By implicitly stating that new can be equated with better, Gibbons et al. (1994) have managed to convince policymakers to denounce some of the traditional approaches in favour of new, albeit empirically questionable, ones.

The distinction of two modes of knowledge production has several implications for national research, as well as innovation systems. As mentioned earlier, the focus of innovation is on the application of knowledge for economic benefit, whereas the focus of research is the production of knowledge as such. Hence, to postulate that science and research are increasingly moving towards Mode II of knowledge generation, suggests that studies in this field should give preference to the framework of national systems of innovation (where knowledge is produced in the context of application) in order to reflect changes in the mode of knowledge production. And, although, current trends in the development of nations must be taken into account, applying this framework runs the risk of attributing less significance to the historical context, which is highly relevant when explaining the development of research systems in transition.
The Concept of the Triple Helix of University, Government and Industry

Alongside *The New Production of Knowledge* (Gibbons et al. 1994), another prominent framework for analysing the changing landscape of knowledge generation has been the Triple Helix, which analyses changes in terms of the dynamics of interaction between and within universities, the government and industry (Etzkowitz and Leydesdorff 1997, 2000; Benner and Sandstrom 2000).

The proponents of the model are conscious of the historical context of institutional development, the changing institutional landscape as reflexively shaped by its actors; and the varying dynamics of the three sectors i.e. “the economic dynamics of the market; the internal dynamics of knowledge production; and governance of the interface at different levels” (Etzkowitz and Leydesdorff 1997, p. 155). Furthermore, the authors recognise that the Triple Helix is shaped by the differences in the institutional set-up and governance, as well as by the functions these sectors carry out; whereby increasing interaction amongst these sectors has lead to the emergence of new institutional structures within and between these sectors (Etzkowitz and Leydesdorff 1997, p. 156).

The authors (Etzkowitz and Leydesdorff 2000) also recognise that the Triple Helix is not a static model but an overlay for an evolving structure. Moreover, the authors identify three variants or configurations of the model: Triple Helix I, Triple Helix II, and Triple Helix III. The premier variant is characterised by a rigid structure, where “the state encompasses academia and industry and directs the relations between them” (ibid. 2000, p. 111), and exemplifies the systems structure of the former Soviet Union. Triple Helix II embodies a more liberal structure, where the government, academia and industry spheres operate at ‘arm’s length’ and the links between them are governed by strictly defined rules and norms. Finally, Triple Helix III represents a contemporary model of the organisation of research, “generating a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other and with hybrid organisations emerging at the interfaces” (ibid. 2000, p. 111). The authors have also aptly observed that “in one form or another, most
countries and regions are presently trying to attain some form of the Triple Helix III” (ibid. 2000, p. 112).

Etzkowitz and Leydesdorff (2000) conceptualise this desirable Triple Helix as based on increasing multi-level governance of industrial relations, where uncertainties and chance processes are stimulated by knowledge creation in industry, or academia (or both – concurrently and interactively), and the driver for this interaction is the expectation of profits (where profits are defined in the widest sense of benefits and interpreted according to individual actors’ perceptions). As a result, the model merges the concepts of research and innovation systems in an intrinsically linked structure, where the different strands or helices operate in an interwoven manner, and in doing so, it provides leeway in studying evolutionary processes in a flexible manner.

Unlike the concept of the New Production of Knowledge, the Triple Helix model is built on empirical observations and systematised through an analytical and theoretical framework. Furthermore, the model steers clear from generalisations, bringing issues pertinent to science, technology and innovation policy to the forefront. However, there are also drawbacks to the theory, namely, the mismatch between the level of abstraction and the empirical data, as well as the emergence of the Triple Helix as a synergy of academia, industry and government, “rather than a readjustment that has modified environments without imperilling the established institutions” (Shinn 2002, pp. 604-607).

Whilst acknowledging the efforts of the Triple Helix to establish a methodologically viable tool for studying changes in innovative, scientific and technological progress, Boden et al. (2004) pinpoint the lack of responsiveness amongst researchers in the field in the use of this framework, but praise its positive contribution to science and technology studies. In summary, the authors provide an overall picture of viewing the abovementioned concepts:

*Existing and dominant conceptual frameworks appear to focus on one or other of the attributes of science without providing a consistent framework*
Finally, a new framework is proposed by the authors in assessing the transformation of government research establishments. The framework focuses on three interdependent aspects or dimensions – the institutional, the cognitive and the ideational or visionary dimension of science. Furthermore, whilst the study concentrates mainly on policy-induced change, where change is intentional, perceived as desirable and where political power is a prerequisite; this phenomenon emerges given the background of organic change and historical context (Boden et al. 2004).

**National Research and Innovation Systems Literature – A Summary**

The preceding review of literature in the area of national research and innovation systems has illuminated the existing broad frameworks for the systemic analysis of research and innovation. However, these frameworks have predominantly focused on either the broad aspects of national research systems or on the innovation capabilities of the nation state. They have enumerated the various characteristics of established research and innovation systems, and stressed the importance of systemic characteristics, such as the institutional set-up, the principal actors and the relationships between these actors, as well as national peculiarities.

Methodologically, authors of the aforementioned studies on national systems are clear about the limitations of the conceptual frameworks used. As it is seen with national research systems, the innovation systems concept faces similar criticisms of being a broadly defined concept that is far from being able to make epistemological generalisations. Furthermore, a comparative approach based on historical and organisational analyses, focusing on the characteristics and mechanisms within the systems can capture the factors that contribute to the efficiency and effectiveness of these systems, yet there have not been significant attempts at a general theory, despite some research focusing on a large number of case studies. Moreover, it is worth mentioning that there are other concepts emerging, notably with the increasing
regionalisation, internationalisation and globalisation i.e. regional innovation systems, sectoral innovation systems etc. Finally, the assessment of these systems in a predominantly quantitative fashion would prove limiting, for it would preclude the possibility of examining a combination of multiple factors leading to certain outcomes.

The main drawbacks of the abovementioned frameworks, however, is that these frameworks do not fully accommodate the particular conditions research systems in transition are facing, such as emerging governance structures and actors, and the reconfiguration of existing relationships. Hence, emerging frameworks for studying research systems in transition must be explored.

**Research Systems in Transition**

Whilst Cozzens et al. (1990) use the term *research system in transition* to denote general trends in the evolution of established research systems; here, the concept of research systems in transition refers to the research systems that have undergone the changes induced by the collapse of the Soviet Union and, more specifically, the communist regime. The need for this distinction comes from the recognition that the former are well-established research systems undergoing a natural process of change, whereas the latter are systems that emerged from the political and economic crises of the demise of an authoritarian regime.

The research systems in transition in Central and Eastern Europe present a special case in the inquiry into research and innovation systems. At the start of the transition, these systems were neither underdeveloped, nor following the pattern of evolution of other industrialised countries. According to Radosevic (1995), in the Socialist era, the research and development (R&D) capabilities and the investment levels in R&D in these systems surpassed those of the newly industrialising countries and even of the less developed European Union countries. However, the systems were forced to transform as a consequence of changes in the political and economic order. Moreover, these systems carry a legacy of established research systems in the framework of the larger communist research and industrial complex.
The loosely defined term *research systems in transition* is derived from the term *transition economies*, which commonly refers to a group of countries, which in the early 1990-ies embarked on a transition from a planned economy to a market economy, and, in particular, to the countries of Central and Eastern Europe and the former Soviet Socialist Republics. To this end, the term *research systems in transition* implies that these systems (with their own characteristics, structures, rules and norms) are sub-systems of the transition economies, and, as such, they are affected by the wider context of transition. Similarly, whereas the economies in transition are guided by the desire to create market economies, the research systems in transition are equally striving towards the liberalisation of science and research in these countries.

Lauristin et al. (1997) argues that the distinction between the process of transition and the process of evolution lies in the fact that the former alludes to an inherent purpose or a root cause for subsequent action. In this respect, the process of transition implies some sort of desirable final state, which is to be achieved by meeting the objectives of structural change. Hence, transition is a “type of societal change” and can be characterised in the following way:

*The permanent tension between structures and agencies: changing structures are creating new agencies exercising new pressure upon the structures. This process cannot be planned from above or from outside (only the legislative process could be more or less rationally planned); it results from the interplay between various societal and political actors in the political, cultural and economic fields. Efforts of these actors to produces changes in the established structures are highly concentrated in time and space.* (ibid., pp. 25-26).

Evidence of this can be found in author’s own work on the overall transition of Estonia and the conclusion that “Westernisation is the most important systemic aspect of the transitions process” (ibid. 1997, p.31). This phenomenon has also been identified in other works on transition of science and technology systems in Central and Easter European countries (Meske et al. 1998), where the desirable final state is
the transition to a market economy and to democratic governance, as it can be found in leading Western industrial nations. Naturally, this overarching goal penetrates the various subsystems of the countries in transition, including the national research systems in Latvia and Estonia (Kristapsons, Martinson and Dagyte 2003). However, while the different actors in the subsystems have frequently alluded to this goal, especially, in the early phase of transition, there does not seem to be a uniform interpretation of this vision among the different actors of the system, or a clear operational consensus of how this is to be achieved. Nevertheless, the necessity for a departure from the former communist regime is not questioned.

In the case of the Baltic countries, however, the rationale of transformation is not only one of Westernisation but, more precisely, that of re-Westernisation. As emphasised by Norgaard et al. (1999), these countries still have a collective memory of pre-war independence, which has also been emphasised in the political context of popular independence movements during the early years of transition.

Theoretical Underpinnings of Systems in Transition

The theoretical development in studying research systems in transition has been summarised by Meske (1998a) in the following words:

Although countless analyses of transformation processes have already been undertaken, no single, nor certainly more than one, theory has been formulated on which the study of the institutional transformation of science and technology (S&T) in the formerly socialist countries could be based (p.4).

Schimank (1995) has attempted to construct an ideal-type of transformation dynamics in these systems, which takes account of the commonalities of the post-communist research systems, and provides a framework for the further assessment of national differences. This framework focuses on two aspects that have presented themselves as the result of the political and economic transformation, these are termed – opportunities (arising from the collapse of the restrictions imposed by the
planned economy), and trouble (ensuing from the restrictions imposed on the research systems by the economic transformation and the subsequent reduction in resources).

According to the author, these opportunities and trouble are directly linked to political action, and the relationship between the political actors and research actors. The utmost importance has been given to the opportunities enabling “the pursuit of goals whose common denominator has been a greater self-regulation of scientific research according to its own criteria and logic” (ibid. p. 633), namely, institutional rebuilding. As seen previously (Lauristin et al. 1997), the rationale for institutional rebuilding stems from the desire on part of the research actors for greater self-regulation and greater Westernisation.

The principle of scientific autonomy has been a key feature of research systems in transition and a rationale very much stressed at the outset of reforms. Subsequently, it has been the main point of departure in reforming of the planned research system in many countries in transition.

In transition economies, the principle of scientific autonomy, however, does not only relate to the right of scientists to determine the kind of research they are willing to pursue but also in the belief that scientists should also have an administrative role in determining, for example, the resources needed for science. As Aaviksoo (2003, p. 34) wrote of Estonia: “there was, and still is a widespread belief among a number of scientists that scientists themselves are the best governors and administrators of the system and the only input they need is money”. At the same time, during the initial stages of transition, scientists were left to their own devices, as the national administrations pursued more urgent policies.

Whilst Schimank’s (1995) work focuses on the interrelationship of the different actors and the dynamics of the relationships among the different entities within the system, Meske et al. (1998) provide a convincing argument for the use of the institutional approach in studies of science and technology systems of Central and Eastern European countries. The authors argue that “individual elements of the system, their mode of functioning, their connections to the other elements, and the
way the science and technology system fits into other societal spheres” (ibid. p.3) determine the function, scope and structure of the science and technology system as a whole. Further research by Meske (1998a, 2000) argues for a three-phase model of transition broadly comprising:

- the dissolution of the Soviet system of science and further fragmentation of the remaining structures due to economic and political changes. This phase encompasses several factors, such as, the withdrawal of state support for science, dissolution of Soviet-type organisations (e.g. the industrial-military complex of R&D), and fragmentation of the management and coordination mechanisms of the existing research systems.
- the restructuring of the institutions (i.e. the intermediary phase between the dissolution of the old system and the emergence of a new one), which focuses on the adaption mechanisms of the existing institutions to the new environmental conditions, and finally,
- the build-up of a new science, technology and innovation system.

The advantage of the three-phase model lays in its applicability to the study of the majority of research systems in transition. Furthermore, this model has been empirically validated on a multitude of country cases, i.e. East-Germany (Meske 1998c), seventeen Central and Eastern European countries (Meske 2000), Hungary (Mosoni-Fried 2004), and Vietnam (Meske and Thinh 2000). However, there are a number of considerations with regard to the applicability of this sequential model in a uniform manner, namely, the timing and duration of the phases varies across countries, as does the level, the extent of, and the actual content of the institutional restructuring. Thus, the main conclusion that can be drawn from assessing the various conceptualisations of transition is their ability to identify a number of general characteristics of research systems in transition. These characteristics are outlined below.

**General Characteristics of Research Systems in Transition**

The earlier studies (Balazs, Faulkner, and Schimank 1995, Schimank 1995, Mayntz et al. 1995, Radosevic 1995) provide a good starting point in the process of
characterising the concept of the research system in transition. The rich descriptions provided in these studies allow for a snapshot picture of the research systems at the onset of the transition, which also coincides with the starting point of this particular study.

The assessment of the conditions at the outset of the transition is also of great analytical importance, since it has been confirmed that, despite that largely uniform structural aspects of former communist countries, these countries in transition have found themselves in specific situations at the end of the Soviet era, and these national peculiarities have become increasingly prominent in the longer-term. Furthermore, a decisive role was played by the positioning of the country relative to the core (the USSR), its role within this larger system, as well as the degree of institutional deviation from the core (Meske 2000, Panagiotou 2001). Despite this recognition, the available frameworks have largely focused on the similarities, rather than the differences, reducing the explanatory power of previous case studies. Thus, the study of differences is one of the elements imperative for the subsequent adequate assessment of these systems.

Several particular features of these research systems in transition have been highlighted in previous studies (Balazs, Faulkner, and Schimank 1995; Schimank 1995; Radosevic 1995, 1998; Kristapsons, Martinson and Dagyte 2003; Meske 1998b; Meske et al. 1998). These can be grouped to be economic, political or organisational. However, all these changes have arisen from or were influenced by the first two types of transformations.

The economic crises of the early 1990-ies lead to a sharp decrease in the demand for research from the research-intensive industries, which could not sustain their capacity in conditions of the new market economy. Radosevic (1995) summarises these as:

- the erosion of the R&D industry, from large conglomerates to small enterprises, effectively leading to a reduction in demand for R&D intensive products and services;
The development of “survival and adjustment strategies” by publicly-owned R&D organisations, and by other public research organisations, which have lost the demand for applied and strategic research and development.

The involvement of the government at the outset of the reforms has been quite limited. The reforms were initiated by the scientific community and in the first years of reform, the governments across Central and Eastern Europe were to varying degrees indifferent in their pursuit of formulating and implementing science policy (Schimank 1995, Martinson 1995, Kristapsons, Martinson and Dagyte 2003). This was also found in a study of the Bulgarian research system, where “after 10 years of difficult economic and political restructuring BRS managed to find new patterns of development almost without (or in spite of) a government science and technology policy” (Tchalakov 2001, p.49).

Government funding for science and its institutions also dwindled in view of other, more pressing concerns. This has resulted in structural changes such as the demise of organisations and downsizing of the research systems, as well as the migration of the workforce to other sectors or abroad (also termed brain-drain). Finally, all these factors have lead to new practices in the organisation of research i.e. contractual work and competition between research teams rather than organisations. However, one of the most detrimental factors at the outset of the transition, as pointed out by several researchers of research systems in transition was the lack of evaluation practices, quality control and policy making capabilities of the new structures of governance (Balazs, Faulkner, and Schimank 1995, Kristapsons and Tjunina 1995a, Kristapsons and Tjunina 1995b, Schimank 1995, Kristapsons, Martinson and Dagyte 2003).

The abovementioned characteristics have provided a general overview of features attributable to research systems in transition and outlined the main trends in their development. However, the existing literature has been unable to explain the differences of these systems with respect to their development over a longer period of time. Hence, this necessitates research that could focus on both the similarities and the differences of research systems in transition with respect to their development over time. The small research systems of two such countries, Estonia and Latvia,
provide the best test cases for such an approach. Both countries display the abovementioned features of research systems in transition, are easily comparable and seemingly similar from the outset of the transition. However, their development over time can be described as that of increasing divergence in terms of performance. Clear differences are seen in terms of total state funding allocated for research, as well as contributions from the private sector, R&D intensity, research output in terms of publication, citation rates and patents, collaborative projects and publications (Kristapsons, Martinson and Dagyte 2003). Based on these indicators, Estonia precedes Latvia on all counts. Thus, the subsequent section focuses on studies previous studies on the two systems to determine possible factors that have enabled this divergence.

Concluding Remarks

Much of the academic literature on research systems in transition has been compiled at the early stages of transition and has been valuable in illustrating the circumstances the research systems in Central and Eastern Europe have found themselves in at the start of the 1990-ies. However, most of these studies have been undertaken at the early stages of transition, thus, being unable to grasp the full extent of the transition. Furthermore, the theoretical frameworks provided have only partially addressed the evolution of research systems in transition. Moreover, this literature was largely descriptive and methodologically – exploratory. Therefore, this thesis attempts to fill this knowledge gap by studying research systems in transition over a longer period of time, and by utilising all available data sources to assess the transition in the light of the reforms that have taken place, and against the resulting performance. Taking as examples the cases of Latvia and Estonia, which are easily comparable due to their size and composition, and which have undergone the most radical transformation, it attempts to identify factors of divergent performance by examining their similarities and differences.
Chapter III: Methodology

The existing theoretical frameworks, established in the preceding chapter, opened up a multitude of possibilities for a number of lines of inquiry, at the same time running the risk of providing a somewhat thin grounding in formal theory. Nevertheless, the benefit of such an approach for the current study lies in the opportunity of conducting an inquiry into a set of novel circumstances (i.e. the transition from a command research system into a democratic one) unhinged by thoroughly predefined set of assumptions and explanations. Thus, this chapter reiterates the main rationale of the study, its aims and research questions, as well as outlines an overall framework by operationalising the main concepts and definitions. Finally, it proposes an overall methodology and justifies the choice of individual methods.

Rationale for the Study

Previous studies of research systems in transition have attempted broad comparisons of reform and research performance in several Central and Eastern European countries; however, no exhaustive systematic comparisons of research systems have been made. This study attempts to add to the existing field of comparative case studies of national research systems in transition by examining and comparing the national research systems of Estonia and Latvia, in depth and over time.

The Latvian and Estonian research systems differ from research systems of other Central and Eastern European countries in the way that they have (along with the Czech Republic) initiated the most radical reforms (Kristapsons, Martinson and Dagyte 2003). There are ample similarities in the approaches taken to reforming the two research systems, yet despite the similarities in reform, the preliminary analysis of secondary quantitative data (ibid. 2003) indicates that Estonia precedes Latvia on all counts of performance in science, technology and innovation and has been more effective in transforming its national research system. However, little research has been done on how the various reforms have affected the research performance in these countries or why certain country-specific strategies for science were adopted.
Hence, further research into the comparative aspects of these country cases is necessary.

The Latvian and Estonian Research Systems in Transition

Almost twenty years after the initiation of the reform, Latvia and Estonia have restructured their science base formally integrating research institutes into universities, passed legislation governing scientific activity, and outlined science and innovation policies that should guide the strategic development of these research systems. However, in Latvia, overall funding for science and research output has increased only marginally, research productivity has been stagnant (Kristapsons, Martinson and Dagyte 2003), there are very few innovative enterprises, as the enterprise sector largely consists of labour-intensive industries, rather than technology-driven industries (Watkins and Agapitova 2003).

In Estonia, the aforementioned factors have been considerably more favourable. The overall funding for research has been continually increasing, a pragmatic administrative framework has been put into place, and research productivity has increased. However, a criticism of both systems is the formation of science policy and innovation policy by separate government departments, the deprivation of research institutions of baseline funding, the weak demand for R&D in the private sector, and the ageing of research personnel coupled with the small number of science and engineering graduates and young researchers (Kristapsons, Martinson and Dagyte 2003).

Similar research, albeit on a smaller scale, has been undertaken to investigate certain aspects of these research systems, notably, the report on developing a national innovation system for Latvia by the World Bank (Watkins and Agapitova 2003), the evaluation of the funding system of Estonia (Nedeva and Georghiou 2003), restructuring R&D in Estonia (Martinson and Raim 2001) quantitative indicators of Latvian scientific production (Kristapsons and Tjunina, 1995a, 1995b; Kristapsons 1998; Kristapsons, Martinson and Dagyte 2003).
Aims of Research and Research Questions

The overall aim of the study is to explore the research systems of countries in transition and to seek a better understanding of their development in the last eighteen years from Soviet-style systems to contemporary research systems in transition. Furthermore, the study focuses on documenting and explaining the various aspects of transition in an attempt to shape the new research systems, as well as on evaluating the performance of the systems. Finally, the study attempts to determine factors that are have affected research performance and enable the explanation of similarities and differences.

Bearing in mind the abovementioned rationale, the study proceeds to raise the following research questions:

- What factors influence the development and performance of research systems in transition over time?
- How do these factors explain the similarities and differences in the performance of these research systems?

Prior to proceeding to answer these questions, it is necessary to establish a conceptual framework based on the preceding literature review and, subsequently, to elaborate on some of the concepts used i.e. to determine the definition and scope of such terms as reform and research performance.

National Research Systems – A Framework

Looking back to the literature review, the study is set in the larger framework of systems research. On a global level, any system can be characterised as the sum total of entities, which are linked by way of some relation and form a coherent whole; the system itself is aimed at fulfilling a function and is delineated from other systems and the larger environment (Ingelstam 2002 in Edquist and Hommen 2008).
The national research system fits the abovementioned general definition, yet it possesses other properties that are not common to all systems, notably, systems found in the natural world. The national research system is first and foremost a social system comprising social entities and social structures; it is complex in essence and varies in composition and functioning across nation states. It is also affected by other systems and processes on the national and international levels (Meske 1998a).

The main role of the national research system is to build upon existing scientific knowledge and to generate new scientific findings that contribute to this knowledge. It has also a secondary role of utilising knowledge for the benefit of other parts of the wider national economy e.g. in generating potential input to new products and processes for the industry and fulfilling advisory functions for a range of governmental bodies. However, there are entities within the system, which do not engage in the aforementioned activities but, which facilitate these activities by distributing resources and developing policies for the future of the system. Their inclusion in the system is a hallmark of the interdependent character of the system (Rip and van der Meulen 1996).

From the examination of the various theoretical frameworks, it is deemed that the study of national research systems should be based on the examination of the main entities and their functions within the system, and the kinds of relations that occur between the respective entities (Freeman 1987, Lundvall 1992, Nelson 1993). Furthermore, a distinction should be made between formal structures (i.e. organisations) and the rules and engrained practices (i.e. institutions) (to use the classification of North 1990).

The main entities operating in the research system, as well as the types of relationships arising from the interaction of these entities are nation-specific. However, “national structures and processes are being increasingly influenced by international structures and processes” (Meske 1998a).

The set-up of the system is defined as encompassing all actors that actively engage in or play a supporting role in knowledge creation or facilitation. To this end, and on various levels, several formal structures can be identified. At the highest level, we
can distinguish the governing bodies of a nation – the parliament, which passes laws or formal rules, and the ministries, which are the administrative and executive branches of the government. In a national research system, it is often the case that several ministries share the competence of overseeing research and technological development depending on which part of the economy the research performed at the various public research bodies is of most significance.

The second level that can be distinguished following a top-down approach is the level of research performers. Traditionally, the main research performers are the universities and, in the case of the post-communist countries, the state research institutes. Although, in terms of scope of activities and specialisation, research institutes cannot be equated with universities, these organisations nevertheless enjoy a high degree of autonomy, just like the universities, which can be subdivided into university institutes, faculties, departments, research centres, research groups and individual researchers. Among the research performers, one can also find the research departments of firms, which may or may not be part of a technological centre aiming to facilitate research-intensive entrepreneurship. At the same time, research performers are often also the main users of research, since it is the predicament of the scientific establishment to build on already acquired knowledge.

The aforementioned technological centres, as well as various government agencies, funding councils, unions, and the Academy of Sciences are organisations that, while not directly involved in the research, participate in the facilitation of this process. All these organisations fulfil their respective roles, and are part of the wider institution that is the scientific enterprise, characterised by the aim of knowledge creation, valuing the autonomy bestowed upon its constituents.

In fulfilling their roles, the different entities of the systems interact in carrying out certain functions that lead to different procedures (formal and informal) and result in certain processes. From the existing literature on research and innovation systems, the evaluation of these procedures and processes leads to a better understanding of the systems’ functioning and development (OECD 1972, Rip and van der Meulen 1996).
As the literature review demonstrates, there are several considerations to be taken into account when studying research systems in transition (as opposed to established research systems). Firstly, it must be born in mind that changes within the research system were heavily influenced by other economic, political and social factors, which are partially responsible for the resulting structures of the systems. Secondly, some of the entities within these systems, notably, newly founded organisations and formal institutions are novel to the system and require some getting used to by the actors. Thirdly, there is an underlying desire to model the system along the lines of established Western systems (Lauristin et al. 1997, Kristapsons, Martinson and Dagyte 2003), often without much consideration of the contextual difficulties involved. Finally, Meske (1998a, p.7) summarises several aspects, which are “central to an understanding of the institutional transformation of STS in CEEC” (here, STS denotes the science and technology system and CEEC – Central and Eastern European Countries). The author argues that, firstly, it is important to survey the state of the system at the outset of the transformation as a point of reference for comparative assessments. Then, the structure and mode of operation of the system and the changes throughout this transformation must be examined for they are dependent on “the endogenous preconditions and internal activities arising from the situation at the outset, as well as from the effects of the (national and international) environments” (ibid., p.8). Finally, it is argued that the system must be studied in the wider socio-political context and that processes in the political system and other spheres have influenced the transformation of the science system greatly.

**Operationalisation of Concepts and Definitions**

Chapter II provided an extensive overview of the various ways in which national research systems and national innovation systems have been defined and studied. A particularly useful definition that enables the encompassing of the contextual background is provided by Rip and van der Meulen (1996). The definition states that:

*(National) research systems consist of research performers (individuals, groups, institutions), other organisations and institutions, interactions, processes and procedures. Their systemic character, as mutual*
The comprehensive definition is particularly suitable for the proposed study as it focuses on a wide variety of actors and processes on a number of levels, and it does not presuppose any importance of some factors over others. However, the transition process has not been static; thus, it must also be outlined in terms of the various developments within the systems. A useful way of doing so is to explore the transition process by examining the variety of reforms, which have started in the early stages of transformation in the late 1980-ies and early 1990-ies and have been (to varying degrees) ongoing for nearly two decades. For the purposes of this study, we can distinguish several reforms that are thought to have had a considerable impact over the development of the research systems:

- the organisational reform i.e. the dissolution and restructuring of existing organisations, as well as the emergence of new ones;
- the funding reform i.e. the restructuring of the principles of funding, the introduction of new instruments and mechanisms of funding, as well as the establishment of appropriate organisations to manage the said mechanisms;
- the legal and policy reform i.e. the provision and updating of the legal base (or the minimum necessary requirements for the adequate functioning of the system) and an overall vision, strategy and outline of future developments of the research system, and
- the reform of evaluation practices – the establishment of monitoring and evaluation practices that serve as the incentive and feedback mechanisms in the development of the systems.

The term reform in its broadest sense denotes change that is perceived positive, or a change from the existing state of affairs to another. The aim of a reform usually is to achieve improvement to an existing or perceived problem. Hence, any reform initiated has a perceived problem it attempts to solve and a rationale, as well as a plan or idea what steps need to be taken to remedy the perceived shortcomings.
Therefore, the aim of this study is not only to explore the multiple facets of all the reforms outlined above but to determine the following:

- the precedent of the reform – the problem/issue that has prompted action,
- the rationale of the reform i.e. the reasoning behind the reform and the justification for it,
- the proposed remedy (the solution) to the problem identified, as well as
- the implementation mechanism i.e. the way in which the problem can be practically solved.

The investigation of these properties of the reform then enables the evaluation of the actual outputs, outcomes and impacts of the reform against the desired outcomes and allows for a comprehensive evaluation of the national research systems.

The main purpose of national research systems is the collective endeavour of knowledge creation and the facilitation of the application of that knowledge. Hence, it can be argued that all the reforms are subordinate to this goal. Here, the term knowledge is used in the traditional sense of comprising the experience and skills, the facts and information, the theoretical and practical understanding of a particular subject. Thus, knowledge creation becomes the acquisition of new information, of new ways of understanding a subject and the acquisition of novel skills and expertise. The facilitation of knowledge creation on the other hand refers to all the supplementary processes that are in place to promote knowledge creation, and the various reforms can be thought of as both part of this facilitation process and sometimes as the determinants of new activities.

To ascertain whether and how the reforms have been conductive of the aim of knowledge creation and facilitation, it is useful to establish a point of reference against which the various reforms will be judged. Here, the term research performance will be used to sum up all the individual ways in which a national research system can be evaluated to have promoted/hindered the process of facilitation of knowledge creation.
Traditionally, the term research performance has been used instinctively to refer to both research output and/or the quality of research i.e. its living up to a certain standard upheld by processes such as the peer review. Moed et al. (1985) define research output as “the extent to which the research creates a body of scientific results” (p.132). Obviously, this is a definition that refers the quantitative aspects of research performance and the measurement of the aforementioned body of scientific results by the way of quantitative indicators or bibliometrics.

For the purposes of this study, however, the concept of research performance is used in a much broader sense to grasp not only the obvious outputs of research but also all the other processes that occur in addition to the quantitative output of knowledge. To that end, three different measures of assessment of research performance are introduced, namely:

- the abovementioned output or the body of scientific results,
- the outcomes of reform that have generated semi-quantifiable and non-quantifiable effects (for example, new collaboration patterns), and
- impact (the benefits to other parts of the national system and society at large).

Outcomes in this context refer to the desired, as well as the unintended effects of various processes of research and research governance that have taken place. The desired outcomes are easily identifiable as they are documented in a variety of ways as rationales for intervention and reform. The unintended outcomes occur naturally as the complementary results or the lack of some intervention and are by and large unanticipated, which makes them difficult to identify.

Impact, on the other hand, can be thought of in terms of a strong influence or effect that the processes connected to the governance and productivity of research systems have on the development of the research system itself (over time) and to other parts of the national economy connected to it.

The assessment of outputs, outcomes and impacts would not be possible without the assessment of the different inputs and facilitation mechanisms that exist within the national research systems. The assessment of inputs and capabilities in national
research systems of countries in transition require more thought due to the rapid changes that characterise the evolvement of the system and due to the erosion of the old governance, funding and policy mechanisms and the replacement of these by others. This is why the evaluation of inputs is set within the framework of reforms.

**The Scope of the Study**

So far, the study has been framed in terms of the aims and objectives, the research questions and the concepts to be used. This section is going to elaborate on these issues and add further detailed descriptions of the scope of the study, the different variables involved before proceeding to issues of measurement.

The assessment of research performance in the two countries focuses on research that is undertaken by the public sector or in collaboration of the public and private sector, and is, at least, partially funded by the public sector. The reason for this is that, in the absence of industrial research, most of the research in the respective countries under investigation is done with public support. However, the relationship between public sector reforms of national research systems and their effect on private sector research will be touched upon marginally.

The time frame under scrutiny comprises the last twenty or so years of development of independent national research systems, from their initiation (following the collapse of the Soviet Union) until the present, effectively leading to an ex-post evaluation. Both secondary and primary qualitative and quantitative data is used to illustrate the process of transition; however, due to a divergence in the quantitative data available, a shorter time-frame is used in certain statistical representations.

The primary object of the assessment is the national research system but equal attention is given to the different parts comprising the system and to their purpose and functionality within the system. The results of the research performance and the impact of the reforms are reflected at the national level. The analysis of these factors along with the outputs and outcomes that can be observed enables the determination of what reforms have affected research performance or, on the contrary, what have
been the obstacles of the development. These are then subsequently compared in the two countries to explain similarities and differences. In methodological terms, this typology of the reforms and their attributes provide the bounds of the case study. A graphical representation of the conceptual framework is provided below, whereas the overall research strategy and methodological considerations in the use of case studies, bibliometric indicators and semi-structured interviews conclude this chapter.
Figure 0: A Conceptual Framework for Analysing Policy Reform and Research Performance in Research Systems in Transition

**Research Systems in Transition**

**Initial Conditions**
- **Legacy:**
  - Interdependency as part of a larger system
  - Large industrial structure
  - Specialisation
  - Extensive capital and human resources

- **Economic, social and political context:**
  - Democratisation of governments and Westernisation
  - Liberalisation of markets and privatisation
  - Erosion of demand for research and industry
  - Limited government involvement
  - Decrease in financial resources and brain-drain
  - Downsizing
  - Deteriorating welfare conditions

**Reform Processes**
- **Organisational Reform**
- **Funding Reform**
- **Legal and Policy**
- **Evaluation Practices**
  - **Characteristics:**
    - Motives
    - Rationales
    - Implementation mechanisms
    - Resources deployed
    - International influences

**Sources of Data and Methods Deployed**
- Academic literature
- Historical and archival research
- Semi-structured interviews
- Historical and archival research
- Secondary statistical data
- Semi-structured interviews
- Secondary statistical data
- Bibliometric analysis
- Semi-structured interviews

**Performance**
- **Outputs:**
  - Publication/citation patterns
  - Global share

- **Outcomes:**
  - Desired/undesired
  - Adjustment strategies

- **Impact on:**
  - Future of the system
  - National economy
Research Strategy

The initial research has been conducted by reviewing literature on established national research and innovation systems, the frameworks of the Triple Helix and the Mode II of knowledge production, as well as by critiquing the main existing arguments with particular reference to countries in transition. In addition, available conceptualisations for evaluating national research and innovation systems in countries of transition have been assessed to illuminate general characteristics and trends in these systems.

The empirical study has been conducted sequentially in two phases. The first phase involved the collection and assessment of secondary archival data and documentary evidence, which forms the backbone of the two case studies. The data collected provides the empirical base for describing the various embedded units of analysis and their attributes and has been sought from a variety of sources, such as – previous studies on the subject, official legislation, strategic and policy proposals, government reports, and other documentation. Furthermore, quantitative indicators reflecting the levels of input of human resources and capital, and the output of scientific knowledge have been collected. Finally, this data has been collected for the eighteen years of the development of the independent national research systems of Latvia and Estonia, spanning the years of 1989-2007. Moreover, it has been supplemented by primary data collected through semi-structured interviews with persons involved in the reform process, and an independent search and analysis of bibliometrics extracted from the database of the Web of Science (Thomson Reuters 2009a).

Following the first phase, the reminder of the research comprises the comparison of the two case studies. Broadly speaking, the assessment consists of contrasting the different embedded units of analysis, of which quantitative indicators are the easiest to compare. However, the listing of specific variables for comparison at the outset of the study has been refrained from, as it was thought to preclude the researcher from adequately examining the broader context in which the cases are set and run the risk of overlooking certain factors. Another issue that has been very pertinent to this type of study was the issue of attribution of certain effects of the independent variables.
(the multitude of reforms) on the dependent variable (the research performance), especially where the data spans two decades. Hence, the aim here has not been to focus on specific points in time, in which some previous measure produced an effect, but to construct a comprehensive and triangulated assessment of the outputs and outcomes generated within the given timeframe.

**Methodological Considerations in the Use of Case Studies**

The case study design is deemed to be the most appropriate research design for this type of study due to the necessity in picturing the occurring changes in a particular context (Yin 2003) and over time (Hague and Harrop 2001). This reasoning has also been expressed in studies of evaluation of science and technology, where “the practice of evaluation of research has always combined commonly held elements with structures and practices specific to the organisational setting in which it occurs” (Georghiou et al. 1993, p.1). Furthermore, the choice of a multiple case study provides an opportunity to produce stronger evidence for particular phenomena.

In the broader sense, the aims and objectives of the study, the resulting research questions, as well as the choice of case studies as the preferred method are set in the domain of the comparative method of social science, and in particular, in the field of case-oriented comparative methods, which “provide the basis for examining how conditions combine in different ways and in different contexts to produce different outcomes” (Ragin 1987, p.52). In the narrower sense, the selection of two cases represents a ‘small N’ study or focused comparison, where “the emphasis is on comparison at least as much as on the cases” (Hague and Harrop 2001, p.73).

The main unit of analysis is the national research system, and the sub-units are the various reforms taking place within the respective system, their attributes (i.e. the precedent, rationale, proposed solution, and the implementation mechanisms) and the different measures of research performance. This design corresponds to the multiple embedded case study design as outlined in Yin (2003).
Due to the embeddedness of the individual units of analysis, the proposed study is conducted using a mixed-methods approach, effectively leading to a two-phase sequential study.

