



ERAWATCH Country Report 2008

An assessment of research system and policies

The Netherlands

Jasper Deuten



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ERAWATCH

COUNTRY REPORT 2008

An assessment of research system and policies

The Netherlands

ERAWATCH Network - Technopolis Group (The Netherlands)

Jasper Deuten

Joint Research Centre
Directorate-General for Research

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Executive Summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs which aims to increase and improve investment in research and development, in particular in the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the performance of the national research system of the Netherlands and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory¹ and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains four main subsections in correspondence with the four steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

The overall picture is that the Dutch research system has a good performance in most domains, while several main weaknesses remain. In the domain of resource mobilisation, expenditures on R&D as % of GDP are declining, rather than growing. Also in terms of the provision of qualified human resources it remains a challenge to have more students in science and technology, and to create an education and research climate that fosters excellence, also to make the Netherlands an attractive place for talented students and research performers, also from abroad. In the domain of knowledge demand, the research system is increasingly becoming responsive, although co-ordination remains a challenge. The Dutch science system has significant strengths in terms of productivity and impact. In view of the weaknesses in the domain of resource mobilisation, future challenges of globalisation and internationalisation of R&D could threaten this strong performance, however. The governance of the research system could be improved, to allow for better co-ordination and coherent long-term investment strategies in R&D. In particular, there is room for improvement in the co-ordination between the part of the policy system

¹ ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

that deals with scientific research and the part of the system dealing with industrial R&D and innovation.

The main strengths and weaknesses of the Dutch research system and governance can be summarised as follows:

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	Strengths exist in a high level of awareness on the need to invest in R&D. However, this has not (yet) translated in increased GERD.
	Securing long term investment in research	Base funding of universities and research institutes is under pressure, but a broad consensus has emerged that a long-term strategy should guide investments in knowledge and innovation.
	Dealing with barriers to private R&D investment	Relatively low BERD remains a serious weakness. The presence of a few large multinational R&D intensive companies is a strength.
	Providing qualified human resources	Strengths exist in an overall good quality of higher education. Weaknesses exist in looming shortages in HRST, a learning culture and a research culture that do not foster excellence sufficiently, also to attract talented students, excellent researchers and investors in R&D from abroad.
Knowledge demand	Identifying the drivers of knowledge demand	The Dutch research system has strengths in identifying knowledge demands in "key areas" and "societal themes". "Relevance" (next to "excellence") is a key objective (and selection criterion) of many R&D instruments.
	Co-ordination and channelling knowledge demands	Co-ordination between priority setting by different governmental actors and across different policy measures has been a weakness.
	Monitoring of demand fulfilment	Evaluation has become a structural part of policy processes.
Knowledge production	Ensuring quality and excellence of knowledge production	Dutch research system has high scientific publication output, especially in Nature and Health related disciplines. Also high scientific productivity (output/input) and high citation impact scores, especially in Nature, Health, Agriculture, Technology and Behaviour and Society related disciplines.
	Ensuring exploitability of knowledge	Many mechanisms exist to match scientific knowledge production to economic and societal needs. However, the research system has become highly complex, with many different (collaborative) institutes, centres and co-ordinating bodies, putting the overall efficiency and effectiveness of the system at risk.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	A broad range of mechanisms and instruments exists to support knowledge circulation and cross-sector collaboration. Universities are increasingly professionalising their knowledge valorisation strategies.
	Profiting from international knowledge	Good participation of Dutch partners in international programmes and research institutes. Relatively low level of foreign R&D investment. The attractiveness of the Netherlands for international students and talented knowledge workers could be better.
	Enhancing absorptive capacity of knowledge users	In view of the (future) demands of a knowledge-based society, the number of students and knowledge workers in S&T should increase.

Major recent policy events include the publication of a new policy programme 2007-2011 in which “knowledge and innovation” is one of the key pillars. An important element is the establishment of a new inter-ministerial “Knowledge & Innovation” programme department (K&I), which aims to address the lack of co-ordination in the policy system. K&I is also responsible for the development of a long-term strategy to guide future investments in knowledge and innovation (published in July 2008) and the development of societal innovation agendas and societal innovation programmes for specific societal themes. The working programme of K&I includes, *inter alia*, new measures to make the Netherlands a “centre for talent” (e.g. a new task force to deal with looming shortages in HRST, an improved integral approach to knowledge migrant, and measures to stimulate the entrepreneurial spirit among students).

Another relevant new policy document is the Strategic Agenda for Higher Education, Research and Science Policy 2007-2011 with renewed emphasis on creating an education and research climate that fosters excellence. For instance, €100m was transferred from the (first tier) base funding of universities to a (second tier) grant scheme for talented researchers in various stages of their careers.

Main policy opportunities and policy-related risks which arise from recent policy responses to the main strengths and weaknesses in the Dutch research system can be summarised as follows:

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> • The long-term strategy for investments in knowledge and innovation could allow for a better co-ordinated and coherent approach. • The attractiveness of the Netherlands for students, knowledge workers and investors in R&D – also from abroad –, could be increased by creating a learning culture and research culture that fosters excellence. 	<ul style="list-style-type: none"> • Efforts to raise R&D intensity fall short of ambitions (3% target).
Knowledge demand	<ul style="list-style-type: none"> • Key societal needs could be addressed by development of societal innovation agendas and societal innovation programmes. • Co-ordination between ministries could be made more effective (in efforts to develop a long-term strategy for research and innovation, and in developing societal innovation agendas and programmes). 	<ul style="list-style-type: none"> • Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in lack of responsiveness to knowledge demands from knowledge users outside the research system.
Knowledge production	<ul style="list-style-type: none"> • The Dutch research climate could be improved by more policy emphasis on “excellence” and talented researchers. 	<ul style="list-style-type: none"> • Notion in research policy that excellent research will, by definition, be relevant for third parties, could lead to under-emphasis on demand-oriented R&D in research policy.
Knowledge circulation	<ul style="list-style-type: none"> • Further improvement of coherence and continuity in policy regarding knowledge circulation and valorisation. • The Netherlands could be made a more attractive international location for (investments in) research and innovation. • Availability of a highly qualified labour force could be ensured by recent policy initiatives. 	<ul style="list-style-type: none"> • Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in under-emphasis on knowledge circulation and valorisation.

Several of the policy opportunities lie in increasing the attractiveness of the Netherlands as a location for higher education and research for students,

researchers and investors in R&D, also from abroad. It contributes to resource mobilisation (via provision of qualified human resources and attracting foreign investors in R&D), knowledge production (by fostering excellent research) and knowledge circulation (by profiting from international knowledge). However, an emphasis on independent and pure scientific research and individual talented researchers also creates policy-related risks in terms of reduced responsiveness to knowledge demands from outside the research system, reduced exploitability of knowledge and diminished cross-sector knowledge circulation. Policy should find the right balance between excellence and relevance. This will require good co-ordination between the part of the policy system that deals with scientific research and the part of the system dealing with industrial R&D and innovation. This is particularly important in efforts to create focus in mass in research and innovation. A co-ordinated long-term strategy to guide investments in knowledge should be helpful in this respect.

Dutch policy responses are largely in line with the Integrated Guidelines for Growth and Jobs No. 7 in the Lisbon Strategy. Although this refers to a Community-wide target, a policy-related risk remains that efforts in the Netherlands will fall short of raising the R&D intensity to 3% of GDP.

The international context plays an important role in Dutch research policy. As a relatively small country, the Netherlands depends on having good linkages with partners around the world. International scientific collaboration is vital, not only for scientific reasons, but also because of economic, political and social reasons. Present ERA-related activities focus at the EU level on mobility, joint programming, the opening up of national programmes and joint European research infrastructures. Regarding European mobility of researchers, the research council NWO has several grants for international travels and visits from abroad. NWO also participates in EUROCORES of ESF. Several Dutch research programmes are open to European and international researchers. For instance, researchers from foreign universities and research institutes can apply to NWO grants for talented researchers. Joint programming with other Members States is still in its infancy, although initiatives are being developed with neighbouring cross-border regions. Finally, a national roadmap has been developed on the further development of research infrastructures in an ERA context. The Committee National Roadmap Large Scale Research Facilities took the European Roadmap for Research Infrastructures (ESFRI) as starting point for its advice on which large research facilities should be included in the first Dutch Roadmap.

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1 - Introduction and overview of analytical framework

1.1 *Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area*

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strength and weaknesses and policy-related opportunities and risks. A particular consideration in the analysis is given to elements of Europeanisation in the governance of national research systems in the framework of the European Research Area, relaunched with the ERA Green Paper of the Commission in April 2007.

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Figure 1: Domains and generic challenges of research systems

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
<ul style="list-style-type: none"> • Justifying resource provision • Long term research investment • Barriers to private R&D funding • Qualified human resources 	<ul style="list-style-type: none"> • Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment 	<ul style="list-style-type: none"> • Quality and excellence of knowledge production • Exploitability of knowledge production 	<ul style="list-style-type: none"> • Knowledge circulation between university, PRO and business sectors • International knowledge access • Absorptive capacity

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures (see figure 1). The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds in the following five steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges. The third step is to analyse recent changes in policy and governance in perspective of the results of the strengths and weaknesses part of the analysis. The fourth step focuses on an evidence-based assessment of policy-related risks and opportunities with respect to the analysis under 3) and in the light of Integrated Guideline 7; and finally the fifth step aims at a brief analysis of the role of the ERA dimension.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory² and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains five main subsections in correspondence with the five steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

² ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

1.2 Overview of the structure of the national research system and its governance

This section provides a brief overview of main structural characteristics of the Dutch research system and its governance. The Netherlands is a prosperous, relatively small country with over 16 million inhabitants, making it one of the most densely populated countries in the world. With its knowledge economy, the Netherlands is, in economic terms, among the better performing countries in the world. According to the European Innovation Scoreboard 2007, the Netherlands (together with Luxembourg, Iceland, Ireland, Austria, France, Belgium and Canada) is an “innovation follower”, with scores below those of the innovation leaders but equal to or above that of the EU27. The expenditures on R&D in terms of GERD per GDP amount to 1.67% (2006) which is below EU27 average (1.84%),³ and still a long way from the 3% ambition of the cabinet. Moreover, the R&D intensity is declining, rather than growing (1.78% in 2004). Especially the R&D intensity of the business sector is relatively low (0.96% in 2006, while EU27=1.17%).⁴ R&D intensity of the government sector is almost the same as EU27 average (NL=0.24%, EU27=0.25% in 2006). R&D intensity of the higher education sector is relatively high with 0.47% in 2006 (EU27=0.4%).

Table 1: Funding flows in R&D in 2005 (in €billion)

	Universities (HERD)	Research institutes (GOVERD)	Business enterprises (BERD)	Total domestic (GERD)
<i>Sources:</i>				
Government	2.1 (84%)	0.9 (75%)	0.2 (4%)	3.2 (36%)
Business	0.2 (8%)	0.2 (17%)	4.0 (78%)	4.4 (50%)
Private non-profit	0.1 (4%)	0.0 (0%)	0.0 (0%)	0.1 (1%)
Abroad and EU	0.1 (4%)	0.1 (8%)	0.9 (18%)	1.1 (13%)
Total	2.5 (100%)	1.2 (100%)	5.1 (100%)	8.8 (100%)
Share of total R&D expenditures	28%	14%	58%	100%

Source: OCW (2007) Kerncijfers 2002-2006, The Hague, May 2007.

Table 1 shows that universities perform 28% of all R&D in the Netherlands, which is above EU27 average (22%), while the business sector performs 58%, which is well below EU27 average (63%). The research institutes perform 14%, which is at more or less at par with EU27 average. Looking at the financing sources, it is noteworthy that the business sector finances half of all R&D expenditures, which is relatively low compared to EU27 average (55%). The government finances 36% of total R&D expenditures, which is slightly above EU27 average (35%). 13% of all R&D financing comes from abroad, which is well above EU27 average (9%).

Main actors and institutions in research governance include the ministry of Education, Culture and Science (OCW) and the ministry of Economic Affairs (EZ). Historically, a strong division of labour has existed between science and basic research (i.e. OCW) on the one hand and technology and innovation (i.e. EZ) on the other, both in terms of policy design, funding and research performers. As a result, two different governance cultures in the science and innovation parts of the system

³ Eurostat website, Science and Technology, Long-term indicators on R&D expenditure, extraction date July 2008.