**Considerations in Using Quantitative Indicators**

Prior to discussing the methods used in primary data collection, the various considerations in using quantitative indicators are outlined as a necessity in determining the limitations of their explanatory power.

The most applicable indicators of research output are the bibliometric indicators (i.e. publication counts, their impact in terms of citation, and other measures derived from these). These indicators are the collective result of the indirect peer review process i.e. “the use of historic peer review judgments made primarily for purposes other than the evaluation in question” (Hong and Boden 2003, p.42). Furthermore, they are based on the following assumptions:

- the output of scientific research is consistently published in scientific journals,
- the number of citations of an article is an indicator of merit, significance and quality of the research published,
- the data collected on publication counts and citation rates is accurate (Gibbons and Georghiou 1987).

However, certain considerations in basing the bibliometric assessment of countries in transition on these assumptions must be born in mind (Kristapsons and Tjunina 1993). Firstly, restrictions placed on publishing for ideological or politically sensitive reasons (e.g. military research) in former Soviet countries have served as a disincentive to publish in international journals. Furthermore, the incentive mechanisms in the research systems of the former communist countries have not been as much conditional upon scientific output as those in the West. Secondly, the abovementioned assumptions do not provide for a language bias, and finally, there is
a multitude of factors (e.g. self-citation, historical traditions within specific research
disciplines), which lead to high citation rates that go beyond the quality criterion.

The bibliometric indicators provide only a subset of all the research output that is
produced, their suitability as a measure of impact in the short-term is questionable
due to issues of attribution, and differences in publishing traditions across fields and
between different types of research (basic, applied, mission-oriented) are also to be
taken into account (ibid.). Luukkonen-Gronow (1987) also concludes that
bibliometric data should be used in connection with other indicators, notably,
interviews. Notwithstanding this argument, bibliometric indicators provide a tool for
“systemic and objective comparisons at various levels of aggregation and across a
range of features including research output, cooperation and knowledge flows”
(Tijssen and van Wijk 1999, p.541).

A study by Crespi and Geuna (2004), analysing the productivity of investment in
higher education institutions, has found that research funding has a considerable
impact on research productivity and output in the long term and that this impact is
characterised by a long and complex lag structure. Furthermore, the authors claim
that no evidence of impact can be assumed in the first two years of publication and
the first three years of citation, reaching the full effect by years five and six, whereby
the full cumulative effect can be determined only after six or seven years. This
applies not only to the impacts of funding on research productivity but also on any
other policy measure that is pitted against the resulting productivity.

Naturally, this time lag varies from one field of science to the next, taking into
account the multitude of reasons why this should be the case – historical traditions of
publishing in the field, the novelty of research area, demands on human capital and
infrastructure and various other considerations. This is confirmed by another study
by the same authors (Crespi and Geuna, 2006) on the productivity of universities in
the United Kingdom. The study concludes that “the science system does not respond
uniformly to changes in funds” (Crespi and Geuna 2006, p. 16) and that the lag
between funding and publication varies between different fields of science, whereby
returns on funding in social sciences are evident in the first few years, effects of
changes in funding in medical sciences can take considerably longer to manifest
themselves, and changes in output from the natural and engineering sciences lie somewhere in between the two other fields.

Furthermore, there are a number of considerations that have to be taken into account when assessing the quality of research output (i.e. the citation rates of publications). Firstly, there is usually a time lag between the time of publication (or, as in the case of the SCI – the inclusion of a publication in the index) and the time, when the respective publication accrues citations. This is field specific; however, as a general rule, the more time has elapsed since the publication, the higher the probability of the paper accruing more citations. Secondly, the larger the number of bibliographic reference items included in an article, the higher the incidence that it will attract citations (bearing in mind that different fields have different rules for citation – i.e. articles in math usually have very few citations, whereas articles in natural sciences, in general, have a lot of references to other publications). Finally, publications in the most prestigious journals are cited more often. Thus, the number of publications and the number of citations must be jointly assessed. This is done by calculating a ratio of the number of citations against the number of papers, which effectively gives the number of citations per paper.

Another aspect in the evaluation of research productivity that cannot be ignored, especially, when analysing long term developments of research output in particular fields of science or countries, is the evolution of research productivity at the global level. While no annual statistics are reported on the coverage of research papers in the Science Citation Index (SCI), the Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (A&HCI), the growth in the production of scientific knowledge as indicated by the increase in the number of scientific journals and the corresponding research papers can be inferred by previous studies.

According to May (1997), between 1981 and 1994 the global aggregate output of scientific papers (as indexed by the SCI – the most commonly referred to source for the assessment of quality and quantity of research output) had increased by 3.7% annually. In the period of 1993-1997 the total number of research papers and reviews indexed by the SCI was over 3.3 million, and in the following period between 1997 and 2001 it had increased to 3.6 million (King 2004). More recent data can be
estimated from the statistics on the share of UK publications (journal articles) of the world total, as reported to the Office of Science and Technology by Evidence Ltd. (2003, 2004, 2006, 2007, 2008 and 2009).

For this study, two sets of bibliometric indicators have been used. Firstly, data provided in previous studies of publication and citation pattern performance in Latvia (Kristapsons and Tjunina 1993, Kristapsons 1998) and Estonia (Allik 1998, 2003 and 2008, Must 2006, Tiits and Kaarli 2001), covering, in aggregate, the time period of 1986-2008, has been drawn on for the initial illustration of the cases. Another data set from Thomson Reuters (2009a) Web of Science was collected for this study, covering the period of 1998-2007. This data set was used to corroborate the findings of previous studies, on the one hand, and to compare the research output in these countries with the funding levels and the available human resources in order to estimate the effects of these factors on research performance. The latter was motivated by the abovementioned research of Crespi and Geuna (2004, 2006), who have demonstrated that funding levels have an impact on research output, but this impact can only be observed in the longer-term and is characterised by a long and complex lag structure. Furthermore, recent trends in publishing, such as the increase in the global research output (May 1997, King 2004) have also been taken into account. Thus, the abovementioned considerations were incorporated in the analysis by, firstly, applying the average lag of six years (as estimated by Crespi and Geuna 2004) in which the cumulative effect of funding on research productivity is reached, and secondly, by taking into account both the changes in the global research output. Further investigation was performed by analysing the data by research areas. Finally, the quantitative data has been supplemented by semi-structured interviews, which are elaborated on in the next section.

A Case for Semi-Structured Interviews

The use of semi-structured interviews has been thought essential in producing a well-rounded case study given the aims and the scope of the proposed research. As the study deals with exploring and explaining reform, it has been deemed necessary to consult persons directly involved in the reform process, since they are invaluable in
providing first-hand knowledge of the different circumstances surrounding the decision-making process, which has led to a particular measure. Furthermore, previous studies have shown that it was mostly at the level of the individual researcher or small groups of leading researchers at the time, that the ideas for the restructuring and the reforms of the system were instigated and carried out (Meske 1998a, Kristapsons, Martinson and Dagyte 2003).

The identification of informants for the interviews was aided by an initial examination of the composition of different organisations and officials that have been involved in the reform process. The interviewing process followed the identification of one person (in a senior position) involved in the decision-making process, which was asked to provide names of further individuals that the respondent deemed to be knowledgeable in and possessing firsthand experience of the issues pertinent to the study.

This nomination method generally falls into the category of non-probability sampling, and, in particular, refers to the snowball/chain-referral sampling technique. Although the population of potential respondents is well known, snowball sampling ensures that greater insight is achieved into determining opinion leaders and persons, which might be excluded by using methods, such as purposive sampling, where the sample is determined largely by the researcher’s knowledge of the respondents.

Generally, semi-structured interviews have been chosen as the preferred method of gathering primary data because:

- they allow corroboration of findings obtained from secondary sources,
- they enable the reconstruction of historical events from witness accounts aiding clarity,
- they facilitate access to non-public deliberations and other materials,
- they provide information on interviewees’ beliefs and values, as well as the institutional rules that govern their behaviour,
- they enable referral to other informants (Tansey 2006).
Applying the chain-referral/snowballing method, over 30 individuals have been contacted, resulting in 23 interviews being conducted with Latvian and Estonian respondents between 2007 and 2010 (further information on the respondents and the interview guide can be found in Annex A and Annex B, respectively). In their professional capacity, these respondents represented a variety of organisations within the two research systems, covering all major sectors i.e. the government sector, the higher education sector and independent research institutes, as well as other funding and administrative bodies.

The majority of individuals interviewed occupied senior positions in their respective organisation at the time of the interviews, and have demonstrated a long track record of senior posts in a variety of organisations. The respondents have included such senior authorities as the President of the Academy of Sciences of Estonia, the Vice-President and Adviser to the President of the Academy of Sciences of Latvia, Rector and Vice-Rectors for Research of the leading universities in Latvia and Estonia, Chairmen and former Chairmen of the funding councils, as well as senior government officials and directors of other supporting organisations. Furthermore, as part of applying the chain-referral method, these respondents were specifically asked to suggest further respondents that they deemed knowledgeable in the field. Thus, a credible constituency of respondents was obtained.

The interview format included a mixture of face-to-face and telephone interviews, as well as electronic correspondence. These were conducted in Latvian and English, and were of varying duration (between 30 minutes and 2.5 hours). Some interviews were recorded and transcribed, and extensive notes were taken in all instances.

The comparatively low response rate can be explained by firstly, the high profile of some of the respondents and secondly, by the fact that several individuals have been nominated multiple times for interviews. The latter phenomenon became apparent already in the early stages of the interviewing process and was recurrent in both countries, signifying the existence of a small community of interconnected individuals.
The interview guide (presented in full in Annex E) was designed to take account of the conceptual framework developed in previous sections, as well as earlier research conducted on the topic and other available background information. The guide aimed at obtaining and verifying historic information on the research systems (in particular, the conditions at the outset of the transition), as well as inciting the respondents’ views on the development of their respective research systems throughout the transition. Furthermore, the interviews explored a diverse range of topics, such as the funding reform, the government involvement in shaping science and technology policy, the inter-organisational dynamics within the system, and included the respondents’ assessment of the effectiveness of reforms. In some instances, the interviews were followed up by personal correspondence to clarify certain issues raised by the respondents.

Finally, while it could be argued that the use of the snowballing method runs the risk of providing a very limited picture of the reform process, the extensive use of other qualitative and quantitative data ensures a balanced representation of the resulting comparative case study. However, prior to embarking on the said case studies, the thesis briefly reviews the legacy of the Soviet research system in order to contextualise the process of transition.
Chapter IV: The Legacy of Soviet Science

Prior to collating the breadth of aspects pertinent to research systems in transition in Latvia and Estonia, an illustration of the historical aspects prior to the outset of transformation is necessary. As the study deals with two former Soviet Socialist Republics, the emphasis is placed on the organisational principles of the research system of the USSR, and to a lesser extent on that of other former communist countries in Central and Eastern Europe. The necessity of such illustration stems from previous studies of transition economies (Panagiotou 2001) and research systems in transition (Meske 2000), where the conformity or deviation of a national research system from the core was found to be of importance.

Soviet science has been studied by several Western historians of science (most notably, Graham 1990, 1992, 1993, and 1998) and an adequate picture only began to emerge in the 1970-ies, when the Soviet Union loosened its restrictions to allow select Western researchers access to the system (Hanson and Pavitt 1997). A more critical account emerged during the early to mid-1990-ies (Gaponenko 1995, Mirskaya 1995) and more recently (Egorov 2002), when academics from the former USSR provided an insider view of the system. The combination of these sources forms the base of the following synthesis.

The Soviet research system, like every other part of the Soviet economy and society, was subject to rigid multi-annual planning and top-down administrative control. Moreover, scientific and technological progress as the cornerstone of communist ideology played a paramount role in government policy. However, the multitude of layers of governance meant that there was no single administrative body directly responsible for overseeing research, development and innovation, and the majority of research and development activities were executed by the different economic branches, governed by ten different all-union departments, and around 50 different branch ministries. Hence, despite the illusion of a structured, top-down system and a multitude of sub-systems, the research system of the USSR was extremely fragmented but very rigid in precluding organisational change at lower levels (Hanson and Pavitt 1987). In this respect, the system resembles what Etzkowitz and
Leydesdorff (2000) have termed – Triple Helix I. The overall structure of the system at the Union and national level is presented in Figure 1.

**Figure 1: The Structure of the Soviet Research System**

![Figure 1](image)

Source: Kristapsons, Martinson and Dabyte (2003, p.17)

Graham (1992) has described the research system of the USSR as a series of pyramids i.e. the academy, the education sector, and the industry, overseen by the State Planning Commission (also known as GOSPLAN) of the Council of Ministers. GOSPLAN played a significant role within the system, as it was responsible for the allocation of resources to the three different sectors, as well as for the multi-annual planning and the setting of output targets. In relation to planning budgetary allocations for research and development, the GOSPLAN was advised by the State Committee for Science and Technology (SCST), responsible for major programmes, and science-industry collaboration, and by the military-industrial commission (VPK) (Hanson and Pavitt 1987). At the very highest level, all activities were supervised by the Communist Party Central Committee (the Politburo). The Politburo and the State Planning Commission were legally responsible for the supervision of policies carried out in the three areas of science, education, and industrial research and development, but interference was rare. Subsequently, each of the three sectors “controlled its own work within the budget assigned to it” (Graham 1992, p.58).
The highest decision-making body in the area of fundamental research was the Academy of Sciences of the USSR, which was directly subordinate to the Council of Ministers of the USSR. This made it subject to direct party control. Referring to previous work by Fortescue, Hanson and Pavitt (1987) have described the Academy of “prestigious, expert and bureaucratically powerful”, as well as “extremely powerful in moulding Soviet science policy” (p. 22).

The central Academy was in charge of coordinating the work of the national Academies, which, in turn, managed a network of institutes. The members of the Academy represented the scientific elite and were often directors of research institutes. The research agenda and funding levels were decided by the various research departments within the Academy and all funded activities required annual reports on their implementation. The organisational structure of national Academies was similar to the one of the central Academy across the Soviet Union, and while the latter was mainly involved in conducting basic research, the institutes attached to the national Academies also engaged in industrial research, conducting around 2% of industrial research and development in the USSR in the early 1980-ies (Nolting cited in Hanson and Pavitt 1987, p. 22).

In a similar fashion, the branch institutes (the industrial arm of research and development) were managed by and accountable to the various branch ministries. Due to this structural set-up of the system, industrial science and the development part of research activity were disjoined from academic research and education. Another reason for this delineation is connected to the large percentage of research in aid of the military sector. Two thirds of government appropriations for research were aimed at supporting the military sector (Gaponenko 1995) and the strategic importance and secrecy surrounding this research precluded it from being closely connected to civilian research.

The education system, comprising organisations of higher education, was also subordinate to a dedicated ministry. The main purpose of the system was to provide education and skills, and not to train researchers. The transfer from the universities and other higher education institutions to the institutes provided the necessary
research education of prospective researchers. Furthermore, almost no research activity took place within the universities due to, firstly, the high teaching load of the lecturers, and secondly, due to the restrictions placed on the staff of the institutes to engage in teaching, as well as out of the necessity of the lecturers to guard their teaching load and income (Martinson 1992, Tonnisson 2004). Hence, the primarily task of university staff was that of teaching, whereas researchers were trained and engaged in the Academy institutes.

In terms of funding, any budgetary appropriations were subject to the approval of GOSPLAN, and the overall appropriations for education, research and industrial development were significant and broadly allocated on an institutional basis (Hanson and Pavitt 1987). Furthermore, within the system of five-year plans and in the absence of competition, budgets for research and development in a particular area continued into the next planning period. The provision of new infrastructure was also generously funded (ibid. 1987), but only in fields of strategic importance (Tonnisson 2004).

The disjoined character of the system had some detrimental implications for the functioning of the overall Soviet model of science. Research policy was often heavily influenced by political motives and the departmental structures, which often clashed with the objective needs of the wider scientific community. The large bureaucracy meant that there was little flexibility in responding to emerging science and technology fields, or in influencing research policy at the national level. This problem was also prevalent in the industrial sector, where branch ministries were highly departmentalised and inter-industrial cooperation was only possible through the proper hierarchical channels (Hanson and Pavitt 1987). However, in practice, national and regional actors did try to assert their interests, knowing that “the only way to get one’s voice heard and accepted was through personal contact networks and indirect lobbying in various ministries and research structures in Moscow” (Tonnisson 2004, p. 157).

The communist research model was also prevalent in the other communist countries of Central and Eastern Europe. Meske et al. (1998) have summarised the main characteristics of science in socialist countries of Central and Eastern Europe as:
the dominance of hierarchical systems,
- a linear model of research and innovation and science as productive force,
- the specialisation and segregation of scientific institutions and enterprises,
- centralised baseline funding on an institutional basis,
- rigid patterns of structure, function and size of the different parts of the system.

One of the trends observed throughout the system was the consistently high investment in R&D that continued up to the 1980-ies and declined dramatically in the early 1990-ies. At the same time, Radosevic (1995) points out that the consistent investment in R&D has not been complemented by adequate levels of manpower in terms of researchers and engineers, resulting in high innovative capacity but low absorptive capacity.

The Role of the Baltic Industry in the Soviet Union

During the Soviet period, the Baltic States were considered the most economically advanced in the whole of the Union, providing a comparatively high standard of living, an educated workforce and higher productivity levels (Pavitt 1990, Martinson 1992, Raun 2001). This was largely the result of the historical and geographical position of the two nations. Closer links to Western Europe and prior experience of being independent and economically viable states distinguished the Baltic countries from the rest of the Soviet Union. This enabled the countries to become important economic centres of the Union.

Throughout the Soviet period, the two Baltic States had developed different industrial structures. Hence, natural resources and the manufacturing of hi-tech equipment characterised the Latvian industry on the eve of transition; whereas, the Estonian industrial fabric has been more varied (Blom, Melin, and Nikula 1996).

Engineering and metallurgy represented 29.6% of the gross industrial output in Latvia in 1987 and only 14.9% in Estonia in 1989. Chemicals and timber generated a
further 13.3% of industrial output in Latvia and 8.9% in Estonia, whereas fuel energy represented 8.4% of output in Estonia and only 1.9% in Latvia. Clothing and textiles, as well as the food processing industries have occupied the largest share within these economies, representing just over 50% of industrial output in Estonia and nearly 45% - in Latvia (Pavitt 1990).

The Latvian industry was more closely linked to the economy of the USSR, as around 35% of all enterprises in Latvia were all-Union enterprises. In Estonia, this figure was only 13.3% (Norgaard et al. 1999). Of course, being an important part of the Soviet industry, Latvia and Estonia relied heavily on the supply of raw materials and energy for manufacturing. This supply was more crucial for Latvia, given the abovementioned presence of all-Union enterprises in the country, and the fact that only 10% of energy was produced locally. At the same time, due to own power sources, Estonia was able to secure 62% of energy within the country (Pavitt 1990). The extent of the magnitude of industrialisation in Latvia in the early 1970-ies has been aptly illustrated by Harned (1973) in the following quote:

*With less than 1% of the USSR’s population, Latvia produces over half of the motorcycles, over half of the telephones, one-third of the trolley cars, more than one-fourth of the railroad passenger cars, about one-fourth of the radios and radio-phonographs, 19% of the refrigeration plants, 12% of the washing machines, and 4.3% of the agricultural machines made in the USSR* (pp. 4-5).

On the eve of transition, Latvia (and to a smaller extent Estonia) was also an important seat of the Soviet radio-electronics industry, housing several major producers of electronic consumer goods, telephone equipment (producing 1.5m handsets per year), communications equipment, integrated circuits and other instruments (Cooper cited in Pavitt 1990, p.45). Together with the other two Baltic Republics, it accounted for 23% of radios, 7% of television sets and 5% of tape recorders produced in the USSR in 1987 (ibid. 1990).

In 1991, the Latvian radio-electronics industry employed 64,000 workers, a quarter of them – highly educated engineers and technicians (Muller 2000). The Estonian radio-electronics industry employed around 25,000-30,000 workers during the Soviet
period (Hogselius 2005). However, upon the restoration of independence, the ties between the former Soviet Union and the Baltic countries were severed, and the electronics sector dwindled, unable to respond to the new demands of the market economy. In Estonia the electronics industry “collapsed almost completely, resulting in a 90 per cent reduction in employment” (Hogselius 2005, p.264). The fate of VEF, a major Latvian player in the industry (summarised by Muller (2000)) illustrates this unfortunate development well:

The Latvian equipment supplier VEF had been an important production center for telecommunications. It even gained considerable experience in the production of digital long-distance business exchanges (the Kwarts and the Kvant) under licence from Nokia (in a barter-type joint venture) during 1983-1991...

As of 1997, VEF had not been privatised, but it is a shadow of its former self with only about 400 engineers remaining. The production of radio receivers (employing at one time 4,000 workers) was closed down in 1992. In 1998, the section producing customer premises equipment (2-3 million telephone sets per annum) was put into liquidation and the VEF transistor company was reduced to refurbishing used telephone sets imported from Germany (pp. 211, 213).

However, examples of small, successful spin-offs in Latvia have also been found, in one instance, securing employment for around 200 engineers in the software and support services sector (ibid. 2000). In addition, some Estonian enterprises in the sector became a source of low-cost subcontracting to Western electronics manufacturers (Hogselius 2005).

Another economically important sector in Latvia has been the pharmaceutical sector, owing much of its success to the historically strong presence of chemical and pharmaceutical sciences in Latvia. The biotechnology industry has been one of the industries were research, development and production were most closely linked. And Latvia is still home to several internationally recognised pharmaceutical companies, such as Grindex and Olainfarm, where the former evolved from the laboratories of the Institute of Organic Synthesis. The Institute has been a major part of the USSR
pharmaceutical sector, and the inventor of 16 original substances (Kristapsons, Martinson and Daygte 2003), and the holder of over 60 patents to date (Stradins 2007). On the basis of this research, 25% of original biologically active compounds (drugs) developed in the Soviet Union, have been synthesized in Latvia (Ministry of Education and Science 2002a).

The Estonian research system, in contrast, was less heavily industrialised (Vaikmae 2007), but still proved to be an important research base for the military complex, and excelled in the natural sciences and engineering (in particular, in branches of physics and chemistry). However, as Stradins (1998) has pointed out, in retrospect, new applied research institutes established at the beginning of the transition have not made a significant contribution to the Latvian industry, and hardly any of the applied research structures established in the 70-ies or 80-ies under the auspices of the Latvian Academy of Sciences have survived the transition. The same is true for Estonia; many institutes engaged in applied research and development activities, serving the industrial complex of the Soviet Union, have ceased to exist (Vaikmae 2007).

A further consideration worth mentioning, in terms of the governance of early transition, is that has been the fact that as part of the agreement between the USSR and the Baltic states on economic autonomy from 1990 onward, a package of legislative, administrative and other proposals had to be put forth by the three countries. The Estonian proposal for self-management - Ise-Majandav Eesti (IME) was considered “the most advanced prototype of Baltic economic independence schemes”, “a coherent approach to creating the framework for a mixed market economy”, and overall “a well thought out approach”, which served as an example for the other two Baltic states (Pavitt 1990, p. 30).

Panagiotou (2001), in explaining the overall success of Estonia in transition to a market economy, concurs that along with a less heavily industrialised structure and smaller reliance on the overall Soviet industry, “it was largely due to the fact that Estonia was the only Baltic state to emerge from Soviet legacy with a serious background of experimentation with economic reform” (p.270). Despite the importance of this fact in terms of the overall transition, its effect on the
transformation of the research system in Estonia has been rarely mentioned in the respective literature. Martinson (1995, p.3) has noted that the overall legislative and institutional changes in the research system have been designed in the framework of this programme, yet no further elaboration has been provided. Furthermore, one of the interviewees in Latvia has briefly alluded to the comparative advantage of Estonians in terms of their supply of knowledgeable economists (Bundule 2007).

**Organisation of Research in Estonia and Latvia under Soviet Rule**

The Soviet organisational structure of the research system was established in the post-war period, and largely remained stable from mid-1960-ies to late 1980-ies. The characterisation of the Academies of Sciences and the employment patterns presented below allow gauging the size of the research systems during the Soviet period. However, as there has not been a single framework for collecting and reporting employment statistics in science, the data is used largely for illustrative purposes and broad comparisons.

According to the historian of Latvian science Janis Stradins (1998, p. 260-261), the period between the mid-1960-ies and late 1970-ies, has been the period in which the Latvian Academy of Sciences, as an “integral system of research institutes”, flourished and peaked. Historically strong scientific fields in Latvia include physics (magnetic hydrodynamics, solid state physics), polymer mechanics, informatics, chemistry (medical and heterocyclic compound chemistry, plasma chemistry, and wood chemistry), as well as virology, molecular biology and hydrobiology (Ministry of Education and Science 2002a).

For the most part of the communist period, the Academy comprised 15 research institutes, grouped into three departments: the physics and technical sciences department (5 institutes), the chemistry and biological sciences department (6 institutes), and the social sciences department (4 institutes). The institutes of the two former departments encompassed a total of 9 construction bureaux and pilot plants, most of which were constructed in the 1960-ies and 1970-ies.
In 1970, the institutes of the Academy employed 4,105 workers, of which 1,449 were scientific workers and 614 of them were Doctors of Science or Candidates of Science\(^1\), by 1985 this number had grown to 7,623 workers, 1,598 scientific workers, and an estimated 895 doctorate degree holders. Based on these figures, only around 15% of all employees of the Academy and its institutes had higher degrees in 1970, and only around 12% - in 1985 (based on data compiled from various sources in Stradins (1998, pp. 278-279)). However, the aggregate figures for personnel in all spheres connected to scientific activity in the late 1980-ies have been estimated in the region of 17,000 (Baltic Statistics Departments cited in Kristapsons, Martinson and D gyrte 2003, figure 2.3, p.81).

At the beginning of 1991, the Academy and its institutes had lost nearly half of its manpower, employing 4,372 workers, and by the end of 1993, the aggregate personnel of the institutes of the Academy amounted to 2,350 workers, 731 (around 31%) of them – with a doctorate (Sil ins 1994). Furthermore, the “old intelligentsia” found itself in a very unstable position in the early 1990-ies, with a very uncertain outlook, deteriorating living conditions and limited means (Blom, Melin, and Nikula 1996), the average salary of a researcher in 1993 being 52.1 US dollars in Latvia, and 77 US dollars in Estonia (Bobeva 1997).

An estimated 69% of Latvian researchers and engineers left the system in the early 1990-ies, predominantly, for employment in other spheres in Latvia (Kristapsons, Martinson and D gyrte 2003). A small percentage of researchers left the country to work in research organisations in North America and Israel (Bobeva 1997). The overall losses were most notable in the technical and engineering sciences, where 86.6% of all manpower left the sector (ibid. 1997).

Due to the diversified industrial structure outlined earlier, Latvian research organisations were also heavily engaged in technical and applied research, and research institutes, in particular, received up to 50% of their funding from contracts with enterprises. In comparison, by 1993, this percentage had decreased to a mere

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\(^1\) In the USSR, two different degree classifications were used for awarding doctorates – the Candidate of Science (resembling the Doctor of Philosophy degree in the West) and the Doctor of Science – a further qualification, akin to a second doctorate.
12% (Kristapsons 1993). In Estonia, 22.8% of funding for research institutes came from contractual research in 1989; two years later, this share was only 14.8% (Martinson 1992).

Similarly to the Latvian Academy of Sciences, the Estonian Academy of Sciences comprised 16 institutes and was organised into 4 divisions or departments (in 1991): the division of astronomy and physics (4 institutes), the division of informatics and technical sciences (established in the 1980-ies and comprising 2 institutes), the biology and geology and chemistry division (5 institutes), and the division of the humanities and social sciences (4 institutes), and six support structures (including design offices and technology centres) (Estonian Academy of Sciences 1992).

A total of 45-47 organisations have been reported as active in research in Estonia at the time; however, during the Soviet period many more organisations (around 300 in Estonia) engaged in or affiliated to research and development enterprises existed, notably, the so called “mail-boxes” or “post-boxes” – branch institutes created to cater to the military industry, often known only by their post-box number (Martinson 1992). Along with a strong background in engineering and technical sciences, molecular biology and biotechnology became important fields of research in Estonia in the latter part of the Soviet period (Vaikmae 2007). Finally, due to the oil shale deposits found in Estonia, research and industrial development in this area was, and still is, of prominence (Martinson 2002, Holmberg 2008).

In 1983, there were 6,919 individuals employed in the science sector in Estonia (data cited in Raun 2001). However, the aggregate figure of all personnel across the different research facilities in Estonia was estimated to be 10,608 in 1991, including over 2,800 doctorates (Laas 1992). At the end of 1991, there were 3,417 persons employed at the Estonian Academy of Sciences, including 1,198 research workers (Estonian Academy of Sciences 1992). By the end of 1992, a total of 2,728 persons worked for the Academy, 994 were directly engaged in research, and 640 (around 23.5% of the total) were in the possession of a doctorate degree (Estonian Academy of Sciences 1993). This is largely consistent with the 46% decrease in aggregate personnel.

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2 This figure includes the Estonian Biocenter and the Botanical Gardens.
3 Including double-counting.
personnel, reported by Kristapsons, Martinson and Dagyte (2003), and the 67.5% decrease in persons employed in engineering and technical sciences (Bobeva 1997). According to a survey by Bobeva (1997) a sizeable portion (13.8%) of Estonian researchers from institutes emigrated to Scandinavia, the United States, and Germany, and 2/3 of them continued to work in the research sector abroad.

In Review

Several notable facts emerge from this preliminary comparison of the two research systems in the Soviet period and in the early transition period. Firstly, during the communist era, Latvia was by far the more industrialised of the two countries, and had a more distinct specialisation. Both countries had notable capabilities in the radio-electronics industry, which along with other industries disintegrated in the early 1990-ies. Other noteworthy industries have been the pharmaceutical industry in Latvia and the energy sector in Estonia, which seem to have survived, albeit on a smaller scale.

Secondly, during the Soviet period, the Latvian and Estonian research systems were similarly organised, to fit into the larger apparatus of Soviet science. The Latvian research system was considerably larger, in terms of human resources, than the Estonian system, yet by the early 1990-ies, and as a result of industrial restructuring and brain-drain, the two systems contracted to similar size. However, brain-drain to the West seems more characteristic of the Estonian research system, while in Latvia, this occurrence seems largely intramural. Moreover, despite this decrease in human resources in the Academies, a large share of the most qualified personnel (i.e. those with doctorate degrees) has remained within the system.

Thus far, the developments are consistent with the description of the properties of soviet research systems by Meske et al. (1995) and the general processes of transition (Balazs, Faulkner, and Schimank 1995), such as the removal of ballast as a result of the contraction of the system. Moreover, only small deviations from the core of the USSR system have been noted in Estonia (i.e. in terms of the administrative capabilities to carry out economic reforms). Thus, the two research systems can be
considered broadly similar; “however, in spite of similar starting conditions in Estonia, Latvia and Lithuania, the three states took diverse approached toward the reform of the R&D system” (Martinson 1999, p.117, Kristapsons, Martinson and Dagyte 2003). Eighteen years later, the systems have evolved along different trajectories and have been firmly placed within a cardinally different context. This transition is investigated in the remainder of this thesis.

The following chapters provide the contextual background for the subsequent analysis. They explore the state of the research systems at the onset of the transition and trace their development throughout the 1990-ies and early 2000s. The ensuing comparative case study focuses primarily on the public research system (as outlined in Chapter III) and is the result of the triangulation of archival and documentary evidence, as well as primary, and secondary data. It must be pointed out at this stage, however, that while every effort has been taken to provide a symmetrical treatment of the two case studies, this has, at times, presented some difficulties, due to the lack of access to Estonian archival and documentary sources in English. Nevertheless, this has been largely remedied through the abovementioned triangulation process.

The primary data has been collected in the form of face-to-face and telephone interviews, as well as electronic correspondence with Latvian and Estonian respondents, representing the government, higher education and research sectors. The Eurostat (2009) and Thomson Reuters ISI Web of Science (Thomson Reuters 2009a) databases, as well as datasets from the Latvian Central Statistical Bureau (2009) and the Estonian Statistical Office (2009) have been used to collect secondary data on funding, human resources, and productivity. This has enabled the construction of a coherent picture of the evolution of the Latvian and Estonian research systems.
Chapter V: The Latvian Research System: A Case Study

The following chapter provides a rich description of the Latvian research system, focusing on the process of transition from the perspective of the reform process. The chapter begins with picturing the research system by illustrating the main reforms as outlined in the conceptual framework presented in Chapter III, at the same time bearing in mind the legacy of the Soviet system outlined in the previous chapter.

The Evolving Structure of the Latvian Research System

As a result of the political discord of the late 1980-ies, significant shifts were apparent in the research system of Latvia. Following the dissolution of the Soviet Union, it was, of course, the legacy of a largely inefficient and scaled-up system that the subsequent research reformers tried to dismantle. Many of the shortcomings of the Soviet model of science were up for debate during the early stages of transition to the market economy, and these also formed much of the reasoning behind the reforms.

Stradins (1998) describes it as a process, which he calls “ideological splitting” – the tension between the old system and the movement to create a new system based on new principles. Furthermore, he points out three concurrent shifts at different levels of the system:

- the tension between the well-established Latvian Academy of Sciences (the main administrative structure of the Latvian research system) and the bottom-up movement of the Latvian Union of Scientists,
- the divergence in ideology between the Academy as the core of the research activity and the universities; and, at the lower structural levels,
- the tension between the Academy and its research institutes, and the tension within research institutes (ibid. p.357).

These three ideological divergences play an important role in describing the subsequent reform, which has been very much centred on the structural aspects of the
system. The following timeline (Figure 2) represents the historical evolution of the Latvian research system in terms of the organisational reform in the 1990-ies.

**Figure 2: A Timeline of the Main Organisational Reforms in Latvia in the 1990-ies**

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latvian Union of Scientists Founded</td>
<td>1988</td>
</tr>
<tr>
<td>Latvian Council of Science Established</td>
<td>1990</td>
</tr>
<tr>
<td>Reorganisation of the Latvian Academy of Sciences</td>
<td>1992</td>
</tr>
<tr>
<td>Formal Integration of Research Institutes and Universities</td>
<td>1996</td>
</tr>
<tr>
<td></td>
<td>1998</td>
</tr>
</tbody>
</table>

Source: Own compilation (based on various sources)

For decades, the Latvian Academy of Sciences had been analogous to a research ministry within the wider system of research funding and administration within the USSR. However, with the increasingly pronounced political changes towards national independence, several new movements and organisations arose to propose new ways of governance. In terms of the reforms within the research system, the most prominent and influential was the Latvian Union of Scientists, established on the 27th November 1988.

**The Latvian Union of Scientists**

The Latvian Union of Scientists was, notably, the first organisation of its kind in the former USSR. It had also a considerable membership of 1,235 researchers at the time of its formation (LATINFORM 1988). Several achievements of the Union at the outset of the reform must be pointed out; these were:

- the proposal on the reform of the Academy of Sciences and its statutes,
- the draft of the new law on scientific activity,
- the new procedure for awarding scientific degrees,
the reform of the funding system (in particular, the formation of the Latvian Council of Science, the election of independent expert commissions, and the institution of a peer review process) (Grens 1991).

Despite its achievements, the role of the Union as an active player in the reform diminished considerably within a few years, owing to the establishment of the Latvian Council of Science, as well as the departure of many opinion leaders within the Union into other spheres of governance (Kristapsons, Martinson and Dagyte 2003). Hence, the Union saw its future role as an umbrella organisation for numerous associations and working groups, thereby retreating from active policy-making (ibid. 2003). Finally, following the early transition period, the Latvian research system started to take shape. Prior to discussing the individual organisational aspects, a snapshot of the resulting system is provided in Figure 3.

**Figure 3: The Structure of the Latvian Research System**

Source: Kristapsons, Martinson and Dagyte (2003, p. 45)
The Latvian Council of Science

Established on the 3rd July 1990, with the dual role as a funding and an administrative body to the research organisations, as well as an advisory body to the government, the Latvian Science Council is still central to the Latvian research system today. The vision of the Latvian Science Council was conceived by the Latvian Union of Scientists, and was subsequently elaborated by the Union and the Latvian Academy of Sciences.

The remit of the Latvian Council of Science has been very broad in terms of functions and responsibilities (Martinson 1999). In fact, for most of its existence, the Council has been the main player throughout all the stages of the policy and administrative life cycle of the research system, from policy formulation, to the receipt and distribution of funding, and the evaluation of research proposals (Kristapsons, Martinson and Dagyte 2003). However, with the recent trend of an increasing policy interest in science, technology and innovation, the government has begun to take over some of the abovementioned functions, where policy is concerned.

The Council is supported by five expert commissions (prior to 2006 there were fourteen expert commissions), which carry out the evaluation of research proposals and determine the amount of funding to be granted from the budget allocated. The commissions are also engaged in evaluating other initiatives, such as proposals for state-commissioned research and national research and innovation programmes.

Increasingly, the duties of the Council widened to also include the approval of the promotional committees of various research organisations and higher education institutions that were entitled to award research degrees. These duties became explicit and were elaborated further with the passing of the new Law on Scientific Activity (Augstaka Padome 1992) on 10th November 1992. This law widened the remit of the Council to include the drafting of policies for the scientific development of the country, the evaluation of research performance within the system, and the representation of national interests in science at the international arena.
Further amendments to the Law on Scientific Activity (Saeima 1996) in 1996 brought additional changes in the composition of the Council, mainly, due to the fact that several institutions had ceased to exist. With the abolition of the Higher Council and the Council of Ministers, the government representation on the Council was relegated to one member of the Cabinet of Ministers (the equivalent of the former Council of Ministers) and an additional seat was given to a member of the Academy of Sciences. In 1998, however, the Minister’s seat was given to a representative from the Ministry of Education and Science (previously, the role of the Ministry was rather limited) (Saeima 1998). In addition, the Council’s duties were now to include the formulation of policies for the funding and promotion of technologies and research in general that would be of significance for the national economy. Finally, with the replacement of the Council of Ministers with the Cabinet, the Latvian Council of Science became accountable to the Ministry of Finance where funding was concerned.

The structure and functioning of the Council, established in the early years of transition, continued very much through the reform period. However, with the increased involvement of the government in policy formation in later years, its role beyond the funding and administration of research grants, has lessened.

The Academy of Sciences and its Research Institutes

In the first few years of the reform, the Academy of Sciences’ long-established position as the centre of the research system considerably diminished. According to Stradins (1998), the organisational reform of the Academy can be characterised in three distinct stages:

- 1988-1990 – characterised by an attempt to democratise the Academy, to regulate the relationship not only between the Academy’s management and its subordinate research institutes, but also within the institutes, in essence, preserving the old system as a type of association of research institutes;
- 1990-1991 – characterised by attempts to radically change the status of the Academy from a corporation of leading researchers to an organisation that
includes both an association of researchers and an association of relatively independent research institutes;

- 1991-1994 – characterised by the transformation of the Academy into an association of prominent scientists, the exclusion of research institutes from the Academy, as well as the removal of any governing or coordinating functions from the Academy. From this point onward, the Academy of Sciences acts as an advisory body providing evaluations and consultations at the national level.

The first step at the decentralisation of the Academy was taken in April 1989 with the amendment of its Statutes. The changes in the statutes redefined the Academy’s top-down, as well as bottom-up governance. On the one hand, the Academy proclaimed its independence from the USSR Academy of Sciences; thus, becoming effectively only accountable to the government of the Latvian SSR. On the other hand, the Academy conferred a higher degree of independence upon its research institutes, in fact, retaining only functions pertaining to the approval of research themes and the accountability for their implementation, as well as the approval of the governing board and management staffing decisions of the institutes.

Despite the somewhat stagnant position of the Academy, it still participated in the most significant reforms – the financial reform, for example. The Academy formed its own commission to put forward a proposal for funding research, thereby sketching out its role within the developing and administrative research system.

In 1990, the Academy dismissed its central apparatus. However, although, formally, its role decreased when the Latvian Council of Science took over its previous obligations, the Latvian Academy of Sciences is, to this day, a deciding force in all of the decision-making processes through its members (Stradins 1998). The influence of the Academy today has also been confirmed by members of the Academy (Kristapsons 2007, Silins 2007), and by an official of the Ministry of Education and Science (Bundule 2007) during the interviews conducted as part of this study.

In 1990, there were 15 research institutes at the Academy of Sciences and 18 state research institutes (subordinate to the various Ministries). With the transformation of the Academy into an association of eminent researchers in February 1992, the former
institutes had officially gained a significant degree of independence, which was already noticeable during the first years of transformation and was aided by the uncertain legal status of the Academy (Stradins 1998). The Law on Scientific Activity (Augstaka Padome 1992), adopted in the same year, pronounced the institutes completely independent in terms of their scientific activity and their administration. Two years later, however, the Ministry of Education and Science took on the supervisory role on behalf of the state. During the 1990-ies the number of research institutes rose to 20, which can be explained by the downsizing and splitting of some of the larger institutes (Kristapsons, Martinson and Dagyte 2003).

Another long-term objective of the policy-makers was the integration of the research institutes into the universities. This process, although widely debated, formally took place during the period of 1996-1998 and involved a multitude of legal wrangling (Stradins 1998). In practice, however, the institutes are still fairly independent in their nature.

In May 1996, the new Minister of Education and Science took upon himself to conduct an evaluation of the research institutes establishing a working group of various ministers and members of the Academy of Sciences. This was the second evaluation of research institutes since the reform (the first being the evaluation of the Latvian research system by the Danish Research Councils in 1992).

According to Stradins (1998) the evaluation marked a positive (although somewhat hasty) development in the reform process as it provided an overall aspect on the scientific, financial and organisational aspects of the research institutes – a vital part of the research system, in which the majority of research was still being conducted. The author also points out that the Academy of Sciences, as well as the Council of Science is largely to blame for neither developing/implementing a strategy, nor proposing any actions in this regard, which ultimately resulted in a lag in science reform from 1992 onward. At the same time, Stradins (1996 cited in Stradins, 1998 p. 558) presents three conditions, which help explain this lag, namely:

- The ambiguity and vagueness of the political and economic strategy of the state,
- The weariness, inertia and scepticism on behalf of the scientists,
- The chronic deficit of funding in science and higher education.

A total of 34 research organisations were assessed. The evaluation consisted of reports provided by the institutes and other organisations, an analysis of the Ministry of Education and Science, as well as the analysis of bibliometric data. The working group concluded that the status of 10 organisations, the Academic Library, and the Botanical Gardens should remain as is, that 20 organisations were to be integrated into higher education institutions, and 6 further organisations were to be promoted to research centres of national importance. Furthermore, it was proposed that government commissioned research programmes should be established for the institutes in the latter category, which would focus on the following areas:

- Chemistry, pharmacy and bio-medicine,
- Forestry and timber manufacturing,
- Humanities (esp. Latvian history, language and literature, folklore, art etc)
- Material science, and
- Information technologies.

The reorganisation legally started at the beginning of 1997. Many institutes of the former Academy of Sciences were in talks of or had already begun integration into the three largest universities (The University of Latvia, Riga Technical University, and The Latvian University of Agriculture) in the second half of 1996. However, there was some tension within the system, since, at the time, the Ministry of Education and Science had proceeded to adopt a number of, what scientists thought as incompetent, decisions without prior consultation (Stradins 1998). To counteract this trend, the Latvian Council of Science set up a working group in 1998 and began drafting the National Conception on the Development of Science (Ekmanis et al. 1998), which the government took under advisement (Stradins 1998).

The formal integration of research institutes was finally completed in 2006. Eight institutes joined the University of Latvia, one institute – the Riga Technical University and a further institute – the Riga Stradins University; seven research institutes, legally, became state agencies. However, as Adamsone-Fiskovica et al.,
referring to an overview of Latvian R&D (Ministry of Education and Science 2005a cited in Adamsone-Fiskovica et al., 2008, p. 9) point out: “at the present time, the majority of state research institutes have transformed their legal status and are now formally incorporated into the universities, however, fully functional integration is still a matter of time and subject to financial and managerial stimuli”. A senior official at the Ministry of Education and Science (Bundule 2007) also confirmed that, in practice, integration commenced only in 2006 and 2007; however, the teaching of university students and the training of young researchers in institutes has also been undertaken in the past. Other interviewees claim that this has not been a uniform occurrence, and only applicable to certain institutes (Grens 2007, Kristapsons 2007). Finally, one interviewee, active in both research and higher education organisations has also pointed to the fact that “actual (rather than formal) integration with regard to both teaching and research is still an issue in many cases given the rigidities of the former division of labour and established spheres of influence” (Anonymous B, 2010).

The Universities and other Higher Education Institutions

During the Soviet period, the universities and higher education institutions in Latvia undertook little research and were largely concerned with producing an educated workforce. The higher education in the Soviet Union was provided at no cost to the student and institutions were entirely funded by the government, which also determined the quota of students to be admitted and the content of their education according to the socialist ideology. Furthermore, there was little involvement of teaching staff in research and vice versa. Hence, the integration of research and education became one of the most prominent issues in the reform process.

In 1991, the government adopted the Law on Education (Saeima 1991) which set the scene for the future development of higher education institutions. By law, these were declared autonomous and governed by their constitutions approved by the Higher Council, the responsibility for the education policy, however, was born by the Minister of Education. The new Law also introduced student fees, where the government would provide funding for only a fraction of the students.
In 1995 the Law on Higher Education Institutions (Saeima 1995b) came into effect. This was a much more comprehensive document than the Law on Education and it clearly outlined the responsibilities of the Higher Education Institutions and their relationship with the state.

All higher education institutions can be split into universities and state higher education institutions, professional higher education institutions and other institutions providing higher education. By definition, universities are state higher education institutions, which encompass several branches of science in which these undertake both education and research, and are allowed to award the degree of Doctor of Philosophy (PhD). There are six institutions in Latvia, which have been awarded the title of a university, these are:

- The University of Latvia,
- The Latvia University of Agriculture,
- Riga Technical University,
- Riga Stradins University (formerly, the Academy of Medicine), and
- Daugavpils University,
- Liepaja University.

In addition to the five universities, there are 14 state higher education institutions that specialise in one or a few disciplines and whose main purpose is to provide education. However, five of the following award PhDs in one or more fields:

- The Latvia Academy of Music,
- The Latvia Academy of Arts,
- The Latvia Academy of Sports Pedagogy,
- The Latvia Police Academy,
- The Latvia Academy of Culture.

The majority of research activity takes place in the two largest universities – the University of Latvia and Riga Technical University. The former engages in a wide range of research areas, the latter is more inclined towards research in engineering.
The University of Agriculture and Riga Stradins University focus on research in agricultural sciences and medicine, respectively.

There are several regulatory bodies that the universities are accountable to. Firstly, the universities are directly accountable to their founding ministry. This ministry is also responsible for their funding and evaluation. Whilst the majority of universities undertaking research are subordinate to the Ministry of Education and Science, the University of Agriculture and Riga Stradins University are under the auspices of the Ministry of Agriculture and the Ministry of Health. Overall, the total number of higher education institutions is subordinate to no less than six ministries. Therefore, for these institutions, the Ministry of Education and Science is formally only responsible for the overall education policy and the accreditation of educational programmes.

As a rule, the universities and other higher education institutions are chaired by a rector, who is responsible for the overall administration of the organisation. All rectors jointly represent these institutions at the Rectors’ Council. The Rectors’ Council is a collegial institution in charge of fostering the cooperation of the various higher education institutions and coordination thereof. It also acts as an advisory body to the Ministry of Education and Science and submits opinions of draft legislation and on the distribution of funding. It also represents the interests of higher education on various government and research committees and working groups. However, a more strategic role in this process is played by the Higher Education Council.

The Higher Education Council is an independent body, which was set up to draft the long-term strategy of higher education policy, to foster cooperation between stakeholders, and to perform the function of quality assurance. The most important function of the Council has been the estimation of the number of student seats to be funded by the state. The Higher Education Council also acts as an advisory body for the Ministry of Education and Science and for its Higher Education Department, and is composed of the representatives of the higher education institutions, the Academy of Sciences, and other social partners (associations etc.). In 1998, the Council prepared a draft National Conception on the Development of Higher Education
Institutions (Higher Education Council 1998), which was the first strategic document to foresee the reorganisation of the higher education system in Latvia. The document was approved by the government in 2001.

As discussed earlier, the funding for each higher education institution is provided by the founding ministry. Unlike for independent research institutes, the basic funding for these organisations is provided by the government. This funding comprises funding for the optimal number of education programmes and students, including the cost of utilities, taxes, upkeep of infrastructure and procurement of new machinery, research costs and salaries.

The allocation of resources is highly regulated and the state in its assignment of funds determines how much universities are allowed to spend on expenses. Furthermore, although, in theory, the costs should be linked to the cost of the student studying for a particular degree and in 1999 the government developed a nominal cost for each state subsidised student place, the lack of funding did not allow this to be fully implemented in practice, hence, the allocated funding is not in proportion to the number of subsidised student places (Kasa 2002). Moreover, the funding is planned and assigned per academic year, which does not provide for any long-term planning. Finally, higher education institutions must supplement their budget from the intake of fees from students not subsidised by the government.

The allocation of research funding to higher education institutions has been minimal. Universities and other teaching bodies have to apply for grant funding and to compete with the research institutes. This situation has persisted throughout the 1990-ies and early 2000s; however, positive changes have been observed in recent years. According to the Rector of the Riga Technical University, Ivars Knets (2007), for the last fifteen years, higher education institutions have suffered from lack of monetary resources, which have affected the ability of these institutions to recruit the optimal number of staff and doctoral students, as well as the ability to update and secure necessary research infrastructure. In recent years, with the introduction of baseline funding, and funding for the development of research capability in institutions of higher education (up to 1% of the higher education budget), has helped to develop the research capacity at higher education institutions. Furthermore, higher
education institutions are increasingly collaborating among themselves, mainly, in training young researchers, whereas collaboration between universities and research institutes is largely dependent on the leaders on individual projects (ibid. 2007).

The Government

The Parliament (Saeima) approves a ten-year strategy for the development of science and technology and the state budget for scientific activity. It also passes legislation in all areas of state governance including laws pertaining to science and education, which are approved by the President. The Parliamentary Commission responsible for science is the Commission for Education, Culture and Science, including the sub-commission for the Future Development of Latvia. The Commission responsible for innovation is the Commission for the State Economy, Agriculture, the Environment and Regional Policy. The composition of these commissions is determined by the Parliament.

The Cabinet of Ministers lays down the state policy for the development of science and technology, approves the criteria for the evaluation of research projects and research programmes, and the criteria evaluating the efficiency of research institutions. Furthermore, it approves the priority fields of science and state research programmes, as well as the control procedure for the utilisation of this funding. The Cabinet of Ministers enforces these in form of Cabinet Decrees or regulations. Finally, it also submits the science budget to the Parliament and determines the yearly increase in funding for scientific activity, which according to Article 33.2 of the current Law on Scientific Activity (Saeima 2005a) should be at least 0.15% of the GDP until the total budget for scientific activity represents 1% of the GDP.

Despite the de facto duties of the government in setting strategic priorities and broad policy guidelines for research and development, the majority of interviewees, representing a wide range of stakeholders (universities, research institutes, the Academy, the Latvian Council of Science), have all commented on the negligence of science and technology by the higher authorities throughout most of the independence period (Anonymous A 2010, Grens 2007, Kristapsons 2007, Silins
Furthermore, others have portrayed the work of these authorities as ineffective (Anonymous A 2010, Anonymous B 2010, Avotins 2010, Vitola 2010). However, certain positive developments (in terms of government approval of initiatives) have been noted, such as the international evaluation of Latvian research by the Danish Research Councils in 1992, the association of Latvia to the Community Framework Programme for Research and Technological Development, and the development of the Lisbon Strategy, which put science and innovation at the forefront of government strategy (Silins 2007). At the same time, the higher levels of government, supported by the Ministry of Finance, have shown significant levels of resistance, in particular, to budget increases (ibid. 2007). A case in point has been the abovementioned provision on a constant budget increase in the Law on Scientific Activity, resistance to which by the Ministry of Finance has been particularly strong during the process of drafting the said legal provisions (Bundule 2007).

The Ministry of Education and Science is the main policy making body in the field of education, science, sport and the official language. Its duties are to formulate policies in the field and to organise and coordinate their delivery. As outlined earlier in Figure 3, public research organisations are either directly subordinate to the ministry, or under the supervision of the ministry. There are a total number of 118 institutions that fall into these two categories. The Ministry also is a shareholder in 11 other organisations and two funds.

The Ministry of Education and Science is organised into departments, where the Department of Science, Technology and Innovation (previously, matters of science have been dealt with at the Department of Higher Education and Science) is responsible for the development, organisation and coordination of science, technology and innovation policy. Other duties of the department include the facilitation, support and coordination of funding of European Union Structural Funds in the general areas of science and education, the establishment of national initiatives and the coordination of participation in international programmes in its area of competence. In addition to this, the department also carries out mainstream civil service functions, such as the drafting of legislation, policies and the budget, engages in consultation and represents the interests of the Ministry, as well as commissions research projects.
The Ministry of Education and Science has been characterised as fairly inefficient by some interviewees, in particular, respondents have cited the small administrative capacity and the lack of necessary expertise (Anonymous A 2010, Kristapsons 2007), as well as “unsolved administrative irregularities” (Silins 2007) as contributing to this inefficiency. At the same time, the representative of the Ministry acknowledged the cooperation between the Ministry and various stakeholders involved in and affected by the policy process (i.e. the Latvian Council of Science, the Latvian Academy of Sciences and universities) but expressed regret that there is a lack of interest from other ministries (Bundule 2007).

The Ministry of Economics is responsible for the drafting and implementation of policies concerned with the national economy, industrial policy, energy policy, external and internal economic policy, commercial development policy, promotion of competition and technology policy, investment policy, and policies in the field of consumer protection. In particular, the Ministry is responsible for the development and implementation of innovation policy, e-commerce and the promotion of small and medium enterprises. Institutions that are subordinate to the Ministry include the Competition Council and the Latvian Investment and Development Agency (overseen by), as well as advisory boards such as the Economic Board and the Small and Medium Enterprise and Trade Board. The Ministry oversees a total of 13 institutions, and is the shareholder in 6 enterprises.

The Department of Commerce and Industry within the ministry consists of four units: the industrial development unit, the commercial development unit, the innovation unit, and the technical standards unit. The Department is responsible for the formulation and implementation of policy in the abovementioned areas, as well as for the drafting of the budget in these areas. Other duties include the development of proposals for policy instruments, proposals for the utilisation of European Union Structural Funds in the area of innovation, and engagement with the stakeholders and the public at large.

The Ministry of Economics has been designated as the main developer of innovation policy and strategy, whereas the Ministry of Education and Science has been largely
responsible for science and technology policy. Such a division of policy areas is largely based on historical circumstances (Vanaga 2007), and has led to a clear divide of focus in the overall strategy for science, technology and innovation, with a split between basic and applied research and deployment (Anonymous B 2010). Furthermore, during interviews, the lack of coordination between the two ministries has been noted (Kristapsons 2007) in explaining the ineffectiveness of the organisations. At the same time, it has been pointed that attempts at coordination of policies have been made, albeit unsuccessfully (Anonymous B 2010) and somewhat sporadically (Avotins 2007). The representatives of the respective ministries, however, state that there has been an improvement in coordination, and that administrative arrangements for consultation are in place (Bundule 2007, Vanaga 2007).

In 2004, the President in agreement with the Prime Minister established the **Commission of Strategic Analysis**, which is a collegial institution under the auspice of the President. It consists of senior academics and its aim is to “generate a long-term vision of Latvia’s development through interdisciplinary and future-oriented studies” (Chancery of the President of Latvia 2007). The research areas the commission is active consist of:

- Latvia’s economic development,
- education, scientific research, technological development and innovation,
- the quality of life in Latvia and its dynamics,
- population changes,
- Latvia in world politics,
- global agenda (ibid. 2007).

The Commission was the first committee of this kind dedicated to dealing with science and technology policy at such a high governmental level. However, despite its positive contribution to policy orientations (largely in the area of science policy) as an advisory body to the government, the Commission does not have any executive power (Silins 2007). Nevertheless, it is claimed to have considerable influence in formulating policy (Kristapsons 2007).
Another, recently (2007) established advisory body is the **National Development Council**, which has been created to oversee the wider long-term strategy of national development. It consists of the members of the Cabinet of Ministers, as well as other stakeholders. This is the first advisory body that has been specifically created to deal with strategic issues of national development in Latvia since the break-up of the Soviet Union, furthermore, this is also the first advisory body, which has involved such a large constituency of stakeholders. The effectiveness of this body; however, remains to be seen.

**Figure 4: The Structure of the Current Latvian Research System**

![Figure 4: The Structure of the Current Latvian Research System](image)

In Review

In the early transition period, the Latvian Academy of Sciences was reorganised into an association of the scientific elite in Latvia and a new structure – the Latvian Council of Science was to take its place as the funder and administrator of the new system. The research institutes, on the other hand, were declared independent of the Academy and, in the absence of the established governance framework at the time, the former planning, funding, and evaluation mechanisms ceased to exist. One notable change in recent years has been the increasing significance of the Ministry of Education and Science, and the Ministry of Economy, as well as the establishment of several advisory bodies. Over time, these governance structures have started to regain increasing control over the research system, but in the initial stages of reform, they were largely absent. Thus, once could argue that the Latvian Council of Science has been the single focal point of the research administration, and especially, research funding in Latvia for the best part of the existence of the new system. This begs for a further investigation of its structure and organisational principles, in the context of the overall funding reform.

The Research Funding Reform

Between the second half of 1988 and all throughout 1989, the administrative and funding reforms of the Latvian research system were on the agenda of the various stakeholders involved – the Latvian Academy of Sciences, the newly established Union of Scientists, the Council of Rectors of higher education institutions, and widely discussed up and down the hallways of every research institute, and in the press. However, during 1990 and partially throughout 1991, Latvian research still received centralised funding from the budget of the USSR. This funding was distributed by the Presidium of the Latvian Academy of Sciences, which also submitted opinions on funding to be granted by the central authorities in Moscow for the different fields of research. Research institutes (especially in the technical sciences), on the other hand, received a large amount of their funding (ranging from 1/3 up to 1/2) through contractual research financed by all-Union departments, including military organisations and large factories (primarily, outside Latvia), which put the research institutes outside the direct influence of the Academy of Sciences.
However, the Academy still requested deductions for centralised expenses, and fairly frequently funding decisions included a degree of bias (Stradins 1998).

To this end, a joint commission (set up in 1989) and composed of members of the Latvian Academy of Sciences, the Latvian Union of Scientists, and members representing the higher education institutions and research institutes in Latvia presented a joint proposal of a new funding and administrative system (see Figure 4).

**Figure 5: The Main Principles of the New Administrative and Funding System**

- The new administrative system must be linked to the system of research funding.
- The new system must be democratic in nature, where suggestions for funding certain branches of science, programmes or individual research projects must be left to experts in the field i.e. the scientists themselves. Furthermore, funding should be distributed taking into account the level of development and the future prospects of each branch of science.
- The new system is applicable to the fraction of research endeavour that is funded from the state budget of the republic (i.e. the Latvian SSR) and other sources at the national level (mainly, fundamental research). The system does not apply to research projects, which are initiated and funded on the basis of contracts with institutions within or outside of the republic, or research that is commissioned by all-union or international institutions on the basis of previous competitions.
- A competitive system should be widely used in funding scientific research.
- The engagement of scientists in concrete research projects should be governed by contractual agreements.
- A system of research evaluation must be established with the aim of providing opinion on specific research proposals and research results.

Source: Latvian Academy of Sciences (1989)

The new administrative and funding principles were adopted swiftly, effectively transforming the structure of the Latvian research system (as illustrated in the
The Latvian Council of Science took over the administrative and funding duties previously performed by the Latvian Academy of Sciences and was tasked to institute the new competitive funding principles. Eighteen years later, the Latvian Council of Science still plays a strategic role in the research system and is responsible for the funding and evaluation of the majority of funding programmes. The evolution of funding instruments is depicted in Figure 6 below.

**Figure 6: A Timeline of the Main Funding Reforms in Latvia**

Between 1990 and 2007, a number of funding instruments have been gradually introduced in Latvia, starting from the Basic and Applied Research Grants in Programme in 1991 to baseline funding in 2005. Most of these funding instruments have shared similar types of funding, disbursement and evaluation mechanisms. An overview of the characteristics of these instruments is provided in Table 1 below.
The majority of these instruments (with the exception of centralised and baseline funding) have been distributed through grants, either to individual researchers, research groups or organisations. Furthermore, the Latvian Council of Science has been the main evaluator and funder of these proposals. Only recently (2005), the Ministry of Education and Science has begun to play a greater role in funding research in Latvia through the State Research Programmes and by disbursing baseline funding. The evaluations, however, are almost exclusively carried out by (or involving) the expert commissions of the Council. The individual funding instruments and mechanisms are described in detail in the next section.

Research Funding Instruments and Mechanisms in Latvia

The new funding system of competitive grants, subsequently known as the Basic and Applied Research Grants Programme, came into effect on the 1st January 1991; at the same time, the scientific organisations still received some centralised funding from the USSR for fundamental research and any expenses relating to the facilitation thereof. Hence, the overall amount of funding earmarked for grants in the first year was very small, but “by the end of 1991, the scientific establishment had to cardinally reorient itself, to move to functioning in the conditions presented by a small country with completely different possibilities and priorities than before”
(Stradins 1998, p.356). As a result, competitive grant funding became the main source of national research funding in Latvia.

The Basic and Applied Research Grants Programme has comprised the largest share of the state budget for research activities between its inception in 1991 (where 92% of all research funding was distributed through grants) and 2005, when this share dropped to 37% (own calculation, based on data from the Latvian Council of Science and the annual budget). At the same time, the amount of funding, in absolute numbers has remained roughly the same. This can be explained by the diversification of the funding instruments and only slight increases in the overall national budget for research activities (excluding European Union and baseline funding) throughout the observed period.

As reported by one of the main leaders of the reform in an interview (Grens 2007), at the earlier planning stages, the proposed funding reform foresaw grant funding (implemented through the Basic and Applied Research Grants Programme) as the main funding mechanism for funding research with the underlying assumption that additional organisational funding would be provided by the government. However, due to the scarcity of resources, centralised funding was only available to common research facilities, such as the Academic Library, the Botanical Gardens and other supporting institutions. Therefore, in practice, the bulk of the grant received for any individual proposal was channelled towards the salary and overheads paid to the parent institution. The overheads for infrastructure in universities have been estimated to represent 16-20% of the grant, whereas in research institutes this share has been as high as 26-30% (Knets 1999).

The grant awarding mechanism entails an annual call for proposals, which are then evaluated by the respective expert commission of the Latvian Council of Science applying standard peer-review criteria (i.e. quality of the proposed research and previous achievements of the research team). Subsequent awards to project proposals are made for up to four years. However, as the budget for science is decided by the government on an annual basis, the project funding is being awarded for a year and continued in any subsequent year, subject to satisfactory performance (Helms 1993).
The latter has been largely a principle that due to scarcity of funding has not been enforced, and very few projects have actually been terminated.

Between the years 1990-1992, the Council developed guidelines for the evaluation of proposals and applied these to approximately 1,000 research proposals submitted for the first round of funding. As a result of this evaluation, funding was granted for 830 project proposals and 154 proposals were declined; the financial resources allocated to each project were comparatively low due to the limited amount of overall funding available, on the one hand, and the considerable demand for funding, on the other (Latvian Council of Science 1991). In 2006, the Council still funded 685 basic and applied research projects annually (Latvian Council of Science 2006a), which points to the prevalence of a proliferation of a multitude of small grants.

Being the largest single source of national funding for basic and applied research for nearly fifteen years, the programme has played an important role in the functioning of the research system. It has been remarked during interviews that, in the early years of its existence, the programme had brought a positive contribution to eliminating the large apparatus of weak research prevalent in the Soviet period (Grens 2007, Silins 2007). In fact, the original rationale for the competitive grant system has been summarised by one interviewee as: “money needs to be given to the outstanding [researchers]”; however, this principle of competitiveness has only been effective in the first two years of the programme (Kristapsons 2007). Subsequently, the programme has been referred to as “semi-objective” (Grens 2007) in disbursing funding and largely ineffective in either increasing research output or quality (Anonymous A 2010, Anonymous B 2010). To counteract this, evaluation of project proposals involving international experts has been called for; however, the lack of resources has so far prevented the institution of this practice (Grens 2007, Kristapsons 2007).

The main single contributing factor to this ineffectiveness of the programme throughout the 1990-ies and early 2000s has been the persistent lack of funding; hence, this period has been largely described as one of “stagnation” (Bundule 2007) and “survival” (Grens 2007). This has made it nearly impossible to apply the
established criteria without leaving whole research areas without funding (ibid. 2007).

Other confounding factors contributing to the ineffectiveness of the programme have been structural in nature. Firstly, the original configuration of the Council (with the establishment of fourteen expert commissions to disburse the funding) has been thought of as excessive, given the small size of the research system (Kristapsons 2007). Consequently, in 2006, the fourteen expert commissions have been merged into five. Secondly, the introduction of five priority fields, which should receive funding as a matter of priority, and the subsequent enlargement of these to nine fields, has done little to ease the application of the selection criteria (ibid. 2007). Finally, other, supplementary programmes have been introduced over the past fifteen years, but none of these programmes have been as large as the Basic and Applied Research Grants Programme, up until the introduction of State Research Programmes in 2005. These funding mechanisms and instruments are outlined in more detail below.

A programme for market-oriented research was established on the initiative of the Science Department of the Ministry of Education in 1993 (Balodis 1993). Originally, the programme was assigned 11% of the total funding for research from the budget of the Ministry of Education and Science in 1994 and was aimed at subsidising research carried out by small and medium enterprises in areas where there was a market demand. The projects proposals were evaluated in very much the same fashion as grant project applications (involving experts from the commissions of the Science Council and/or other independent assessors). The main criteria for the obtainment of funding were the viability of the project and its innovative nature (e.g. a novel approach to an existing problem or new products or services with market appeal) (Ministry of Education 1993).

Throughout its operation, the funding for the programme has gradually decreased as a percentage of the public research budget, from 11% in 1994 to 2% in 2007 (own calculations based on data from the Latvian Council of Science and annual budgets). As in the case of the Basic and Applied Research Projects Programme, this can be explained by the budget for market-oriented research projects remaining the same (in
absolute numbers) in face of an increased aggregate research budget. The programme has been favourable insofar as to provide an alternative mechanism for applied research funding, as well as an incentive for supporting the local economy through research (European Communities 2008b). At the same time, the success of this programme to date has not been fully evaluated and its impact on the economy and the strengthening of academia-industry links is still to be seen. In addition, the programme administration by the Ministry of Education and Science has received criticism from the State Audit Office (2006), which found notable procedural inconsistencies in the selection, funding and the evaluation of projects. Finally, in recent years, it has been commented that the programme has practically ceased to exist (Stabulnieks 2009, 2010).

The Joint Research Projects Programme⁴ was instituted in 1995 on the initiative of the Latvian Council of Science and as an extension to the Basic and Applied Research Projects Programme. This programme facilitated the execution of collaborative projects between different research organisations in Latvia, carrying out research in a specific field or addressing interdisciplinary topics (as opposed to individual research projects in the context of the Basic and Applied Research Projects Programme). The programme was set up as a response to the limited funding that was available for any single project through the original programme, and to enable the undertaking of larger research projects (European Communities 2009).

The aim of these new joint research projects was fourfold: firstly, to promote new research areas of benefit and importance to the development of the Latvian nation state; secondly, to encourage collaboration between researchers from different scientific disciplines; thirdly, to improve the organisational structure of the research system insofar as bringing together different institutes and research groups (as opposed to research groups within the same or similarly specialising institutes competing for grants); and finally, to prevent the fragmentation of resources, thereby supporting the research infrastructure and teaching efforts (Zvidrins 1995).

⁴ Prior to 2005, the Joint Research Projects Programme and its projects have also been referred to in the literature as National Research Programmes. However, the name Joint Research Projects Programme has been used throughout the text to avoid confusion with State Research Programmes introduced in 2005.
Unlike in the Basic and Applied Research Grants Programme, a two-step process was put in place comprising a first phase of expressions of interest from the researchers on suitable themes and a second phase of proposal submission (ibid. 1995). The implementation of this funding instrument as a two step process, whereby the first phase embodies the proposal of themes by the future beneficiaries of the programme, testifies to the extensive autonomy enjoyed by the research community, on the one hand, and the lack of policy direction from the science administration, on the other.

Following the initial consultation with the research community, the Latvian Science Council formulated five themes:

- Natural Resources and Ecological Stability in Latvia,
- Inhabitants of Latvia and National Health,
- Letonica (Latvian Studies),
- Competitiveness of Latvian Science and Economic Productivity

Contrary to the established mechanism of awarding grants to individual researchers or research groups, these grants were awarded to research organisations. The evaluation of project applications within these programmes paid special attention to the following criteria: the importance of the research to the national economy and culture, and to the creation of new intellectual capital and its preservation, as well as the scientific merit of the proposed research and of the researchers (Latvian Council of Science 1994a, 1994b).

For the administration and evaluation of the programmes two new committees (three people each) were established, comprising members from the Latvian Council of Science, the Ministry of Education and Science, and the Rectors Council of Higher Education Institutions. The selected proposals were then funded by the Latvian Council of Science (ibid. 1994a, 1994b).
Between 1995 and 1998, the level of funding for the programme was very low and comprised only around 5% of the grant funding. However, in 1999, the grant funding for Basic and Applied Research Grants Programme and the Joint Research Projects Programme was distributed in proportion of 3:1 (i.e. 25% of the grant funding for the latter) (own calculations, based on data provided by the Latvian Council of Science).

Additional funding mechanisms, such as the support for doctoral studies and international cooperation, as well as small infrastructure payments emerged in 1995, albeit on a very limited scale (1-2% of the subsequently allocated overall budget for research activities). Initially, the Ministry of Finance (responsible for the allocation of the budgetary resources, in the first instance) refused to consider any funding for infrastructure, claiming that the upkeep, maintenance and any procurement of new infrastructure was the responsibility of individual research organisations. Furthermore, the Ministry was reluctant to factor in the inflation rate, which, at the time, was an exorbitant 25% (Knets 1995).

The introduction of these new funding instruments proved ineffective in securing substantial levels of further government funding for research organisations, despite the budget proposal put forth by the Latvian Council of Science (1994b), which originally foresaw an increase in overall funding for science by 70% (18% of which was earmarked for the Joint Research Projects Programme). Finally, a 19% annual increase from previous year’s budget was approved by the government (Anonymous 1995, Saeima 1995a), which was effectively less than the reported inflation rate.

Significant budget increases were also unsuccessful in spite of the subsequent recommendations from the European Union to increase research and development funding as part of fulfilling the accession criteria (European Communities 2004). By and large, this policy produced the effect of resource reshuffling.

A further attempt to consolidate research funding and to redistribute the constant proportions of funding between the research areas (Kristapsons 2007) was made with the establishment of priority research areas in 2001, which would make certain research areas of importance eligible for priority funding through the Basic and
Applied Research Projects Programme and the Joint Research Projects Programme. For the period of 2002-2005, the following areas were:

- Information Technologies,
- Organic Synthesis and Biomedicine,
- Material Sciences,
- Wood Sciences and Pulp Technologies,
- Letonica (the study of Latvian language, culture and history) (Cabinet of Ministers 2001).

Despite the introduction of these priorities, no further change to the share of funding for the abovementioned fields under the Basic and Applied Research Project Programme or Joint Research Projects Programme in the years of 2002-2004 were observed and only minor increases were registered in 2005 (see Annex D for detailed figures).

In 2006, a new set of priority fields were announced for the period of 2006-2009 (Cabinet of Ministers 2006). These were:

- Information Technologies,
- Organic Synthesis and Biomedicine,
- Materials Science,
- Forestry and Wood Processing Technology,
- Letonica (Latvian Studies),
- Agro-biotechnology,
- Medical Science,
- Energy, and
- Environmental Science (Cabinet of Ministers 2006).

In essence, this represented an extension of the previous five fields by the subdivision of some areas (i.e. Organic Synthesis and Biomedicine was replaced by Agro-biotechnology, Biomedicine and Pharmacy, and Medical Science) and the inclusion of others (i.e. Energy and Environmental Science), effectively resulting in nine priority areas. According to a witness to the transition process (Kristapsons
2007), the institution of almost all research fields as priority areas, presented a coping mechanism in view of very scarce monetary resources. As in the previous reference period, no significant changes in the distribution of funding were observed but overall funding for the programme increased by over 20% between 2006 and 2007 (own calculations, based on various sources of data provided by the Latvian Academy of Sciences and the Ministry of Education and Science).

**State research programmes** were already envisaged in the legal documentation as of 1999 (Saeima 1999) but were officially established only in 2005 as a policy instrument to promote fields of research important to the economy and society. Overall, these programmes focus on the promotion of research in the nine priority areas outlined in the previous section.

Their specific aims and objectives are established by the various research ministries in consultation with the Latvian Council of Science, the Latvian Academy of Sciences and other stakeholders. The areas of research are proposed by the Council and approved by the Minister for Education and Science and funded by the Ministry of Education and Science directly (Saeima 2005a). As with previous funding instruments, state research programmes are evaluated by the expert commissions, in terms of their research quality, but, additionally, an independent economic evaluation is also carried out. A supervisory board, including members of the government, industry and academia has been set up to periodically evaluate the implementation of the programmes (Cabinet of Ministers 2006c).

Ten percent of the total budget for science was allocated to funding State Research Programmes in the first year (i.e. 2005), rising to 16% in the third year of operation (2007). In absolute terms, in the second year, the funding increased by over 60%, and doubled from year 2006-2007 (own calculations based on data provided in Saeima 2004, 2005b, 2006).