⁴ Ibidem.

have emerged. While EZ's approach can be characterised as "hands on" with an active role in policy design, programme design and programme management, OCW's approach is rather "hands off", delegating more responsibilities to the research council NWO and the various organisations in the science and research system. However, at different levels in the system these two spheres are gradually moving towards each other. The latest sign of this is the new inter-ministerial Knowledge & Innovation programme department. Besides OCW and EZ, other ministries are also involved in R&D. They focus, however, not on generic policy, but on R&D and innovation within their specific policy domains. Since 2006, each ministry has a "knowledge chamber" to organise "policy for knowledge" (e.g. foresight) and "knowledge for policy".

Decisions on R&D policy to be taken by the plenary Cabinet One are prepared by one of the sub-councils of the Council of Ministers: the Council for Economy, Knowledge and Innovation (REKI). The agenda and the foreseen decisions are co-ordinated and prepared by the Committee on Economy, Knowledge and Innovation (CEKI), which consists of high-level civil servants of all ministries involved.

The Innovation Platform (IP) is a high-level co-ordination and strategy-setting mechanism in the Dutch governance structure. The IP was installed by Royal Decree and is headed by the Prime Minister. In the period 2007-2011 it will primarily focus on R&D and innovation in societal fields such as health care, education, energy and water management.

Advisory bodies in research governance include the Advisory Council for Science and Technology Policy (AWT) and the Royal Netherlands Academy of Arts and Sciences (KNAW).

R&D policy is implemented (mainly) by two key agencies: the research council NWO and the innovation agency SenterNovem. NWO – the Netherlands Organisation for Scientific Research – is an independent administrative body and functions as a funding agency of the ministry of OCW. NWO is responsible for enhancing the quality and innovative nature of scientific research in all fields, and for initiating and stimulating new developments in scientific research. NWO mainly does this by allocating resources, especially to university research. NWO also administers nine research institutes in the fields of physics, mathematics and computer science, astronomy and space research, marine research, history and penal science. SenterNovem is an agency of EZ which implements R&D and innovation schemes mainly for EZ (half the turnover) and other ministries. A third organisation in research policy implementation is the Technology Foundation STW, which operates as an independent part of NWO. STW supports and finances scientific-technological research projects and promotes utilisation of results of research by third parties. EZ and NWO are main financiers of STW.

Given the relatively small size of the Netherlands, the regions only play a minor role in research governance.

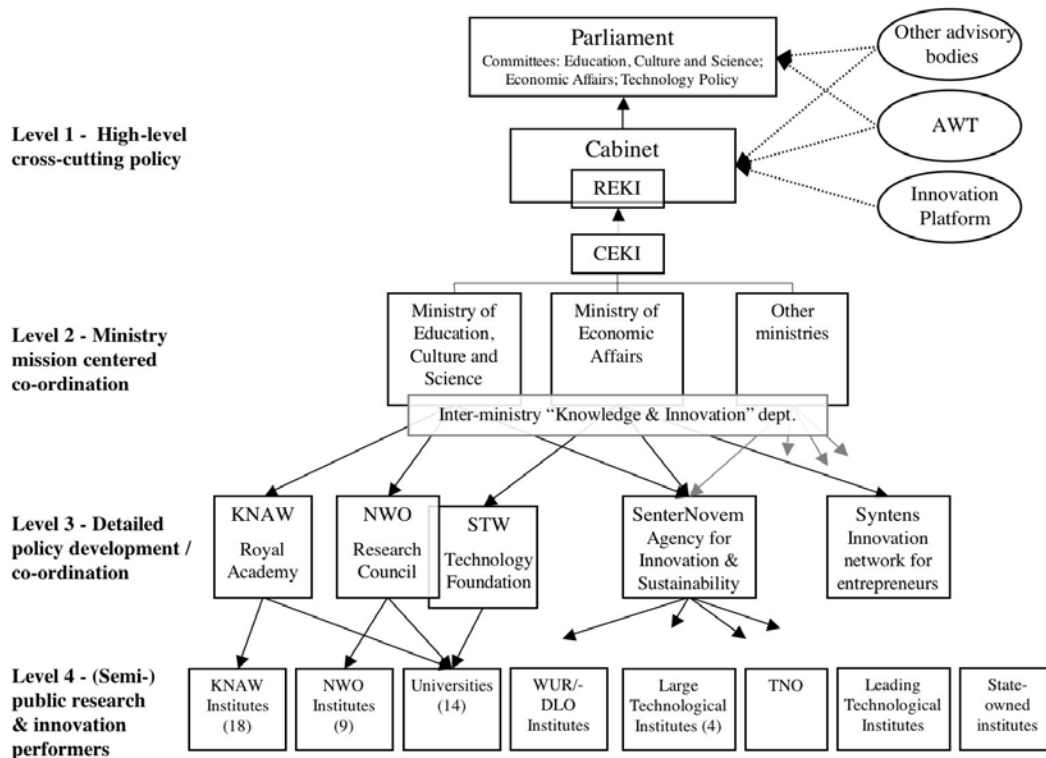
Main research performers in the public knowledge infrastructure are the 14 Dutch universities, the 18 research institutes of the Royal Academy KNAW, the nine research institutes of the research council NWO, the research institutes of the Wageningen University and Research Centre⁵, TNO (Netherlands Organisation for

⁵ The specialised research institutes are active in agro technology & food sciences, animal sciences, environmental sciences, plant sciences and social sciences.

Applied Research), the four Large Technological Institutes⁶, various Leading Technology Institutes⁷, and several state-owned research and expertise centres.

By far the most important private research performers are eight large R&D intensive companies (Philips, ASML, AkzoNobel, NXP, Shell, DSM, Océ and Unilever). Together they are responsible for 73% of the business expenditures on R&D. Philips, for instance, is responsible for roughly 20% of total BERD in the Netherlands.

Figure 2: Overview of the governance structure of the Dutch research system



Source: Technopolis

2 - Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

⁶ The LTIs are active in aerospace (NLR), energy (ECN), water management and hydraulic engineering (Deltares) and maritime research (MARIN).

⁷ The “technological top institutes” are (virtual) research organisations in which companies, universities and research institutes participate in public-private partnerships for research and innovation. In 2008 such top institutes are active in ICT, polymers, materials, food, pharmaceuticals, molecular medicine, life sciences and water.

Four different challenges in the domain of resource mobilisation for research which need to be addressed appropriately by the research system can be distinguished:

- Justifying resource provision for research activities;
- Securing long term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

2.1 Analysis of system characteristics

2.1.1 Justifying resource provision for research activities

Since a few years, a lively debate has developed in the Netherlands about the necessity of raising the investments in R&D. Various advisory bodies, including the Innovation Platform (IP), the Advisory Council for Science and Technology Policy (AWT) and the Social and Economic Council of the Netherlands (SER), the Confederation of Netherlands Industry and Employers (VNO-NCW), the research council NWO, the government and others, have participated in the debate. Science, technology and innovation are broadly regarded as the main impetus for the social and economic development of the society. It is recognised that the “knowledge society” exerts an increasingly pressing demand on the ability to generate new knowledge and to promote its use.⁸ Because the Netherlands is a small, densely populated country, and because it is already economically developed and already as open to international trade as realistically possible, sustainable growth can mainly be achieved with creativity and innovativeness, both now and in the longer term.⁹ In view of the Lisbon strategy, the Netherlands has set itself the ambition to be among the leading knowledge economies in the EU. This ambition is a result from an analysis that national wealth in the 21st century is strongly dependent upon the vitality of the knowledge and innovation processes in the economy and the extent to which they provide new impulses for growth. In addition, international developments and societal trends (e.g. globalisation, ageing, climate change) increase the importance of substantial investments in research and innovation.

In 2004, the IP published an advisory report¹⁰ with the observation that Dutch investment in knowledge is “well below the level required to realise our ambition to be among the leaders in the EU”. In 2005, the AWT published an advisory report on the need to increase the investments in “Knowledge”.¹¹ In 2006, the IP published a green paper on the Knowledge Investment Agenda (KIA) for 2006-2016,¹² in which it gave an elaborate rationale for increasing the investments in “Knowledge”, which should result in a well-trained labour force, an excellent knowledge base, and a high level of innovative capacity. All three are necessary to secure the future of the Netherlands

⁸ EZ & OCW (2006) Science, Technology and Innovation in the Netherlands: Policies, facts and figures 2006, The Hague, September 2006.

⁹ OCW (2004) Science Budget 2004: Focus on excellence and greater value, The Hague, June 2004.

¹⁰ Innovation Platform (2004) ‘Vitalising the Knowledge-based Economy, The Hague, November 2004.

¹¹ AWT (2005) Time for a KIQ start! More investment in education and research, The Hague, October 2005.

¹² Innovation Platform (2006) Kennisinvesteringsagenda 2006–2016, The Hague, May 2006.

as an advanced “knowledge society”. The KIA has been signed by 21 (representative) organisations.¹³

The current government Balkenende IV (2007-2011) has identified the development of an “innovative, competitive, entrepreneurial economy” as one of the key pillars under its policy programme. One of the policy challenges in this pillar is to create “more efficient higher education and research”. In order to address this challenge the cabinet focuses on “independent and pure research”.¹⁴ Stimulating good research is justified with two main reasons. First, it forms the basis for an innovative, creative and competitive economy and a vivid, progressive society. The need for the Netherlands to position itself at the forefront of innovative countries in order to preserve future prosperity and competitiveness is emphasised in policy documents as a justification for channelling resources into research. In order to be innovative, the Netherlands needs high-level research so it will be able to attract excellent researchers, to improve higher education, and the international reputation of the higher education, which is necessary to train the required highly skilled personnel for an innovative economy.¹⁵ Second, research leads to innovative solutions for societal problems, for instance for sustainable energy and health care. In the political discourse, both arguments are used to underpin the expenditures on research.

The Netherlands has substantial revenues from natural gas exploitation. In 2005 it was decided that any unexpected additional revenues in the future shall be partly used for investments in knowledge and innovation, thus acknowledging the strategic importance of knowledge production for the future of the Dutch economy.

The Lisbon strategy, the 3% objective and the importance of contribution to European research are referred to explicitly in the justification of resource provision of research activities. Increasing the expenditures on R&D in general (to 3% of GDP) and of the business sector in particular (to 2% of GDP), is one of the main challenges for the Dutch government in view of the European agenda. In spite of the ambition to be at the forefront of science and to achieve the Barcelona objective of 3%, the Netherlands has relative low expenditures on R&D. Indeed, R&D intensity has decreased from 1.82% in 2000 to 1.67% in 2006. Especially the private R&D expenditures are relatively low with 0.96%. The share of GBAORD has dropped from 0.77% in 2000 to 0.72% in 2006, which is below EU27 average (0.76% in 2006).¹⁶ In sum, the statistics on investments in R&D do not yet reflect the high ambitions.

2.1.2 Securing long term investment in research

The lump sum base funding of public research institutes is under pressure. In order to make the public research organisations more responsive to demands, the government has decided to increase the programmatic funding of TNO and the Large Technological Institutes (LTIs), at the expense of base funding. The programmes are multi-year, though. The lump sum financing of universities is also

¹³ See, for a full list, http://www.innovatieplatform.nl/index.cfm/t/Kennisinvesteringsagenda_-_ondertekend_door_21_organisaties/objectid/1F0A91CB-F8F3-27B3-B52D7BAC51B7946E/vid/D891FE4F-3FFA-497D-97B988FBDF1E7365/containerid/666415AA-C09F-296A-61DB669427684CB2/displaymethod/display_news.

¹⁴ Policy Programme of the Cabinet Balkenende IV, 2007-2011. Samen Werken, Samen Leven.

¹⁵ Ibidem.

¹⁶ Eurostat website, Science and Technology, Long-term indicators on R&D expenditure, extraction date July 2008. The share of GBAORD in 2005: NL=0.70%; EU27=0.74%.

under pressure. In 2007, the government decided to transfer €100m of the lump sum funding to competitive funding (via NWO). Nonetheless, the share of the government in the financing of R&D by universities remains relatively large (87% in 2004). Moreover, a relatively large part of financing of R&D by universities is in the form of general university funds (75% of total financing in 2004).¹⁷

The Netherlands participates actively in European R&D programmes and shared infrastructure facilities. It is an additional long-term investment instrument, but national investments are significantly larger. The share of financing of R&D from abroad is above EU27 average and has increased slightly since 2000 (13% of GERD, 18% of BERD, 4% of HERD and 8% of GOVERD in 2005) (see Table 1).