Alongside the State Research Programmes, a small part of research funding (6.4% in 2001 and less than 1% in 2003) (Ministry of Education and Science 2001, 2003) has been allocated to **state-commissioned research projects**. These projects are ad hoc projects commissioned by the government to tackle certain problems requiring
scientific expertise. These are commissioned and funded by the procuring ministry on a competitive basis (prior to 2005, all projects were funded by the Ministry of Education and Science). The projects are evaluated by the expert commissions of the Latvian Council of Science (Cabinet of Ministers 2002).

The scarcity of resources in the early 1990-ies did not permit the implementation of comprehensive baseline funding. As mentioned earlier, some baseline funding was provided for the upkeep of common infrastructure and research facilities (incl. libraries, and the Academy but not research institutes or universities), but even those resources largely went to the payment of salaries and utilities. In the period of 1994-2004, this funding represented around 20-25% of the total national budget for science (own calculations based on data provided by the Latvian Council of Science and the Ministry of Education and Science).

Specific provisions for baseline funding came into effect with the adoption of the new Law on Scientific Activity in 2005 (Saeima 2005a). The law stipulates that baseline funding is provided by the founder of the research organisation (often the ministry under the auspices of which the organisation is placed) and it is distributed in block grants. It comprises expenditure on the upkeep of infrastructure, the coverage of expenses (e.g. utilities) and personnel costs of technical and support personnel and personnel involved in the projects commissioned by the founding body (other personnel costs are still covered by grant funding) (ibid. 2005a). In determining the level of support, there are a number of variables taken into account (e.g. number of personnel, consumption of resources etc) to calculate the exact amount of funding. A coefficient is applied to distinguish resource-intensive fields (i.e. natural sciences) from research fields requiring smaller research resources (Cabinet of Ministers 2005).

The implementation of the said provisions in the first two years was hampered by the lack of budgetary provisions. In a response to a letter of the Latvian Education and Science Workers Union, enquiring about the shortages in the baseline funding made available to the research organisations, the Minister of Education and Science (Druviete 2006, p.1) stated that “the necessary amount of baseline funding significantly exceeded the government budget provisions for this aim, and hence it
has been proportionally reduced for all organisations”. Overall, baseline funding increased only marginally from 2005-2006; however, in 2007 baseline funding (representing 38% of the national budget) was paid out in full (Ministry of Education and Science 2007a).

Baseline funding for research was implemented as a response to the extremely dated research infrastructure. Some steps towards improving the research base in terms of equipment had already been made a year earlier with the introduction of European Structural Funds (a more detailed discussion of these support initiatives is provided in the next section).

**European Support for Research**

In 1995, Latvia signed the Association Agreement with the European Union and shortly afterward expressed its wish to join the Union. The Association Agreement entitled Latvia to participate in designated support programmes for research, such as the Cooperation with Third Countries and International Organisations (INCO), as part of the Fourth European Community Framework Programme for Research and Technological Development (1994-1998), and as an associate member, under more lenient conditions, in the Fifth European Union Framework Programme for Research and Technical Development (1998-2002). This proved to be an important boost for the financially restricted research system, as an additional provision of 15 million Euros was secured in 178 projects (out of a total of 667 proposals submitted), throughout the lifetime of the Fifth Framework Programme (Rambaka 2003, Ministry of Education and Science 2005a). This represented an average of 3.76 million Euros per year, and around 10% of the government expenditure for research in the given period. Latvia continued its participation in the Sixth and the Seventh Framework Programme. Throughout the former, Latvian research organisations participated in 998 project proposal submissions with a success rate of 21% (i.e. 198 successful projects), and obtained 18.6m Euros (an annual average of 4.65m Euros) in funding (European Communities 2008c, Ministry of Education and Science 2007b).
The significance and the benefits of the funding received by Latvian research organisations through the Framework Programme was unequivocally confirmed through the fieldwork conducted (Anonymous A 2010, Anonymous B 2010, Anonymous C 2010, Avotins 2010, Grens 2007, Knets 2007, Kristapsons 2007, Silins 2007, Vitola 2010). Many respondents agreed that the Framework Programme has been important in increasing the quality of research and the competitiveness of researchers. Furthermore, prior to the accession of Latvia to the European Union, the Framework Programme and, in some cases, other international funding mechanisms on a smaller scale (such as the Eureka initiative, support from the Soros Foundation and from UNESCO), have proven to be one of the few alternative routes of securing research funding, in response to the meagre national provisions for research (Grens 2007). The weight of external funding is also demonstrated by the significant share (an average of 25%) of this funding in the GERD throughout the period (a more detailed description of aggregate funding flows is provided toward the end of this chapter).

Upon the accession of Latvia to the European Union in 2004, the research system received an additional boost of funding as part of the European Union Structural Funds. Support for the development of the national research system and for innovation was foreseen by, both, the European Regional Development Fund (ERDF) and the European Social Fund (ESF). These activities were jointly funded by the EU (75% of the total funding) and by the national government (25%). In essence, in 2004, the European funding was the only additional source of funding in the budget in supplementing the grant mechanisms, as State Research Programmes and baseline funding started became operational only in 2005.

The national strategy for Structural Funds in Latvia – the Single Programming Document 2004-2006 (Ministry of Finance 2003) emphasised the need for updating of the country's outdated research base and introduced the measure 'Development of Public Research' under the ERDF's priority 'Promotion of Enterprise and Innovation', as well as the measure 'Development of Education and Continuing Training' of the ESF's priority 'Development of Human Resources and Promotion of Employment' to attract young researchers.
Under the ERDF's 'Development of Public Research' measure, two activities were implemented, namely:

- 'Support for Applied Research Projects in State Research Institutions', and
- 'Provision of Modern Equipment and Infrastructure in State Research Institutions'.

The ‘Support for Applied Research Projects in State Research Institutions’ initiative was implemented on a competitive basis by funding specific research projects, and in its execution and evaluation mirrored that of the existing national grant project programmes. Overall, forty-two projects in twenty organisations have been supported in four priority areas i.e. material science, organic synthesis and biomedicine, information technologies, and wood sciences and pulp technologies (Ministry of Education and Science 2007a).

The 'Provision of Modern Equipment and Infrastructure in State Research Institutions' initiative was implemented as a national programme with funding assigned to specific research organisations. Forty-three projects in nineteen research organisations have been funded in eight of the nine priority areas. The overall funding provided for the two initiatives was 32.7m Euros (Ministry of Finance 2009).

The ESF's activity 'Support for the Implementation of Doctoral Programmes and Post-doctoral Research' was carried out as a national programme, where funding was provided to the five main universities in Latvia to train doctoral students and post-doctoral researchers. The ESF activity comprised funding of around 10m Euros (Ministry of Finance 2009).

In the years 2004-2006, the funding provided through the Structural Funds proved to be a significant boost to the national science budget, making up around 30% of the total budget in 2004, 22% in 2005 and 20% in 2006 (own calculations based on data of Ministry of Education and Science 2004c, 2005b, 2006). Furthermore, by committing to channel Structural Funds toward research and innovation, the government also committed to cover a quarter of this increase.
The significance of the influx of funding for infrastructure, applied research projects and the training of early-career researchers has been acknowledged in the literature (Kristapsons, Ulnicane and Adamsone-Fiskovic 2006, Rammer, Sellenthin, and Holmberg 2007, Arnold 2010), and remarked on positively by the interviewees. Some of the favourable benefits of the activities under the Structural Funds noted by respondents have been the accessibility of funding to a larger constituency of research performers, intensification of research activity in universities (Anonymous A 2007), modernisation of infrastructure (Bunudule 2007, Knets 2007), and their contribution to the return of Latvian researchers from employment abroad (Bundule 2007, Grens 2007).

Overall, Structural Funds “have acted as a crucial substitution of the limited local (national) funding and have allowed for the introduction of measures addressing several of previously identified challenges within the national research and innovation system” (Anonymous B 2010). At the same time, some concerns were voiced on the ability of the Latvian research system to effectively absorb and utilise this funding (Grens 2007).

**Other Funding Mechanisms**

An alternative strategy of some research organisations has been the conclusion of contractual agreements with foreign companies (Grens 2007), the main benefactors of which have been research institutes with a strong applied research orientation. This mechanism has been judged fairly important in terms of boosting the quality of research and the competitiveness of researchers (Anonymous B 2010). However, the overall provision of private funding for research and innovative activities (either intramural or extramural) has been reported as weak by the majority of interviewees. Finally, the adequate assessment on the provision of private funding for research is cumbersome, due to the constrained availability of either aggregate or micro level data. Finally, bilateral and tri-lateral government agreements on collaboration in science have been concluded with several countries (France, Lithuania, Taiwan, Belarus, Ukraine, and Russia) (Bundule 2007).
Concluding Remarks

In Latvia, competitive funding through research grants and distributed by the Latvian Science Council became the main source of national research funding for the first fifteen years of independence. Between 1991 and 1993, it was the only source of state funding (European Communities 2009), and from 1995-2000 grant funding was annually making up around 80% of the already extremely limited state budgetary appropriations for research. Other instruments such as the programme for market oriented research (1994) and national programmes were also disbursed on a project basis. Furthermore, up until 2005, there were no separate budget appropriations (institutional funding) for the upkeep of infrastructure, salaries or any additional costs. All of these were to be covered from the grants received by the respective organisation. Of course, the organisations most affected by this reform were research institutes; universities and other institutions of higher education were largely funded through budget appropriations for higher education.

The radical steps taken in reforming the disbursement of research funding in Latvia was beneficial in the short-term. The institutionalisation of competitive funding in the first years of independence enabled the removal of what Balazs, Faulkner, and Schimank (1995) termed the research ballast – the institutions and research teams that had not been contributing to the productivity of the national system, but were structures fulfilling a role within the larger system of USSR science. This is one of the findings that has also been confirmed by the interviews conducted on site with respondents who have been at the forefront of the reforms in the late 1980-ies and early 1990-ies (Grens 2007, Silins 2007). However, the institution of these new funding principles, coupled with the persistently low funding levels throughout the 1990-ies and early 2000s produced long-term negative effects. Firstly, the low funding levels resulted in the distortion of the competitiveness principle of the new financing system. The critically low funding levels resulted in the adaptation of a coping mechanism that, instead of facilitating adequate level of funding to the best researchers and research teams, distributed the funding proportionally to a large group of good research teams across all research areas. This is also reflected in the
figures of distribution of funding for the respective research areas of the Latvian Council of Science. Furthermore, the research funding under the Basic and Applied Research Programme under which this funding is distributed has, in absolute numbers, not increased and no significant redistribution of funding per field has been undertaken. This is further compounded by the small research system and the absence of independent foreign experts in evaluation. Finally, it has been widely acknowledged that foreign funding, in particular, the European Community Framework Programmes, and the subsequent provision of European Union Structural Funds have contributed significantly to the revival of the system, and to influencing national provision of increased funding for research and innovation. At the same time, the effects of these recent developments on the research system remain to be seen.

Legal and Policy Reform

The legal reform has seen several amendments to the laws and regulations governing scientific activities throughout the transition period. These developments, by their nature, are continuous. Furthermore, the legal reform touches upon all aspects of scientific activity, ranging from the formulation of definitions of all parties involved in the process to the different procedures and duties of the various organisations that comprise the scientific system. Hence, it is extremely difficult to delineate the developments in the legal aspects of science from developments in other spheres of governance, notably, the financial and institutional reform. However, this section attempts to portray the legal reforms insofar as to delineate different formal and informal processes of the organisation and governance of scientific activity. Once again, a timeline of the most significant developments is provided in Figure 6 below.

The legal reform of the Latvian research system began in 1992 with the enactment of the Law on Scientific Activity (Augstaka Padome 1992). This document came into force several years after the establishment of the new administrative and funding system; it was straightforward in its wording and a very simple document with very general provisions. However, overall, the emphasis was on the rights and freedoms of the researcher, frequently citing the prohibition of “censure” and the prohibition of
the placement of “administrative restrictions” on scientific activities. This further reflects a transition towards re-Westernisation and efforts to move away from past ideologies (ibid. 1992).

**Figure 7: A Timeline of the Main Legal and Policy Reforms in Latvia**

The law specifies several entities as comprising the organisational structure of the research administration in Latvia. However, the Ministry of Education and Science is was not to be found among these institutions until the amendments to this law in 1996. According to the Law on Scientific Activity (Augstaka Padome 1992), the state has no right to interfere in the undertakings of the research institutions, insofar as these are not in conflict with the legal provisions of the State.

The responsibility of financing of scientific activities from the state budget lies with the Latvian Science Council, which draws up a budget to be approved by the Parliament and then executes it. The Law on Scientific Activity specifies that budget funding is to be used for project grants to be awarded following a competition, for centrally administered research supporting organisations (such as libraries, state publishing houses), and specific research-related events.
Once again, the law emphasises the liberties of the researcher in this process. The Latvian Science Council has the right to give binding instructions on the way grant funding is used; however, it cannot limit the researchers’ legal capacity in managing their funding. On the other hand, in terms of funding, the law does not make any provisions for research organisations. Hence, these are not to be directly funded by the state budget. Nevertheless, the law specifies a range of activities, which can be undertaken by the research organisations to obtain further income, namely, contractual research agreements, donations, loans etc.

The first amendment to the Law on Scientific Activity (Saeima 1996) was enacted in 1996. First of all, it provided a wider remit for research performers to include enterprises. Secondly, it broadened the scope of duties of the researcher to include not only the duty to make known the findings of research to the wider public but also “to give opinion on the use of modern technologies and management methods for furthering the economic competitiveness of Latvia” and “to participate in the formulation of research activities, whose aim is to further the economic competitiveness of Latvia and to develop the national identity” (Saeima 1996). In addition, for the first time, the law delegates certain rights to the Ministry of Education and Science.

In terms of funding, the law introduces a distinction between fundamental and applied research projects and determines that priority to receive a project grant for fundamental research is to be given to researchers from higher education institutions and only then to researchers from research institutions. It also introduces the notion of market-oriented research projects, which can be undertaken by researchers in state or private enterprises. In this respect, the law reflects the introduction of the new Joint Research Projects Programme and the programme for market-oriented research projects outlined in the previous section. Finally, it is interesting to note that there is hardly any record of decrees (i.e. implementing rules) issued by the Cabinet of Ministers on the basis of this law prior to 1997. According to the official database of state legislation in Latvia (Latvijas Vestnesis 2009), only two decrees were passed on the basis of this law in 1997, one in 1998, yet six decrees were passed in 1999. This, furthermore points to the fact that prior to 1999, the different structures of the
Latvian research system were largely self-governing entities (with the exception of higher education institutions, which are concurrently governed by the Law on Higher Education Institutions (Saeima 1995b)).

The major milestone and importance of the 1998 amendments to the Law on Scientific Activity (Saeima 1998) lies in the clause that specifies that the board of the Latvian Science Council must include one member from the Ministry of Education and Science. Prior to these amendments the Ministry of Education and Science had no representation on the board of the Latvian Science Council and hence, was not party to the decision-making as regards the budget or the distribution of public funding, or even the drafting of science policy.

The status of scientific organisation (i.e. research institutes) has been changed from non-profit institutions to state institutions and whilst previously the definition of a scientific organisation postulated that it is a self-governing entity, this provision has been repealed. In effect, this has meant that the government has legally increased its powers in terms of institutional control. Finally, with regard to these changes, research organisations are governed by government-approved legislation.

A new Law on Scientific Activity (Saeima 2005a) was passed in 2005. This law was notable for the changes that have been made to the obligations and duties of the state and government bodies in relation to the management of research. The law transferred some significant obligations from the Latvian Science Council to the Ministry of Education and Science. Firstly, it compelled the Ministry of Education and Science to draft the science and technology policy of the state, as well as to submit the draft budget for research. Secondly, it relegated the Latvian Science Council to an advisory role in the aforementioned matters. While in previous legislative documents the Latvian Science Council was responsible for the drafting of the policies and the budget, the new law stipulated that the Latvian Science Council make suggestions in these matters. Thus, the law has firmly delegated the responsibility of policy drafting to the government. Finally, as the previous law, it attempted to redefine the legal status of research institutes, for despite the efforts to integrate these institutes and universities; the legal aspects of such an undertaking have been cumbersome.
During the interview process, some of the respondents also remarked on the existing legal framework, in particular on the frequent changes in the legal status of the institutes (Bundule 2007) and resulting lack of stability (Anonymous A 2010), as well as on the inability of the government to define the roles and responsibilities of the actors within the system, and to effectively regulate the relationship between the different legal entities in the system (Anonymous B 2010, Avotins 2010, Vitola 2010). To that end, these uncertainties have also been linked to the wider formulation and implementation of policies, which is the main topic of the next section.

Policy Reform

The policy reform in Latvia and in the other Baltic States has been characterised as consisting of an initial period of self-governance, where, similarly to the legal and organisational reform process, the policy initiation and reform were largely carried out by the scientists themselves, and the subsequent period of increasing government involvement, where “the most significant catalyst for developing a state research and innovation policy (with an emphasis on technological innovation) and setting priorities in all three Baltic States was the adoption of the clear political target of European integration” (Kristapsons, Martinson and Dageyte 2003, p. 146).

The first draft policy that sketched out a long-term strategic view of the development of the national research system was the National Concept on Research Development of the Republic of Latvia (Ekmanis et al. 1998). The paper was drafted within a matter of months in the spring of 1998 by the working group of the Latvian Council of Science. In some aspects, it can be seen as a response to the voluntary and uncoordinated government measures that were observed during the previous years (especially, the top-down fashion in which the integration of the institutes was orchestrated), and at the same time, it was the realisation on the part of the research community that the reforms ought to proceed in a stepwise and though-out fashion (Stradins 1998). To some extent it also responded to the increasing alignment of national policies towards European integration. The paper was submitted to the
government, and taken into consideration, but not officially approved as a
government document (ibid. 1998). Nevertheless, subsequent policy and other
documents have frequently referenced it as the forerunner of government policy

The two principal problems highlighted in the draft paper were the aforementioned
lack of understanding and cooperation between the research community and the
government and the chronic lack of funding. At the same time, the paper recognised
the achievements in reorganising the system so far and the favourable level of
academic science in the international context. The main theses contained in the paper
were:

- to create an intellectual environment for the development of higher education
  and society at large,
- to create a basis for the development of modern technologies, for mechanisms
  that facilitate the introduction of such technologies into the marketplace, as
  well as to foster the extensive use of research methods and approaches in the
  government administration and in the economy,
- to promote a dynamic and balanced social and economic growth and to
  facilitate the preservation of research into the national identity and the cultural
  heritage of the nation (Ekmanis et al. 1998).

In the context of these aims, the paper set forth a proposal to, first and foremost,
increase government funding for science and research to 0.8% of the GDP by 2001,
and to increment it by 0.1% of the GDP annually until 2010. Furthermore, the paper
once more outlined the established priority areas in science that should receive
preferential support. At the same time, it reiterated the priorities set by the Ministry
of Education and Science in cooperating with the European Union, which coincided
with the priorities of the 5th European Framework Programme.

In terms of the organisational framework, the research in fields prioritised by the
government and the European Union should be undertaken in state research centres.
These would be groups of researchers at universities or institutes that would fit in the
proposed framework with regard to the criteria of excellence and the aims and
objectives set out above. These would also be receiving additional funding for infrastructure and other expenses.

The proposal was to be implemented through existing mechanisms, such as the grant system and the state research programmes, where priority would be given to higher education institutions, which train doctoral students, state research centres that undertake research in the prioritized areas, state supported technology centres and science parks, enterprises and other structures that fit the criteria.

Other measures to be taken included the increase of the number of doctoral students (with a target of at least 2000 doctoral students by 2001) and the number of research staff (to 1.2 researchers per 1000 inhabitants in 2000, and 3 researchers per 1000 inhabitants – by 2010), support for international cooperation (further state funding to accommodate the costs of the associate membership to the EU 5th Framework Programme, and funding associated with raising the level of competitiveness of research organisations willing to take part in the Programme), promotion of innovative activity in small and medium enterprises, and fostering of social science and humanities (Ekmanis et al. 1998).

The next policy document of this nature was formulated in 2002 by a sixteen member working group at the Ministry of Education and Science that included the Minister himself, and representatives from the Ministry of Economics, the Ministry of Finance, the Latvian Science Council and the Academy, as well as various higher education institutions. Entitled the Guidelines for the Development of Higher Education, Science and Technologies for 2002-2010 (Ministry of Education and Science 2002b), it was also discussed with the interested parties at a conference organised by the Ministry.

The document shares many similarities in its aims and objectives with its predecessor, the National Concept of Research Development (Ekmanis et al. 1998), at the same time increasingly focusing on the role of innovation and technologies. Broadly, the document encompasses the following guidelines:
to strengthen the leading role of universities in the further development of higher education and science,

- to renew the potential of and to foster research in the field of innovative technologies (Ministry of Education and Science 2002b).

The multitude of the tasks formulated within the Guidelines, on the one hand reiterated the need for prioritising fields of research that are of national importance, for supporting research organisations, doctoral students, research personnel, and innovative enterprises nationally and internationally. On the other hand, it also called for the inclusion of the development of science and research-based technologies in the forthcoming National Development Plan (Ministry of Finance 2001), the National Concept on Innovation (Ministry of Economics 2001) and the National Innovation Programme (Ministry of Economics 2003). Furthermore, the Guidelines indicated proposals on the evaluation of research organisations and the re-assessment and optimisation of the administrative and legal system. Finally, there were a number of quantitative targets that were to be achieved by 2010:

- the number of doctoral students – 4,500,
- the number of professors – 1,000,
- the number of active researchers with a doctorate – 5,000,
- the total number of research personnel – 12,000,
- the state budget for higher education – 1.4% of the GDP,
- the state budget for research and development – 1% of the GDP (0.4% of the GDP – for research at universities),
- the private sector funding for research – 1 – 1.3% of GDP,
- the private sector funding for higher education – 1 – 1.4% of GDP,
- the number of graduates – 30,000,
- the number of graduates with a doctorate – 700,
- the number of SCI publications – 1,000,
- the percentage of high technologies within the export structure – 20 – 25% (Ministry of Education and Science 2002b).

The guidelines were adopted at the ministerial level and have been consulted in further policy development; however, similarly to the National Concept of Research
Another document that was approved by the government in 2001 was the *National Concept on Innovation* (Ministry of Economics 2001) conceived already in 1997. This document was formulated by a working group comprising members from the government, the universities and institutes, and other organisations. The overall aim of the paper was to promote an economy that is open to innovation. The proposed actions ranged from the short-term goals of improving the understanding of science, technology and innovation, and the role these play in the economy at the government level and in society, to longer-term goals of increasing the proportion of high technologies in the export structure and developing a balanced and stable economy. These goals then were to be implemented with the aid of the *National Innovation Programme* (Ministry of Economics 2003), which would propose mechanisms in developing an innovation policy that is in line with the innovation policy of the European Union, identify changes in policies and legislation that are conductive of innovative activity, and coordinate the cooperation of the government and private sector in this matter.

Initially, the National Concept foresaw two alternate arrangements for the implementation of innovation policy in Latvia – it was either to be the competence of the Ministry of Education and Science or the Ministry of Economics. Subsequently, it was decided that it should be the task of the latter, with the provision that other ministries would be included in the decision-making process. In 2003, the Ministry of Economics published the *National Innovation Programme* (ibid. 2003) for the years 2003-2006, which restated and elaborated on the agenda of the National Concept on Innovation. Furthermore, it proposed some impressive targets i.e. an increase in public funding for research from 0.22% to 0.45% of the GDP, and in private funding for research from 0.08% to 0.9% of the GDP, an increase in progressive technologies in the export structures from 16% to 40-50% within three-four years, the foundation of 50-100 new technology oriented companies, to name a few. To achieve this, the Programme called for a raise in the budgetary assignment for research and development in the amount of over Ls 68m, and a redistribution of
the proportion of funds for fundamental and applied research from 60% and 40% to 30% and 70%, respectively (ibid. 2003).

The aforementioned policy documents progressively stressed the issues and possible implementation approaches as found in European policies. The accession of Latvia to the European Union in 2004 saw the introduction of further policy documents of this kind. Science, technology, research and development, innovation and the building of a knowledge-based economy formally became priorities of the new European Union member.

One of the first policy mechanisms approved by the European Commission in 2003 was a programme on the implementation of Structural Funds outlined in the Single Programming Document for Latvia 2004-2006 (Ministry of Finance 2003) under Objective I (promotion of convergence in economic regions that are lagging behind in development) of the European Union cohesion policy. Among its longer term objectives were the promotion of competitiveness, and the development of human resources and infrastructure. As part of this vision, activities for the modernisation of research infrastructure, support to applied research, and to young researchers have been implemented. These activities have already been discussed in greater detail in the previous section on funding reform.

According to Watkins and Agapitova (2004), the majority of these policy papers “clearly describe some of the most critical weaknesses and pressing challenges that Latvia must overcome” (pp. 5-6); however they “tend to downplay policies or programmes that would ... help Latvia to develop an efficient system to absorb and diffuse knowledge produced elsewhere” (p.6). Furthermore, the earlier policy papers have been drafted by different organisations and a lack of coordination has been observed (Kristapsons, Martinson and Dагyte 2003). Finally, these issues have also been raised by, at the time, newly established, Strategic Analysis Commission, whose members have pointed out that the national strategy and policy documents have not been linked to a clear funding perspective (Ekmanis 2005).

In 2005, the Commission’s Education, Science, Technological Development and Innovation Working Group drafted the Guidelines for the Research, Technological
 Development and Innovation Strategy (European Communities 2009). This document can be seen as a follow-up on the previous guidelines and a further attempt to persuade the government to adopt an explicit strategy. An elaborated version of the document to be drafted by the Ministry of Education and Science was foreseen for the approval by the government; however, the adoption of the new guidelines in the Cabinet of Ministers in the fall of 2008 has been postponed indefinitely (ibid. 2009). At the same time, the Working Group of the Strategic Analysis Commission can be credited with the adoption of priority fields in research for the period 2006-2009 by the Cabinet of Ministers (2006a).

In parallel, another strategic document – the National Lisbon Programme for 2005-2008 (Ministry of Economics 2005) was in preparation at the Ministry of Economics in cooperation with other ministries and government agencies. This white paper was subsequently approved by the Cabinet of Ministers.

The Programme stated the national strategy for the achievement of goals set in the Lisbon Agenda, thereby focusing on national growth and employment. A prominent role in the paper was given to science, research and development, and technology transfer. Once again, it brought up the key issues in research policy that have been highlighted by the previous policy drafts. However, in comparison with previous policy papers, a positive trait of this document was the articulation of explicit measures for the achievement of the stated objectives. These measures included:

- increased public investment into research (supported by the legislation) and innovation, and encouragement of funding from the private-sector,
- modernisation of infrastructure at public research institutes and higher education institutions with the help of European Union Structural Funds,
- renewal of the intellectual potential through the provision of scholarships for young researchers,
- promotion of international cooperation by participation in international programmes, and
- implementation of measures for knowledge and technology transfer.
In terms of indicators, the document foresaw a target general expenditure on research and development of 1.5% of GDP by 2010 (The Ministry of Economics 2005).

Historically, a recurring theme within the policy development has been the attempt to formulate clear strategies for research and innovation. Yet, very often, these have not proceeded to the implementation stage. In assessing the development of science, technology and innovation policies, interview respondents in Latvia have also remarked on such issues as the inability of the government to adopt a clear policy stance throughout the 1990-ies and into the 2000s (Kristapsons 2007, Anonymous A 2010), the lack of consistency and continuity (Anonymous A 2010), as well as “long-term commitment to the defined strategic goals” (Anonymous B 2010), the fragmentation of existing guidelines and the low capacity to implement the strategic vision (Avotins 2010).

Respondents have also pointed to the misalignment between the overall government strategy and individual policies, where the former is “insufficiently backed by concrete and efficient policy measures” and existing measures are poorly coordinated (Anonymous B 2010). On the other hand, some progress has been achieved in line with the Europeanisation of Latvian policy, as one of the respondents put it: “the overall strategy is fine, in terms of at least rhetorically prioritising research and innovation, but it has, on numerous occasions, proven to be too unrealistic in its goals (e.g. with regard to the Lisbon target) and detached from the actual capacities of the national innovation system, both in terms of budgetary allocations and the performance capacity” (Anonymous B 2010).

**Evaluation Practices**

Evaluation practice in Latvia in the respective period has been already alluded to in the previous sections, in particular, in the review of the funding reform. To date, research evaluation in Latvia has largely focused on the evaluation of projects and programmes implemented through grants.
Since the establishment of the Latvian Council of Science, the overarching principle for the evaluation of projects, funded through the Basic and Applied Research Projects Programme, has been the quality of research in terms of its contribution to the advancement of science. Initially, the assessment of research quality was governed by the internal rules of the Council and motivated, partially, by the need to relieve the research system of some of the inefficient research structures that were counterproductive to the new conditions, and partially, to introduce an element of competitiveness that would increase productivity (Grens 2007, Silins 2007). Finally, the implicit motive was to move away from the research funding and administration practices of the Soviet Union (where research quality was only one, and not always the determinant factor in funding) to those employed in the West (Grens 2007). However, it was only with the amendment of the Law on Scientific Activity in 1998 (Saeima 1998) that the criteria for the evaluation of projects became legally instituted. It took a further two years for these to be approved by the government and to come into the effect in September 2000 (Cabinet of Ministers 2000).

The quality of research, the project applications were also evaluated against the following criteria:

- their feasibility in terms of the level of funding and other available resources (i.e. the infrastructure);
- the quality of the applicants (the lead researcher and the other participants);
- the prospective application of the research in the economy or, alternatively, its contribution to education and culture;
- the efficient use of funding (ibid. 2000).

The abovementioned criteria also carried a quantitative equivalent, where possible. Thus, the feasibility of research would be determined by the past accomplishments of the lead researcher and the research group or research organisation undertaking the project (i.e. the number of internationally recognised publications, patents, dissertations and participation in international projects) and the availability of infrastructure (ibid. 2000).
The three funding instruments – the Basic and Applied Research Project Programme, the Joint Research Project Programme, and the Market-oriented Research Programme – followed a very similar pattern of evaluation of proposals. All proposals were subject to an evaluation by the experts enlisted by Latvian Council of Science and, in some cases, experts nominated by other stakeholders. Thus, the Latvian Council of Science and its expert commissions form the most influential funding and evaluative body in the country.

De facto, the abovementioned practices resemble closely those applied elsewhere in the world and are consistent with the academic peer-review process. However, as it has been pointed out in the previous sections, and will be further elaborated in subsequent sections on research output and productivity, these mechanisms have not been applied consistently, especially, in relation to requirements to publish internationally and in journals indexed by the Science Citation Index (Kristapsons and Kozlovskis 2009, Dombrovskis 2009, Anonymous A 2010). One interviewee commented on the evaluation practices as not being sufficiently result-oriented but noted that there has been a slight shift, at least in the shape of reporting annual results (Anonymous B 2010). Indeed, from 2006 onward, the Latvian Council of Science has been publishing annual reports on their website, as well as the main results of the projects funded by area (Latvian Council of Science 2006).

Apart from the evaluation capabilities of the Latvian Council of Science, there is hardly any evaluation experience outside the scope of project proposal evaluation. Two notable evaluations have been the evaluation of the Danish Research Councils (1992) of the scientific quality of research organisations in Latvia at the outset of the reform, and the evaluation of research institutes by the Ministry of Education and Science (1996) with the aim of integrating these into research universities. Furthermore, despite frequent recognition that there is a need for international evaluators, no mechanisms have been put in place to facilitate this process. Only as recently as 2005-2006, efforts on behalf of the government have been made to institute a regular reporting and monitoring mechanism of publicly funded research. One of the first areas to set targets and report on these has been the European Union Structural Funds earmarked for research and development. This has been largely as a response to the requirements of the European Commission. However, comprehensive
figures and indicators are still largely absent. Thus, to fill this gap in the secondary data, a quantitative appraisal of the Latvian research system is provided below, and a bibliometric comparative assessment is carried out in Chapter VII.

**Quantitative Assessment of the Latvian Research System**

This section characterises the Latvian research system in quantitative terms, in particular, it illustrates the inputs to the system i.e. the monetary resources available, the research intensity (as reported by the different statistical sources used), as well as dynamics in funding by source and by expenditure in different sectors (based on author’s own calculations).

The available data has been obtained from the Central Statistical Bureau of Latvia (2009) and Eurostat (2009). It covers the period of 1992/1993 to 2007; however, statistically representative and comparable data for Latvia (collected according to the Frascati Manual (2002)) had become available from 1995 onward. Therefore, for reasons of coherence, any data prior to 1998 will be used for illustrative purposes only.

Data for the Business Enterprise Sector (BES) prior to 2000 does not reflect the research activities of the sector, and subsequent data collections (in 2001 and 2002) have not yet yielded statistically representative information (Central Statistical Bureau 2009). Kristapsons, Ulnicane and Adamsone-Fiskovica (2006) illustrate one of the main problems of classifying innovative activity in the Community Innovation Survey, namely, the authors report that over half of the total BES expenditure on R&D was spend on acquisition of new equipment and machinery and only 10% on R&D activities.

**Gross Domestic Expenditure on Research and Development and Research Intensity**

In the ten-year period between 1998 and 2007 the total Gross Domestic Expenditure on Research and Development (GERD) in Latvia has, in nominal terms, increased more than five-fold – from 24m Euros to 125.6m Euros (Eurostat 2009). In real
terms, however, the GERD has grown around three times in the same period with an average annual growth rate (AAGR) of approximately 14.6% year-on-year and a compound annual growth rate (CAGR) of just below 13%. This translates to an expenditure of 60.6m Euros in 1998 and 180.7m Euros in 2007 in Purchasing Power Standard at constant prices of the year 2000.

Aside from statistical sources, hardly any previous research has reported expenditures on research and development in current prices other than for illustrative purposes. However, it is believed that price and inflation adjusted data is more representative of the situation, despite the fact that purchasing parities are usually calculated for a standard basket of consumption goods (not representative of the average costs involved in the undertakings in research and development). Furthermore, it is judged more appropriate for the purposes of comparison (as will be seen in the subsequent chapters).

As can be seen from the graph below (Figure 7), there has been a minute but steady increase of GERD in current prices. However, if adjusted for price level changes and inflation, the real figures demonstrate that the curve presents a slightly more varied picture (to the extent that it is possible on figures of such small scale). In particular, GERD in constant prices has grown much faster from 2004-2006 than in current prices, and even decreased in 2007 (as opposed to the figures reported in nominal terms). This can be largely explained by the high inflation in Latvia throughout the 2000s.

While no statistically comparable data exists for the GERD in the period up to 1998, an estimate of the GERD in current prices has been computed for the period from 1992. According to this calculation, the real GERD in 1992 (74.4 m Euros) was 18% higher than in 1998 and only in 2002, the level of real GERD surpassed the level of expenditure observed in 1992. Overall, the aggregate expenditure has been latent throughout the 1990-ies, where the average GERD has comprised 55.8m Euros. During this period, notable year-on-year increases occurred in 1995 (by 23.7%) and in 2000 (by 22.2%). The former can be explained by the results of the preceding government election, where Prof. A. Silins (a member of the Academy of Sciences) was elected Member of the Parliament and engaged in intense lobbying for the
increase of the science budget (Silins 2007). At the end of 1999, another significant growth of 30% in research funding took place. This signified the second period of latency, which lasted from 2000 to 2003, where the average funding for research comprised 75.8m Euros (Eurostat 2009).

**Figure 8: GERD in Latvia in Current and Constant Prices 1998-2007 (m Euro and m Euro in PPS 2000)**

The third period from 2004-2006 can be described as a period of rapid growth, the GERD increasing, respectively, by 20%, 48% and 40% year-on-year. The onset of this phase of growth coincided with the accession of Latvia to the European Union, which entitled it to receive support from the Community’s Structural Funds. In 2007, though this rate of growth has shown signs of contraction with a year-on-year decrease of 6.5%. No further data beyond 2007 has been collected for the purposes of this study; however, due to the economic slow-down of Latvia and the decrease of the GDP, it can be safely assumed that this trend is most likely to continue.

The abovementioned developments are also reflected in the measurement of research intensity (GERD as a percentage of GDP). This indicator is of particular use when comparing how research expenditure has progressed within the context of the overall development of the economy. According to estimates (Latvian Council of Science 1994b), the Gross Domestic Expenditure on Research and Development (GERD) in
1990 in Latvia comprised 1.6% of the Gross Domestic Product (GDP). In 1991, this figure had dropped to 0.3% of the GDP (Stradins 1998). This coincides with the time Latvia stopped receiving funding from the USSR.

Between the years of 1993 and 2004, the average GERD percentage of the GDP was 0.41%, growing to 0.56% in 2005, and 0.7% in 2006, followed by a decline to 0.59% in 2007 (Eurostat 2009). The most recent data published by the Latvian Statistical Bureau states research intensity in 2008 as 0.61% of the GDP (Central Statistical Bureau 2009). Thus, prior to 2005, despite the increase in research expenditure, research intensity largely remained unchanged within the context of the growing economy.