A standard government period is 4 years. The budget rules are derived from the inflation-based budget policy developed and applied in the period 1994-2007. The rules are geared towards administrative tranquillity and having the budget keep pace with economic developments.¹⁸ Funding flows to universities and public research institutes do not fluctuate very much when a new government takes office. Publicly funded GERD as % of GDP – as a proxy for long-term investments in R&D – for the Netherlands was 0.64% in 2002 and 2003, which is the same as EU27 average.¹⁹ The percentage of GERD financed by government has remained rather stable, with 36% in 2005 (see Table 1), which is above EU27 average (34% 2005²⁰).

The IP developed a long-term Knowledge Investment Agenda (KIA) 2006-2016 to guide long term investments in knowledge and innovation.²¹ In its first annual evaluation, however, it appears that more additional funds and actions are required to fulfil the ambitions. Public investments in the knowledge infrastructure remain too low, compared with the path of growth set out in the KIA. The good intentions are insufficiently translated into concrete policies, according to this evaluation by the IP.

In the same vein, the AWT concluded in 2007 in an advisory report²² that more efforts are necessary to maintain a base in research that is both sufficient broad and sufficiently high-level. More should be invested in creating focus and critical mass in the Dutch R&D system. In science policy, more attention is needed for basic knowledge rather than knowledge-as-product. The AWT recommends the minister of OCW to invest more in the knowledge infrastructure. This investment should cover the broad range of research domains and should be done with a long-term perspective. Also the lump sum funding of universities should be increased.

¹⁷ NOWT (2008) Wetenschaps- en Technologie-indicatoren 2008 (A publication for OCW), The Hague, March 2008.

¹⁸ The most important budget rules are the following: Annual budgets are based on inflation-based economic predictions; One principal decision-making moment (in the spring); Strict separation between income and expenditure (i.e. what comes in does not affect what goes out); Expenditure framework and ceilings (i.e. the overall real expenditure during the government term is fixed); Income framework (i.e. changes of tax and contribution rates during the government term are limited); Automatic stabilisers; Warning levels. (<http://www.minfin.nl/en/subjects,budget/budget-policy/current-budget-policy/The-rules-of-the-budget-policy.html>).

¹⁹ DG Research Regional Key Figures Database (based on integrated Eurostat/OECD data). Extraction date: March 2008.

²⁰ Eurostat website, Science and Technology, Long-term indicators on R&D expenditure, extraction date May 2008.

²¹ See website of the IP at <http://www.innovatieplatform.nl/>.

²² AWT (2007) Balanceren met beleid: Wetenschaps- en Innovatiebeleid op hoofdlijnen (Advice 71), The Hague, 10 April 2007.

2.1.3 Dealing with uncertain returns and other barriers to business R&D investment

The relatively low BERD (0.96% in 2006) in the Netherlands is partly due to the sector structure in the Netherlands with large R&D extensive sectors. The sectoral composition of the Dutch economy is characterised by a relatively high share of R&D extensive sectors (e.g. services) within the total economy, and a relatively small share of R&D intensive sectors (e.g. high tech sectors).

The largest share of BERD (73%) is invested by a few large multinational companies (see section 1.2). In the Netherlands, there are eight large R&D intensive companies that invest more than €100m in R&D per year. Philips, with €730m in 2007, is by far the largest. (See section 3.1.1 for more detailed information on the structure of knowledge demand from the private sector.)

Looking at the financing sources of BERD, the business sector finances 78% of BERD (in 2005) itself and 18% comes from abroad (see Table 1). So the share of the government in financing of BERD is rather small (4%). Nonetheless, the government has a mix of policy instruments to stimulate private R&D, of which the tax scheme [WBSO](#) is the most important. In 2006 €505m was available for tax reductions on R&D wages.²³ Other measures (which are much smaller in budgetary size) are the [Innovation Vouchers](#) scheme, the [Innovation Performance Contract](#) scheme, and the [TechnoPartner](#) programme (including a Seed facility). For the “key areas” – i.e. areas that have been identified by the IP as being strategically important for the Dutch economy – innovation programmes have been (or will be) developed in close collaboration with the private sector.

The business sector finances only 50% of GERD in the Netherlands (see Table 1), which is clearly below EU27 average (55%). Indeed, the Netherlands is among the countries with a low share of the business sector in both total domestic R&D expenditures (58%) and total financing of R&D expenditures (50%). GERD funded by the private sector as % of GDP was 0.90% in 2003, well below EU27 average (1.01%).²⁴ Even given the sector structure, the expenditures of the business sector can be considered too low in view of the ambitions of the Netherlands. In addition, foreign companies conduct relatively little R&D in the Netherlands, which is another cause of low R&D spending.

In 2006 and 2007 the seed and start financing further recovered from a weak period since 2000. An indication that the investment climate for young technology companies in the Netherlands is recovering is, for example, that the investments in seed and start capital have increased (from €24m to €86m in 2006). These seed or start capital related investments amount to 30% of the total number of venture capital investments, compared to 10% in 2004 and 2005. Other positive signs are that the [TechnoPartner](#) Seed facility for “technostarters” has resulted in the establishment of twelve new funds and that other funds have come back to this segment.²⁵

²³ A recent evaluation of WBSO suggests that from each euro fiscal benefit, an additional €0.72 is spent by companies on R&D.

²⁴ DG Research Regional Key Figures Database (based on integrated Eurostat/OECD data). Extraction date: March 2008.

²⁵ NVP/PriceWaterhouseCoopers (2007) Ondernemend vermogen: De Nederlandse private equity-markt in 2006, April 2007.

2.1.4 Providing qualified human resources

The Dutch reservoir of knowledge workers is under pressure. The attractiveness of the Netherlands for highly educated migrants is not high. A limited “brain gain” is worsened by a high “brain drain”. The Netherlands is one of the few OECD countries that does not benefit from a positive net brain gain.²⁶ It indicates a strong international orientation of Dutch workers and businesses. In the past few years, the attractiveness of Dutch universities on students from abroad appears to have increased. The share of students from abroad increased from 4.2% in 2003/04 to 4.7% in 2006/07.²⁷ The government has put forward measures to facilitate and stimulate the inflow of knowledge workers from abroad. In 2006, the Knowledge Migrant Scheme was adapted to increase the attractiveness of the Netherlands for international knowledge workers.

An important element in the attractiveness of the Netherlands for foreign students and researchers is the quality of higher education, which can be characterised as on average good, with few visible differentiations in quality.²⁸ The global position of Dutch universities is good, partly due to a satisfactory quality care system that results in a high average quality. But a high average level is not enough in view of the ambitions of the government. Current challenges in higher education require a more ambitious learning culture, in the sense of motivation, effort, attitude and challenge. At the same time, the demand for more highly educated people means that participation, yield and the number of diplomas awarded will have to increase. This presents a dilemma with regard to quality and quantity. Up to now, universities and colleges of higher professional education in the Netherlands have succeeded in combining increasing participation with an educational quality that is fundamentally sound. But, for the future, a more ambitious learning culture is required.

The reservoir of knowledge workers can be supplemented by education and training. The number of tertiary graduates in S&T per 1000 of population aged 20-29 years has increased from 5.8 in 2000 to 8.6 in 2005. It is, however, still below EU27 average (12.9 in 2005).²⁹ Indeed, a shortage of graduates in S&T is looming,³⁰ and a special “Platform Beta Techniek”³¹ was set up in 2004 by the government to promote the availability of sufficient technicians and engineers. The number of PhD doctorates has increased strongly with 3.5%-point each year since 2000/01. 1.3 per 1000 persons between 25-34 years obtain a doctorate, which is, however, not more than an average score in international perspective.³² The low attractiveness of a career as a scientist / researcher is one of the explanatory factors. The ministry of OCW has put in place a number of instruments to increase the career perspectives of researchers at universities. The most important instrument is the [Innovational Research Incentives Scheme](#), which is directed at providing encouragement for

²⁶ NOWT (2008) Wetenschaps- en Technologie-indicatoren 2008 (A publication for OCW), The Hague, March 2008.

²⁷ CBS (2007) Kennis en economie 2007, Voorburg/Heerlen.

²⁸ OCW (2007) Kennis in Kaart 2007, The Hague, December 2007.

²⁹ Eurostat website, Science and Technology, Long-term indicators on R&D expenditure, extraction date May 2008.

³⁰ NOWT (2008) Wetenschaps- en Technologie-indicatoren 2008 (A publication for OCW), The Hague, March 2008.

³¹ See http://www.platformbetatechniek.nl/pagina_346.html.

³² NOWT (2008) Wetenschaps- en Technologie-indicatoren 2008 (A publication for OCW), The Hague, March 2008.

individual researchers and gives talented, creative researchers the opportunity to conduct their own research programme independently and promote talented researchers to enter and remain committed to the scientific profession.³³

2.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the Dutch research system in terms of resource mobilisation can be summarised as follows:

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • High level of awareness and consensus of the need to invest in R&D • Presence of large multinational R&D intensive companies • Good quality of higher education 	<ul style="list-style-type: none"> • Low business expenditures on R&D • Looming shortages in HRST • The Netherlands is insufficiently attractive for foreign talented students and excellent researchers and for foreign investors in R&D

The Netherlands has strengths in justifying resources provision for research activities. However, although there appears to be broad consensus on the need to invest more in R&D, actual investments do need increase sufficiently. Especially BERD is relatively low, partly due to the R&D extensive sector structure in the Netherlands. Thanks to the presence of eight large multinational R&D intensive companies in the Netherlands, the business expenditures on R&D are not as low as they could have been otherwise. Although the quality of higher education is good, the provision of qualified human resources, especially in science and technology, remains a weakness. There is need for more ambitious learning culture with more opportunities for excellent students and knowledge workers – also from abroad.

2.3 Analysis of recent policy changes

The underlying analysis of need to invest (more) in R&D has not changed much in recent years. Nonetheless, in the policy programme 2007-2011 of the cabinet Balkenende IV, several new policy items are relevant with regard to resource mobilisation.

Regarding the justification of resource provision for research activities and securing long term investments in research, the new inter-ministry “Knowledge & Innovation” programme department (K&I), supported by the Innovation Platform (IP), has developed a long-term investment agenda, which should guide investments in R&D for the coming years. In July 2008, the cabinet presented this “Long term strategy ‘The Netherlands Entrepreneurial Innovation Country’”, based on the KIA of the IP.³⁴ The strategy focuses on three factors that drive the growth of sustainable productivity: 1) strengthening and utilisation of talents; 2) strengthening and utilisation of knowledge in public and private research; and 3) promoting innovative entrepreneurship. These three factors have been elaborated in concrete objectives and measures. In the strategy document, it is recognised that a long-term strategy requires continuity and commitment from the government. Therefore, the strategy also includes policy perspectives for the longer term.

³³ See http://www.nwo.nl/nwohome.nsf/pages/NWOA_4YJDQ3_Eng.

³⁴ EZ & OCW (2008) Naar een agenda voor duurzame productiviteitsgroei, The Hague, June 2008.

A new policy objective in the policy programme 2007-2011 is to have more, and more top-level, graduates. Talented and ambitious students will get the opportunity – via special grants or other forms of study financing – to participate in “top studies”. The budget for Huygens Scholarship Programmes for talented students in the Netherlands and elsewhere, will be increased to €10m per year. In addition, selective extra funds will be used from 2008 to achieve greater excellence in higher education and to investigate what obstacles will have to be removed to achieve that goal. A total of €50m will be available for this purpose up to and including 2011.³⁵ The universities and colleges of higher professional education will be challenged by OCW to provide more than basic quality. More students should study more than just the basic programme. In this respect, differentiation in education and intensive supervision are considered very important. Furthermore, the American graduate school system will be used as an inspiration for a reform of the Dutch system, also to improve the training of PhD students. To address looming shortages in HRST, a new taskforce ‘Technology, Education and Labour Market’ is established, with a leading role for the business sector. In addition, a new action plan will be developed for the improvement of education in (natural) sciences, with close involvement of the three Universities of Technology.

Challenges	Policy changes
Justifying resource provision Long term research investment	<ul style="list-style-type: none"> • Development of long-term strategy for research and innovation by K&I and IP
Barriers to private R&D funding	<ul style="list-style-type: none"> • Broadening of WBSO scheme • Stimulation of entrepreneurship, also in schools and universities
Qualified human resources	<ul style="list-style-type: none"> • Various measures to stimulate “an excellent learning culture” • Establishment of taskforce “Technology, Education and Labour” to address looming shortages in HRST • More funding to talented researchers in various stages of their careers • Brain gain programmes and changes in regulations for knowledge migrants

The existing scheme to stimulate excellent researchers in various stages of their careers, the [Innovational Research Incentives Scheme](#), will be strengthened with an additional €150m (€100m of which is transferred from the lump sum funding of universities).