**GERD by Source of Funds and Sector of Performance**

The previous section illustrated that for the most part of the 1990-ies and early 2000s, the increases in GERD (at constant prices) have been fairly latent, and significant growth took place only from 2004 onwards. Concurrently, this has been mirrored in the similar pattern of growth of research intensity. However, to explain funding dynamics, it is important to ascertain the sources of funding and the sectors of performance, as well as to attribute these to wider processes of transition within the research system. The following section deals with these issues by firstly, looking at the main funders of research activity in Latvia and secondly, at the research performers in receipt of this funding.

Between 1998 and 2007, the government has largely been the main investor in R&D in terms of funding, surpassed by business enterprise sector only in 2004 and 2006. At this point, it must be reiterated that the business enterprise sector data has been collected is not sufficiently statistically representative, and only around 10% of expenditure reported is spent on R&D activities (Kristapsons, Ulnicane and Adamosone-Fiskovica 2006). In addition, most of the BES funding for R&D is spent within the sector; thus, its contribution to the national research system (i.e. to public research and higher education institutions) has been limited. Therefore, this quantitative overview will refrain from a deeper investigation of this particular
sector, and concentrate largely on the government expenditure on R&D and the contribution of foreign sources to the national R&D effort.

During the second half of the 1990-ies, the government funding for R&D made up over a half of the total GERD (see Figure 9). During the period of 1998-2004, government expenditure on R&D remained largely unchanged at an average of just under 33m Euro (with the highest increase at 36.3m Euro in 2001 and the lowest – at 29m Euro in 2004). However, this decline was followed by the doubling of government funds for R&D in 2005 to 63.2m Euros, and growing further to 99.8m Euros in 2007 (Eurostat 2009). On the whole, the government sector funding experienced a compound annual growth rate of nearly 10%, mainly due to the developments in the last 3 years of the respective period.

**Figure 9: GERD by Source of Funds in Latvia, 1998-2007 (in Euro PPS 2000)**

A significant proportion of research funding in Latvia has originated from foreign sources, which up to 2004 included contributions from the EU. In terms of the share...
of foreign funds in the overall GERD structure, in the decade of 1995-2004, foreign funds have constantly exceeded one fifth of the total expenditure as a source of funding, averaging at 25% and even peaking to 35% at the turn of the millennia, but dropping to 1/5 in 2003-2005. In 2006, the funding from abroad declined to 7.5% and has remained at that level also in 2007 (largely due to the accession of Latvia to the EU). On average, only half of this funding has gone to public research organisations and universities between 1998 and 2007 (fluctuating between 20% in 1998 and 80% in 2007).

The stagnant levels of government expenditure on R&D in Latvia up to the year 2004 confirm the unwillingness of the government to provide increased funding and have been unequivocally referred to in all previous studies examining the Latvian research system, and in the interviews conducted (as outlined in the previous sections on funding reform). At the same time, while no comparative figures exist in constant prices; this substantial increase can be partially explained by the utilisation of European Union Structural Funds (SF) for R&D in Latvia during the period of 2004-2007. As seen in the earlier description of the funding system, the government of Latvia established two initiatives in R&D as part of the deployment of SF for public research organisations. And while according to the regulations governing SF, these are shared-cost actions, and the EU contributes only 75% of these costs if the recipient of the funds is a public organisation, the Latvian government was to contribute the remaining 25% from its budget. (It also has to be noted that 100% of this expenditure is included in the aggregate government expenditure figures, as the accession of Latvia to the EU in May 2004 reclassified EU contributions from foreign funds to national funds).

To fully understand the dynamics of funding, the expenditure must be aligned to the sector of performance (see Figure 10). Between 1998 and 2007, on average, 93% of government expenditure was distributed between the government sector and the higher education sector. It is also worth mentioning that while part of the research institutes have been integrated into universities, some large institutes are independent in Latvia, thus, belonging to the government sector, which explains why a sizeable proportion of government expenditure on R&D is intramural. In the late 1990-ies, this split between government expenditure in the higher education sector and
intramural expenditure was 60:40, whereas throughout the 2000s, it was 70:30, which indicates a growing shift towards funding university research.

**Figure 10: GERD by Sector of Performance in Latvia, 1998-2007 (%, m Euro PPS 2000)**

From 2005 onward, statistics have become available on the expenditure of higher education sector on research and development; however, this amount has been negligible as it comprised only 1-2% of the total GERD and was spent within the sector. The private non-profit sector has not reported any investment in R&D in the last decade.

In a nutshell, with fairly unreliable statistics for business enterprise expenditure on R&D, the government sector remains the largest funder of R&D in Latvia, followed by funding from abroad. Over 90% of government expenditure on R&D is spent in the public sector, with over 2/3 being spent in the higher education sector, and 1/3 in the government sector (which includes a sizable portion of research institutes). Therefore, it can be assumed that aggregates in real figures for the government sector
are broadly comparable with nominal figures (i.e. figures reported in the national budget) in terms of the share in expenditure. Foreign funding has largely originated from EU funds, notably, the Framework Programmes, and has been appropriated mainly in the research and higher education sectors.

**Main Findings**

Overall, the organisational structure of the Latvian research system established in the early 1990-ies has not radically changed throughout the period. However, there has been a shift in the dynamics of interaction between the different parts of the system. The significant autonomy enjoyed by the research constituency has been increasingly reoriented toward, at least – formal, government control. To that end, new advisory bodies have taken their respective role in the process. Furthermore, there has been a drive to bring research organisations and universities closer together. Nevertheless, the general assessment of the governance of research in Latvia is consistent with the review of the Latvian research system by Arnold (2010), which summarises the situation in the following way:

*Latvia has not kept pace with changes in innovation system governance implemented in other countries. Repeated attempts to improve the legal basis for research and innovation have met with limited response and do not appear to have captured the political imagination needed to drive through reforms. Administrative and managerial capacities in state institutions seem insufficient to implement many of the changes that are widely recognised as being necessary (p.i).*

The principles of research funding have been cardinally reoriented towards competitive funding principles, based on Western practices of evaluation through peer review. The management and administration of the funding has been largely concentrated in one organisation – the Latvian Council of Science. However, due to the low levels of funding, the principles of selectivity and competitiveness have not achieved the desired effects. Furthermore, they have led to adjustment strategies, such as the loosening of the peer review criteria, the proliferation of funding mechanisms, which, in the absence of adequate funding levels, have failed to
produce significant impacts, and reorientation of research activities toward such schemes as the European Framework Programmes, and contract research.

Positive developments have been noted in connection with the provision of European Union Structural Funds, and the provision of baseline funding, which, among other things, have in recent years contributed to the improvement of the outdated research infrastructure. Yet, the long-term effects of these initiatives remain to be seen.

The productivity of the Latvian research system, in terms of the quality and quantity of publications is described in detail in Chapter VII, whereas the overall effects of the abovementioned reforms on the performance of the Latvian research system are summarised in Chapter IX. Moreover, how Latvia’s Northern neighbour – Estonia has fared through the transition is the subject of the next chapter, whereas a comparison of the two systems is discussed in Chapter VIII.
Chapter VI: The Estonian Research System

The reform of the Estonian research system began in 1988, when Estonia was still part of the USSR. The reform was started on the initiative of the scientific community with the establishment of the Estonian Union of Scientists in June 1989, and as part of the larger course of national awakening (Martinson 1995). A timeline of the most significant organisational reforms in Estonia is provided below (Figure 11).

Figure 11: The Organisational Evolution of the Estonian Research System

[Diagram showing organisational changes]

Source: Own compilation
Notes: → denote restructuring of one organisation into another.

Martinson and Raim (2001) distinguish two phases of the formation of R&D policy in Estonia: the ‘bottom-up’ reorganisation of the research system, spanning the period of the late 1980-ies up to 1994, and the ‘top-down’ transformation from 1995 onward. The former period can be characterised as one of spontaneous structural
change in terms of governing bodies and sectoral R&D organisations (ibid. 2001, p. 33). It is also during this period that the reform of higher education was carried out and the system of academic degrees was altered significantly. Structural reform became more prominent, as the Estonian government proceeded swiftly with the integration of research institutes and universities (1996-1998), accreditation of university degree programmes, formulation of priorities in research policy and the reorganisation of the funding awarding and advisory bodies (including the establishment of the Science Competence Council). All of these reforms were given legal status in the new Organisation of Research and Development Act (Riigikogu 1997). The association of Estonia to the European Union in 1994 and the consequent drive for EU membership (which also implies the alignment of the science and technology policies) is seen as the main impetus of the resulting structural reforms (Martinson and Raim 2001).

Organisational Reform

The first democratic organisation to implement the reforms of the Estonian research system - the Estonian Union of Scientists was formed in June 1989 with approximately 600 members (Martinson 1992). A working group was established to develop the funding reform and to create the organisations that would be responsible for executing the new procedures (Martinson 1995). The Union was instrumental to the aforementioned changes and was able to execute its strategic vision due to the following favourable factors. Firstly, the Estonian Union of Scientists was created at the time of Gorbachev’s glasnost – a policy, which called for public discussion, openness and transparency; thus, the political regime at the time was lenient towards the Union’s endeavours (Kristapsons, Martinson and Daagyte 2003). Secondly, the old governance structures were losing their power and influence making way for new possibilities, and following the declaration of independence in 1990, most of the old organisations persisted; however, their influence at the governmental level was non-existent (Martinson 1995). Finally, the scientists themselves had come to the conclusion that for the institution of a democratic research system based on the principles of freedom and the autonomy of science, the initiative for the reform should come from within the scientific community (ibid. 1995).
To this end, the Estonian Union of Scientists can be credited with the establishment of the Estonian Science Council, the Estonian Science Foundation, the Estonian Innovation Foundation, and the Estonian Informatics Foundation, as well as with the establishment of the ground rules for the functioning of these organisations. The former has been the forerunner of the Research and Development Council, whereas the three Foundations have been the main pillars of the research funding structure. Most of these newly created organisations have been the backbone of the Estonian research system since their conception. The evolving organisational structure of the system is presented in the Figure 12. However, from 1993 onward, and with the creation of the new governance structures completed, the role of the Estonian Union of Scientists diminished and the Union’s role in the reform process even became obsolete (Kristapsons, Martinson and Dabyte 2003).

**The Estonian Science Council and the Estonian Research and Development Council**

The first organisations for funding research in Estonia were the three foundations created on July 16, 1990, shortly followed by the Estonian Science Council at the end of the same year. Since 1991, the Estonian Science Council has been the main decision-making body in the Estonian research system. Originally, appointed for three years, the Council was chaired by the President of the Estonian Academy of Sciences and composed of the Minister of Education, the Rectors and Vice-rectors of the universities, representatives of the Councils of the three Foundations, and other eminent scientists nominated by the Prime Minister (Martinson 1995). The Estonian Science Council was created as an advisory body to the Estonian government, providing input on issues concerning higher education, research and technological development (Tartes 1999). Its main functions were:

- the submission of proposals relating to the establishment, restructuring and closure of research organisations,
- the drafting of the state budget to be submitted to the government for approval,
- the prescription of optimum levels of research funding,
the supervision of the three Foundations (Martinson 1995).

Its main achievements during the first years of operation were the drafting of a strategy for the future development of the Estonian research and higher education (including proposals on the reorganisation of the Academy of Sciences, the establishment of new organisational structures, and the integration of university and research institutes), the drafting of the first laws governing research and education, and the organisation of the international evaluation of Estonian research by the Royal Swedish Academy of Sciences in 1991 (Martinson 1995, Martinson 1999, Engelbrecht 1999, Kristapsons, Martinson and Dżyte 2003). However, despite these efforts, the unstable political environment and the frequent changes in government hampered the efficiency of the Council. Furthermore, the pragmatic stance of the government towards science was another contributing factor (Martinson 1995).

A more positive development (Martinson 1995, Villes 2007) came with the restructuring of the Estonian Science Council into the Estonian Research and Development Council in December 1993. It largely retained the functions formerly fulfilled by the Estonian Science Council, additionally being responsible for the representation of Estonian science internationally. Furthermore, its position was strengthened by enforcing the accountability of all ministries and other government bodies to the Council in matters of research and development. Last but not least, the reorganised Research and Development Council played a more active role in its advisory duties compared to its predecessor (ibid. 1995), and according to one interviewee, played an important role in securing “communication between administration, enterprise and science” (Villes 2007).
Figure 12: The Organisational Structure of the Estonian Research System in 1990 and 2000

The abovementioned reorganisation and the newly enacted Law on Research Organisation (approved by the Parliament on the 15th December 1994) also prompted changes in the composition of the Council. From May 1995, the Research and Development Council is appointed for a term of three years, chaired by the Prime Minister and has twenty members – six ministers, one Member of the Parliament, the Rectors of universities, the President and other distinguished members of the Academy of Sciences, the Chairman of the Council of the Estonian Science Foundation and representatives from the industry. The new Council was instrumental in conducting an internal evaluation of the Estonian research establishment, on the basis of which it proposed fundamental organisational changes in December 1994, notably, the reorganisation of the Academy of Sciences into an association of the scholarly elite (Martinson 1995).

Another set of reforms was decided upon by the government on the 19th May 2000. It was felt that the Council was overly oriented toward academia and less oriented toward the national requirement for research, development, entrepreneurship and competitiveness. Hence, the Council was given additional responsibilities in approving state research and development programmes and criteria for their evaluation (Vabariigi Valitsus 2008).

The new extended duties of the Research and Development Council, as well as the new rules of formation were promulgated through amendments of the Organisation of Research and Development Act of 10th April 2001 (Riigikogu 1997). The Act stipulates that the new composition of the Council is to consist of twelve members (as opposed to the former Council of twenty-six) approved by the government for a term of three years. The government is represented on the Council by the Prime Minister, the Minister for Education and Research, the Minister for Economic Affairs and Communications by virtue of office and one other member appointed by the Prime Minister, who is also the chairman of the Council. The remainder of the Council is composed of representatives of academic organisations and industry. During the period of 2001-2004 this representation was balanced (four members from each sector), in the current period of 2007-2010 there are four government members, five members of academia and three industry representatives (Vabariigi Valitsus 2008).
The Research and Development Council meets 2-3 times a year to make strategic decisions in the field of research and innovation policy. However, according to Tiits (cited in European Communities 2008a, p.13), the Council primarily advises the Prime Minister on specific policy issues, rather than visibly engages in systematic strategy formulation. Since 2005, the Research Policy Council and the Innovation Policy Council (formed respectively at the Ministry of Education and Research and the Ministry of Economic Affairs and Communications) act as standing committees to the Council and as another level of governance (in the capacity of an advisory body) between the Research and Development Council and the Ministries (Vabariigi Valitsus 2008). An overview of the tasks and responsibilities of the Council is presented below.

**Figure 13: Responsibilities and Tasks of the Research and Development Council**

<table>
<thead>
<tr>
<th>Advises the Government of the Republic in matters relating to:</th>
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<tbody>
<tr>
<td>a) research and development strategy;</td>
</tr>
<tr>
<td>b) international co-operation in research and development;</td>
</tr>
<tr>
<td>c) the initiation of research and development projects which have national significance;</td>
</tr>
<tr>
<td>d) the preparation of the draft state budget in respect of the amounts prescribed for research and development and with regard to the different ministries and types of financing for research and development;</td>
</tr>
<tr>
<td>e) the establishment and reorganisation of research and development institutions and the termination of their activities;</td>
</tr>
<tr>
<td>f) the establishment of the conditions and procedure for the evaluation of research and development.</td>
</tr>
</tbody>
</table>

Presents its opinion to the Government of the Republic on national research and development programmes presented by ministries.

Submits a report on research and development in Estonia and the objectives of research and development policy for the forthcoming period to the Government of the Republic each year.

Determines the fields of targeted financing for three years and the proportions of financing within the fields and between fields on the basis of the proposal of the Minister of Education and Research.

Source: Riigikogu (1997)
The Estonian Science Foundation

The Estonian Science Foundation was one of the first organisations established by the Estonian Union of Scientists on July 16, 1990. It was presided over by a 15-17 member Council appointed by the Estonian government for a term of three years. The main function of the Foundation was to support basic and applied research by distributing funding for research following a competitive evaluation of research proposals and science fields, in general. In its duties it was assisted by seven expert commissions (one of each sub-field of science), comprising up to 10 experts each and soliciting the help of 300-400 reviewers for the evaluation of grant proposals (Martinson 1995, Kaarli and Laasberg 2001). The heads of the expert commissions were elected by their peers to represent the commissions on the Council; thus, taking seven seats in the Council. The other members were appointed from the ministries, the universities and other research organisations. Following the first term, the formation of the Council of the Estonian Science Foundation was amended to include 18 members and eight expert commissions, heads of which were appointed by the previous Council and on the recommendation of the universities and other research organisations (Kristapsons, Martinson and Dagyte 2003, Martinson 1995, Nedeva and Georghiou 2003). Currently, the Estonian Science Foundation has decreased its Council membership to seven members (four of which are heads of expert commissions and one member from each of the Ministry of Education and Research and the Academy of Sciences, as well as a chairman) and has four expert commissions whose membership varies between 11 and 14 experts. In the first years of its existence, the Council of the Estonian Science Foundation had to institute the procedure for the submission of grant proposals and the requirements for their evaluation. As the Estonian Science Council was inactive in the formation of an effective funding policy, the Estonian Science Foundation took upon itself to lay down the basic principles of how to distribute the state budget among the different funding streams (Martinson 1995).

Initially, the Estonian Science Foundation was engaged in both funding grant proposals, as well as determining the levels of basic funding to be distributed among the different research organisations. In fact, the council of the Estonian Science Foundation was solely responsible for all the research funding decisions between 1991 and 1997 (Martinson 1999). However, from 1997 onward, the Foundation’s sole aim became the distribution of competitive research grants. In doing so, the Foundation annually submits a proposal to the Ministry of Education and Research outlining the estimated level of funding necessary for the grants and administrative costs associated with the award procedure for the forthcoming year. Finally, from 1997 onward, the Estonian Science Foundation and the Estonian Innovation Foundation operate as private non-profit foundations (Kaarli and Laasberg 2001).

The main argument for the reorganisation of the foundations at the time was the enhancement the performance of the functions of the state in the implementation of national economic policy (Sarapuu 2008). However, more recent reasoning for the establishment of foundations has been the appropriateness of this type of organisational structure in instances where the organisation has a specific role that is not directly linked to exercising state power and could be deemed autonomous in this respect (ibid. 2008). Thus, although private, foundations in Estonia receive public funding and are heavily regulated in terms of disbursing this funding.

**Estonian Innovation Foundation**

The Estonian Innovation Foundation was set up by the Estonian government in July 1990 to complement the work of the two other foundations (the Estonian Science Foundation and the Estonian Informatics Foundation) in terms of supporting technological development and entrepreneurship. In fulfilling its tasks, the Foundation relied on state funding appropriations; initially, these consisted of a percentage of the state property income, but, subsequently, were amended to include direct government funding (Martinson 1995).

The Estonian Innovation Foundation distributed budget appropriations assigned to it by the Ministry of Economic Affairs, to which the Foundation was subordinate. The
two mechanisms through which the funding was distributed were subsidies and loans. These were granted on a project by project basis, following a competition. The subsidy entitled the applicant of a successful project proposal to up to 50% of the total cost of the project; the remaining cost was to be covered by the applicant. The loan entitled the successful applicant to an advance of up to 85% of the total project cost, to be repaid at an interest rate of 12% (ibid. 1995).

The project proposals were subject to an evaluation by experts and to a technological-economic survey. The main criteria for project selection were their innovativeness, economic viability and their significance for the wider economy (ibid. 1995).

Overall, the Estonian Innovation Foundation was managed by a council, whose members include representatives of ministries, universities and industry. The council of the Foundation evaluated the project proposals, makes decisions on the basis of these, and, subsequently allocated funding to successful applicants. The Foundation was entitled to hire experts for the purpose of carrying out project evaluations (Hernesniemi 2000).

In 1998, the Estonian Innovation Foundation was reorganised into the Estonian Technology Agency. The main reasoning behind this reform was “raising the effectiveness of the R&D system management by reinforcing the organisations that belong to the system and by strengthening the co-operation between them”, and in case of the Technology Agency in particular – “increasing state allocations and channelling them in more effective and productive ways” (Kaarli and Laasberg 2001, p. 13).

**The Estonian Technology Agency and Enterprise Estonia**

The Estonian Technology Agency was operational for two years (1998-2000) and its main contribution to the development of technology and innovation policy was the fundamental alteration of the funding procedures for the distribution of grants and loans. Furthermore, the strategic and operational planning of the Agency was
supported by a senior director of the Finnish Technology Agency TEKES. In 2000, the Agency was incorporated into a new government agency – Enterprise Estonia, which was created by merging a total of seven previously separate public agencies. Considerable reorganisation efforts ensued in the period of 2002-2003 and Enterprise Estonia became fully operational on October 1st 2003 (European Communities 2008a). The agency deals largely with the implementation of measures in the area of innovation policy.

The Estonian Informatics Foundation

The Estonian Informatics Foundation was established in 1990 to facilitate the uptake and development of information and communication technologies by supporting research in the area and with the view to building a national information system. Like the Estonian Innovation Foundation, it has been providing funding in the form of grants. The Foundation ceased to exist in the mid-1990-ies (Kaarli and Laasberg 2001).

The Science Competence Council

With new developments in the funding reform (i.e. the introduction of targeted financing of organisations) and the introduction to further amendments of the Law on Research and Development in 1997, the Estonian government decided to set up an additional funding body, which would be subordinate to the Ministry of Education. This organisation became the Science Competence Council and it was charged with the task to manage all aspects of the distribution of targeted financing (see Figure 13).

Figure 14: The Responsibilities of the Science Competence Council

<table>
<thead>
<tr>
<th>Drafts proposals concerning:</th>
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<tbody>
<tr>
<td>a) the opening, amendment and termination of targeted financing of research themes at research and development institutions;</td>
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</tbody>
</table>
b) the approval of the results of evaluation of research and development;
c) the coverage of infrastructure expenses of research and development institutions within the area of government of the Ministry of Education and Research.

Assesses the effectiveness of the targeted financing of research at research and development institutions and the conformity of the research results with international standards.

Submits a report on its activities to the Minister of Education and Research and the Research and Development Council at least once every three years.

Source: Riigikogu (1997)

The Science Competence Council acts as an advisory body to the Ministry of Education, and as such it comprises a nine member Council appointed by the Minister of Education for a term of three years (Nedeva and Gerorghiou 2003). The Council distributes targeted funding to research organisations for long-term research projects (up to six years) following a review of the projects and the approval of the Minister of Education (Kristapsons, Martinson and Dagyte 2003). In addition, the Science Competence Council also distributes grants to support the education of doctoral students. The main criterion for the evaluation of the proposals is the quality of the proposed research, its viability in terms of expected outcomes and qualified manpower (Kaarli and Laasberg 2001). Research projects approved for funding are re-evaluated every year.

**The Archimedes Foundation**

The Archimedes Foundation is another administrative agency of the Ministry of Education. Established in 1997, it is active in supporting the Ministry in administering and coordinating all European Union initiatives concerning education, research and development in Estonia. The main aim for founding Archimedes was to build national competence in managing European Union programmes and their implementation. Prior to 1997, these tasks were outsourced to private consultancies (Archimedes Foundation 2007a). Currently, it also provides administrative support to the Science Competence Council, and is the implementing agency of the Structural
Funds in the area of research for the period 2007-2013 (Archimedes Foundation 2007b).

The Universities

At the end of the Soviet-era, Estonia was host to seven higher education organisations (their current names are included in parentheses): the State University of Tartu (the University of Tartu), the Tallinn Polytechnic Institute (the Tallinn University of Technology), Tallinn Pedagogical Institute (Tallinn Pedagogical University), the Estonian Academy of Agriculture (the Estonian University of Life Sciences), the Estonian Socialist Republic State Institute of Culture (the Estonian Academy of the Arts), the Tallinn State Conservatory (the Estonian Academy of Music), and the Military Academy (which ceased to exist following the dissolution of the Soviet Union) (Tomusk 2001). Out of the remaining six, only four organisations have been extensively involved in research, whereas the Academy of the Arts and the Academy of Music have conducted research on a project basis (Martinson 1995).

The two largest universities are the University of Tartu and the Tallinn University of Technology. Historically, Tartu University has been a classical university; established by the Swedes in 1632 and heavily influenced by the German tradition of scholarship, it was an important seat of learning in the Russian Empire and had a great impact on the whole of the Baltic region (Kristapsons, Martinson and Dagyte 2003). The Tallinn University of Technology, on the other hand, was established fairly recently – in the early 20th century as a means of training engineers.

During the Soviet period the University of Tartu was predominantly focused on teaching, but its legacy as a Western university with a long-standing research tradition was revived during the independence movement.

A further and very significant step in the reform for the universities was the revision of the system of scientific degrees. Under the Soviet system, the undergraduate diplomas and the two types of research degrees (the Candidate of Sciences and the
Doctor of Sciences) were awarded by the universities and institutes. In the case of the latter two, the stringent procedure was delegated to specialised councils established at the universities and institutes, who then sought the approval of the Supreme Attestation Committee in Moscow before awarding a degree.

The degree structure in Estonia was changed in July 1990 with the passing of a government decree that established three types of degree: a Bachelor’s degree, a Master’s degree and a Doctorate degree (of which the two latter are considered research degrees). The decree also stipulated that the legal right to confer research degrees should be granted exclusively to the universities, the rationale behind this decision being the integration of teaching and research. Unlike in the other Baltic States, it was decided that degrees awarded by the former Soviet Union did not have to be re-certified as such a procedure would prove both costly and inefficient (Martinson 1992, Martinson 1995, Kristapsons, Martinson and Dagyte 2003). Furthermore, the procedure for awarding research degrees was simplified and the core requirement for obtaining a doctorate degree became the presentation of high quality research that was substantiated by publication in international peer-reviewed scientific journals (Martinson 1995).

Overall, Tomusk (2001) divides the reform of the Estonian higher education sector into two periods in time:

- 1988-1992, a period characterised by “chaotic, individually and institutionally driven changes still within the Soviet Union”, and
- 1992-1999, a period characterised by the attempts of the newly independent state to establish new legislation and higher education policy in the face of “four years of most unorganised reform initiatives” (p.202).

All in all, despite the attempts of internal reorganisation and government containment, no other significant changes were implemented until December 1994, when the new Law on Universities was passed by the Parliament (ibid. 2001). The Law on Universities (Riigikogu 1995a) instituted the general of the higher education system, as well as the provisions for the accreditation of universities, which also mandates the general principles of their evaluation in terms of the respective research
activities. It is also interesting to note that the largest university in Estonia - the University of Tartu – has its own act, and thus, it is bound by the Law on Universities, as well as by the University of Tartu Act (Riigikogu 1995).

The Academy of Sciences and the Institutes

During the Soviet era of science in Estonia, most of the research activity was performed in the institutes of the Estonian Academy of Sciences. As already described in Chapter IV, the Academy was acting as a governing body to the institutes, facilitating the distribution of funding and drafting and implementing the research and development policy of the Soviet Union. During the early reform of the 1990-ies, countless debates on the reorganisation of the Academy ensued.

Naturally, the Estonian Academy of Sciences was seen as “the cornerstone of the old, centralised system in science” (Martinson 1995, p. 10). Furthermore, its structure and functions were generally considered a barrier to the integration of teaching (which took place in universities) and research (which largely took place in institutes). The latter was regarded as a key necessity during the transition, and it was also an important recommendation from the evaluation of the Estonian research system conducted by the Swedish Research Councils (as reported in Engelbrecht 1999, Martinson 1999).

Nevertheless, the political instability of the government and the hesitant attitude of the first Estonian Science Council contributed to the decision to discuss the issue of the integration of education and research but delay any implementation measures until a more favourable point in time. Furthermore, although the Estonian Union of Scientists supported the integration, many members of the government and the Academy argued that the organisational structure of the Soviet Academy-type (or similar to it) was prevalent in other countries and thus, did not warrant a drastic restructuring (ibid 1995). Overall, there was some minor effort at bringing fundamental research to universities. Some institutes began participating in the training of research students and, in turn, some researchers from the institutes
accepted professorships at the university and became lecturers during the period of 1992-1993 (Kristapsons, Martinson and Dagyte 2003).

The changes that took place between 1990 and 1994 were generally started on the initiative of the Academy institutes. Some branch institutes (focusing on applied research) were reorganised into joint-stock companies, others ceased to exist (Vaikmae 2005), and yet others either merged to form larger institutes or disintegrated into smaller organisations (Martinson 1995). However, the Academy retained its old structure up until 1995, when it was finally reorganised into the association of the scholarly elite of Estonia. At the same time, some research institutes became independent state research institutes under the auspices of the Ministry of Education and some were integrated into universities (Kristapsons, Martinson and Dagyte 2003).

In the period between 1996 and 1998, most research institutes of the Academy have been formally and in legal terms integrated into universities (Kaarli and Laasberg 2001). However, during the fieldwork of this study, it has been established that some difficulties remain (Kivi 2007, Kaarli 2007), and in 2007 the process of fusion was still reported as ongoing (Villems 2007). In particular, the problem largely consists of several issues: firstly, the capacity of small university departments to absorb large research institutes with an often higher quality and quantity of research (Villems 2007), secondly, the concerns of institutes stemming from the former, as well as from loss of identity, have resulted in some resistance (Ainsaar 2007, Kivi 2007). Thus, in practice, the actual work that takes place in university departments and institutes is not always done in cooperation, but this also is highly dependent on the area of research, and historical cooperation (or lack thereof) (Kivi 2007, Kaarli 2007). Furthermore, the collaboration between universities and institutes, especially, in respect to collaboration in teaching and research was followed up with the interviewees in 2010, where the majority of respondents found that the level of collaboration has been good in both cases (Anonymous D 2010, Kaarli 2010, Kivi 2010, Vaikmae 2010). Some found the collaboration between institutes and universities in research is far more advanced than collaboration in teaching (Haller 2010, Allik 2010). One of the respondents remarked, the availability of Structural Funds in recent years has provided a novel incentive to collaborate more intensely.
(Anonymous 2010 D). Finally, the administrative process of integration has been by and large completed, and there seems to be no necessity to regulate this process further (Villems 2010).

The Government

Similarly to the other two Baltic States, the Estonian research system passed through three stages of development characterised by:

- state management (prior to 1990),
- complete internal democracy of the scientific establishment (1990-1992), and

This meant that in the beginning of the 1990-ies the government of Estonia had little direct involvement in the reorganisation of the system and very limited supervisory and policy implementation power. The legal and administrative system was in the initial stages of development characterised by frequent reorganisation, and research activity was governed by a few basic government regulations. Initially, the education and science policy was relegated from the Academy of Sciences to the Education Committee, which in 1993 became the Ministry of Education and Culture, and in 1996 – the Ministry of Education (European Communities 2008a). Furthermore, in the first years of the new independent Estonian government, there was no unit within the government structures responsible for the daily management of research policy. At the Ministry of Education, only one person was responsible for science (Kristapsons, Martinson and Dagyte 2003).

The first significant development in the area of science and technology policy in the early 1990-ies was the passing of the Law on Research Organisation in 1994. This law outlined a comprehensive legal framework for the research system and explicitly conferred responsibility for research and organisation to the Ministry of Education: “the Law was addressed to the rights of state bodies in matters of science organisation; its emphasis was on administration rather than on researchers”.
The Ministry is first and foremost a coordinating body that acts as a mediator between the Government (and its advisory body – the Research and Development Council) and the respective funding bodies – the Estonian Science Foundation and the Science Competence Council. Among the main tasks of the Ministry, as conferred by the Law, are the development of research and development policy, the drafting, distribution and supervision of the expenditure of state funding, and the enforcement of government regulations (Riigikogu 1997). Its main responsibilities are summarised in Figure 15.

**Figure 15: The Responsibilities of the Government in Organising the Research and Development in Estonia**

Develop a research and development policy which takes into consideration the potential, conditions and needs of Estonia, and shall prepare national development plans for research and development and submit them to the Riigikogu.

a) At least once a year, the Prime Minister shall, on behalf of the Government of the Republic, present an overview of the research and development situation and of government policy in this field to the Riigikogu.

b) Approve national research and development programmes according to national development plans and ensure co-operation between the ministries in the implementation of research and development policy, taking into consideration the proposals of the Research and Development Council.

c) Establish the procedure for:
   a. the formation of the Scientific Competence Council and shall establish its rules of procedure and approve its membership;
   b. the formation of and the rules of procedure of the Research Policy Council and shall approve its membership for up to three years on the proposal of the Minister of Education and Research;
   c. the formation of and the rules of procedure of the Innovation Policy Council and shall approve its membership for up to three years on the proposal of the Minister of Economic Affairs and Communications;
   d. the evaluation of research and development.

Establish and reorganise state research and development institutions and terminate their activities on the proposal of the ministry which administers them, after having considered the opinion of the Research and Development Council.
The Estonian Science Foundation and the Science Competence Council are accountable to the Ministry of Education for their activities in grant funding and targeted funding. Furthermore, the Ministry is in charge of funding the National Research and Development Programmes and providing budget appropriations for the universities.

In 2004, the Ministry established a Research Policy Council to fulfil an advisory role to the Minister of Education in all matters of research policy. The Council is in essence an intermediary between the Ministry and the Research and Development Council and includes representatives from all parties involved in the research system (the government, public research organisations and private enterprises). As of January 2003, the Ministry has changed its title to the Ministry of Education and Research.

While the Ministry of Education and Research is responsible for coordinating all research activities in the public domain, the Ministry of Economic Affairs and Communications is responsible for innovation policy. The Ministry of Economic Affairs was established in 1991 and merged with the Ministry of Transport and Communications in 2003.

The advent of government-led innovation policy in the newly independent Estonia is fairly recent. The Ministry of Economic Affairs and Communications strengthened its activity in the field of innovation policy when it set up the Division of Technology and Innovation within the Economic Development Department in 1999. Prior to this it was overseeing the activities of the Estonian Innovation Foundation (European Communities 2008a).

Similarly to the Ministry of Education and Research, the Minister of Economic Affairs and Communications is advised by the Innovation Policy Council on all strategic matters of innovation policy that are brought before the Research and
Development Council. Both the Research Policy Council and the Innovation Policy Council are *ex officio* chaired by the respective Ministers.

**In Review**

The organisation of the Estonian research system is characterised by a governance structure of multiple levels. The Ministry of Education and Research remains the supervisory authority of all public research organisations; however, although it formally approves funding and administrative decisions, it is structurally removed from the execution of these decisions by a layer of advisory bodies and funding agencies. A snapshot of the resulting governance structure is provided in Figure 16.

An interface between the government and the different research performers has been created in the shape of the Research and Development Council, chaired by the Prime Minister, and research performing universities are well represented on the boards of the abovementioned advisory bodies.

An important dimension of the organisational reform has been the integration of universities and the research institutes of the former Academy of Sciences, which despite several teething issues has been largely completed. Finally, the general consensus among the interviewed stakeholders in Estonia has been that the administrative and organisational set-up of the Estonian research system is working well.
Figure 16: The Organisation of Estonian Research System in 2011

Funding Reform

The first major development in the restructuring of the Estonian research system was the reform of the financing of research and development and the amendment of funding procedures. A working group at the Estonian Union of Scientists was formed to draft new principles of research funding. As part of this progress, the funding systems of other countries, notably, Sweden, Finland and similarly small European countries were surveyed and used as reference models for the reform (Kristapsons, Martinson and Dagyte 2003). During fieldwork, interviewees confirmed that they have learned from the experiences of Scandinavian countries, in particular, their close neighbour – Finland, but they were also adamant to point out that the processes and procedures were not directly copied (Kaarli 2007, Kivi 2007).

The main aim of the reform was to "guarantee within the limited resources available the continuity of tuition and basic research” as a response to the realisation that” the research establishment created during the years of the Soviet occupation could not be maintained in full: it was far too large for a small independent republic like Estonia” (Martinson 1995, pp. 9-10). As the President of the Estonian Academy (Villems 2007) put it during the fieldwork for this study: “it was not so much the question of money, but rather of optimisation”.

As already described in the previous section on organisational reform, research in Estonia has been largely funded through competitive principles of grant funding. Only as recently as 2005, separate baseline funding provisions have been introduced. The main organisations involved in the process of awarding competitive funding have been the Estonian Science Foundation and the Science Competence Council. How this process of allocating research funding has unfolded in practice and what mechanisms have been utilised in this regard is illustrated in Figure 17 and described in the following section.
**Funding Mechanisms**

In 1991, the Estonian Science Foundation enacted the procedure for the funding of basic and applied research based on the principles of peer review and expert opinions. It also introduced funding for research projects in the shape of research grants, as opposed to the old system of purely organisational funding. The Informatics Foundation and the Innovation Foundation also distributed its funding for specific projects in the respective areas, the former in the form of grants, the latter – as partial grants and loans.

This process was a reflection of a paradigm shift from maintaining the old order (and funding) of research organisations to supporting project groups and individual researchers. The main principles for granting project funding were the originality and quality of research, as well as its standing in the international arena. The research
proposals were evaluated against the abovementioned criteria by the seven expert commissions (one for each of the science fields\(^6\)) attached to the Foundation (Martinson 1995). Since 1995, foreign experts have also been involved in the evaluation of research grant proposals. The procedure takes place once a year and subsequently the funding is awarded for a period of between one and four years. However, since funding is linked to the annual budget cycle of the state, *de facto* money is committed to a project subject to the overall budget not decreasing in the coming years. In essence, there is high uncertainty whether and how much of the funds are going to be available in the subsequent years of the project. This uncertainty that ultimately leads to short-termism in research has also been pointed out by Nedeva and Georghiou (2003).

The implementation of the projects is periodically monitored and projects may be suspended or terminated if the quality of a given project is unsatisfactory. At the same time, in practice, and especially in the early years of implementation, the lack of funding resulted in a high proportion of favourable evaluations and the award of many grants of smaller monetary value. This was rectified later, when the grant system was amended to set a minimum threshold of research funding (Kaarli and Laasberg 2001).

The introduction of a grant-awarding system was gradual, as it was reasoned that a radical change within the system could affect the continuity of basic research; hence, the basic funding of research organisations was maintained with a steady increase in grant funding (approximately 5% for the first two years (1991-1992) following the reform, growing to 20% in 1993, 28% in 1995 and reaching 32% in 1996 (Martinson, Dabyte and Kristapsons 1998). The budget for grant funding was subsequently reduced again to one fifth of the total government funding in the late 1990-ies to accommodate new funding mechanisms. In 2003, this percentage has decreased to a mere 18.6% (Ministry of Education and Research data cited in Nedeva and Georghiou 2003). An overview of these proportions in the early 1990-ies is provided in Table 2.

---

\(^6\) The respective science fields were: exact sciences, natural sciences, medical sciences, agricultural sciences, social sciences, engineering and the humanities. In recent years, the expert commissions have been downsized to include four commissions in total.
The basic financing of organisations was distributed by the Estonian Science Foundation to the Academy of Sciences, the universities and the respective ministries, which established special financing commissions to distribute the funds to individual units observing the funding proportions established between science fields. Furthermore, a third category of goal financing was introduced along the grant and basic funding mechanisms. This served to provide single grants for special needs that fell outside the spectrum of conventional funding practices i.e. publishing, emergency infrastructure repairs etc (an overview of the proportion of basic, grant and goal financing in the early 1990-ies is presented below) (Martinson 1995, Kristapsons, Martinson and Dagyte 2003).

Table 2: Distribution of Basic Funding, Grants and Goal Funding (%), 1991-1995

<table>
<thead>
<tr>
<th></th>
<th>Basic Funding</th>
<th>Grants</th>
<th>Goal Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>92.8</td>
<td>4.6</td>
<td>2.6</td>
</tr>
<tr>
<td>1992</td>
<td>95.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>75.0</td>
<td>20.0</td>
<td>5.0</td>
</tr>
<tr>
<td>1994</td>
<td>72.0</td>
<td>24.0</td>
<td>4.0</td>
</tr>
<tr>
<td>1995</td>
<td>68.0</td>
<td>28.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>


During the restructuring period, an analysis of the proportions of funding assigned to different fields of sciences was carried out and compared to the funding proportions of some established research systems. It was concluded that in Estonia the natural sciences, engineering and agricultural sciences were receiving disproportionately large amounts of funding, while social sciences were underfunded. Hence, this prompted a decision to balance out these disparities over time commencing with an adjustment in the proportions of grant money earmarked for each field (see Table 3). Another decision taken was to gradually increase the basic funding for universities (see Table 4) in line with the aim to reconcile research activities and higher education (Martinson 1995).
<table>
<thead>
<tr>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Sciences (including)</td>
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<td>34.5</td>
<td>36.0</td>
<td>36.0</td>
<td>-</td>
<td>30.0</td>
<td>-</td>
<td>37.1</td>
<td>38.2</td>
<td>38.8</td>
<td>39.7</td>
<td>-</td>
</tr>
<tr>
<td>exact sciences</td>
<td>12.8</td>
<td>14.8</td>
<td>14.3</td>
<td>14.3</td>
<td>-</td>
<td>10.2</td>
<td>-</td>
<td>14.0</td>
<td>13.8</td>
<td>13.3</td>
<td>13.4</td>
<td>-</td>
</tr>
<tr>
<td>chemical sciences</td>
<td>-</td>
<td>-</td>
<td>10.3</td>
<td>10.3</td>
<td>-</td>
<td>9.6</td>
<td>-</td>
<td>11.1</td>
<td>11.4</td>
<td>11.8</td>
<td>12.2</td>
<td>-</td>
</tr>
<tr>
<td>bio-geosciences</td>
<td>-</td>
<td>-</td>
<td>11.4</td>
<td>11.4</td>
<td>-</td>
<td>10.2</td>
<td>-</td>
<td>12.0</td>
<td>13.0</td>
<td>13.7</td>
<td>14.1</td>
<td>-</td>
</tr>
<tr>
<td>Engineering</td>
<td>22.0</td>
<td>14.2</td>
<td>16.7</td>
<td>16.7</td>
<td>-</td>
<td>17.1</td>
<td>-</td>
<td>16.8</td>
<td>16.5</td>
<td>16.3</td>
<td>15.7</td>
<td>-</td>
</tr>
<tr>
<td>Medical Sciences</td>
<td>7.7</td>
<td>16.7</td>
<td>16.5</td>
<td>16.9</td>
<td>-</td>
<td>18.5</td>
<td>-</td>
<td>16.8</td>
<td>16.6</td>
<td>16.0</td>
<td>16.2</td>
<td>-</td>
</tr>
<tr>
<td>Agricultural Sciences</td>
<td>19.2</td>
<td>15.3</td>
<td>11.4</td>
<td>11.0</td>
<td>-</td>
<td>10.3</td>
<td>-</td>
<td>10.2</td>
<td>9.8</td>
<td>9.3</td>
<td>8.5</td>
<td>-</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>8.1</td>
<td>10.5</td>
<td>9.8</td>
<td>9.8</td>
<td>-</td>
<td>13.6</td>
<td>-</td>
<td>9.5</td>
<td>9.5</td>
<td>10.0</td>
<td>10.1</td>
<td>-</td>
</tr>
<tr>
<td>Humanities</td>
<td>3.6</td>
<td>8.8</td>
<td>9.6</td>
<td>9.6</td>
<td>-</td>
<td>11.2</td>
<td>-</td>
<td>9.6</td>
<td>9.3</td>
<td>9.5</td>
<td>9.7</td>
<td>-</td>
</tr>
<tr>
<td>Grant funding as a percentage of state budget for R&amp;D</td>
<td>-</td>
<td>20.0</td>
<td>24.0</td>
<td>28.0</td>
<td>30.8</td>
<td>22.8</td>
<td>21.8</td>
<td>21.4</td>
<td>18.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total number of grants (including)</td>
<td>-</td>
<td>477</td>
<td>695</td>
<td>931</td>
<td>848</td>
<td>846***</td>
<td>763</td>
<td>744</td>
<td>782</td>
<td>738</td>
<td>653</td>
<td>650</td>
</tr>
<tr>
<td>continuing projects</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>495</td>
<td>521</td>
<td>560</td>
<td>496</td>
<td>487</td>
<td>454</td>
<td>488</td>
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<tr>
<td>new projects</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>249</td>
<td>261</td>
<td>178</td>
<td>242</td>
<td>166</td>
<td>164</td>
<td>146</td>
</tr>
<tr>
<td>Total number of applications</td>
<td>-</td>
<td>695</td>
<td>1167</td>
<td>1276</td>
<td>1185</td>
<td>991</td>
<td>982</td>
<td>961</td>
<td>902</td>
<td>890</td>
<td>-</td>
<td>827</td>
</tr>
<tr>
<td>Total number of grants (my first Grant)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
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<td>-</td>
<td>23</td>
<td>41</td>
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<tr>
<td>Total number of applications (my first Grant)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>32</td>
<td>49</td>
<td>76</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: *Distribution of total financing by the data of the ESC; ** the proportions changed due to the introduction of the OECD classification in research statistics; *** data for 1999; **** from 2007, the committees have been reorganised. Share of funding by column might not add up due to varying sources of data.

Table 4: Distribution of Basic Funding for Research Organisations in 1991-1995 (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Ministry of Culture and Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(including)</td>
<td>19.9</td>
<td>20.2</td>
<td>25.0</td>
<td>27.9</td>
<td>27.9</td>
</tr>
<tr>
<td>Tartu University</td>
<td>10.5</td>
<td>13.6</td>
<td>14.7</td>
<td>14.7</td>
<td></td>
</tr>
<tr>
<td>Tallinn Technical University</td>
<td>7.9</td>
<td>9.6</td>
<td>10.3</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Tallinn Pedagogical University</td>
<td>1.7</td>
<td>1.7</td>
<td>1.8</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Estonian Science Foundation</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Ministry Grants</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Academy of Sciences</td>
<td>53.9</td>
<td>53.4</td>
<td>52.0</td>
<td>48.8</td>
<td>48.8</td>
</tr>
<tr>
<td>Ministry of Social Affairs (incl.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>medical research institutes)</td>
<td>7.1</td>
<td>7.1</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Ministry of Agriculture</td>
<td>17.6</td>
<td>17.8</td>
<td>15.2</td>
<td>15.3</td>
<td>15.3</td>
</tr>
<tr>
<td>Agricultural University</td>
<td></td>
<td></td>
<td>3.2</td>
<td>4.3</td>
<td>7.6</td>
</tr>
<tr>
<td>Institute of Forestry</td>
<td>1.5</td>
<td>1.5</td>
<td>1.8</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Source: Martinson (1995)

In December 1994, the Law on Research Organisation (Riigikogu 1994) was passed by the Estonian Parliament. It envisaged an alteration of the former funding mechanisms, which was to be introduced in 1996. From this point onwards, there were three types of public funding available: research grants, target funding and funding for infrastructure (for a complete list of funding mechanisms, see Table 5). The grant awarding procedure saw no significant alterations.

Table 5: Overview of Funding Instruments and the Year of their Inception

<table>
<thead>
<tr>
<th>Funding Instrument</th>
<th>Year of Inception</th>
<th>Funding Type</th>
<th>Funding Body</th>
<th>Evaluating Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Funding</td>
<td>&lt;1991-1996</td>
<td>Lump sum</td>
<td>ESC</td>
<td>-</td>
</tr>
<tr>
<td>Grant Funding</td>
<td>1991</td>
<td>Grants</td>
<td>ESF</td>
<td>ESF</td>
</tr>
<tr>
<td>Goal Funding</td>
<td>1991-1996</td>
<td>Grants</td>
<td>ESF</td>
<td>-</td>
</tr>
<tr>
<td>Target Funding</td>
<td>1996</td>
<td>Grants</td>
<td>MoER</td>
<td>SCC</td>
</tr>
<tr>
<td>Funding for Infrastructure</td>
<td>1996</td>
<td>Lump sum</td>
<td>Ministries</td>
<td>SCC</td>
</tr>
<tr>
<td>State Research and Development Programmes</td>
<td>1999</td>
<td>Grants</td>
<td>Ministries</td>
<td>Independent Experts</td>
</tr>
<tr>
<td>Product Development Programme (formerly, R&amp;D Financing Programme)</td>
<td>2001</td>
<td>Grants</td>
<td>EE (formerly EIF)</td>
<td>Independent Experts</td>
</tr>
<tr>
<td>Centres of Excellence Programme</td>
<td>2001</td>
<td>Grants</td>
<td>MoER</td>
<td>Independent Experts</td>
</tr>
</tbody>
</table>
The new procedure of **target funding** entailed the distribution of monetary resources for strategic research projects (by topic or area of science) to research organisations and was aimed at providing longer-term resources and continuity. From its inception in 1996, the funding was distributed by the Estonian Science Foundation but by the end of 1997 a new consultative body – the Science Competence Council – was established to advise the Minister of Education and Research on the distribution of target funding, as well as on strategic research directions and doctoral studies. Similarly to grant funding, the targeted funding was also to be distributed on a project-by-project basis but to organisations rather than individual researchers or research groups. The criteria for the award of this funding were:

- the research quality of the proposed project,
- the feasibility of the project, in terms of the adequate provision of human resources, and
- the sustainability of the project, in terms of the prospect of continuity beyond the envisaged period (Kaarli and Laasberg 2001).

From 1996-2003, the funding comprised around half of the research budget (see Table 6) and has been allocated for a period of up to five years (prior to 2004) and up to six years (from 2004 onward); however, due to the annual budget cycles, research groups have to reapply for funding every year. Following an assessment of the Estonian research and innovation funding system, Nedeva and Georghiou (2003) pointed out that there is a mismatch between the strategic aim of providing security of funding and continuity of research, on the one hand, and the short-term competitive allocation of funding with annual re-application on the other.

In 2001, the principles of the targeted financing have been also applied to create an instrument to support **Centres of Excellence**. The initiative was established to
support collaboration between different research groups or research organisations working on a common theme (ibid. 2008). The Centres of Excellence programme has also been used as one of the instruments in the appropriation of European Union Structural Funds for infrastructure support (see next section on European support for research in Estonia).

In 2006, 202 research projects continued under the targeted funding scheme, and 24 new projects were approved (Roll, Uus, and Noukus 2007), whereas over 6m Euros have been earmarked for the improvement of infrastructure under the Centres of Excellence scheme in the period of 2005-2007. Thus far, the University of Tartu has been the main beneficiary, having received over 80% of this funding (Masso and Ukrainski 2008).

Table 6: Distribution of Grants, Targeted Financing and Funding for Infrastructure from State Budget in 1996-2003 (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Grant Funding</th>
<th>Target Funding</th>
<th>Funding for Infrastructure</th>
<th>Other Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>30.8</td>
<td>49.6</td>
<td>18.0</td>
<td>1.6</td>
</tr>
<tr>
<td>1997</td>
<td>31.4*</td>
<td>47.0</td>
<td>18.1</td>
<td>3.5</td>
</tr>
<tr>
<td>1998</td>
<td>28.6</td>
<td>46.4</td>
<td>18.9</td>
<td>6.1*^</td>
</tr>
<tr>
<td>1999</td>
<td>22.8</td>
<td>48.2</td>
<td>17.4</td>
<td>11.6^**</td>
</tr>
<tr>
<td>2000</td>
<td>21.8</td>
<td>47.8</td>
<td>17.6</td>
<td>12.8</td>
</tr>
<tr>
<td>2001</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2002</td>
<td>21.4</td>
<td>53.0</td>
<td>12.0</td>
<td>13.6***</td>
</tr>
<tr>
<td>2003</td>
<td>18.6</td>
<td>48.8</td>
<td>12.4</td>
<td>20.2***#</td>
</tr>
</tbody>
</table>

Notes: * including funding for centres of strategic competence; ^ including funding for scholarships to doctoral students; ** including participation fee to the Fifth Framework Programme and funding for state research programmes; *** including baseline funding for state research institutes, the Academy of Sciences, and the Estonian Academic Library; # including participation fee to the Sixth Framework Programme and other membership fees, and funding for the Archimedes Foundation.


The third funding stream, namely, funding for infrastructure was developed to cover the subsistence and maintenance costs of research establishments and was to be covered by the budget of the owner of the research organisation i.e. the respective
ministry, local government, private owner or other (Kaarli and Laasberg 2001, Martinson 1995). Subsequently, infrastructure funding has been provided to research organisations based on the opinion of the Science Competence Council, and in proportion to the funding received from targeted financing and to the previous year’s infrastructure budget of the receiving organisation (Masso and Ukrainski 2008).

In addition to the existing funding mechanisms, a limited number of national programmes i.e. state commissioned research into topics vital for the national economy and society were introduced in 1999. The programmes are administered by the endorsing ministry and focus on specific areas; however, in terms of funding, these programmes have occupied only a marginal share of the overall budget. In 1999, three programmes were launched, namely:

- State Targeted Research Programme for Public Health 1999-2009 (Ministry of Social Affairs),
- The State Programme – Estonian Language and National Culture 1999-2003 (Ministry of Education and Research),
- The State Programme for the Preservation and Development of the South Estonian Language and Culture (Ministry of Culture).

From 2004 onward, new national programmes under the auspices of the Ministry of Education and Research have been devised in the following areas:

- Estonian Language and National Memory (2004-2008),
- Collections of Humanities and Natural Sciences (2004-2008),
- National Programme for the Estonian Language Technology (2006-2010).

The most recent funding mechanism introduced in 2005 has been the provision of baseline funding. Similarly to the provision of funding for infrastructure, the initiative disburses funding to research organisations to stimulate the continuous development and new fields of research within these organisations.

An overview of the proportions of the different research funding streams from state budget and foreign sources between 2000 and 2006 is presented below. As can be
seen from Figure 18, targeted financing and foreign funding⁷ have played an increasing role in the Estonian funding structure (the impact of this development is outlined in the next section). Provisions for national programmes have also grown considerably, yet basic grant funding by the Estonian Science foundation has largely remained the same, with a marginal increase toward the end of the respective period.

**Figure 18: Main Sources of Funding from the State Budget and Foreign Sources in Estonia in 2000-2006 (‘000 EEK)**

![Figure 18: Main Sources of Funding from the State Budget and Foreign Sources in Estonia in 2000-2006 ('000 EEK)](image)

Source: Kaarli (in Archimedes Foundation 2010, Figure 4, p. 16)

The abovementioned mechanisms have been judged as effective in increasing research output, the quality of research and the competitiveness of researchers by the majority of Estonian respondents. This is largely due to the evaluation mechanisms instituted for the obtainment of funding, where publications play an important role. Thus, publication and collaboration with other researchers deemed productive, in terms of output, “has become an aim *per se*”, at the same time it has meant that the focus on “output rather than outcome is strong” (Haller 2010). At the same time, it has been noted that there is a lack of effective mechanisms for applied research (Vaikmae 2010), and that the constituency representing social science and

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⁷ Unlike in the case of Latvia, European Union Structural Funds and other funding outside the country is, in some instances, represented as foreign funding in Estonia.
humanities is discontent with the funding proportions assigned to these fields (Anonymous D 2010).

**Participation in European Initiatives**

Estonian researchers have been active participants in international (COST, EUREKA, International Science Fund) and European Community support programmes (such as TEMPUS, PHARE, PECO) and in the Framework Programmes for Research and Technological Development from 1993 onward (Archimedes Foundation 2002). Starting with the Fourth Framework Programme, where around 30% of all proposals by Estonian researchers were successfully funded (Kaarli and Laasberg 2001), Estonian participation has continued on a good level in the Fifth and Sixth Framework Programmes, with a success rate of 26.8% (in the former) (Archimedes Foundation 2002) and a rate of 23% (in the latter) (Archimedes Foundation 2010). Despite the decrease in the success rate of project proposals, Estonian researchers received a considerably higher amount of funding (33.6m Euros) through the participation in the Sixth Framework Programme, as compared to the 19.2m Euros obtained through the Fifth Framework Programme. These amounts represented over half of foreign funding for research and development in Estonia in the respective period (ibid. 2010).

The participation in earlier Framework Programmes, produced such positive learning effects as experience in proposal writing (Martinson 1999), and access to the knowledge of other European researchers (Archimedes Foundation 2002). Foreign funding as an important input to research activity in Estonia, and the strong impact of Framework Programmes has been also confirmed through the interviews conducted (Villems 2007, 2010, Anonymous D 2010, Haller 2010, Kattel 2010, Kaarli 2010, Vaikmae 2010), where respondents confirmed that international collaboration through the Framework Programmes has contributed to the overall competitiveness of Estonian researchers, and their effectiveness in increasing research quality and output.

As part of the European Union support to new Member States, Estonia has received considerable funding through the Structural Funds. Some of this funding has been
earmarked for the support for research. In the planning period of 2004-2006, the Estonian National Development Plan for the Implementation of the EU Structural Funds (Ministry of Finance 2004), outlined support for higher education and research through the following:

- activities under the measure ‘Educational Systems Supporting the Flexibility and Employability of the Labour Force and Providing Opportunities of Lifelong Learning for All’ funded by the European Social Fund;
- activities under the measure ‘Modernisation of Infrastructure for Vocational and Higher Education, also funded by the European Regional Development Fund;
- activities under the measure ‘Promotion of Research, Technological Development and Innovation’ funded by the European Regional Development Fund.

The two former activities have been targeted at establishing doctoral schools, and attracting foreign researchers and professors, as well as infrastructure support for universities. The latter of which has secured financial commitment for the amount of 27.9m Euros (Masso and Ukrainski 2008).

The measures under the activity ‘Promotion of Research, Technological Development and Innovation’ have been earmarked 51.68m Euros, representing 65.7% of the total budget funding for research and development (Technopolis 2006). Numerous initiatives have been launched under this measure, including a programme for infrastructure support for Research Centres of Excellence, and for market oriented research projects, the Competence Centre Programme for research projects with industrial relevance, and other activities funded through competitive projects in public and private organisations (Masso and Ukrainski 2008, Kalvet 2010).

As the majority of these support measures have started in 2004 and 2005, it would be too premature to estimate the effects of these initiatives at this stage. However, interviewees in Estonia have acknowledged the significance of the role Structural Funds play, especially in the support for infrastructure and human resource development (Vaikmae 2007, Vaikmae 2010, Villems 2007, Kaarli 2010).
Legal and Policy Reform

Any reform undertaken in Estonia requires a legal base. Hence, all reforms in other spheres go hand in hand with legal reform (see Figure 19 below). However, it is more difficult to gauge the timing of the legal reform i.e. whether the legal reform was enacted first, causing the adoption of new rules on behalf of its subjects or bottom-up changes were implemented and legally enforced. Finally, a practical hindrance in assessing the legal reform has been the unavailability of multitude of Estonian legal documents in English.

Figure 19: A Timeline of the Main Legal and Policy Reforms in Estonia

During the first years of the reform, the government had very little involvement in shaping the funding and organisational reform as seen in previous sections of this chapter. Furthermore, the government also did not object to any reforms proposed by the newly created Union of Scientists or the Estonian Science Council. Thus, having more pressing concerns, its role was limited to approving regulations that enabled the new funding and organisational principles to take effect. The legal reform was further hampered by the frequent turnover of the government (Martinson 1995).

By 1992, the Estonian Science Council had adopted a conception of development of research and university education in Estonia and it had discussed draft laws on science and universities. However, it was not until December 1994 when the Organisation of Research Act was approved by the government, a further year until it
came into force on 1st January 1996, and two additional years were granted as a transition period to bring the research organisations into compliance with the new law (Riigikogu 1994).

The *Organisation of Research Act* (ibid. 1994) was the first legal document to outline the structure of the research systems and to determine the responsibilities of the organisations comprising this system. This act distinguished two types of organisations – research and development organisations (those organisations mainly concerned with organising the research system) and research and development organisations (those organisations whose main field of activity is research). The former included the Research and Development Council, the Estonian Academy of Sciences, the Estonian Science Foundation, and other research and development financing bodies. The latter included all universities, higher education organisations, research institutes and other establishments who predominantly, according to their statutes, carried out scientific research (Riigikogu 1994, Martinson 1995).

Research organisations, as well as research organisations according to the Law (ibid. 1994) were public bodies and hence were accountable to the Government. Research organisations were supervised by the respective Ministries or by local government bodies. These organisations were primarily funded by the state budget, which was drawn annually and supervised by the Ministry of Finance and the Ministry, which had authority over the particular organisations. The budget funding was approved by the government and channelled through the respective Ministries or local governments to the different organisations and organisations for disbursement. The owner (founder) of the research organisations was responsible for costs arising from the maintenance of the infrastructure of research organisations. The research organisations were obliged to report on their expenditure and account for their activities to their supervisory Ministry. Furthermore, the Act required that each research organisation shall be subjected to an evaluation at least once every seven years, based on the criteria devised by the Research and Development Council and carried out by local and foreign experts. Finally, the Act legally recognised the academic degrees acquired in the former USSR as the degrees of a foreign state and permitted the holders of the Candidates of Sciences of the USSR to use the title Doctor of Philosophy as the English equivalent (Riigikogu 1994).
Overall, the Act was pragmatic in essence (Martinson 1995) and primarily focused on the responsibilities of the state, on the one hand, and the responsibilities of the research organisations towards the state on the other hand. Moreover, it needs to be pointed out that, overall, the Ministry of Culture and Education (at present – the Ministry of Education and Research) had very limited responsibilities as prescribed by the law.

On the 26th March 1997, a new law was passed to regulate the Estonian research system. This Law came into effect only 15 months into the transition period of the previous Law. The new Organisation of Research and Development Act (Riigikogu 1997) largely focused on the legal status of research organisations. This was done to bring coherence to the legal system and to ensure that there is no contradiction between the various legal documents in view of the changes happening in the system. The classification of research organisations and research organisations was abolished and all research organisations became either state or local government agencies or legal persons in public (or agencies thereof) or legal persons in private law.

The most significant changes promulgated in the new Act (ibid. 1997), as already alluded to in previous sections, were the introduction of the Science Competence Council as a new advisory body, the status of the Academy of Sciences as an association of the scholarly elite of Estonia, as well as the new funding structure delineating target funding, grant funding and national research and development programmes. Furthermore, the responsibilities of the Ministry of Education were significantly increased, and for the first time, the Ministry of Economic Affairs became legally responsible for drafting an innovation policy for Estonia.

Over the course of the past decade, the Act (Riigikogu 1997) has been amended ten times; the last amendment was passed and entered into force in 2006. There have been two significant revisions (in 2001 and 2004) and eight minor revisions (in 1998, 1999, 2002, 2003 and 2006).

The first significant revision that took place in 2001 is notable for the elaboration of the duties and responsibilities of the Science Competence Council, the Ministry of...
Education and the Ministry of Economic Affairs. Furthermore, these amendments to the law also specify a more detailed procedure for evaluation of research organisations. The law states that the research organisations shall be evaluated once every seven years (later amended to eight years) jointly by the Ministry of Education and the Science Competence Council. This is to be done by forming a temporary evaluation committee composed of three to six experts, three of which must be foreign experts. In case of a negative outcome of the evaluation, the Minister of Education, on a proposal of the Science Competence Council, has the right to decrease target funding and to terminate target funding altogether for the following year (for those science fields that have received a negative evaluation) (Riigikogu 1997).

The amendments introduced in 2004 gave a legal basis to the newly formed Science Policy Council and the Innovation Policy Council. The Act specified their functions and responsibilities and their interaction with other state bodies. Furthermore, the second notable development was the introduction of base-line funding for research organisations. The Act denoted that the funding is to be provided by the Ministry of Education and Research from the state budget following a positive evaluation and taking into account the quality of research and the scope for the provision of research training. The Research and Development Council gives its opinion before the annual amount is decided (Riigikogu 1997).

**Policy Development**

During the 1990-ies the Estonian research system was organised and reorganised several times. There were multiple discussions with regard to the actions that policy makers ought to take in terms of the structure and funding of research and development and higher education organisations but no long-term strategy was set out. “During the first years the resource allocation problems ... tended to dominate science policy considerations. There was almost no discussion on what kind of science does Estonia need, which must be the priority areas of research, which areas must be maintained in national interests” (Martinson 1995, pp. 104-105). Furthermore, most policy proposals were based on government or Research and
Development Council decisions and there was no unifying document that set out the future plan of action.

The first strategic policy document in the area of research and development policy was published in 2002 and entitled *Knowledge-based Estonia: Estonian Research and Development Strategy 2002-2006* (Research and Development Council 2002). This document acknowledged the importance of knowledge for competitiveness and defined key objectives of the state in fostering knowledge creation and utilisation. The two main aims to be achieved were to update the knowledge pool and to increase the competitiveness of enterprises. The preconditions for these, as defined by the strategy, were the availability of a highly qualified labour force capable of conducting high level scientific research and the increase in the cooperation between the research and business sectors. Furthermore, in terms of the implementation of this strategy, the Estonian government defined three key areas that would be strategically important for the future competitiveness of the state, namely, information technologies, biomedicine, and material technologies (ibid. 2002).

The strategy foresaw a few concrete measures aimed at achieving the abovementioned goals. In terms of financing research, the government pledged to increase research and development expenditure to 1.5% of the GDP by 2006 and to 3% of the GDP by 2010, in line with the Lisbon Agenda. This entailed an increase in monetary resources from the state budget, on the one hand and more efficient and effective spending on the other, as well as the aim to attract more private funding for research and development. Furthermore, a rebalancing of the state expenditure for research and development ratio was sought, foreseeing 60% of the total funding for research and 40% for development instead of the existing ratio of 90% and 10% respectively. In its pursuit of updating the knowledge pool, the strategy focused on the development of adequate human capital to carry out research and development. To this end, it aimed at increasing the number of Master’s and Doctoral student positions funded by the state budget at the universities and institutes in Estonia. Finally, the strategy outlined several initiatives in the field of university-enterprise cooperation and international collaboration in science and technology (Research and Development Council 2002).
Reid and Walendowski (2006), as well as Koch, Pukl and Wolters (2007) in their analysis of the policy implementation process in this period, have remarked on the ambitiousness of the strategy, particularly, in relation to the provision of funding for research and innovation, and the expectation that the increases in public funding will be matched by the private sector. Masso and Ukrainski (2008) have assessed the progress towards this goal and have concluded that total expenditure as a fraction of GDP of 0.95% in 2005 is still well below the target of 1.6%.

Furthermore, Reid and Walendowski (2006) have commented on the lack of specific measures for priority fields of research, as well as the lack of broader national programmes with economic and societal relevance. Finally, the strategy is very much in line with European policy developments, and runs the risk of adequately assessing the applicability of European strategic goals to such a small country as Estonia.

The preparation of a successor strategy entitled Knowledge-Based Estonia II: Estonian Research and Development and Innovation Strategy 2007-2013 (Ministry of Education and Research 2007) was initiated in 2004 with the establishment of a working committee representing various stakeholders. Subsequently, the draft was published and extensively discussed in the academic community and in the government organisations. The Parliament approved the strategy in February 2007.

The new strategy defined three broad aims to be achieved, namely, competitive quality and increased intensity of research and development, innovative enterprises creating new value in the global economy, and innovation friendly society aimed at long-term development. As the previous strategy, it reiterated its focus on the development of human capital, the improvement of research organisation, and the promotion of innovative enterprises. Furthermore, it emphasised the need to increased the expenditure for research and development to 1.5% of the GDP by 2008 (a target measure that was already envisaged in 2002 to be achieved by 2008) and to 3% of the GDP by 2014. Also, the number of researchers and engineers were to rise to 8 professionals per 1,000 employees (Ministry of Education and Research 2007).

Overall, as Koch, Pukl and Wolters (2007) have concluded: “the conceptual basis for RTDI policy in Estonia is very well developed, but ... there is both a ‘coordination
gap’ as well as an ‘implementation gap’” (p. 18), in terms of the multitude of policy measures on the one hand, and the limited capacity to implement them on the other. Some interviewees, notably from the government sector (Kaarli 2010) have also referred to this, citing the need to keep abreast of the multitude of instruments and frequent changes in regulation as important factors in the estimation of adequate capacity. In general, however, the existence of such a strategy has also been positively assessed by the majority of interviewees in Estonia. However, some remarked the fragmentation of the administrative structures is hindering strategic change (Kattel 2010) and that its influence on focusing R&D activities and setting priorities has been rather limited (Anonymous D 2010). Others remarked that the strategy has not been monitored in the broadest sense of convergence with the targets therein and with respect to the effectiveness of the administrative bodies (Willems 2010).

The monitoring and evaluation of the Estonian research policy and instruments is also the topic of the next section. An overview of relevant assessments and evaluation practices in Estonia is provided below.

**Evaluation Practices**

Estonia has considerable track record of evaluations undertaken during the transition period. These have ranged from international evaluations of the research system as a whole (notably, the evaluation carried out by the Swedish Research Councils in the period of 1991-1992), to the evaluation of certain aspects of the system, such as its funding modes (Nedeva and Georghiou 2003), and the evaluation of the overall design and implementation of Estonian research, development and innovation policy (Reid and Walendowski 2005).

The Estonian researchers have also been active in carrying out in-house evaluations. Following the evaluation by the Swedish Research Councils in 1992, an in-house evaluation of the Estonian research base, organised by the Research and Development Council, took place in 1994-1995. Subsequently, these two evaluations “served as a basis for principal structural changes of the whole research
establishment” (Martinson 1999, p. 121), especially, the integration of research institutes and universities.

Systematic evaluations of research organisations have been firmly established within the functioning of the Estonian research system and are mandated by the legal base. The last cycle of evaluations took place in 2000-2004 and a further cycle will start in 2008.

The Organisation of Research and Development Act of 1997 (Riigikogu 1997) stipulates that research organisations are subject to international evaluations every eight years. These evaluations, as a rule are evaluations of research fields, and usually are undertaken at the departmental (research group) level, where the main criteria are quality of research, and the overall capabilities of the organisations to conduct research in a particular area (Roll, Uus and Noukas 2007). Implicitly, the overarching aim is then to benchmark these capabilities against international standards.

The evaluations, as a rule, must involve international experts and are extensive in nature, involving field visits and interviews, as well as the examination of documentary evidence and bibliometric data on previous achievements. The past track record of an organisation or research area (for example, for baseline funding, this period spans the three years prior to evaluation) is important in determining subsequent budget allocation. Among the assessment criteria are such considerations as the novelty of research, national and international cooperation, and future strategy and implementation capabilities (European Communities 2008a).

The Estonian evaluation practices have been described positively (OECD 2006) and as based on the principles of “auditing society” (Weingart in Roll, Uus, and Noukas 2007, p. 20). Furthermore, the overall evaluation process of research by organisations has generally been accepted by the organisations as a “necessary evil” (OECD 2006). A criticism of this approach, however, has been the use of a limited set of quantitative bibliometric criteria, which precipitate the Matthew Effect due to an evaluation system that favours the historically strong fields, such as the natural and applied sciences (Aitolla cited in Roll, Uus, and Noukas 2007, p. 21).
The results of these evaluations are linked to future funding levels, in particular, this applies to baseline funding, but evaluation results are also taken into account in determining project funding i.e. a negative appraisal of a research area within an organisation can result in the withdrawal of project funding. Furthermore, evaluations of research areas are also linked to higher education, and an unsatisfactory evaluation can result in the withdrawal of accreditation of doctoral programmes (European Communities 2008a).

Evaluation practices have also been established at the programme and project level. As discussed in previous sections, the individual projects funded through the Estonian Science Foundation and the Science Competence Council undergo a thorough peer-review procedure, involving national and international experts, and are subject to periodical review (usually in annual or triennial cycles) throughout the duration of the projects.

Finally, ex ante and ex post assessments of major policy initiatives are undertaken to assess their feasibility and performance. These are often commissioned by the respective ministry and frequently done by involving international expert groups or consultants. The frequency of these assessments has also increased in view of the planning of European Union Structural Funds (Reid 2003). Numerous feasibility studies, especially, in the field of innovation policy, have been conducted in the mid-2000s and their implementation is in the process of being assessed.

**Quantitative Assessment of the Estonian Research System**

In Estonia, comprehensive figures for the Gross Domestic Expenditure on Research and Development (GERD) have become available from 1998 onward, when the Estonian Statistical Bureau began collecting statistics in accordance with the Frascati Manual (OECD 2002). At the outset of this period, the GERD totalled at 28.6m Euros in current prices (the equivalent of 61.3m Euros in constant prices) and has grown to 173.6m Euros in current prices and 227.1m Euros in constant prices a decade later (Eurostat 2009). Thus, in nominal figures, this equals six times more than in 1998; in real figures, though, it is still a considerable increase of 3.7 times
with an average year-on-year growth rate of 16.17% and a CAGR of 15.67%. Thus, it can be concluded that the GERD in Estonia has grown steadily over the respective period, with a sharp year-on-year increase (35.6%) in overall GERD in 2006 (see Figure 20).

**Figure 20: GERD in Estonia, Current and Constant Prices 1998-2007 (m Euro and m Euro PPS 2000)**

![GERD in Estonia](chart)

Source: Eurostat (2009)

In terms of the growth of expenditure for research compared to the overall economy, which is demonstrated by the GERD as a percentage of the GDP, it can be said that Estonian R&D intensity has increased steadily. The rise in the percentage of the provision of funds for research in the overall provision of funds in the economy has been constant, and this has been also reflected in the research intensity, which has risen from 0.57% GDP in 1998 to 1.14% GDP in 2007 (Eurostat 2009).

**GERD by Source of Funds and Sector of Performance**

In Estonia, the increase in overall expenditure for research and development has also meant an increase in funding provided for R&D by the different sectors. The three largest contributors or sources of funding for R&D in the period of 1998-2007 have been the Government Sector (GOV), the BES, and sources from outside of the country i.e. funding from abroad. The provision of funding has grown continuously...
in all but the private non-profit sector (PNP). However, a slow-down to this growth is present in 2007 (see Figure 21).