To attract foreign excellent researchers, “brain gain” programmes will be developed. To increase the attractiveness of the Netherlands for foreign knowledge workers, regulations for migrants will be changed to make it easier for them to stay and work in the Netherlands. This will also increase the attractiveness to foreign investors in R&D.

To stimulate BERD (especially by SMEs), existing schemes (e.g. [WBSO](#)) will be continued and/or broadened and entrepreneurship will be stimulated in various ways, also in schools and universities.

³⁵ OCW (2007) Strategic agenda for higher education, research and science policy, The Hague, November 2007.

2.4 Assessment of policy opportunities and risks

The main opportunities and risks for resource mobilisation in the Netherlands arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • The long-term strategy for investments in knowledge and innovation could allow for a better co-ordinated and coherent approach. • The attractiveness of the Netherlands for students, knowledge workers and investors in R&D – also from abroad –, could be increased by creating a learning culture and research culture that fosters excellence. 	<ul style="list-style-type: none"> • Efforts to raise R&D intensity fall short of ambitions (3% target).

Policy opportunities in resources mobilisation arise from the combination of policy responses to policy weakness and strengths. Especially the weaknesses in relation to human resources (looming shortages in HRST, too little attention for ‘excellence’, and insufficient international attractiveness) create policy opportunities. The development of a long-term investment agenda could help to realise R&D investment objectives. The 3% target, however, remains very ambitious for the Netherlands, given the relatively low (and stagnating) BERD. Indeed, it can be considered a risk that not enough policy efforts will be developed to increase the investments in R&D and to keep and attract R&D intensive companies. (The share of GBAORD has decreased from 0.83% of GDP in 1997 to 0.71% in 2007.)³⁶

2.5 Summary of the role of the ERA dimension

The Netherlands participates substantially in large international research organisations such as the European Space Agency (ESA). The European Space Research and Technology Centre (ESTEC), the largest site and the technical heart of ESA – the incubator of the European space effort – is in Noordwijk, the Netherlands. The Netherlands also participates in the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), European Organisation for Nuclear Research (CERN), European Molecular Biology Laboratory (EMBL), and the European Molecular Biology Conference (EMBC). Dutch partners also participate above average in European R&D programmes.

³⁶ Eurostat website, Science and Technology, Long-term indicators on R&D Expenditure, extraction date July 2008.

3 - Knowledge demand

The purpose of this chapter is to analyse and assess how research related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement, due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand;
- Co-ordinating and channelling knowledge demands; and
- Monitoring demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted in IG7 of the Lisbon Strategy.

3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

Structure of knowledge demand

A broad picture of the demand structure can be sketched out by the share of R&D spending of the private vs. public sector (see Table 1 in Ch. 1). BERD is relatively low in the Netherlands, while HERD is relatively high and GOVERD is more or less at the level of EU27 average.³⁷ Looking at the source of the financing of R&D expenditures, it appears that the Dutch business sector finances a relatively small part (50%), while the government (36%) and abroad (13%) finance relatively large shares.³⁸ Thus, a relatively large part of R&D is performed by the public knowledge infrastructure, and a relatively large part of R&D is financed by the public sector.

In terms of GBAORD specialisation, Netherlands is highly specialised in civil research and land use, while there are also specialisations in a large number of socioeconomic objectives such as energy, space, industrial technologies, agriculture and the environment.³⁹

The business sector structure of the Netherlands is characterised by a number of strong sectors, i.e. the community services, business activities and the ICT sectors, electronic equipment and office machinery industries, the chemicals and the food industry and mining (natural gas & oil) and agriculture. There are correlations between economic, technological and BERD specialisations in the Netherlands. Compared to EU15 average, sectors that have relatively high BERD include mining, electronic equipment and office machinery, trade, food, agriculture, construction,

³⁷ The statistics for the Netherlands in 2006 are: BERD=0.96% (EU27=1.17%); GOVERD=0.24% (EU27=0.25%), HERD=0.47% (EU27=0.4%). (Eurostat website, Science and Technology, Long-term indicators on R&D Expenditure, extraction date July 2008).

³⁸ Countries with a high R&D intensity are generally characterised by a share of 70% by the business sector and 25% by the government (NOWT, 2008).

³⁹ ERAWATCH (2006) Country Specialisation Report: The Netherlands, June 2006.

chemicals, ships, and basic metals.⁴⁰ As already mentioned previously, a very large part of R&D by Dutch businesses is performed by a limited number of large multinationals (the “big eight”): Philips (electronics), ASML (integrated circuits equipment), AkzoNobel (healthcare products, coatings, and chemicals), NXP (semiconductors), Shell (oil & gas), DSM (nutritional and pharma ingredients, performance materials and industrial chemicals), Océ (copiers), and Unilever (food, personal care). These companies tend to have a good absorptive capacity and good relations with the public knowledge infrastructure.

With regard to the knowledge “demand” that is “intrinsic” for the research sector itself, it can be mentioned that HERD is relatively high in the Netherlands (0.47% in 2006). A relatively large share of the R&D expenditures by universities is financed by the government (84%). A relatively large share of this governmental funding of universities is via general university funds,⁴¹ which implies that universities have a rather large degree of autonomy in allocating their resources and to respond to knowledge “demand” that is “intrinsic” from the research sector itself.

Processes for identifying the drivers of knowledge demand

The Innovation Platform (IP) is a high-level co-ordination and strategy-setting mechanism in the Dutch governance structure. In its first period (2003-2007), one of the main activities of the IP was to identify several “key areas”, i.e. strong combinations of demand and supply of knowledge, for the Dutch knowledge economy, based on a broad consultation process. “Key areas” are combinations of entrepreneurial activity and knowledge production in which the Netherlands excels. Selected “key areas” are in line with the specialisation pattern of the Netherlands.⁴² In the period 2007-2011, the IP focuses on “societal themes” such as health care, education, energy and water management. The IP also contributes to the long-term strategy for innovation and entrepreneurship, which is developed as part of the inter-ministry project “Netherlands Entrepreneurial Innovation Country”.

For each of the “key areas” and selected “societal themes”, innovation programmes have been (or are being) developed in an interactive and bottom-up process, giving knowledge demand a central role in the programme design. The requirement of public-private partnership constructions is also used as a way to identify drivers of knowledge demand at the level of selected domains. SenterNovem, the agency for innovation, plays a central role in the development and implementation of the innovation programmes.

In order to facilitate the identification and articulation of demands in the policy areas of the ministries, each ministry has established a “knowledge chamber”, to align knowledge demand and knowledge supply between government, knowledge institutes, societal organisations and advisory councils/bodies. Since 2006, these knowledge chambers organise “policy for knowledge” (e.g. foresight) and “knowledge for policy”. Each ministry can choose its own specific form for a knowledge chamber.⁴³

⁴⁰ Ibidem.

⁴¹ NOWT (2008) Wetenschaps- en Technologie-indicatoren 2008 (A publication for OCW), The Hague, March 2008.

⁴² The key areas are: Flowers & Food, High Tech Systems & Materials, Creative Industry, Water, Chemicals Industry, Pensions & Social Security. The areas ICT and Energy were identified as “innovation axes”. Life Sciences & Health was identified as a potential key area.

⁴³ With the introduction of the knowledge chambers, the previous system of “sector councils” has been abolished, as part of a major reorganisation of the governmental advisory system. The sector councils

Society's demands are also addressed by funding of non-university public research institutes and departmental research institutes. TNO, the Netherlands Organisation for Applied Research, is by far the largest (semi-)public research organisation in the Netherlands. It focuses on five areas: quality of life, defence/security/safety, science & industry, built environment & geosciences, and ICT. In addition, there are four Large Technological Institutes (LTIs), which focus specific strategic areas: aerospace (NLR), energy research (ECN), water management and hydraulic engineering (Deltares) and maritime research (MARIN). A relatively large part of the funding of TNO and the LTIs comes from the private sector, which indicates that the institutes are responsive to their knowledge demands. Indeed, making TNO and the LTIs more responsive to knowledge demands, has been a key policy objective. Several ministries have their 'own' designated governmental research institutes, e.g. in health and agriculture.

The Royal Netherlands Academy of Arts and Sciences (KNAW) provides advice to the government on matters of science and technology, especially in the field of basic research. As part of this advisory role, the KNAW conducts each year a number of research foresight studies in order to shape the thinking and discussion about scientific developments in a particular field and to create good conditions for the development of that particular field of science.⁴⁴

The national research council, NWO, has as one of its action lines to develop more focus and mass in the research system. To achieve this, several research themes have been identified. The identification of the drivers of knowledge demand was part of this exercise.

There are three (temporary) task forces ("*regie-organen*" for the domains of the "strategic technologies" genomics, advanced chemical technologies and ICT. These bodies have the task to align knowledge demand and knowledge supply in their domains.

The Rathenau Institute is an independent organisation that concerns itself with issues on the interface between science, technology and society, and that provides information to politicians. The Rathenau Institute has two core tasks. It studies the impacts of science and technology on society from the point of view of the public (*i.e.* Technology Assessment). Since 2004, the Institute has also been investigating how the science system performs and how it responds to scientific and social developments. This task is called Science System Assessment.

3.1.2 Co-ordinating and channelling knowledge demands

Because a relatively large share of public R&D funds is allocated to universities via general university funds, universities themselves appear to have a relatively large degree of freedom in developing their research agendas. In practice, however, this freedom is reduced because a significant part of the first tier (lump sum) funding is tied via matching requirements of second and third tier funding flows.

used to carry out foresight exercises and make analyses of scientific and social trends. These explorations informed programming studies for fundamental and strategic research, which, in turn, informed the programming of research (e.g. by the research council NWO). Since 2008, the horizon scan function is transferred to the department Knowledge within the ministry of OCW.

⁴⁴ For more information, see <http://www.knaw.nl/research foresight/research.html>.

Knowledge demands from the private sector are addressed in various priority setting processes. For knowledge demands from the “key areas” in the Dutch economy (water, flowers & food, high-tech systems & materials, chemicals industry, creative industry, pensions & social security)⁴⁵ thematic innovation programmes have been (or will be) developed, in which stakeholders themselves have played an active role in the design and implementation. As part of the innovation programmes, several Leading Technological Institutes (“*Technologische Topinstututen*”) have been established. These are public-private partnerships, introduced to make the public research infrastructure more responsive to the needs of businesses in the key areas.

Knowledge demands from society are addressed via the identification of societal themes (education, health care, energy and water) for which “societal innovation programmes” are being developed (launch in 2008), based on “societal innovation agendas”. These agendas are developed via stakeholder involvement with a co-ordinating role by the (new) inter-ministerial department “Knowledge & Innovation” (set up in 2007).

In the fields of so-called “key technologies” (ICT, genomics/life sciences, catalysis and nanotechnology) three co-ordinative bodies (“*regie-organen*”) have been set up to translate knowledge demands in co-ordinated research agenda’s. The task forces have a semi-permanent status and are accommodated by national research council NWO.

Through thematic research programmes, the national research council NWO aims to address knowledge demands from both the academic sector and society. 23% of NWO’s subsidy budget (total subsidy budget of NWO is €364m in 2006) is allocated to thematic programmes. Demands from the academic sector are also addressed through the research institutes of NWO and KNAW.

In terms of GBAORD by socio-economic objective, the Netherlands has specialisations in “other civil research”, “land-use”, “agriculture”, “general university funds”, “energy”, “industry” and “space”. The Netherlands is not specialised in “defence”, “earth”, “human health”, “social issues” and “non-oriented research”

Since the mid-1990s, revenues from the exploitation of natural gas in the Fund for Economic Structure Enhancement (FES) have been invested in research and innovation (ca. €2.5b in the period 2003-2007 for multi-annual programmes). The priority setting and selection processes have not been very systematic and were not guided by a long-term strategy. In 2008, the Cabinet has announced to present such a strategy in order to guide future investments and prevent investments to become part of inter-ministry power struggles. The inter-ministerial “Knowledge and Innovation” programme department (K&I) was launched in 2007 as a new mechanism to co-ordinate R&D activities of various ministries in societal areas and to develop a long-term investment agenda for R&D. The IP is another co-ordinative mechanism.