**Figure 21: GERD by Source of Funds in Estonia, 1998-2007 (m Euro PPS 2000)**

Throughout the period of observation, the government sector has been by far the largest contributor to funding research and development, providing over 38.8m Euros in 1998 to 103.7m Euros in 2007 (Eurostat 2009). However, its share in the overall GERD has decreased from 65% of GERD to 45% during the period under observation. This translates into an average year-on-year growth of 12.3% and a compound annual growth of 11.5%. The year 2006 must be noted as experiencing the highest year-on-year increase of 39% in government funding, which can be explained by the provision of European Union Structural Funds for R&D in Estonia during this period.
The majority of government funding (around 70% in 1998-2008) has been granted to the higher education sector. Nearly a quarter of this funding (25%) has been spent within the sector, and 5% of funding has gone to the business enterprise sector. Notably, the funding for the business enterprise sector prior to 2004 has, on average, comprised 3-4% and shown an increase to 7-9% between 2005 and 2007. This is in line with the increasing importance of innovation-oriented initiatives of the Estonian government.

The second largest funder of R&D in Estonia has been the business enterprise sector. From 1998 onward, the sector has not only increased its contribution to R&D from 14.2m Euros to 94.5m Euros in 2007 (Eurostat 2009), but also increased its share of funding as a percentage of GERD from 23% to nearly 42%. In terms of growth, it has been the second fastest growing funding sector (surpassed only by the foreign funding sector) with an average year-on-year growth rate of 25% and a cumulative CAGR of 23.4%.

In the distribution of funding, a number of trends can be observed. Firstly, there has been a growth in the share of this expenditure that is utilised in the business enterprise sector. In 1998, this share was 70% but by 2007 it had increased to 95%.

Furthermore, according to the Community Innovation Survey in Estonia 2002-2004 (Estonian Statistical Office 2009), the majority of business expenditure for innovative activities (including R&D) has been utilised for the acquisition of novel machinery and equipment and only around 20% of the expenditure has been used to conduct intramural R&D and a further 4.3% to sponsor extramural R&D. This points to a very weak linkage between the business and the public R&D sector. In fact, only around 6% of business expenditure on R&D was spent in the higher education sector and close to 0% in the government sector in 2007 (compared to 18% and 10%, respectively, in 1998).

The third largest sponsor of R&D has been the overseas sector; as mentioned earlier, it has also been the sector with the highest average year-on-year growth rate (26.4%) and the highest compound annual growth rate (24%). Having spent 3.8m Euros on
R&D in Estonia in 1998, in absolute terms, the foreign sector funding has increased to 26.5m Euros in 2007 (peaking at 35.2m Euros in 2006) (Eurostat 2009). This figure has almost tripled between 1998 and 2000, and overall increased nearly seven-fold in a decade.

Nearly half (48%) of foreign funding went to the higher education sector in the last decade, a further quarter has been provided to fund enterprises (this share has grown to nearly one third in 2005-2007), and the remainder was earmarked to fund government (19%) and private non-profit organisations (8%).

The share of GERD financed by the higher education sector is very small (less than 1%) and has decreased from the early 2000s. However, in absolute terms it has increased (1.6m Euros in 1998 and 2m Euros in 2007) at a compound growth rate of 2.3%, which is a welcome development.

The private non-profit sector investments in R&D, contrary to other sectors, have shrunk during the last decade. In 1998 PNP funding comprised 2.8m Euros and around 5% of all research funding, in 2007, however, the percentage of GERD funded by the private non-profit sector was 0.18%, which in absolute values was around half a million Euros. Hence, the contribution of this sector to the Estonian research system is negligible.

Overall, the main findings of the quantitative assessment of the funding dynamics of R&D in Estonia can be summarised as follows. Over the period of 1998-2007, the overall GERD has increased nearly four-fold, largely due to an increase in government, business and foreign spending on R&D in Estonia. The latter two sectors, with compound annual growth rates of around 23% each, are responsible for the majority of this growth. The growth of the government sector contribution at approximately 12% has been more moderate.

Most of the GERD in terms of sector of performance (see Figure 22) has been incurred in the higher education and business sectors. At the same time, the share of higher education expenditure on R&D in the overall GERD has decreased over time, whereas the share of the business enterprise expenditure on R&D has increased. The
The share of intramural government expenditure on R&D in Estonia has also decreased, which has meant that an increasing share of research is undertaken in the HES.

**Figure 22: GERD by Sector of Performance in Estonia, 1998-2007 (% , m Euro PPS 2000)**

The government sector, nevertheless, has been the largest contributor to research funding in the higher education sector, whereas expenditure in the business sector was largely due to intramural funding. The foreign sector has contributed considerably to the GERD in Estonia, and has been growing at 24% annually. This growth has been particularly prominent in the period in 2004-2006. Half of this funding has gone to the higher education sector, but increasingly, a large proportion (approx. 30%) of this funding is going to the business enterprise sector. Thus, it merits further qualitative investigation.
Main Findings

In the past two decades, the Estonian research system has undergone a radical transformation; moreover, the success of Estonia as a catching-up transition economy has been frequently lauded. Within this period, the research system has transformed its administrative and funding structures, as well as instituted a coherent legal framework, international evaluation practices, and developed two research and innovation policy strategies.

In the context of organisational reform, Estonia has established a multi-level governance of the research system. Headed by the Research and Development Council, directly linked to the highest levels of decision-making, it has connected a multitude of stakeholders. This, along with the presence of a well thought-out and pragmatic legal framework, has helped to ensure government involvement. Finally, integration of the majority of research institutes with universities has moved the system closer to established Western-style research systems.

The gradual introduction of competitive funding with the provision of some basic funding has mitigated the severity of the transition period. Furthermore, a proliferation of funding mechanisms, coupled with an increase in funding has helped to sustain the system. Finally, the introduction of evaluation mechanisms based on Western standards, the use of international experts and the systematic assessment of policies and instruments has had a favourable impact on the output and competitiveness of researchers nationally and internationally.
Chapter VII: Comparison of the Quantitative Aspects of the Estonian and Latvian Research System

Chapter V and Chapter VI illustrated the development of research systems in the two cases in a qualitative and quantitative fashion. This chapter will build on the evidence presented so far and establish a comparative perspective, primarily through the use of quantitative indicators. The results of this chapter will then feed into Chapter VIII, which will triangulate the findings elucidated so far with the observations on the quantitative data.

The Research Output of the Latvian and Estonian Systems – A Historical Perspective

In an early analysis of publication patterns from 1986 to 1992, Kristapsons and Tjunina (1993) stipulated that in research fields in which publication has not traditionally been a highly regarded requirement there is an inclination towards regional seclusion and no real incentive to publish internationally. Furthermore, the same analysis showed that Latvia has traditionally had a higher propensity to publish in scientific journals of USSR origin and has been slower to secure publications in Western journals. The share of scientific work published in the USSR and in the rest of the world in Latvia in 1986 was 64% and 35%, seven years later it had changed to 47% and 53%, whereas in Estonia these figures were 45% and 55% in 1986 and 26% and 74% in 1992. Thus, it appears the Estonian researchers had already subscribed to the Western tradition of publishing in the late 1980ies and therefore were able to reorient themselves much quicker than their Latvian counterparts (ibid. 1993). However, during the Swedish and Danish Research Councils’ evaluation of the two research systems, the experts recommended that both countries reorient their publishing policies toward international journals. Hence, while at the outset of the transition, Estonia had better track record of international publishing, further improvements needed to be sought. According to Martinson (1999), these changes in the patterns of publishing have been actively pursued, and, as seen in the outline of the Estonian research system earlier, publication in internationally recognised peer reviewed journals has been a key requirement in obtaining funding.
There is a small number of scholars (Kristapsons and Tjunina 1993, Kristapsons 1998, 2003, Kristapsons, Martinson and Dagyte 2003, Allik 2003, 2008, Must 2006, Kristapsons and Kozlovskis 2009) in Estonia and Latvia, who have taken a keen interest in the publication and citation patterns of the two countries. By and large these studies have used aggregate publication counts (all types of publication) and pre-defined indices (such as the Thomson Reuters Essential Science Indicators database). More restricted results have been reported for Latvia (Kristapsons and Kozlovskis 2009, Dombrovskis), but all previous searches have covered different periods in time. The various results of these studies have been collated in the table below; however, due to the multitude of sources and variety of filtering methods, these results are reported for illustrative purposes only. An independent analysis of the Web of Science database has been undertaken, the results of which are reported in the next section.

**Table 7: Aggregate Publication Count in Latvia and Estonia (1986-2007)**

<table>
<thead>
<tr>
<th></th>
<th>Latvia</th>
<th>Estonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>246</td>
<td>226</td>
</tr>
<tr>
<td>1987</td>
<td>219</td>
<td>231</td>
</tr>
<tr>
<td>1988</td>
<td>282</td>
<td>216</td>
</tr>
<tr>
<td>1989</td>
<td>254</td>
<td>225</td>
</tr>
<tr>
<td>1990</td>
<td>237</td>
<td>239</td>
</tr>
<tr>
<td>1991</td>
<td>221</td>
<td>239</td>
</tr>
<tr>
<td>1992</td>
<td>294</td>
<td>260</td>
</tr>
<tr>
<td>1993</td>
<td>236</td>
<td>243</td>
</tr>
<tr>
<td>1994</td>
<td>241</td>
<td>305</td>
</tr>
<tr>
<td>1995</td>
<td>233</td>
<td>355</td>
</tr>
<tr>
<td>1996</td>
<td>251</td>
<td>390</td>
</tr>
<tr>
<td>1997</td>
<td>257</td>
<td>411</td>
</tr>
<tr>
<td>1998</td>
<td>303</td>
<td>468</td>
</tr>
<tr>
<td>1999</td>
<td>296</td>
<td>490</td>
</tr>
<tr>
<td>2000</td>
<td>290</td>
<td>527</td>
</tr>
<tr>
<td>Year</td>
<td>Estonian Publications</td>
<td>Latvian Publications</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>2001</td>
<td>334</td>
<td>592</td>
</tr>
<tr>
<td>2002</td>
<td>371</td>
<td>603</td>
</tr>
<tr>
<td>2003</td>
<td>367</td>
<td>702</td>
</tr>
<tr>
<td>2004</td>
<td>380</td>
<td>753</td>
</tr>
<tr>
<td>2005</td>
<td>406</td>
<td>862</td>
</tr>
<tr>
<td>2006</td>
<td>346</td>
<td>874</td>
</tr>
<tr>
<td>2007</td>
<td>405</td>
<td>987</td>
</tr>
<tr>
<td>Total</td>
<td>7022</td>
<td>11362</td>
</tr>
</tbody>
</table>

Sources: Own compilation based on data reported in Kristapsons (1998, 2003) and Thomson Reuters (2009a) (includes all publications indexed by the ISI Web of Science)

An Independent Analysis of Research Output in Estonia and Latvia

To establish a more nuanced picture of the research capabilities and the productivity of the two systems, a subset of all aggregate data on the publishing activities in Estonia and Latvia was sought. To that end, an independent search of the ISI Web of Science, surveying only journal articles, conference proceedings and reviews for the period of 1998-2007 has been undertaken and it has been found that the number of publications with a strong research component has been a smaller subset of all publications presented in other studies of the Latvian and Estonian research systems (see previous section).

According to the data obtained from the independent search of the ISI Web of Science database for the respective period, Estonian researchers had produced 6,494 publications, whereas Latvian researchers had produced only 3,360 publications (just over a half of the total of their Northern neighbours)\(^8\). The choice to survey this ten-year period for the study is based on previous studies (Moed et al. 1985; Geuna and Martin 2003; King 2004) and the assumption that the average number of years to see impact of changes in research policy and impact is 6 years (Crespi and Geuna 2004, 2006, 2008). Furthermore, this period has also been chosen to limit the possibility of

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\(^8\) To establish the number of publications in the given reference period, the ISI Web of Science, Science Citation Index Expanded database was searched for articles, which matched the country name ‘Latvia’ or ‘Estonia’ in the respective address field. Publications with more than one author from the respective countries are considered only once.
effects of research policy in previous periods i.e. resulting from initiatives promoted by the Soviet government.

Table 8: The Total Number of Publications (Journal Articles, Conference Proceedings, and Reviews) in Latvia and Estonia 1998-2007

<table>
<thead>
<tr>
<th></th>
<th>Latvia</th>
<th>Estonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>349</td>
<td>525</td>
</tr>
<tr>
<td>1999</td>
<td>370</td>
<td>567</td>
</tr>
<tr>
<td>2000</td>
<td>331</td>
<td>524</td>
</tr>
<tr>
<td>2001</td>
<td>341</td>
<td>579</td>
</tr>
<tr>
<td>2002</td>
<td>353</td>
<td>564</td>
</tr>
<tr>
<td>2003</td>
<td>308</td>
<td>597</td>
</tr>
<tr>
<td>2004</td>
<td>339</td>
<td>688</td>
</tr>
<tr>
<td>2005</td>
<td>314</td>
<td>739</td>
</tr>
<tr>
<td>2006</td>
<td>295</td>
<td>782</td>
</tr>
<tr>
<td>2007</td>
<td>360</td>
<td>929</td>
</tr>
<tr>
<td>Total</td>
<td>3360</td>
<td>6494</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters (2009a)

As can be seen from the table above, while research publications from Estonian organizations have increased (with an average year-on-year increase over the nine year period of approximately 7%, and a compound annual growth rate of 6.5%), the number of publications from Latvian organizations has remained unchanged (average year-on-year increase of less than 1%, and a compound annual growth rate of a mere 0.3%).

Estonia had also taken the lead in producing more articles (81%) than conference proceedings (17%). In Latvia, this proportion has been 72% for the former and 26% for the latter. This can be explained by the historically stronger presence of engineering sciences in Latvia, where publication of conference papers is more prominent. The proportion of reviews among all publications was equal in both countries (2%).
In the respective decade the number of journal articles in the SCI from Latvia has not seen any significant changes from 256 articles in 1998 to 269 articles in 2007, the mean number of articles being 241. It is also interesting to note that in the same period, Latvian researchers had still written 7% of their articles in Russian. In Estonia, the corresponding figures are 431 articles (1998) and 759 articles (2007), the average number being 522 articles. This represents a compound increase of 6.5% in Estonia and 0.6% in Latvia.

In terms of journal coverage, Latvian researchers have published their articles, proceeding papers and reviews in over a thousand (1,028) different publications. As Estonian researchers have produced far more publications, it has also meant wider journal coverage. In the given period, Estonian research output has been published in 1,836 different journals indexed by the SCI. For the most part, each of the different journals has attracted a small number of publications; however, there are a number of journals, which have attracted a significant number of articles from the respective countries.

Over six percent of the total research output from Latvia has been published in *Khimiya Geterotsiklichesikh Soedinenii* (Chemistry of Heterocyclic Compounds) a journal originating in Latvia with articles published in Russian and English. The journal, first issued in 1965, has a long history attracting publications in this sub-field of chemistry from the republics of the former Soviet Union. Interestingly, 98% of all articles in this journal from Latvian authors were published in Russian. Another journal that has attracted a substantial amount of publications from Latvian researchers (4.5%) is *Mechanics of Composite Materials*, a translation of the Russian journal *Mekhanika Kompozitnykh Materialov*, also edited by Latvian researchers (as is the journal Automatic *Control and Computer Sciences*). However, in contrast to the journal on Chemistry of Heterocyclic Compounds, all articles from Latvia have been published in English. These and other journals, attracting at least 1% of the Latvian research output are summarised below.
<table>
<thead>
<tr>
<th>Name of the Journal</th>
<th>General area of Research/Scope of the Journal</th>
<th>Number of Total Publications (Articles/Proceedings/Reviews) (1998-2007)</th>
<th>Percentage of the Total Number of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khimiya Geterotsiklichesikh Soedinenii</td>
<td>Chemistry, Organic Chemistry</td>
<td>211 (182/16/13)</td>
<td>6.3</td>
</tr>
<tr>
<td>Mechanics of Composite Materials</td>
<td>Chemistry and Materials Science</td>
<td>150 (147/3/0)</td>
<td>4.5</td>
</tr>
<tr>
<td>Ferroelectrics</td>
<td>Physics, Condensed Matter Science, Multidisciplinary</td>
<td>95 (7/88/0)</td>
<td>2.8</td>
</tr>
<tr>
<td>Automatic Control and Computer Sciences</td>
<td>Computer Science</td>
<td>64 (64/0/0)</td>
<td>1.9</td>
</tr>
<tr>
<td>Radiation Effects and Defects in Solids</td>
<td>Physics, Condensed Matter Science, Multidisciplinary</td>
<td>41 (14/27/0)</td>
<td>1.2</td>
</tr>
<tr>
<td>Journal of Non-Crystalline Solids</td>
<td>Materials Science</td>
<td>39 (15/24/0)</td>
<td>1.2</td>
</tr>
<tr>
<td>Physical Review B</td>
<td>Physics, Condensed Matter Science, Multidisciplinary</td>
<td>35 (35/0/0)</td>
<td>1</td>
</tr>
<tr>
<td>Journal of Physics – Condensed Matter</td>
<td>Physics, Condensed Matter Science, Multidisciplinary</td>
<td>33 (29/4/0)</td>
<td>1</td>
</tr>
<tr>
<td>Nuclear Instruments &amp; Methods in Physics Research, Section B</td>
<td>Physics</td>
<td>33 (3/30/0)</td>
<td>1</td>
</tr>
<tr>
<td>Radiation Measurements</td>
<td>Physics</td>
<td>33 (0/33/0)</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters (2009a)
Table 10: Journals with Most Estonian Publications

<table>
<thead>
<tr>
<th>Name of the Journal</th>
<th>General area of Research/Scope of Journal</th>
<th>Number of Total Publications (Articles/Proceedings/Reviews) (1998-2007)</th>
<th>Percentage of the Total Number of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Shale</td>
<td>Geology</td>
<td>246 (219/21/6)</td>
<td>3.8</td>
</tr>
<tr>
<td>Hydrobiologia</td>
<td>Biology</td>
<td>77 (35/42/0)</td>
<td>1.2</td>
</tr>
<tr>
<td>Journal of Luminescence</td>
<td>Multidisciplinary</td>
<td>67 (15/52/0)</td>
<td>1</td>
</tr>
<tr>
<td>Astronomy &amp; Astrophysics (incl. supplements)</td>
<td>Astronomy, Physics</td>
<td>67 (64/0/3)</td>
<td>1</td>
</tr>
<tr>
<td>Thin Solid Films</td>
<td>Physics, Material Science</td>
<td>55 (14/41/0)</td>
<td>0.8</td>
</tr>
<tr>
<td>Physical Review B</td>
<td>Physics, Condensed Matter Materials Science, Multidisciplinary</td>
<td>45 (45/0/0)</td>
<td>0.7</td>
</tr>
<tr>
<td>Boreal Environment Research</td>
<td>Agriculture, Biology and Environmental sciences</td>
<td>34 (30/4/0)</td>
<td>0.5</td>
</tr>
<tr>
<td>Journal of Electroanalytical Chemistry</td>
<td>Chemistry</td>
<td>33 (33/0/0)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters (2009a)

The publication patterns in Estonia are more varied. The journal most widely published in by Estonian researchers has been the journal *Oil Shale*, where 246 publications (3.8% of the total number of publications) have been published in the ten year period under review. The journal is published by the Estonian Academy of Sciences publishers and is the only journal in the world, which focuses solely on research on oil shale. Furthermore, it is also fitting that such a journal would be published in Estonia and would attract a large number of articles, since oil shale is one of the most important natural resources for the Estonian economy and is the main source for power generation in the country.

Given the data for Estonia and Latvia, collected from the ISI Web of Science SCI for the period of 1998-2007 (Thomson Reuters 2009a), the aggregate number of articles and citations have been grouped into the individual sub-categories and ranked in
terms of number of papers published, number of citations, and citations per paper. The summary of this analysis is presented below. Taken separately, these indicators provide only limited insight into the publication activities and their quality. However, in combination, they present a clearer picture of the research effort (an exhaustive list of all publications and citations is provided in Annex C).

The SCI divides all its journals into six broad subject fields of Natural Sciences and Mathematics, Life and Agricultural Sciences, Clinical Medicine and Pharmacy, Engineering, Technology and Computer Sciences, Interdisciplinary and Multidisciplinary Sciences, and Social Sciences (the latter is indexed by the Social Sciences Citation Index, which will be explored later). These are then further subdivided into narrower specialisations (over 170 in total). The journals are ascribed to each category and sub-category according to their scope.

Of all Estonian publications between 1998 and 2007 over one third (34%) has been in the general field of Life and Agriculture Sciences, a further third (33%) were concerned with Natural Sciences and Mathematics, followed by Clinical Medicine and Pharmacy and Engineering, Technology and Computer Sciences making up the remainder. Interdisciplinary and Multidisciplinary Sciences comprised only around 2% of the total research output.

In Latvia, almost 40% of research output over the last decade has been produced in the field of Natural Sciences and Mathematics, another third of publications were in the field of Engineering, Technology and Computer Sciences, one fifth in Natural and Agriculture Sciences, and approximately 9% in Clinical Medicine and Pharmacy. A comparison of the publication dynamics, in terms of the broader fields of science, is summarised graphically in Figure 23.

In addition to the abovementioned absolute publication counts by field of science, which mirror the publication efforts or the quantity of scientific information in Latvia and Estonia, the quality of these publications also needs to be considered. The worthiness of an article or a conference proceeding can be gauged by its citation rate i.e. the number of times a publication is cited by another scientific publication, as well as by the ratio of citations per publication. As it can be seen from Table 11,
although the two countries have focused on different fields of science in terms of published output, the fields that have exhibited the greatest publication patterns have not always achieved the greatest recognition in other works. For example, the abovementioned fields that produced most publications in Latvia also attracted the lowest citation rates per publication. In Estonia, the citation rates per publication correspond with the largest areas in terms of published papers, with Natural Sciences & Mathematics being the only area where the publication count has not attracted as many citations given the large presence of the field in the overall research system.
Figure 23: Distribution of Estonian and Latvian Publications (%) by Field of Science (1998-2007)

Source: Own calculations based on SCI data (Thomson Reuters 2009a)
<table>
<thead>
<tr>
<th>Area of Science</th>
<th>Estonia</th>
<th>Latvia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Publications</td>
<td>%</td>
</tr>
<tr>
<td>Life and Agriculture Sciences</td>
<td>2208</td>
<td>34</td>
</tr>
<tr>
<td>Natural Sciences and Mathematics</td>
<td>2150</td>
<td>33.1</td>
</tr>
<tr>
<td>Clinical Medicine and Pharmacy</td>
<td>1028</td>
<td>15.8</td>
</tr>
<tr>
<td>Engineering/Technology and Computer Sciences</td>
<td>970</td>
<td>14.9</td>
</tr>
<tr>
<td>Interdisciplinary and Multidisciplinary Sciences</td>
<td>138</td>
<td>2.1</td>
</tr>
<tr>
<td>Total</td>
<td>6949</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters (2009a)
Further analysis of the bibliometric data by sub-fields of science has been undertaken and it has been found that in some areas Estonia and Latvia have performed similarly in terms of research output. For example, in chemistry, a field with a rather long history and tradition in both countries, the gap in the number of publications is very small. The same applies to another traditionally strong field – physics, and to the whole scope of engineering disciplines. At the same time, the publication data exhibited different specialisations within the disciplines, for example, Latvian researchers largely undertaking research and publishing articles and proceedings in organic chemistry, while Estonian researchers publishing more in the field of physical chemistry. Furthermore, Latvian researchers have published twice as many articles in Materials Science as their Estonian counterparts. The opposite applies to the field of Biochemistry & Molecular Biology, where Estonian researchers have taken the lead. A snapshot of the scientific sub-fields, which have produced the largest number of research publications is provided in Figure 24.

Concurrently, the fields that have attracted the most citations in both countries are Biochemistry & Molecular Biology (the largest number of citations), Physical Chemistry, General & Internal Medicine, and Genetics & Heredity. In Estonia, high citation rates were also observed in Ecology, Multidisciplinary and Environmental Sciences, as well as Neurosciences, Astronomy & Astrophysics. As for Latvia, the most cited fields also included Multidisciplinary and Condensed Matter Physics, Multidisciplinary and Ceramics Material Sciences, Organic Chemistry and Immunology.

Thus far, aggregate publication counts by sub-field of science have been compared. However, given the differences in overall productivity, both countries have actually produced a large share of scientific publications in Biochemistry & Molecular Biology, Physical Chemistry, Multidisciplinary Materials Science, and Condensed Matter Physics. In addition, Estonian researchers have extensively published in the fields of Energy & Fuels, Plant and Environmental Sciences, and Astronomy & Astrophysics. At the same time, Latvian researchers focused more on fields of Organic Chemistry, Mechanics, and Agricultural Engineering.

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9 For illustration purposes, only fields with the publication count of 100 and above have been included
Figure 24: Science Fields with the Highest Number of Publications (>=100) in Estonia and Latvia (1998-2007)

Source: Own calculations based on SCI data (Thomson Reuters 2009a)
By merging the two indicators of publication and citation, the average citation rate or the number of citations per paper in a particular research area can be calculated. This provides a better estimation of the quantity and quality of publications, as well as allows for comparisons across countries. The higher the number of citations per paper, the more influential the scientific results obtained in a particular research area. However, it must be remembered that small publication counts with large citation rates distort the adequate representation of research effort in the field. This was also found in the data at hand, namely, the number of publications in the larger field of Clinical Medicine and Pharmacy in Latvia was 3.5 times smaller than in Estonia and comprised only 8.8% of the total research output in the country (compared to Estonia, where the field amounts to 15.8% of the total number of publications), yet due to the higher number of citations these publications attracted, their citation rate per paper was also higher. The largest citation rate per paper (290 citations) was achieved in Latvia in the sub-field of Geriatrics & Gerontology, which included only one proceedings paper. A similar pattern, though not quite as skewed, is also observed in other sub-categories of Clinical Medicine and Pharmacy in Latvia. This can be explained by large citation rates to the few articles that were published in such prestigious journals as the Lancet, the New England Journal of Medicine and Science Medicine. In Estonia, the same trend was observed in the sub-fields of Critical Care Medicine; however, the citations per paper did not exceed 52. Perhaps, the Latvian case best illustrates the pitfalls this measure has in small countries, where there is a minute number of articles in a field. Larger countries, which specialise in a multitude of areas, are unlikely to encounter such an occurrence.

The measure of citations per paper is perhaps most accurate, where there is a large number of publications and a large number of citations. And there are a number of sub-fields of science for which it is the case in Estonia and Latvia. The former displays consistently high publication and citation rates in the sub-field of Biochemistry & Molecular Biology, at a rate of 21 citations per paper, in Ecology (20), Neurosciences (19), and Multidisciplinary Chemistry (18). The latter excels in the fields of Multidisciplinary Physics (16.8), Materials Science – Ceramics (11.8), Biochemistry & Molecular Biology (12).
In both countries, research is focused in a small number of organisations, and with the integration of research institutes into universities, it is hardly surprising that most research output in form of publications is concentrated there. This is especially evident in Estonia, where the four leading universities published over 92% of all research papers in the decade under observation. The University of Tartu is the main producer of scientific papers, having produced 60% of the total research articles, conference proceedings and reviews included in the SCI database between 1998 and 2007. A further 20% of the published content is attributable to the Tallinn University of Technology and another 10% to the Estonian University of Life Sciences. The newly reorganised Tallinn University (formerly, the Tallinn Pedagogical University) accounts for only 2.3% of the total research output.

In Latvia, the distribution of publications is more widely dispersed, as there are more independent research institutes. Unlike in Estonia, the three major universities in Latvia have produced only three quarters of all publications. The largest university (the University of Latvia) has produced a slightly lesser but still noticeable proportion of the overall publication count at 54% than its counterpart in Estonia – the University of Tartu. Riga Technical University produced 15% of the overall research output, and the Riga Stradins University (the former Latvian Academy of Medicine) an additional 5%. Among the independent research institutes, the Institute of Organic Synthesis has produced in excess of 12% of all publications from researchers affiliated to a Latvian research organisation. The other institute that can be singled out as producing a considerable share of papers is the Institute of Wood Chemistry with 2.3% of publications.

Thus, not only have Estonian researchers produced more articles, proceedings and reviews, and targeted a wider range of journals in the respective period; they also have published in more research areas than their Latvian counterparts. However, due to the lack of access to data provided by the Essential Science Indicators database, as well as the divergence of the time frames and the types of analysis, the results of the given survey of bibliometric data cannot be directly compared with previous studies (see Allik 2003 and 2008). Nevertheless, the results seem to be largely consistent, in terms of the general trends reported elsewhere.
The Productivity of the Estonian and Latvian Research Systems in the Global Arena

Another concern in the analysis is the evaluation of the standing of the research output of these two countries in the global arena. With the onset of the digital age, the number of research publications worldwide has increased continuously; this also applies to the SCI, which has continuously expanded. From the year 2000, the number of journals included in the SCI increased by 13% - from 5686 journals to 6426 journals in 2007 (Thomson Reuters 2009b). Unfortunately, no exact public data is available on the number of papers published in the three indices of the Thomson ISI Web of Science every year; thus, secondary data from a UK case study (Evidence Ltd. 2003, 2004, 2006, 2007, 2008 and 2009) is used to derive the total number of research articles published globally in 1997-2005 and in 2007.

The annual studies commissioned by the UK government and executed by Evidence Ltd monitor (ibid. 2003, 2004, 2006, 2007, 2008 and 2009), among other things, the research output of the UK research base as measured by journal articles in the Thomson ISI Web of Science database. With the help of this study, the necessary figures for global publication counts were obtained, which in turn enables the calculation of the total share of Estonian and Latvian publications in the global research system. The findings are presented in Table 14.

As no annual data for the number of articles published worldwide is available from 1997-2001, the five-year average is used as a starting point. From 1997-2001, the average share of Estonian journal articles in the total number of articles indexed by the Web of Science was 0.064%, the Latvian share was almost half of its neighbour at 0.035%. From 2002, the share of Estonian publications has somewhat fluctuated, at the same time increasing its overall share in the world journal article count to 0.092% in 2007. Hence, Estonian researchers were not only able to maintain the growth in research output on par with global trends but also surpass this growth and claim a larger share of world publications than in the past.

The share of Latvian publications, on the other hand, has decreased from 2002 onward, only regaining its share of 2002 in 2007 (at 0.031%), and not surpassing the
average share of 1997-2001. The data is consistent with the results reported by Allik (2008), where the total share of Latvian publications in the world in 2007 was estimated at 0.029%, as opposed to 0.036% in 1990. Thus, it can be concluded that Latvian researchers were not able to keep up with the publishing rates of their neighbours and international counterparts, in terms of the growth needed to sustain its share of publications in the world. Furthermore, more publications in internationally recognised journals are needed annually to increase research productivity.
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The Interrelatedness of Funding and Research Output

As a rule, research funding plays an important role in knowledge production; it is, along with the necessary human capital, the primary and most essential resource in knowledge production – the means by which every research system fulfils its functions. It must be noted, however, that although an increase in research funding does not automatically guarantee an increase in knowledge production or an adequate/superior level of research performance, a certain amount of capital is needed to ensure the adequate functioning of the system (be it the installation or the upkeep of the scientific infrastructure, or the remuneration of research staff).

Motivated by previous research of Crespi and Geuna (2004, 2006, 2008), the subsequent analysis of funding patterns will elucidate the historical trends in the provision of this most basic resource and how it has affected the knowledge production, the research performance and the functioning of the research systems in Estonia and Latvia. It will also argue that critically low levels of research funding have not only led to the near destruction of the research systems but also to the ineffective functioning of the funding mechanisms and subsequently the failure to foster competitiveness and excellence of research, which these mechanisms were designed to ensure. However, there are a number of considerations that must be taken into account before one can embark on the assessment of the abovementioned relationship.

Firstly, and irrespective of the methodological biases (such as different types of scientific output, differences in publishing traditions in different fields of science, peculiarities of publishing in former Soviet research systems and language bias) that have been documented elsewhere in the thesis, there is a time lag between the period of funding and the period in which outputs can be expected (Crespi and Geuna 2004, 2006).

The examination of the research funding–research output relationship in the two Baltic countries in view of the abovementioned constraints is by no means straightforward and the inferences that can be drawn from these comparisons are
utilised solely in an exploratory fashion, in view of providing a better understanding of the systems’ functioning. In addition, the following analysis is further impinged by several factors largely related to data availability.

From 1990 onward, the Estonian and Latvian research communities were granted full access to the international and global science arena. Any barriers to the dissemination of research results internationally (provided these fulfilled the necessary requirements of scientific merit) were lifted. Hence, it stands to reason that the representation of publications in the SCI from researchers in these countries would increase, especially, given the positive evaluations of the standard of research in these countries by international experts in 1992 and 1993 (Danish Research Councils 1992, Swedish Research Councils 1993).

At the same time, prior to 1990 these systems enjoyed a steady stream of research funding, and up until 1992, the two research systems were still marginally funded by the government and the industry of the former USSR. Thus, bearing in mind the time lag in the appropriation of research funding, the full effects of the funding reform, accompanied by a drastic reduction in monetary resources for research, are estimated to emerge in the analysis of the publication data from the late 1990-ies, and specifically, from 1997/1998 onward. This supposition largely applies to the natural and exact sciences, as the effects of the funding of social sciences have a shorter time lag. In addition, as the history of the development of social sciences in the former USSR is contradictory, the effects of funding of social sciences will be touched upon only marginally.

This analysis is further hampered by the lack of comparable data from the two countries on funding levels prior to 1998; nevertheless, it has been widely reported that the funding levels in Latvia have been constantly low with minor fluctuations throughout the 1990-ies. Hence, the analysis will be based on this assumption. Finally, all research output indexed by the SCI (as outlined at the beginning of this chapter in Table 7) has been used for this analysis, as this allows comparison of the data with earlier periods.
In Estonia, the levels of funding have increased nominally and an estimate percentage will be used to evaluate the effects of this growth on the growth in publications in general, and in journal articles – in particular. The decrease in human capital as a dependent variable is also of importance, as it has been established previously that the research systems in Estonia, as well as in Latvia have suffered from internal and external *brain-drain*; this presupposes a decrease in the productivity of the research system. Furthermore, factors such as language barriers in terms of reorientation towards publishing in English rather than Russian and the lack of experience in international publishing are also born in mind.

The constant levels of funding enjoyed by the two research systems during the Soviet period ensured a small number of international publications, given the heavy regulation of such publications. From 1990 onward, the independent research communities of Estonia and Latvia did not experience such restrictions anymore and were granted free access to publish in international journals. Concurrently, the steady stream of research funding enjoyed up to 1992, still translated into the publication of research results obtained during the Soviet period. Hence, the adequate levels of funding coupled with the lifting of any barriers to publication in 1990, make for an interesting observation.

The time lag between funding and publication has been established at six years to estimate the full effects of investment in research on productivity. Thus, an increase in publications would be expected from 1990 onward up until 1998. However, given the publication data from 1986-1998 (including all types of publication indexed), no significant increase in productivity of Latvian researchers has been observed (the compound annual growth rate being 1.6%), whereas the Estonian research effort has grown only marginally (at 5.8%). A possible explanation of this could be the inability of a large share of researchers to reorient themselves to the practices and demands of international publishing, especially in Latvia (Kristapsons and Tjunina 1993).

The GERD in Latvia following the funding reform in the time period of 1993-1999 has been fairly constant at nearly 56m Euros (PPS at prices of 2000) (Eurostat 2009), a notable decrease from the high funding levels it enjoyed during the Soviet era and
considerably lower than in 1990-1992. Given the abovementioned assumptions the effects of this radical and perpetuated decrease should manifest themselves in the output of publications no earlier than 1995 and achieve the full effect from 1999-2005. Estonian researchers also received a fairly constant amount of funding in 1993-1999 at 56m Euros (PPS at prices of 2000) (Eurostat 2009). The average amount of funding in 1993-1999 was nearly identical to that in Latvia (also around 56m Euros). However, the average number of knowledge producers i.e. the number of researchers within the two systems for the period under consideration diverged by 12% in favour of Estonia (see Table 15).

When these figures of funding levels and research population are compared to the publication counts in the Thomson ISI database (bearing in mind the respective time lag), it becomes apparent that despite the stagnant research funding and the decrease in the researcher population (especially in 1993-1994), Latvian researchers managed to keep their publication output on par with previous periods and even showed an increase of 4.6% in publication activity between 1999 and 2005, whereas the growth in the output of Estonian researchers was 8.4%. Nevertheless, when the constantly growing rate of the total number of publications in the world is accounted for, the share of the contribution from Latvian researchers diminishes.