The overall picture is that there are various mechanisms in place to channel knowledge demands. However, there is fragmentation and a lack of co-ordination. Priority setting has not been a well-co-ordinated process in the Netherlands, with each ministry following their agendas. The combination of substantial sums of

⁴⁵ These key areas were proposed by the Innovation Platform in 2004 after a broad consultation process. In 2005, the ministry of Economic Affairs adopted the key area approach in its innovation policy, in line with its ambitions to create more ‘focus and mass’.

additional money from the FES being available and no systematic and co-ordinated approach in place, created opportunities for new or growing demands to be addressed. For instance, the emerging area of life sciences & health benefited the most from the investments in R&D from the FES – even though it was not identified as a “key area” by the IP. The downside is that the process is rather vulnerable for lobbying and policy turbulence. The upside is that funding is given in the form of temporary impulses, rather than structural funding to (new) institutes, which enhances flexibility and responsiveness to new demands. However, the relations between the government and the universities have suffered because of a lack of mutual trust that has arisen. On the one hand, universities feel that they are confronted by a plethora of temporary research initiatives by the government, to force them into “relevant” directions. On the other hand, the government perceives inertia in the universities, a lack of responsiveness to economic and societal needs and a lack of accountability.

The European dimension increasingly acts as an additional mechanism to channel the demand for knowledge. Especially when an overlap exists between national and European priority areas, the Netherlands tries to be actively involved. As an indication of a more active orientation towards Europe, the ‘Netherlands house for Education and Research’ (NethER) was established in Brussels in 2007. It is an international association of Dutch organisations in the fields of education, research and innovation based in Brussels. Its mission is to enhance the influence of the Dutch institutions on the European policy formulation in the fields of education, research and innovation; to maintain, and where possible to increase, the participation and share of Dutch institutions in European education, research and innovation programmes.

The innovation programmes in the “key areas” explicitly have the task to develop an international dimension, and to position themselves at the European level.

In general, Dutch universities score well in European framework programmes, which can – at least in part – be attributed to the emphasis on research excellence *and* economic/ societal relevance in research policy.

3.1.3 Monitoring demand fulfilment

Since January 2002, policy design and policy evaluation have been subject to the ministerial regulation on performance measurement and evaluation (RPE)⁴⁶, which poses a number of requirements on policy preparation (ex ante evaluation), monitoring and ex post evaluation. The requirements concern the use of evaluation instruments; the obligation to consider an ex ante evaluation when starting to think about a new instrument; the frequency and extent of ex post policy evaluations (every instrument has to be evaluated every five years); the quality of the evaluation instruments; informing the minister, head of the department and parliament about the outcomes of an evaluation;⁴⁷ and the distribution of responsibilities within the department with regard to the implementation of the decree (RPE). Recently, there has been a tendency to shift attention from ex post evaluations to ex ante evaluation

⁴⁶ In Dutch: *Regeling Prestatiegegevens en Evaluatieonderzoek* (RPE)

⁴⁷ All results from evaluations are given to the administrative and political top-level. In case of major consequences (in terms of policy or politics) they are informed directly. In case of new policy or adapted policy, they are informed indirectly via directors and DG, who subsequently decide what to transfer.

and monitoring. Baseline measurements have become standard practice. Although evaluation has become a structural part of policy processes, it is not always clear to what extent the results of the evaluations are considered before new R&D policy measures or programmes are launched.

Also research institutes and research organisations like the national research council and the Royal Netherlands Academy of Arts and Sciences (KNAW) are periodically evaluated.

Where economic and/or societal relevance is part of the objectives of the instrument/institute, the evaluation should measure the effects on this dimension.

3.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the Dutch research system in terms of knowledge demand can be summarised as follows:

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • Dutch research system has strengths in identifying knowledge demands in “key areas” • “Relevance” (next to “excellence”) is a key objective of many instruments in R&D policy 	<ul style="list-style-type: none"> • Lack of co-ordination between priority setting by different governmental actors and across different policy measures

Since the mid 1990s, many efforts have been undertaken to make the Dutch research more responsive to knowledge demand. The downside of all these efforts is that the level of co-ordination has not been as good as it should have been, which led to lack of cohesion and a multitude of initiatives. The fact that Dutch universities get a relatively large share of their income via lump sum financing can be a strength, if universities further develop their strategic capabilities to identify and address knowledge demands.

3.3 Analysis of recent policy changes

One of the main new elements regarding knowledge demand in OCW’s Strategic Agenda for Higher Education, Research and Science Policy for the period 2007-2011 is the renewed emphasis on creating an excellent research climate. The cabinet wants to allocate funding so as to reinforce the primacy of independent and fundamental research: not by imposing themes or dispersing money through institutions, but by ensuring that funding goes directly to the best researchers. The emphasis in OCW’s new policy is on excellent, investigator-driven research. This means that the government opts for a hands-off approach, and lets the researchers themselves decide which scientific research to perform. Focus and mass will emerge “naturally” because excellent groups attract more talented researchers. Thus, recent research policy highlights the demands for knowledge from academic researchers themselves, rather than demands from society or the economy.

The leading role of independent and basic scientific research will be strengthened by increasing research funds provided by institutions and by distributing resources on the basis of competition, with excellence as the criterion. In this respect, the cabinet has chosen not to impose plans. The researchers know best where opportunities are likely to arise. Young people must be able to determine their own research plans early in their scientific career. The [Innovational Research Incentives Scheme](#) (“*Vernieuwingsimpuls*”) will be extended considerably. For this purpose, €100m has

been transferred from the first tier (lump sum) funding to universities to the second tier (project based) funding by the research council NWO.⁴⁸ In order to increase the options for young people even further, the one-third contribution of the institutions will be cancelled. Agreements have been made with the universities regarding the phasing of these plans.

The Strategic Agenda of OCW recognises that the management mechanism of the researchers themselves works only *within* scientific disciplines. For choices *between* scientific disciplines other mechanisms are required. In a strongly decentralised research system it is not easy to ensure that these choices are in line with short and long-term agendas of government authorities, businesses and civil organisations. In the period 2007-2011 several mechanisms that have been developed will be further detailed and strengthened. In practice, the government will leave choices relating to research priorities as far as possible to those involved. Only in some instances, where the government felt it was necessary, the government has set priorities, such as the designation of the genomics, ICT and nanotechnologies as national research priorities.

New policy plans are also presented in the Working Programme “Netherlands Entrepreneurial Innovation Country” (2007) of the new inter-ministerial “Knowledge & Innovation” programme department (K&I). It addresses both the needs from the business sector (by focusing on competitiveness of the Dutch economy) and societal needs (using innovation to solve societal problems). As a first step, a long-term strategy for research, education, innovation and entrepreneurship will be developed (in 2008). Second, “societal innovation agendas” will be developed, from which “societal innovation programmes” will be developed. The IP and other stakeholders will play an important part in these processes. K&I has the difficult task to co-ordinate the efforts from all parties involved, including nine ministries. It will not start from scratch, however, and will build on existing experiences with the “key area” approach and existing foresight studies etc. The budget that has been made available for the societal innovation programmes in water, security, health care, and energy amounts to €258m for the period 2008-2012.

With regard to knowledge demands from the business sector, policy will largely remain unchanged. The “key area” approach has remained a central element in research and innovation policy of EZ.

Challenges	Policy changes
Identification of knowledge demand drivers	<ul style="list-style-type: none"> • Development of long-term strategy for research and innovation • Development of societal innovation agendas and societal innovation programmes • More funding for individual talented researchers, assuming they know best where opportunities are likely to arise
Co-ordination of knowledge demands	<ul style="list-style-type: none"> • Establishment of inter-ministerial “Knowledge & Innovation” programme department to co-ordinate activities of nine ministries with regard to the long-term strategy and the societal innovation agendas/programmes
Monitoring of demand fulfilment	<ul style="list-style-type: none"> • No new developments

⁴⁸ An addition €50m is allocated that has become available because of the discontinuation of the Smart Mix subsidy programme.

3.4 Assessment of policy opportunities and risks

The main opportunities and risks for knowledge demand in the Netherlands arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • Key societal needs could be addressed by development of societal innovation agendas and societal innovation programmes. • Co-ordination between ministries could be made more effective (in efforts to develop a long-term strategy for research and innovation, and in developing societal innovation agendas and programmes). 	<ul style="list-style-type: none"> • Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in lack of responsiveness to knowledge demands from knowledge users outside the research system.

New policies do address the weakness of poor co-ordination between priority setting by different actors and across different measures. In particular, the new inter-ministerial “Knowledge & Innovation” programme department with its new working plan can be considered a policy opportunity. The new policy continues the “key area” approach and uses a similar approach to address societal needs (via the societal innovation agendas and programmes). This can be considered a policy opportunity.

The strengthening of project-based research funding of individual researchers at the expense of lump sum funding of universities results in a (small) adjustment of the relatively large share of general university funds in the total financing of university R&D. This shift in funding could be considered a policy opportunity from the perspective of making the research system more responsive. At the same time, however, the new policy aims to increase the primacy of independent and fundamental research, arguing that an excellent climate that fosters the best scientific researchers, is the best way to address societal and economic knowledge demands in the long term. From the perspective of demand orientation, this new policy can be considered a risk, also because it undermines the importance of “relevance” vis-à-vis “excellence” in public funding of R&D. The policy bypasses the universities and expresses trust in the capacity of individual researchers and research groups to be able to respond to relevant knowledge demands within their domains.

3.5 Summary of the role of the ERA dimension

The role of the ERA dimension in ensuring an appropriate identification, co-ordination and monitoring of knowledge demand is limited, but appears to be increasing. Where overlaps exist between FP7 thematic priorities and national “key areas”, “national research priorities” (ICT, genomics and nanotechnologies) and selected “societal needs”, synergies are sought, but not yet in a fully integrated or systematic fashion. The mutual reinforcement of European and national research is, however, becoming a more central element in policy thinking. Synergies between European Technology Platforms and the innovation programmes in the “key areas” are explicitly explored. Furthermore, the Netherlands is active in most (53) ERA-NETs (12 in life sciences, 18 in environment & energy, 8 in humanities & social sciences, 9 in fundamental

research, 21 in industrial technologies).⁴⁹ Opportunities for cross-border collaboration with neighbouring regions (North-Rhein Westphalia and Flanders in particular) are also being explored.

4 - Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable for economic knowledge producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

4.1 Analysis of system characteristics

4.1.1 Improving quality and excellence of knowledge production

The main knowledge producers in the Dutch research system are fourteen universities, eighteen KNAW institutes and nine NWO institutes. The largest (semi-) public research institutes are the Netherlands Organisation for Applied Research TNO, four Large Technological Institutes (LTIs) and several state-owned research and expertise centres. With only 0.25% of the world population, the Netherlands produces 2% of all scientific publications and receives 3% of all citations worldwide to these publications. Also in terms of scientific productivity (publication/input in terms of investments or human resources), the Netherlands is among the best countries. Circa 70% of the total national scientific publications is produced by university researchers. The (bio-)medical sciences and natural sciences account for more the 75% of the publications.⁵⁰ Citation impact scores indicate that the Dutch research system performs above world average in these two domains. In general, the quality of scientific research in the Netherlands is 30% above world average and is still on

⁴⁹ <http://www.senternovem.nl/egl/eranetten/index.asp>.

⁵⁰ "In terms of scientific specialisation, Netherlands are specialised in a number of fields with the exception of most natural sciences (...). Moreover, with the exception of molecular biology and genetics where it became under-specialised during the 1993-2003 period, Netherlands are specialised in all medical related fields. This specialisation profile is also validated by the citations profile" (ERAWATCH, 2006, p. 1).

the rise – measured in terms of citation impact. Only Switzerland and the USA have higher impact scores.⁵¹ In the first round of the ERC, Dutch applicants also scored very well.

The Dutch specialisation pattern is characterised by a lack of disciplines that are both relatively large (in terms of share in total Dutch publication output) *and* very strong (in terms of citation impact scores).⁵² The specialisation pattern does have correlations with the investments in efforts to create “focus and mass” in the Dutch research system. This is not surprising, because “scientific excellence” is usually a key selection criterion (next to “economic/societal relevance”).

Academic knowledge quality is assessed by the authorized assessment agency Quality Assurance Netherlands Universities (QANU).⁵³ According to the Standard Evaluation Protocol 2003-2009 for Public Research Organisations (SEP) formulated by the KNAW, NWO and VSNU, universities must carry out a self-evaluation of their research activities once every three years, and these research activities must also be assessed by an external panel once every six years. The external assessment covers not only the content of the research programme but also the management, strategy and mission of the research centre where it is carried out. The evaluation protocol leaves scope for assessment of one or more research centres within the same university or for comparison with similar centres at home or abroad.⁵⁴ The evaluation exercise has a twofold objective: it is an instrument for the steering of research (because it provides insight in where the research group stands in qualitative terms) and for assessing whether the research meets the ambitions. In 2004 the “Meta Evaluation Committee Quality Assurance Scientific Research” was set up by the KNAW, NWO and VSNU to (i) supervise the implementation of the Standard Evaluation Protocol 2003-2009; (ii) to assess the influence of the reports of external evaluation committees on decision-making processes of universities, KNAW and NWO; and (iii) to evaluate the functioning of the SEP and to make recommendations to improve the efficiency and effectiveness of the processes of quality assurance. In 2007, the first report of the Committee (“Trust, but verify”) was published with a number of points of interest, including the issue of evaluation of a discipline versus evaluation of separate institutes, the follow-up of the evaluations, the relation between scientific and societal relevance, the benchmark of the evaluation, the usage of scores.

Although the Netherlands has a good reputation in terms of the evaluation culture and the use of peer reviewed evaluations in the science system, the results of these

⁵¹ NOWT (2008) Wetenschaps- en Technologie-Indicatoren 2008 (A publication for OCW), The Hague, March 2008.

⁵² Disciplines with very high citation impact scores but relatively small size include: Chemistry and chemical technology; Physics and materials sciences; Information and communication sciences; Arts, culture and music; and Literature sciences. Disciplines with a high citation impact and relatively large size include: Agricultural sciences and Clinical medicine. Disciplines with a high citation impact and an average size include: Geo sciences and technologies; Computer sciences; Environmental sciences. Disciplines with high citation impact scores and relatively small size include: Electrical engineering; Civil engineering; Instruments and instrumentation (NOWT, 2008).

⁵³ QANU offers universities external assessments of academic education and research programmes, and advice on ways of improving internal quality assurance.

⁵⁴ For more information, see: www.qanu.nl.

evaluations appear not to be used fully in making strategic decisions and creating focus and mass.⁵⁵

According to its mission, NWO is responsible for enhancing the quality and innovative nature of scientific research as equally initiating and stimulating new developments in scientific research. NWO has a good reputation in terms of quality assurance of research. NWO mainly fulfils its task by allocating resources, it facilitates the dissemination of knowledge from the results of research that it has initiated and stimulated to (societal/economic) users, and it mainly focuses on university research in performing its task.⁵⁶ NWO spends its means in competition on the best researchers and research groups. The selection is in the hands of independent experts. The core criteria in the implementation of NWO's mission are the high quality of the funded research and the innovative nature of the research agenda, which enable Dutch science to achieve (and maintain) a world-class position. In 2006, NWO allocated a total of €364m subsidies. €98m was allocated in "open competition", €83m to thematic programmes, €75m to talented researchers in different stages of their scientific careers.

One of the three action lines of NWO is "consolidation of strengths within science"⁵⁷. In the period 2003-2006, NWO for the first time selected themes with the aim of creating focus and mass in research. For each of the nine themes programmes have been developed. For the period 2007-2010, NWO has again selected (thirteen) topical scientific and/or societal subjects as carriers of thematic programmes, on the basis of broad consultation. In absence of an overarching long-term agenda for the Netherlands, the alignment of NWO's themes and other priority areas is less than optimal.⁵⁸

Since the early 2000s, many new (often virtual/temporary) institutes and centres have emerged, resulting in a research system that is becoming increasingly complex and interwoven. For instance, universities and public research institutes participate in Leading Technological Institutes ("*Technologische Topinstituten*") and many different public-private consortia. In effect, these centres create a new intermediate layer in the research system, getting a larger influence on the allocation of research funds – thus bypassing the traditional allocation mechanisms such as NWO and the universities. It is not always clear whether the quality assurance has the same standards as the national research council has. On the other hand, this process has enabled openness to new scientific opportunities, often beyond disciplinary borders.

4.1.2 Improving exploitability of knowledge production

Exploitability of knowledge is an important feature of the Dutch research system. Patent law and other intellectual property rights institutions have been established for

⁵⁵ OMC Policy Mix Review Report. Country Report The Netherlands, April 2007. (http://ec.europa.eu/invest-in-research/pdf/download_en/omc_nl_review_report.pdf).

⁵⁶ Website of NWO: www.nwo.nl/nwohome.nsf/pages/NWOP_5SME25_Eng.

⁵⁷ The creation of "focus and mass" in the Dutch research landscape has been a major policy objective for more than a decade. The other two action lines are creating opportunities for talented researchers and stimulating science for society.

⁵⁸ Unfortunately, these themes were not closely co-ordinated with the "key areas" identified by the IP. (AWT (2007) Weloverwogen impulsen: Strategisch investeren in zwaartepunten (Advice 72), The Hague, 12 November 2007.) The government has announced, in a reaction to criticisms of the AWT that synergies will be sought between the "key areas", the "societal themes" and the "NWO themes". (TK 27406, nr. 117, The Hague, 29 February 2008).

a long time. The Netherlands has a relatively high position in terms of patent output, but this is largely thanks to Philips.⁵⁹ The number of EPO patent applications per million inhabitants for the Netherlands is more than two times higher than EU27 average (243,342 and 111,960 for 2004, respectively).⁶⁰ Concerning the technological specialisation (measured by patents) of Netherlands, the country is specialised in three sectors, namely the electronic equipment, office machinery and the food industry. Particularly for the first two industries, the specialisation increased during the 1993-2003 period, while in all other sectors Netherlands became less specialised. This increase in specialisation can most probably be attributed to large enterprises such as Philips, for whom patenting activities became increasingly important by the end of the 1990s.⁶¹

A range of mechanisms is in place to facilitate matching of scientific knowledge production specialisation with economic specialisation, including the three technological universities (TU Delft, TU Eindhoven and University of Twente), TNO and the four LTIs, various collaborative academia-industry research programmes and innovation programmes in the “key areas”. Together, they cover the relevant parts of the Dutch knowledge economy.⁶²

The Technology Foundation STW operates as an independent part of NWO for technical-scientific research. STW supports and finances scientific-technological research projects and programmes in which research institutes collaborate with third parties, in order to ensure the exploitability of research results. Thus, research “excellence” is as important as “relevance”.

In addition, there are several mechanisms in the Dutch research system to drive knowledge production for societal purposes. Some of the abovementioned institutes explicitly focus on societal issues (e.g. sustainable energy, health). In 2005, three Leading Societal Institutes (“*Maatschappelijke Topinstututen*”) were established: HILL – Hague Institute for the Internationalisation of Law; Netspar – Network for Studies on Pensions, Aging and Retirement; and NICIS – Netherlands Institute for City Innovation Studies.

4.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the Dutch research system in terms of knowledge production can be summarised as follows:

⁵⁹ The number of patents in a country is largely dependent upon the industrial structure, and on via which country large knowledge-intensive multinational companies apply for patents.

⁶⁰ Eurostat website, Science and Technology, Long-term indicators on R&D expenditure, extraction date May 2008.

⁶¹ ERAWATCH (2006) Country Specialisation Report: The Netherlands, June 2006.

⁶² The three universities of technology have strengths (in terms of publication output) in physics and materials sciences, chemistry and chemical technology, computer sciences, electrical engineering and in mechanical engineering. TNO focuses on Built Environment and Geosciences, Defence, Security & Safety, Science & Industry, ICT and Quality of Life. The Large Technological Institutes focus on aerospace, energy research, water management and hydraulic engineering, and maritime research. The Leading Technological Institutes are active in ICT, advanced chemicals/polymers, materials, food, pharmaceuticals, molecular medicine, life sciences and water. Finally, the innovation programmes focus on the (key) areas water, food, high-tech systems & materials, water, advanced chemicals/polymers, life sciences & health, and sustainable energy.

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • High scientific publication output, especially in Nature and Health related disciplines. Also high scientific productivity (output/input) and high citation impact scores, especially in Nature, Health, Agriculture, Technology and Behaviour and Society related disciplines • Many mechanisms to match scientific knowledge production to economic and societal needs 	<ul style="list-style-type: none"> • Complexity of research system with many different institutes, centres and co-ordinating bodies

The Dutch research system has strengths in scientific knowledge production. As a response to a recognised need to enhance the exploitability of knowledge production, various mechanisms have been put in place to match scientific knowledge production with economic and societal needs. While this has contributed to the responsiveness of the research system, it has also resulted in a rather complex research system with a crowded intermediate level of research fund allocation mechanisms.

4.3 Analysis of recent policy changes

OCW's Strategic Agenda for Higher Education, Research and Science Policy for the period 2007-2011 contains several new measures regarding knowledge production. First, the leading role of independent and pure scientific research will be strengthened, also by distributing more resources to individual talented researchers on the basis of competition, with excellence as the criterion. Second, to address relevant economic and social needs, genomics, ICT and nanotechnologies have (again) been designated by the government as "national research priorities". Funds from the FES have been allocated to these priority fields. Third, with regard to societal embedding of scientific research – i.e. societal relevance – more unequivocal rules will be introduced for the extent to which researchers can profit from the yields of intellectual property. It will be investigated whether it is desirable and possible to adjust current legislation for higher education and research regarding this point. Finally, OCW's new policy emphasises the importance of independence of research and proper quality assessment. While the details will be left to the institutions in question, these institutions must account for their actions in a transparent manner and ensure that the quality of the research is clearly visible. Agreements will be sought with the universities about giving a transparent account. The government wants to be able to gain a proper picture of the quality, efficiency and the effectiveness of the result evaluations put in place by the universities. It also wants insight in how the universities handle evaluations. The evaluations per institute cannot be used to make a comparison per discipline. Consultations will be held with VSNU, NWO and KNAW regarding the possibilities of deriving a national picture per discipline from the result evaluations.

Challenges	Policy changes
Quality and excellence of knowledge production	<ul style="list-style-type: none"> • More emphasis on talented researchers, and a (relatively small) transfer of funds from lump sum base funding to competitive funding • Efforts to increase transparency and comparability of accounts by universities • Efforts to derive at a national picture of the scientific quality per discipline
Exploitability of knowledge production	<ul style="list-style-type: none"> • More emphasis on the capacity of excellent researchers to do excellent research which is also relevant for third parties • Introduction of more unequivocal rules for the extent to which researchers can profit from the yields of intellectual property

4.4 Assessment of policy opportunities and risks

The main opportunities and risks for knowledge production in the Netherlands arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • The Dutch research climate could be improved by more policy emphasis on “excellence” and talented researchers. 	<ul style="list-style-type: none"> • Notion in research policy that excellent research will, by definition, be relevant for third parties, could lead to under-emphasis on demand-oriented R&D in research policy.

A policy opportunity arises from the new policy effort to focus more on an excellent research climate in order to further improve the international position the Dutch research system in terms of scientific knowledge production. However, the risk of this renewed focus is that this will lead to lack of attention for demand-oriented “relevant” R&D in research policy and a further split between research policy (OCW) and innovation policy (EZ).

4.5 Summary of the role of the ERA dimension

In OCW’s Strategic Agenda 2007-2011, internationalisation provides an important rationale for the cabinet’s ambition to create an excellent research climate in the Netherlands. As a relatively small country, the Netherlands depends on having good linkages with partners around the world. However, the ERA dimension is not explicitly mentioned in the Strategic Agenda. The long-standing policy efforts to create “focus and mass” in the Dutch research system are a response to the recognition that the Netherlands needs to have a few clusters and centres of excellence that are relevant at an international (and European) level. The international attractiveness of the Netherlands as a location for R&D within the world (and EU) is a key policy objective.

5 - Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of the knowledge produced. This is vital for its further use in economy and society or as the basis for subsequent advances in

knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors to overcome institutional barriers;
- Profiting from access to international knowledge by reducing barriers and increasing openness; and
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

Effective knowledge sharing is one of the main axes of the ERA green paper and significant elements of IGL 7 relate to knowledge circulation. To be effectively addressed, these require a good knowledge of the system responses to these challenges.