To illustrate the full extent of the differences between research output and the number of researchers the output of 1999-2005 was compared to the research performers of 1993-1999 and results of the annual output per 1000 researchers were obtained. In Latvia, bearing roughly the same funding levels in mind, one thousand researchers published on average 87 papers a year during the respective period. In Estonia, on the other hand, the productivity was 1.6 times higher in the same period and a thousand researchers were able to produce 141 papers annually. Thus, it can be stipulated that the critically low amount of research funding in the early years of reform and the significant decrease in the number of research performers did not affect research output to the extent it would be otherwise expected.
Table 15: General Expenditure on R&D (GERD, m Euro PPS 2000), the Number of Researchers (head count) 1993-2001, and the Total Number of Publications Produced in Estonia and Latvia (1999-2007)

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Source: Own compilation based on data reported in Eurostat (2009), Kristapsons (1998, 2003), Thomson Reuters (2009a)
The Effects of Increased Funding in early 2000s on Output

In the 1990-ies, the research systems of Latvia and Estonia had suffered great losses in terms of human and monetary resources. In the early 2000s, a gradual increase in funding and manpower has looked promising in terms of the effects it would have on research output. However, due to the limitations in the availability of data and due to the respective time lag, one can only estimate the effect the first two years of the new millennium have had on the number of publications produced.

In Latvia, research funding at the turn of the millennium increased by 30% and remained at that level for the next four years. The researcher population, on the other hand, has also increased by over 40% in the same period. This can be attributed to the large increase in the number of researchers in the business sector. Furthermore, there is some ambiguity as to whether this increase should be taken into account as there is no institutionalised requirement to publish in the sector. The effect of these changes should translate into publications from 2006. During that year, no difference in publications had been observed from the previous year; however, the annual increase from 2006 to 2007 amounted to 148 publications or nearly 37%.

Unlike in Latvia, the funding in Estonia at the turn of the millennium stayed roughly at the same level from the previous year. There were also no changes in the researcher population. This led to a small increase in publications six years later. Nevertheless, a year later there is a definite increase in the funding, as well as in the researcher population. This is also evident in the increase of publications. However, year-on-year increases in both funding and the number of researchers from previous periods do not indicate a corresponding increase in publications.

The total amount of publications indexed by Thomson ISI Web of Science represents a variety of publications, some of which do not carry a considerable research component. However, up to now, total publications have been used to assess the research capacity of Latvia and Estonia for reasons of comparability to previous studies.
When the year-on-year increase in articles is compared to the annual growth in funding and researcher count, no correlation is apparent between these three variables. Even the rise in funding in the early 2000s has failed to translate into significant growth of research output in Latvia at the end of 2007. These hypotheses can only be fully confirmed in the coming years when more data becomes available. Thus, one can conclude that there are other factors contributing to the researchers’ incentives to publish and perhaps, the funding is below the critical level at which increases in productivity can be achieved (especially in Latvia). Moreover, in Latvia there is a trend to publish, largely, by institutions with a long standing tradition, whereby researchers who have published throughout their careers are more likely to continue to do so. In addition, scholars of Latvian bibliometrics have on several occasions pointed out (Kristapsons and Kozlovsksis 2009, Dombrovskis 2009), the evaluation of project proposals in Latvia is not only dependent on the number of SCI publications but on a wider range of publications in other local and international sources, and other databases are used to compensate for the lack of SCI, SSCI and A&HCI publications.

The annual research productivity in the SSCI is very low. The complicated and contradictory status of the social sciences during the communist era carries its implications. However, Estonian researchers are well on their way in increasing their share of publications in the social sciences. The number of research articles published in the SSCI by Latvian researchers is negligible, with some growth during the last few years of the period observed. The data on research articles in the A&HCI from the two countries is negligible.
Chapter VIII: Comparative Analysis of the Reforms of the Latvian and Estonian Research Systems

The historical development of the research systems of Estonia and Latvia has been illustrated in Chapters V and VI. These have also been devoted to the examination of secondary quantitative data, pertaining to the inputs to the research systems (i.e. monetary and human resources), and Chapter VII has examined the bibliometric aspects of research productivity and how these interrelate with monetary inputs and human resources.

This section draws on the conclusions of previous chapters and links these with the primary data obtained through interviews, to answer the research questions posed in Chapter III. Specifically, it attempts to link the various reforms and outputs to outcomes and impacts that these reforms have produced, in order to explain similarities and differences in the performance of the research systems of Estonia and Latvia.

The Outcomes and Impacts of Funding Reform and Research Performance

Chapter VII showed that in the late 1990-ies the availability of research funding in the two countries was at roughly the same level and the difference in the researcher population was marginal. Furthermore, it concluded that research output is not necessarily directly correlated with changes in research funding or manpower. This contradicts previous studies and a large number of interviews, which have presupposed that Latvia was largely underfunded compared to Estonia. However, the manner in which funding was disbursed provides a more feasible explanation of the divergence in research performance.

The more gradual funding reform and the variety of funding mechanisms in Estonia have shown to be more effective than the radical reorientation towards a single type of grants in Latvia. The investigation of the latter through interviews has revealed that the mechanism was largely ineffective due to the absence of other public funding
mechanisms, which were originally envisaged but did not materialise. This ineffectiveness of government funding for research in Latvia was also confirmed by the majority of interviewees. The Estonian respondents, however, deemed the provision of government funding to be largely adequate. At the same time, foreign funding as an input to the research system was reported as an important factor in both countries.

Foreign funding has played a significant role in the two research systems; however, its effects in view of the funding reforms have been quite different. In Estonia, foreign funding was largely seen as supplementary to national funding, but in Latvia, it played a far more important role in view of the funding reform. Foreign funding, either through European Union collaborative projects or collaboration with companies, in Latvia was portrayed as a “survival mechanism” (Grens 2007, Kristapsons 2007) for sustaining research productivity. This is also a possible explanation why research output in Latvia had not declined during the transition period.

Another important development, identified by the interviewees in both countries, has been the provision of European Union Structural Funds, a large proportion of which has been earmarked for research, development and innovation. The prioritisation of the knowledge-based economy as the driver of economic prosperity in Europe has also permeated policy-thinking in Estonia and Latvia. This explains why previously conservative provision of government funding for research (especially, in Latvia) has been so generously supported through Structural Funds from 2004 onward. Comparatively, in the same period, Structural Funds for research in Estonia were implemented on a smaller scale (mainly, for updating research infrastructure), and planned to increase from 2007 (Kaarli 2010).

The Structural Funds are seen as important and promising mechanisms of research funding in both countries, especially in Latvia, where these are seen as a “lifeline” to the research system (Grens 2007). At the same time, a variety of respondents in Latvia, and some in Estonia questioned the ability of the system to effectively absorb the large influx of funding.
As seen in previous sections, one of the main aims of the funding reform in Estonia and Latvia have been the streamlining of the research system to fit in with the capacities of small countries, the build-up of competitiveness, and the integration of these into European and global academic community.

The effectiveness of funding reform in increasing the research output, quality, competitiveness of researchers, and attracting human capital have been investigated with interview respondents. In Estonia, most existing funding mechanisms have been conducive to research output and the bibliometric analysis undertaken as part of this study has confirmed this. In Latvia, national funding mechanisms have been deemed largely inadequate for raising research output. The drivers for increased research output, according to the majority of interviewees in Latvia, lie in the availability to participate in international programmes, and to apply for Structural Funds. In Estonia, both national and international funding mechanisms have been identified as favourable to increasing research output. This finding can be explained by the existence (or the absence) of adequate evaluation practices.

The significance of evaluation practices and quality control as determinants of successful development have already been highlighted in the early studies of research systems in transition (Balazs, Faulkner, and Schimanek 1995), and the subsequent analysis of the two research systems supports this proposition.

Both systems have instituted mechanisms of evaluation of research but the extent and application of these has differed in these countries. In Estonia:

*From the beginning of the reorganisation of Estonian research and development structure there has been evaluation culture and the reorganisation of the system* (Kaarli 2010).

Moreover, this evaluation culture has been instituted through a variety of evaluation mechanisms (evaluation of projects, evaluation of organisations, international reviews of the research system as a whole) and the adherence to these criteria and policy-learning from evaluations explain the success of these mechanisms.
The interview data obtained in Latvia has identified that the lack of evaluation in Latvia is due to the poor provision of clear evaluation criteria against which the performance can be judged. In the words of one interviewee:

*One of the problems has been that many funding mechanisms (even large programs such as state research programs) do not have strong results orientation and defined evaluation criteria in terms of international peer reviewed publications and international patents* (Anonymous A 2010).

The abovementioned conditions have also affected the quality of research and the competitiveness of researchers. The combination of variety of funding and evaluation mechanisms in Estonia has led to these being effective in increasing the quality of research, and, in turn, raised the competitiveness of researchers (within the national system and internationally). In Latvia, the effectiveness of national funding mechanisms in raising research quality has varied. Most interviewees had mixed views on this, but agreed that international funding mechanisms were more effective in raising the quality of research than national ones. The same was true for the competitiveness of researchers. Thus, this strengthens the presupposition that implementation of funding and evaluation mechanisms determines research output, quality and fosters competitiveness.

**Effects of the Organisational Reform**

The political and economic climate in the early 1990-ies paved the way to reforms across all sectors of the economy, including reforms in the research system. The funding reform was the first step in the process, and it also introduced changes in the organisational set-up of the system. These changes included the transformation of the structure of the research system in three aspects: firstly, some organisations ceased to exist; secondly, others were merged or restructured; and finally, new research organisations were established.

The organisational changes that took place in Estonia and Latvia in the early 1990-ies were radical and within a space of a few years, the former management and
funding organisations were replaced by new ones. The Academies of Sciences that in Union times functioned as quasi-Ministries of Science were relegating their powers to other organisations. However, prior to 1995 the organisational reform of the Estonian research system progressed more slowly and cautiously, awaiting the passing of the respective legislation (Martinson 1995). The Estonian Academy of Sciences was also much smaller during the respective period, despite hosting approximately the same number of institutes.

This process was much more drastic in Latvia - a large share (40-50%) of the central apparatus of the Latvian Academy of Sciences was liquidated by mid-1990 and in the same year the Academy decided to abolish the so-called complex evaluations of its research institutes that were scheduled every 3-4 years (Stradins 1998). Instead, institutes were required to submit annual reports, which amounted to an outline of the main research themes, an account of the personnel involved and main results achieved. As much as it reduced the bureaucratic burden endured in Soviet times, it significantly affected the coordination of interdisciplinary research and made it impossible to get a clear overview of the research system and its respective entities during this period. At the same time, a new mechanism of co-ordination envisaged at the time did not come into existence and no comprehensive information on the funding and research activities of research institutes in Latvia was provided until an evaluation carried out by the Ministry of Education and Science in 1996 (ibid. 1998).

All these decisions led to the relinquishing of authority from the Latvian Academy of Sciences to the various research institutes (where research activity was concerned), and to the Latvian Council of Science (which took over the funding responsibilities). Nevertheless, the Academy (as an association of the scholarly elite in Latvia from 1992 onward) still exerts influence on the research system through the work of its members in the Latvian Council of Science and various other committees that are engaged in the planning of research policy (Stradins 1998, Kristapsons, Martinson and Dagyte 2003, Kristapsons 2007). This has also been confirmed during fieldwork.

The drastic reduction in resources and the cessation of strong links with the academic and industrial establishment of the former USSR decreased the need for the significant research capacity and the infrastructure that was built up during Soviet
Many industrial establishments ceased to exist, as did the need for applied R&D. With the large presence of all-Union industries, Latvia was much more affected by these changes than it was the case for Estonia.

As can be seen from the case studies outlined earlier, the newly established research councils assumed their role at the centre of the two research systems. However, already in the early 1990-ies, differences in the organisational set-up of the Estonian and Latvian research system began to emerge in terms of the overall structure.

The main motive for the foundation of research councils has been the desire to create highly democratic organisations, which would embrace the new funding principles discussed above. Once again, the set-up of these organisations and the operating principles designed at the outset of the reform, reflect the notions of scientific autonomy, self-determination, and democratic principles of funding.

Both systems have been similarly motivated to embrace these principles; however, there are notable differences in their implementation. The Latvian Science Council has been central to the national research system for over a decade, and in the first half of the 1990-ies was the only organisation to concern itself with issues of science policy. The Council has also reconciled its threefold role of the policy-maker, the evaluator of research proposals and activities, and the funder of publicly undertaken research, disbursing over 2/3 of government funding for research. In the mid-2000s and with the advent of new policy initiatives from the government, the role of the Council has decreased, but up to this point, it can be said that the Latvian Council of Science assumed the central governing role in the Latvian research system. In retrospect, however, interviews with stakeholders indicate that the Council was overburdened with responsibilities with no direct links to central governance structures (Silins 2007), which could partly explain why, along with the chronic lack of research funding it proved ineffective in implementing the abovementioned funding reform.

The Estonian Science Council (subsequently renamed the Estonian Research and Development Council) has assumed a more strategic role compared to its neighbouring counterpart. Essentially, it is part of a two-tier system of research
governance, in the sense that the Council oversees the policy process and approves funding decisions, but it delegates decisions on the disbursement of funding to another set of organisations i.e. the foundations. The disbursement of general grants has been implemented by the Estonian Science Foundation, whereas targeted funding (i.e. grants for institutions) have been subsequently relegated to the Science Competence Council. These funding organisations have held a dual role – that of the funder and the evaluator, ensuring a more diversified representation of interests within the system. Furthermore, the close association of the Research and Development Council to the higher levels of government (i.e. the Council of Ministers) has ensured the visibility of research policy initiatives and a channel for lobbying and engagement for the scientific community and various other stakeholders. At the same time, it has to be pointed out that in the early 1990-ies, Estonia faced a similar situation of government disinterestedness in science policy as Latvia (Martinson 1995). Nevertheless, the strategic position of the Council has been named as one of the structural advantages of the Estonian research system over the Latvian one, both in the relevant literature (Kristapsons 1998, Kristapsons, Martinson and Dagyte 2003), as well as during the interviews conducted with stakeholders.

Another factor, pertinent to explaining the efficiency and effectiveness of these organisations, and ultimately linked to the overall performance of the system is the ability of these to adapt to changing circumstances. One of the criticisms of the Latvian Science Council has been its inability to transform alongside the multitude of other developments within the system. Part of this rigidity is demonstrated by the Council’s inability to shift the constant proportions of funding allocation among research fields, and the reduction of its numerous (fourteen in total) expert committees. The latter issue has been addressed in 2005, reducing the number of expert commissions to five by merging them. This has somewhat reduced the size of the commissions but has not enabled the redistribution of funding.

In Estonia, the modifications of the Research and Development Council have been numerous, starting from the first one in 1993, then in 1995, 1996, 2001, and in 2005. Its role has been constantly evolving from the early days of the limited advisory role of the Science Council, to the advisory and supervisory role in all matters concerning research and development, to extending its scope of responsibilities to include
competitiveness and entrepreneurship. Furthermore, and this is where it differs from its Latvian counterpart, its legal standing has been increased considerably and all the above mentioned roles have been firmly established in legislation. Once could argue that the fulfilment of the abovementioned duties also falls under the remit of the Latvian Council of Science, albeit more implicitly, which in essence weakens its positions within the governance structure of the system.

The organisational reforms of the research councils have produced some favourable effects on the productivity of the research system. The Latvian Council of Science can be credited with developing the Joint Research Projects Programme, thereby securing additional funding for interdisciplinary research, as well as funding for international collaboration and doctoral studies. In addition, it also put forward the first strategic document on research and development policy – the National Concept of Research Development in 1998 (Ekmanis et al. 1998). However, due to its inability to assert its position, in particular, to the government, no direct relationship between these endeavours and research performance can be established.

The Estonian Research and Development Council, on the other hand has been able to produce two consecutive strategic policy papers, approved by the government, in the course of its existence. Due to the two-tier system of Estonian research administration and funding, the comparison of the two systems necessitates the comparison of the different functions of the Latvian Council of Science (both as a policy forming body and a funding body) to the Estonian Research and Development Council (as undertaken above) and the Estonian Science Foundation. There is no equivalent of the Estonian Science Competence Council in Latvia; therefore, no direct comparisons can be made.

The funding distribution mechanisms of the Estonian Science Foundation are similar to those in Latvia. In this respect, the similarities in constant proportions of funding between fields of science exist in both. Yet, the Estonian Science Foundation disburses a significantly lower share of research funding, and a multitude of other funding mechanisms help to ensure a competitive balance. The second difference is the involvement of international experts in the evaluation of project proposals. In
Estonia, this practice has been instituted since 1995; in Latvia, the use of foreign experts was still in the planning stages in 2007.

At the same time, the main concern faced by the grant funding bodies is the large number of applications. In Estonia, a threshold of funding per grant was set to reduce oversubscription, whereas in Latvia the large number of small grants as a result of oversubscription still persists.

The implementation of the organisational reform has been similar in both countries, in terms of the larger processes of the transformation of Academies of Sciences, integration of research and teaching organisations, and the build up of the administrative structures, such as research councils and other funding bodies.

The resulting organisational landscape has been more varied and in constant transformation in Estonia. The multitude of funding mechanisms has been complemented by the emergence of different organisations to implement them. Overall, most respondents agreed that the majority of established organisations have been effective in their respective roles. The integration of higher education institutions and research institutes has been deemed largely deemed completed, and good collaborative arrangements have been reported between the remaining independent institutes and universities:

*I think that this question has by now largely lost its content for Estonia. The process is essentially over and while seemingly some administrative measures can still be enforced, none of such changes will address in any meaningful ways R&D quality and scope, carried out in Estonia. Neither does it concern much university teaching. There are some problems, now and then, with PhD studies, but these are equally seen inside complex institutional setup within research universities and thanks to their extensive legal independence, it is not much worthwhile to try to regulate some (disputed) shortcomings "from above"* (Willems 2010).

The organisational set-up in Latvia and the effectiveness of the organisations in fulfilling their respective roles has been less positive than in neighbouring Estonia.
Most interviewees judged the work of the majority of organisations as mediocre (especially, the work of the Latvian Council of Science and the functioning of the Ministries). The research institutes were judged to be the most effective in fulfilling their role in the creation of knowledge; universities were considered to be less engaged. Finally, the views of the interviewees on the integration of research institutes and universities have varied; however, there has been consensus on the view that integration has differed across organisations and even across scientific disciplines.

*De facto*, the majority of institutes have been integrated into universities, at the same time, the largest and most research intensive institutes have retained agency status. This points to a possible resistance to integration; however, the examination of the issue at the national level only allows for generalised assessment, and further research at the organisational level needs to be undertaken to fully comprehend the scale of integration.

**The Legal Reform and Policy for Science, Technology and Innovation**

The late 1980-ies and the early 1990-ies not only gave the newly independent states of Estonia and Latvia a platform for launching new and democratic institutions, it also called for new policies and legislation.

An important factor in explaining the development of research systems that has emerged from the literature and from the interviews has been the involvement of different actors in formulating science, technology and innovation policy. In the early 1990-ies the involvement of the government was mostly limited to approving proposals put forth by the representatives of the research community but more concrete government engagement in policy formulation gained momentum towards the late 1990-ies. The drive towards Westernisation and the alignment of national policies to European Union policies in anticipation to the accession to the Union has played an important role. However, while in Estonia two subsequent strategies for
research and development have been put in place, Latvia has failed to adopt such a document.

Many interviewees in Latvia that have been involved in the development of policies for research have alluded to the lack of political support. Many policies and even legislative proposals have been submitted to the Parliament or the Cabinet of Ministers but have never been accepted formally, or legislation has been passed last minute due to clashes with other legal requirements. This echoes Lundvall’s (1992) work on national systems of innovation, where the author points to the significance of certain institutions in reinforcing or blocking the process of development.

Based on a survey of political elites in the early stages of the transformation process, Steen (cited in Norgaard et al. 1999, p.113) notes a strong desire for the new political actors to “drastically limit the role of the state and its institutions in the transformation process”. Similar rationales prevailed at the research system level, which is reflected in the bottom-up transformation process initiated by the Unions of Scientists in Estonia and Latvia, and particularly vividly in the early legislation governing research in Latvia, where the researchers and institutes were given complete autonomy and the role of the state was rather marginal.

Several interviews with these opinion leaders, conducted during this study, also concluded that, indeed, many of the policies adopted in the early stages were based on the ideas and perceptions of the key reformers. At the same time, these were widely discussed among the academic communities both in Estonia and Latvia (Martinson 1995, Kristapsons, Martinson and Dagyte 2003) and were based on consensus-building. Furthermore, the early policies focused on overhauling the funding and the organisational systems of research governance in their entirety. The two main reasons for this were the need for a new system, as much as the desire to break from the past. In both cases, the reformers had very little experience in policy formation and, and during these turbulent times, foresight was aided by examples of established systems. However, the results have been most fruitful in Estonia, where these models have been applied taking into account national specificities.
The early policies have focused on reforming the funding system and were implemented at the level of the Science Councils. In Latvia and Estonia, these were internal documents and although widely publicised in the academic press, were not implemented as legislative acts. The first legislative acts, in turn, reflected much of the initial sentiment of the research community, and subsequently, have seen multiple amendments due to inconsistencies, particularly in Latvia. Comparatively, the legal base of the Estonian research system and the interaction between the different administrative and funding bodies was defined more clearly. This can be partially explained by what Lieven (1994) observed in Estonia during the early transition period, namely: “Estonian political culture also contains a strong streak of legalism, and Estonians tend to justify their national positions in legal terms” (p.20); whereas, “indecision, a certain lack of direction, has been characteristic of Latvian policy in recent years” (p.34).

In recent years, a broader strategy for national development along the lines of building a knowledge-based economy in Latvia has been put in place, and has been beneficial in “at least rhetorically prioritising research and innovation, but has on numerous occasions proven to be unrealistic in its goals (e.g. with regard to the Lisbon targets) and detached from the actual capacities of the national innovation system (both in terms of budgetary allocations and the performance capacity)” (Anonymous B 2010). In general, the analysis of policies underpinned by interviews has pointed to a frequent attempt to transfer policies from established economies. Using the classification of Dolowitz and Marsh (2000), this transfer in the early stages of reform can be classified as uninformed transfer (due to insufficient information about its implementation), whereas subsequent transfer can be classified as possessing both the elements of an inappropriate transfer (due to a mismatch between the national contexts) and those of an incomplete transfer (due to a mismatch in the available implementing structures).

Most interviewees in Estonia, on the other hand agreed that the national research, development and innovation strategy provided a good overall framework and was largely matched to the different policy initiatives and their objectives in the area. Thus, it can be argued that a lack of a coherent set of policies and identifiable
objectives, within a framework of an overall strategy, has affected the ability of the national research system to develop.
Chapter IX: Key Findings and Future Work

The literature review conducted in Chapter II has provided a platform for characterising the two countries through the research systems concept, and it has demonstrated that research systems in transition represent a special case and are influenced by a multitude of factors. This enabled the development of a conceptual framework to frame the transition process through the classification of four types of reforms that have taken place, and to appraise their development through their performance and in light of these reforms. The application of qualitative and quantitative methods in analysing the transition within this conceptual framework has demonstrated that research performance in countries in transition is not so much conditional upon the provision of the right inputs to the system but on the implementation of the reforms to achieve the desired outcomes.

The literature review on systems in transition identified several common traits that these systems possess. The existence of these traits was examined in light of the two case studies and observations from previous studies have been largely confirmed as follows:

- The research systems in transition have been directly affected by the economic and political turbulences of the early 1990s, and have displayed a dramatic decline in financial and human capital within the systems, as well as a decline and even disappearance of research-intensive industry. The latter has been more prominent in previously highly-industrialised countries.

- The process of transition can be characterised as that of a rapid departure from the hierarchical and planned model of Soviet research systems to an autonomous, open and meritocratic model perceived as characteristic of Western established research systems. In that respect, this development can be compared to the Triple Helix model developed by Etzkowitz and Leydesdorff (2000), where the two research systems have departed from Triple Helix I in an attempt to move toward the much desired Triple Helix III. This desire of Westernisation has been an overarching goal and an underlying rationale for virtually all reforms, and this goal has been largely achieved in
making the governance of these systems highly democratic, yet the implementation of Western practices has been most successful in cases, where the reforms have taken into account the transition context and where governance structures have exhibited the necessary administrative capability and competence. Once again, applying the analogy of the Triple Helix model (ibid 2000), the two research systems can be classed as variants of the Triple Helix II, where the individual helices have been encouraged to connect (as in the case of the integration of universities and research institutes) or have, for various reasons been unable to either create or maintain the necessary linkages (as in the case of the disappearance of industries).

- The transition process largely follows a three-phase model, from the fragmentation and dissolution of the existing system, through organisational restructuring, to the emergence of a new system, as proposed by Meske (1998) in earlier transition literature. Analogously, it can also be seen as a transition from bottom-up initiatives of the research community to top-down formation of government policy, where development is conditional upon the relationship of research and political actors (as described by Schimank 1995). Two decades after the beginnings of the transition, most systems in transition have to varying degrees proceeded to the third stage of transition, and have departed from a predominantly bottom-up approach to policy formation. A more favourable transition process has been reported in cases, where a supportive relationship between research and political actors has been established (both in terms of strategic vision and in terms of the institution of official structures to promote interaction).

- Early scholarly work on research systems in transition has stressed the importance of policy making capabilities and the development of evaluation practices as a key determining factor in the future development of these systems (Balazs, Faulkner and Schimank 1995). This has certainly proven to be true. Research systems that have struggled to formulate and/or implement their science, technology and innovation policies, or have not established systematic evaluation mechanisms, have struggled to achieve their aims in a consistent manner.
On the surface, and as testified by the available exploratory literature of the two research systems investigated in this thesis, the underlying rationales of the transition have been overwhelmingly similar. The institution of competitive funding principles; the transformation of the Academies of Science into scholarly societies; the integration of research institutes and universities; and the formation of science, technology and innovation policies are all processes that have been set in motion throughout the 1990-ies. However, the observation that both systems exhibit considerably diverging levels of research productivity, and that underlying differences exist in how the transition has proceeded and what effects it has created, supports the principal hypothesis of this thesis, namely, that differences in research productivity can be elucidated by the investigation of the underlying implementation mechanisms of these reforms.

The comparative analysis of these mechanisms at country level has been undertaken in the preceding chapter and the following summary demonstrates the evidence gathered to support the hypothesis:

- The institution of new, competitive funding mechanisms has overall consolidated the research base, familiarising and conditioning the research community to strive in competitive conditions. However, the differences in performance under this new regime have been conditional upon the adequate provision of financial resources (i.e. resources for both competitive grants and infrastructure), the implementation of appropriate incentive mechanisms (i.e. the linkage of funding mechanisms to evaluation mechanisms), and the flexibility of the systems to respond to changing circumstances.

In brief, the Estonian research system has responded well to the introduction of grant mechanisms, firstly, due to the fact that these were implemented gradually, and secondly, due to the incentive and feedback mechanisms implemented through engaging international reviewers and upholding funding criteria. Another factor contributing to the positive developments in Estonia has been the ability to alter existing funding mechanisms and to
introduce new ones, as testified by the transition from grants for individual groups to grants for organisations.

In Latvia, the rapid transition to grants as a sole mechanism of funding, coupled with the bare-minimum provision of funding has not only hampered productivity but led to some unintended outcomes of the funding reform. Firstly, constant funding proportions between fields have been maintained for nearly two decades, ensuring the minimum provision of funding to most projects. Secondly, the obtainment of funding based on merit (largely, determined by publications in internationally peer-reviewed journals) has not materialised, as this standard was lowered to include regional and national publications. Thus, the funding reform has largely faltered in achieving its original objectives, leading to the institution of mechanisms that have promoted the status quo. And, while this has been essential to safeguarding the research base, it has failed to provide the necessary incentive mechanisms to improve the productivity in terms of research output.

- The organisational landscape was found to be important in analysing research systems. The importance of this landscape did not lie so much in its typology (i.e. the classification of organisations into research funding bodies versus research performing bodies) but in its variety.

The absence of a diverse organisational landscape in terms of a variety of research funding bodies in Latvia, and research performing bodies in Estonia, taking into account the small size of these systems, has the potential of developing monopolistic tendencies and the strengthening of the Matthew Effect.

- In the Soviet model of science and technology governance, the research and teaching functions were strictly separated; thus, the integration of these two functions has been a key rationale in the transition. Formally, this objective has been achieved in both countries, yet structural differences of the emergent system that point to a persisting divide have been observed. A clear influence of this integration on research productivity in terms of output could not be established due to lack of available data.
In Estonia, the majority of institutes have been fully integrated into the university structures and qualitative primary data collected for this study has shown that integration has lost its relevance as a policy issue. In neighbouring Latvia, however, there is a larger proportion of institutes that have not integrated into the university and there has been a strong undercurrent to remain independent (i.e. institutes as government agencies), or remain quasi-independent even within university structures (i.e. institutes as university agencies). The emergence of this hybrid structure can be to some extent explained by the general lack of funding for research and for infrastructure. Universities are apprehensive to merge with often considerably large institutes due to the financial commitment of upkeep of infrastructure in absence of public funding dedicated for this type of expense. Institutes, on the other hand, are apprehensive to join universities due to the increasing complexity in administration, the transfer of funding and an increased obligation to teach. Nevertheless, there are positive developments in integration as voluntary arrangements for collaboration in research and teaching between universities and independent institutes have become increasingly common.

- The governments’ main role, aside from the provision of funding, has been to institute the legal and policy frameworks conductive of the development of the research systems. The clarity and consistency of legal provisions has had a considerable effect on the functioning of research systems. More importantly, the existence and evolution of a thought-out policy framework, underpinning these legal instruments has been found to be of essence. The absence of formal legal requirements and provisions for, among others, organisational responsibilities, guidelines for evaluation and reporting mechanisms have directly affected the incentive mechanisms of the funding reform, and also the organisational reform. Where absence of these was found, the transition and evolution of research systems was hindered. Finally, the effectiveness of science, technology and innovation policies was to some extent determined by the existence of adequate administrative capacity (both, in terms of size and knowledge of policy formation).
This finding was especially pertinent to the case of Latvia, where, for example, administrative involvement of the Ministries in the research system was legally not provided for until 1998. In addition, several quasi-policies for research and innovation have been developed, yet the majority of these have not been approved by the government, thus, not being legally binding. The accession to Latvia to the European Union can be seen as a favourable development in this regard, committing the state to formulate a policy for science, technology and innovation, and appropriate measures of accountability.

- The development and the effective implementation of evaluation mechanisms and practices has been a determining factor in the successful development of research systems in transition, especially in small countries. Effective evaluation (in its role as an incentive mechanism) has helped to uphold the competitiveness of the funding system, as well as aided policy formation. Where effective evaluation mechanisms have been absent, the research system was unable to regulate its performance.

The successful implementation of evaluation mechanisms in Estonia has led to adequate implementation of the new funding system, and acted as an incentive mechanism. Moreover, the systematic evaluation of programmes and policy initiatives enabled further fine-tuning of policies, and facilitated the evolution of the system. In Latvia, on the other hand, the lack of independent evaluators of projects and programmes has led to the institution of a fairly ineffective funding system, unrealistic policy targets and an overall stagnation of the research system. However, in recent years, some measures have been taken to develop measures of reporting and accountability. The effectiveness of these measures remains to be seen.

The reform in research funding and the change in evaluation practices have produced the most visible effects on research performance. In the case of the former, quantification of inputs and outputs has enabled a clear comparison. In the latter, primary qualitative interviews enabled the corroboration of secondary sources outlined in the case studies. Finally, the thesis has contributed to existing literature on national research systems in that it provides the first attempt at, what could be
loosely termed, a longitudinal and systemic study of research systems in transition. In particular, it portrays two examples of a research system in transition, thus, taking forward the work of other scholars (Martinson 1995, Kaarli and Laasberg 2001, and Kristapsons, Martinson and Dagyte 2003).

The findings of this study can also be related to the overall theoretical frameworks, which have motivated this research in the first place. The adoption of a systems approach to the study of national research systems in transition has allowed for a comprehensive examination, in particular of the different entities and relationships within the systems. The necessity to examine organisations, institutions, interactions, procedures and processes (as mandated by the definition of Rip and Van der Meulen (1996)) has led to the identification and exploration of multitude issues, which in the presence of a more restricted definition, might not have come to the surface. However, methodologically, the study also bows to previous criticisms of national research and innovation systems, which have postulated that the absence of a micro-level analysis (Mietinnen 2002) does not allow for an in-depth investigation.

As briefly mentioned at the outset of this section, the study aids itself easily to the application of the Triple Helix mode (Etzkowitz and Leydesdorff 2000) as an overlay for the study of research systems in transition. In particular, the variants of the model lend themselves easily to the examination of the historical legacy of the Soviet period (Triple Helix I), the transition period (Triple Helix II), and the move towards a research system as desired by contemporary policymakers in the West (Triple Helix III). In particular, the structuring of the model as a dynamic evolution of three helices of industry, government and academia, aids the exemplification of such issues reported above as the absence of the industrial sector, the limited involvement of the government, and partial integration of research institutes and universities.

The findings reported above are also largely consistent with previous research on systems in transition, for example, Radosevic’s (1995a) observations on the erosion of industry and the development of “survival and adjustment strategies” of public research organisations have clearly been demonstrated in the case of Latvia, where European and contractual funding mechanisms have proven to be highly important in
view of limited national funding. Thus, such strategies should be investigated in further studies of research systems in transition.

Meske’s (1998a) three-phase model has also been highly conducive of this study. However, although it can be reasonably argued that the research systems of Latvia and Estonia have restructured their institutions, it begs further elaboration as to the timing of the third-phase, where the build-up of a new system has occurred, and whether such a final state is consistent with the continuous evolution of research systems.

The theme of Westernisation or re-Westernisation, developed by Lauristin (1997) and Norgaard et al. (1999) has clearly emerged in this study. In particular, this has been demonstrated in the case of Estonia, and has subsequently also emerged in the case of Latvia, especially in the few years leading up to the accession to the European Union. Thus, policy transfer and convergence towards global ideals is an important aspect in studies of research systems in transition.

Finally, the legacy of the Soviet period and the proximity of the two research systems under investigation to the core of the Soviet system (Meske 2000, Panagiotou 2001), as an explanatory variable, has not provided sufficient evidence to draw distinct conclusion.

In conclusion, the study identifies some of the remaining gaps in the existing knowledge that should be further explored to achieve a better understanding of the development of research systems in transition. Possible avenues for further research are explored below.

**Further Work**

The current has answered some of the questions linked to the development of research systems in transition and their performance, at the same time it presents a multitude of avenues to take this research further.
There has been a revival of interest in the study of research systems in transition in recent years. However, this research has broadly adopted the innovation systems perspective. Additional and supplementary research material has also emerged on the two particular cases used in this study.

First, there has been an increase in the data available for performance monitoring, as evaluation mechanisms have been put into place to assess the outputs and outcomes of policy interventions. Furthermore, recently, more studies on output indicators have been undertaken to investigate the progress in scientific productivity, going beyond the use of ISI Web of Science as the benchmark for quality.

The recent developments in the utilisation of European Union Structural Funds are also set to produce impacts on the two funding systems. Unfortunately, as not enough time has passed, these have not been investigated fully and serve as an avenue for future research.

With regard to the choice of research methods, the approach used for this study is considered to have been fruitful in the investigation of the research questions at hand; however, as the interviews have largely been conducted with policy-makers and highly regarded researchers and opinion leaders (and often with respondents, who are active in both areas), future research could concentrate on a broader scope of respondents – research producers (in particular, in the higher education sector), innovative companies, and other users of research, as well as a wider scope of policy-makers. Another alternative to this approach is the investigation of the cases at a deeper, micro-level.
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Annexes

Annex A: List of Respondents in Latvia

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<tr>
<th>Name</th>
<th>Position</th>
<th>Organisation</th>
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<td>Dr Maija Bundule</td>
<td>Head of Department</td>
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Source: Thomson Reuters (2009a)
Annex D: Grant Proposal Funding by the Latvian Council of Science by Field of Science (1991-2007)

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Source: Latvian Council of Science (2006-2007)
Annex E: Interview Guide

Position……………………………………………………………………
Organisation represented………………………………………………

Permission to Quote with Reference?     Y/N

I.  How has the level of funding affected:
   a.  research output (in terms of patents and publications),
   b.  propensity to publish?

II. How have the different funding mechanisms affected:
    a.  research output (in terms of patents and publications),
    b.  propensity to publish?

III. How effective have the different funding mechanisms been in achieving their aims?

IV.  What are the main factors that have promoted/hindered the development of the system in the past 18 years (key moments, breaking points, milestones, main reforms, reasoning behind these reforms)? NB: If the respondent is not familiar with developments of the past 18 years; of course, they are free to speak of the developments as far as they are aware.

V.  How would you evaluate the achievements/outcomes of the Research System (Estonia/Latvia) since the reestablishment of independence? How would you evaluate the country’s position in relation to its neighbor (Estonia/Latvia (as far as you know))?

VI. How is the Research System governed in practice:
    a) how are policies debated/drafted/decided upon,
    b) how are evaluations carried out/criteria established,
    c) who is influential in the shaping of policy, setting priorities, direction or strategic vision?

VII. Could you name two other people who are knowledgeable in the issues discussed above?