5.1 Analysis of system characteristics

5.1.1 Facilitating knowledge circulation between university, PRO and business sectors

The performance of the Dutch research system in terms of public-private linkages can be assessed by looking at various indicators. On the positive side, the percentages of HERD, and especially GOVERD, financed by the business sector are above EU27 (see Table 1). Only in a few other countries, more private money is invested in research at universities and public research institutes. The fact that companies finance a relatively large share of research performed by Dutch universities and public research institutes should, however, be interpreted with some caution, because the Dutch research system contains relatively large (semi-)public research institutes that are explicitly oriented at knowledge demands from the business sector (and society).⁶³ The contribution of universities and public research institutes to the total number of patents in the Netherlands is relatively low,⁶⁴ which suggests that circulation of knowledge from the public knowledge infrastructure to the business sector is less than good. In addition, from the Community Innovation Survey it appears that only 12% of all innovative Dutch companies mention a university as partner. Very few innovative companies (3%) see universities as very important

⁶³ The Dutch research system is characterised by relatively large public research institutes, of which TNO is the most prominent with some 4,500 employees. TNO is application oriented and strongly dependent upon contract research. In many other countries, such large (semi-)public research institutes are not present. It is possible that a part of the R&D activities that TNO performs in the Netherlands, are performed by private engineering and consultancy firms in other countries. Since TNO is included in the indicator, and private engineering and consultancy firms are not, the relatively high score on the Netherlands may provide a flattering picture of the situation (CPB (2002) *De pijlers onder de kenniseconomie: Opties voor institutionele vernieuwing*, The Hague, 2002).

⁶⁴ In the period 2001-2003, only 1.4% of the patents that were granted to Dutch organisations, was property of universities or public research institutes (OCW (2007) *Kennis in Kaart 2007*, The Hague, December 2007).

sources. The importance of universities and public research institutes has, however, increased in the last few years.⁶⁵ It should also be mentioned that differences between countries in use and appreciation of public research are partly caused by differences in sector structure, i.e., whether a country has many innovative companies in R&D intensive sectors like biotechnology, pharmaceuticals, electronics, food and chemicals. The Dutch sector structure is characterised by a relatively large R&D extensive services sector and a relatively low number of innovative companies within the R&D intensive industrial sectors.⁶⁶ Nonetheless, several specific business sectors in the Netherlands have relatively many innovation oriented collaborations between companies and universities and other public research institutes, especially mining (Shell and NAM), energy, natural gas and water (water treatment companies), chemical-pharmaceutical industry (DSM and Akzo Nobel) and the electrotechnical industry (Philips).

While statistics on the relevance of universities for Dutch innovative companies indicate that there is a bottleneck, collaboration between non-university research institutes and companies is higher than in most EU-countries.

Various incentives and mechanisms for inter-sector R&D co-operation and R&D personnel circulation are in place. The relatively large public research institutes (TNO and the LTIs) not only produce knowledge, but also have an intermediating role between universities and companies. Other mechanisms include a range of policy schemes to stimulate public-private R&D collaboration (e.g. the Innovation Oriented Research Programmes (IOP), Leading Technological Institutes, Leading Societal Institutes, investment impulses from FES⁶⁷). Indeed, public-private partnership in research and innovation has become an important element in Dutch R&D (and innovation) policy. Many programmatic instruments have the precondition that public and private parties (i.e. both knowledge producers and knowledge users) should be committed, also financially, to the programmes.

The [Casimir](#) scheme is a relatively small researcher exchange programme that aims to increase the mobility of research staff in the public and private sector.⁶⁸ Exchange projects aim to improve circulation of knowledge and also ensure fuller use of existing research potential and create stronger networks and closer interaction between parties in the public and private sector.

To overcome barriers for technology-based start-ups (“technostarters”), the government has introduced the [TechnoPartner](#) scheme, which includes: (1) the *TechnoPartner Seed facility*, which aims to promote and mobilise the Dutch venture capital market to the benefit of technostarters; (2) the *TechnoPartner Knowledge*

⁶⁵ NOWT (2008) Wetenschaps- en Technologie-Indicatoren 2008 (A publication for OCW), The Hague, March 2008.

⁶⁶ Ibidem.

⁶⁷ The FES is an investment fund with revenues from natural gas. In the past several years, there have been several FES-impulses, which led to various rather large research and innovation programmes.

⁶⁸ Mobility in the form of exchanges of workers between the two sectors should not only make research careers more attractive and interesting, but it should also enable academic researchers to participate in corporate R&D and industry researchers to participate in research at public knowledge institutions. Because the Casimir scheme tended to be used to fund four-year PhD projects, the maximum subsidy was reduced, making it insufficient to fund a complete PhD project.

*Exploitation Subsidy Arrangement (SKE)*⁶⁹, aimed at stimulating knowledge institutes to generate technostarters; and (3) the *TechnoPartner label*: with such a label technostarters can get a credit from a bank more easily because TechnoPartner provides a guarantee.

Utilisation or “valorisation” of results from research has received more attention since the early 2000s as one of the three key tasks of universities. As a result, universities have developed more explicit strategies on valorisation. Especially the three universities of technology play an active role in stimulating academic spin-offs. They have joint forces by collaborating in setting up “Innovation Labs” which combine activities aimed at intensification and strengthening of strategic cooperation with big enterprises, development of innovation projects and fostering of business development with SMEs, and boosting the entrepreneurship of starters. These joint efforts were supported with an investment impulse from the FES in 2005.

The largest R&D intensive company in the Netherlands, Philips, has embraced the ‘open innovation’ philosophy. As a result, the High Tech Campus Eindhoven was set up, which is a technology centre with many thousands of researchers and engineers and advanced facilities. High Tech Campus Eindhoven focuses on technological areas such as microsystems, infotainment, high-tech systems, embedded systems, life tech and nanotechnology. It offers opportunities for cooperation, joint ventures, creating partnerships and turning ideas into business ventures. In line with the ‘open innovation’ philosophy, equipment, services and knowledge is shared. Since 2002, non-Philips companies can also establish their businesses on the campus site, on the condition that their activities are linked to the type of activities that take place on the campus. Since 2006 High Tech Campus Eindhoven has been an open campus, also physically.

Finally, science parks and campuses of Dutch universities, e.g. in Delft, Twente and Leiden, appear to be increasingly contributing to a better exchange between the public knowledge infrastructure and the business sector.

5.1.2 Profiting from access to international knowledge

For a long time, many scientists in the Netherlands – as a relatively small country – have collaborated with European and international scientists. Often, the collaborative relations are close and long-standing. Statistics on the number of scientific publications with foreign co-authors indicate that Dutch scientists have further increased their collaborations with foreign colleagues in the past 10 years. Dutch parties were relatively successful in participation in FP6, with 3,700 project that had a Dutch participant. The Netherlands was particularly successful in aerospace, food quality and safety, energy and policy supportive research. Also in FP7, Dutch participation is above EU average. Most Dutch participants participate in the themes Health and ICT.

The attractiveness of Dutch universities on students from abroad grew in the last years. The share of students from abroad increased from 4.2% in 2003/04 to 4.7% in 2006/07.⁷⁰ There have also been efforts by the government to facilitate and stimulate

⁶⁹ SKE consists of a Pre-Seed facility for potential technostarters (in order to promote more and better utilisation of scientific knowledge by technostarters) and a Patent facility for knowledge institutes to professionalise their patent policies.

⁷⁰ CBS (2007) Kennis en economie 2007, Voorburg/Heerlen.

the inflow of knowledge workers from abroad. In 2006, the Knowledge Migrant Scheme was adapted to increase the attractiveness of the Netherlands for international knowledge workers. However, the Netherlands faces a net outflow of higher educated workers, which makes it one of the few OECD countries that have a higher 'brain drain' than a 'brain gain'.⁷¹ On the other hand, it indicates a strong international orientation (and circulation) of Dutch workers and businesses.

Foreign countries have become major players both in outsourcing of R&D and in funding of R&D. Some 18% of BERD is funded by foreign parties (see Table 1). Almost 10% of R&D outsourced by companies went abroad since 2000. Outsourcing of R&D was, however, stronger than attracting foreign funding for R&D. These cross-border R&D related flows were dominated by a few large companies.⁷² Moreover, more than half of the outsourcing abroad was done within the boundaries of a business group. Almost all funding from abroad in 2003 was funding from own companies within a group.⁷³

The international dimension in research policy is also visible in the contributions to international scientific organisations and participation in European research programmes. The rationale behind such contributions is to enhance the efficiency and effectiveness of scientific research. For the Netherlands, international scientific collaboration is vital, not only for scientific reasons, but also because of economic, political and social reasons. Collaboration in large networks and international institutes and programmes offers economies of scale and creates access to advances research facilities for Dutch scientists. Via funding of various national research institutes, the Netherlands aims to create "portals" to international research programmes.⁷⁴ Furthermore, the Netherlands contributes substantially to large international research organisations such as ESA, ESO, CERN, EMBL, and EMBC.

EG-Liaison (part of SenterNovem) supports and stimulates Dutch participation in FP7 by providing information, offering advice and training programmes and helping to find European partners. The [TWA network](#) is another part of the Dutch research system that supports international relations in R&D.⁷⁵ It aims to form a link between Dutch and foreign knowledge institutes, high-tech companies and local and national government. The TWAs gather and analyse information about technology/innovation and technology/innovation policy for Dutch companies, knowledge institutes, universities and the government. The Royal Netherlands Academy of Arts and Sciences (KNAW) and the research council NWO have bilateral collaboration programmes with China, Indonesia and Russia.

⁷¹ NOWT (2008) Wetenschaps- en Technologie-Indicatoren 2008 (A publication for OCW), The Hague, March 2008.

⁷² Two-thirds of the R&D that was outsourced by businesses to foreign parties in 2003 was done by the ten largest R&D companies in the Netherlands. The same group of companies received almost half of all R&D funded by foreign parties.

⁷³ CBS (2007) Kennis en economie 2007, Voorburg/Heerlen.

⁷⁴ There is a broad range of research institutes, including the research institutes of NWO and KNAW. A good example of such an institutes is the Foundation for Fundamental Research on Matter (FOM). FOM promotes, co-ordinates and finances fundamental physics research in the Netherlands. Elements of FOM's task include encouraging international participation and acting as a national focal point for organisations and researchers abroad.

⁷⁵ TWA = Technical-Scientific Attachés. EZ has stationed TWAs in Brussels, London, Paris, Berlin, Stockholm, Helsinki, Rome, Singapore, Tokyo, Beijing, Seoul, New Delhi, Washington and Silicon Valley.

The innovation programmes in the “key areas” also have the ambition to improve access to international knowledge. By creating “focus and (critical) mass” in a limited number of “key areas”, the Netherlands aims to internationally distinguish itself and create a distinct (research) profile for itself – for example in FP7. By creating internationally renowned R&D clusters, the innovation programmes should improve the attractiveness of the Netherlands for foreign knowledge workers and foreign investors in R&D. The innovation programmes will also tie in, wherever possible, with international programmes such as FP7 and EUREKA. In principle, the innovation programmes in the key areas are open for participation of foreign partners (with requirements of co-funding and complementarity). Also some other research and innovation schemes are open for participation of foreign actors. With surrounding regions (Flanders, North-Rhine Westphalia) policy discussions are being organised to open up programmes for cross-border participation.

5.1.3 Absorptive capacity of knowledge users

Knowledge circulation can only be effective if knowledge users have sufficient absorptive capacity. In particular for small firms and in low tech sectors it is a challenge to ensure sufficient expertise and learning capabilities. In Dutch innovation policy, increasing the innovativeness (and absorptive capacity) of SMEs is one of the priorities. One of the specific initiatives is the [Innovation Vouchers](#) scheme which aims to enable SMEs to buy knowledge from knowledge institutes with “innovation vouchers” and thus to stimulate interaction and exchange between the knowledge suppliers and SMEs, and to increase the absorptive capacity of SMEs.⁷⁶ A second specific initiative is the [Innovation Performance Contract](#) (IPC) scheme, which was introduced in 2007 to improve the innovativeness of SMEs. The aim is to provide assistance to groups of SMEs to collectively execute their own multi-annual innovation plans. Co-operation and knowledge transfer play an important role in this scheme and will therefore be fostered.⁷⁷ The [RAAK](#) scheme⁷⁸ is another mechanism to improve the absorptive capacity of SMEs by stimulating the interaction and exchange between SMEs and colleges of higher professional education. With this scheme, practice oriented research in the colleges of higher professional education (via so-called lecturers and knowledge circles) is coupled to external networks (of SMEs).⁷⁹ The Ministry of Economic Affairs also supports [Syntens](#), which is an “innovation network for entrepreneurs”. It is a network of 15 centres, that provide support and advice to SMEs on technology and innovation. Syntens also supports SMEs to find a match with knowledge institutes. The innovation programmes in the

⁷⁶ With an innovation voucher, SMEs can buy knowledge from (semi-)public knowledge institutes, from large companies with R&D expenditures that exceed €60m/year, and from foreign public knowledge institutes within the EU. The knowledge supplier can hand in the voucher with SenterNovem and receive payment. In 2007 two types of vouchers are available: small (€2,500) and large vouchers (€7,500).

⁷⁷ 15 to 35 companies can form a group within an IPC should be substantively connected. They can all be located in a particular geographical area, they can all work in a particular sector, or they can all be linked in a product or service chain. A budget of €17m was allocated to the IPC grant scheme in 2007, in 2008 the budget amounts to €10.5m.

⁷⁸ RAAK is an acronym of Regional Attention and Action for Knowledge circulation.

⁷⁹ In the current RAAK approach, the focus is on network formation and knowledge circulation. This approach will be broadened to programmatic practice oriented research. From 2008, a structural budget of €1.9m is made available.

“key areas” are in fact “mini mixes”⁸⁰, which may include an element aimed at improving the capabilities and competences of SMEs and Human Resources. For an elaborate overview of mechanisms to enhance the absorptive capacity of SMEs, see the INNO-Policy TrendChart for the Netherlands.⁸¹

The availability of a highly qualified labour force is crucial to ensure sufficient absorptive capacity of knowledge users. It was already mentioned in Ch. 2 that the Dutch reservoir of highly qualified HRST is under pressure. Explanatory factors include a rather low attractiveness of the Netherlands for foreign knowledge workers, an ageing population of knowledge workers, a decreasing labour participation of scientifically educated workers, and a relatively low share of higher educated workers in the total labour force. To address the shortages of graduates in S&T, the Deltaplan Science & Technology (2004) was established as an integral approach of several ministries to increase the number of scientists and engineers in the Netherlands. The aim is to make education and jobs in S&T more attractive and to make the Netherlands more attractive for foreign knowledge workers. A set of measures addresses all phases of the education system (primary, secondary and higher education) and focuses on the transition from one phase to another and the choices that are made at those specific moments by individuals. S&T is also made more attractive in general by changing the image, provide interesting jobs and promote mobility. From the mid-term review it appeared that more attention is needed for the inflow into the colleges of higher professional education, the participation of girls and women and for the labour market. In terms of life long learning, the Netherlands scores well above EU27 average. The share of adults (25-64 years) that participate in education and training amounts to 16% (EU27 average is 10%).

5.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the Dutch research system in terms of knowledge circulation can be summarised as follows:

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • Broad range of mechanisms and instruments to support knowledge circulation and cross-sector collaboration • Good participation in international programmes 	<ul style="list-style-type: none"> • Looming shortage of students and knowledge workers in S&T jeopardising the absorptive capacity of knowledge users • Knowledge valorisation strategies of universities could be further professionalised

Cross-sector circulation is relatively strong in specific sectors where large R&D intensive companies are present. In other sectors, public-private circulation could be better. However, there is a broad range of instruments and mechanisms to address

⁸⁰ Some issues/sectors/themes require a multi-faceted approach, rather than single R&D policy instrument. This could be called a ‘packaged’ approach where certain policy issues are tackled simultaneously with more than one policy modality. Thus a “mini-approach” is a policy programme that explicitly uses different types of policy instruments (e.g. human resource initiatives, fiscal exemptions, grant schemes, regulation) to achieve a specific policy goal or support a specific target group. These instruments can be non-R&D policies – regulation, fiscal, innovation oriented- as well (<http://rid.intrasoft-intl.com/PolicyMix/page.cfm?pageID=54>).

⁸¹ See <http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=261&parentID=52>.

this issue. Access to international knowledge also is a strength of the Dutch research system, which is illustrated by good participation in international programmes. A main weakness in the domain of knowledge circulation is the looming shortage of students and knowledge workers in S&T. Finally, universities could further improve their “valorisation” strategies and approaches.

5.3 Analysis of recent policy changes

The cabinet’s Working Programme for 2007-2011 announced a long-term strategy for investments in knowledge and innovation. In July 2008 the strategy was published.⁸² It contains three lines of action which all have relevance for knowledge circulation: strengthening and utilisation of talents; strengthening and utilisation of knowledge in public and private research; and promotion of innovative entrepreneurship.

Another element in the Working Programme with relevance for knowledge circulation is that fact that the government wants to make the Netherlands “a centre for talent”. In practice this means that (i) a *Task Force Technology, Education and Labour Market* will be established to deal with the shortages of HRST; (ii) an integral approach to knowledge migrants (covering the whole chain from “branding” to “living”) will be implemented; and (iii) an entrepreneurial spirit among students will be stimulated.

To improve knowledge circulation, the government will re-launch the Platform Valorisation to stimulate the generation of innovative start-ups from knowledge institutes. It will also further streamline the current mix of instruments for valorisation, and broaden the focus of valorisation schemes to include social sciences and humanities. The current mix of instruments that stimulate collaboration between SMEs and knowledge institutes will also be streamlined and improved.⁸³

In addition to these generic measures, the new inter-ministerial “Knowledge & Innovation” programme department will develop societal innovation programmes for specific societal themes, which are a new element in the Dutch policy mix.⁸⁴ They are inspired by the approach to innovation programmes in the “key areas”. In 2008, the first societal innovation programmes will be launched.

OCW’s Strategic Agenda for Higher Education, Research and Science Policy 2007-2011 elaborates two central challenges: (i) to create an *ambitious learning culture* in the higher education system and (ii) to create an *excellent research climate*. One of the approaches that addresses the first challenge has relevance for knowledge circulation: improving the link between education, research and the labour market. Colleges of higher professional education will be stimulated to acquaint their students with design and development, as well as with types of applied research.

⁸² EZ & OCW (2008) Naar een agenda voor duurzame productiviteitsgroei, The Hague, June 2008. (<http://www.ez.nl/dsresource?objectid=158858&type=PDF>)

⁸³ For instance, more innovation vouchers are made available in 2008, which will also be usable for European patents and for knowledge questions related to application of ICT.

⁸⁴ This means that for the fields of energy, water, health care and education (and later also safety/security and sustainable agro innovation) societal innovation agendas will be developed, which will form the basis of societal innovation programmes. Improving the interaction, collaboration and knowledge circulation between knowledge institutes, governmental actors, and firms is a key part of such programmes.

Consequently, the research activities of colleges of higher professional education will be given form and content in close association with regular educational practice. In addition, it will remain important to ease the transition from learning to working and to encourage life-long learning.

One of the approaches to address the second challenge is to stimulate a solid societal embedding of scientific research. It is argued that research must be firmly embedded in society in order to preserve social support for science and to encourage young people to opt for a career in science. With active communication, public interest in science should be improved. In addition, researchers will get more opportunities to benefit from the revenues of the intellectual property they have generated, which should help to improve circulation and valorisation of knowledge.

Furthermore, OCW's new research policy prioritises independent and pure scientific research, also with respect to circulation and utilisation of knowledge. Therefore, more emphasis is also given to talented researchers, rather than programmes and institutes. The underlying belief is that excellent scientific knowledge is the best guarantee that it will be used by other parties in the research and innovation system.

Finally, worth mentioning is the re-launch of the Innovation Platform (IP), which has broadened its scope from innovation in companies to innovation in private *and* public sectors and entrepreneurship.

Challenges	Recent policy changes
Facilitating knowledge circulation between university, PRO and business sectors	<ul style="list-style-type: none"> • Societal innovation programmes (in the fields of energy, water, health care and education) • Establishment of inter-ministerial "Knowledge & Innovation" programme department • Establishment of Task Force Technology, Education & Labour market • Renewal/streamlining of current mix of instruments for knowledge circulation/valorisation and for collaboration between SMEs and knowledge institutes • Stimulating colleges of higher professional education to perform R&D with relevance for SMEs, also to acquaint students with applied research with industrial relevance • More opportunities for individual researchers to benefit from the revenues of the intellectual property they have generated
Absorptive capacity of knowledge users	<ul style="list-style-type: none"> • Establishment of Task Force Technology, Education & Labour market • Renewal/streamlining of current mix of instruments for knowledge circulation/valorisation and for collaboration between SMEs and knowledge institutes • Stimulating colleges of higher professional education to perform R&D with relevance for SMEs, also to acquaint students with applied research with industrial relevance
Profiting from access to international knowledge	<ul style="list-style-type: none"> • More emphasis on independent and pure scientific research with international excellence • Improving the knowledge migrants scheme to improve the attractiveness of the Netherlands

5.4 Assessment of policy opportunities and risks

The main opportunities and risks for knowledge circulation in the Netherlands arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • Further improvement of coherence and continuity in policy regarding knowledge circulation and valorisation. • The Netherlands could be made a more attractive international location for (investments in) research and innovation. • Availability of a highly qualified labour force could be ensured by recent policy initiatives. 	<ul style="list-style-type: none"> • Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in under-emphasis on knowledge circulation and valorisation.

While a range of instruments and mechanisms to improve knowledge circulation already exists, a further improvement and streamlining of this policy mix is a policy opportunity. Perhaps the biggest opportunity for policy is to address the weakness of relatively low attractiveness, both for foreign students and knowledge workers and foreign investors in R&D. Although existing policy efforts to alleviate the shortage of HRST already are beginning to show results, further policy efforts to ensure availability of HRST are an important opportunity for policy. Finally, the current emphasis on independent and pure research could be a risk for policy, as it tends to oversimplify the mechanisms of knowledge circulation (e.g. the notion that excellent knowledge will “automatically” find its way in the innovation system).

5.5 Summary of the role of the ERA dimension

The international context plays an important role in Dutch research policy. For the Netherlands, international scientific collaboration is vital, not only for scientific reasons, but also because of economic, political and social reasons. Collaboration in large networks and international institutes and programmes offers economies of scale and creates access to advances research facilities for Dutch scientists. The Netherlands also plays an active role in contributing to participation in European R&D collaboration (see, for instance, the high level of participation in FP6 and international research organisations).

6 - Overall assessment and conclusions

6.1 Strengths and weaknesses of research system and governance

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	Strengths exist in a high level of awareness on the need to invest in R&D. However, this has not (yet) translated in increased GERD.
	Securing long term investment in research	Base funding of universities and research institutes is under pressure, but a broad consensus has emerged that a long-term strategy should guide investments in knowledge and innovation.
	Dealing with barriers to private R&D investment	Relatively low BERD remains a serious weakness. The presence of a few large multinational R&D intensive companies is a strength.
	Providing qualified human resources	Strengths exist in an overall good quality of higher education. Weaknesses exist in looming shortages in HRST, a learning culture and a research culture that do not foster excellence sufficiently, also to attract talented students, excellent researchers and investors in R&D from abroad.
Knowledge demand	Identifying the drivers of knowledge demand	The Dutch research system has strengths in identifying knowledge demands in "key areas" and "societal themes". "Relevance" (next to "excellence") is a key objective (and selection criterion) of many R&D instruments.
	Co-ordination and channelling knowledge demands	Co-ordination between priority setting by different governmental actors and across different policy measures has been a weakness.
	Monitoring of demand fulfilment	Evaluation has become a structural part of policy processes.
Knowledge production	Ensuring quality and excellence of knowledge production	Dutch research system has high scientific publication output, especially in Nature and Health related disciplines. Also high scientific productivity (output/input) and high citation impact scores, especially in Nature, Health, Agriculture, Technology and Behaviour and Society related disciplines.
	Ensuring exploitability of knowledge	Many mechanisms exist to match scientific knowledge production to economic and societal needs. However, the research system has become highly complex, with many different (collaborative) institutes, centres and co-ordinating bodies, putting the overall efficiency and effectiveness of the system at risk.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	A broad range of mechanisms and instruments exists to support knowledge circulation and cross-sector collaboration. Universities are increasingly professionalising their knowledge valorisation strategies.
	Profiting from international knowledge	Good participation of Dutch partners in international programmes and research institutes. Relatively low level of foreign R&D investment. The attractiveness of the Netherlands for international students and talented knowledge workers could be better.
	Enhancing absorptive capacity of knowledge users	In view of the (future) demands of a knowledge-based society, the number of students and knowledge workers in S&T should increase.

The strengths and weaknesses of the Dutch research system and governance are summarised in the table above. The overall picture is that the Dutch research system performs rather well in most domains. Main weaknesses remain in the domain of resource mobilisation. Expenditures on R&D as % of GDP are declining, rather than growing. Also in the provision of qualified human resources it remains a challenge to have more students in science and technology, and to create an education and research climate that fosters excellence, also to make the Netherlands an attractive place to study and perform R&D. In the domain of knowledge demand, the research system is increasingly becoming responsive, although co-ordination remains a challenge. The Dutch science system has significant strengths in terms of productivity and impact. In view of the weaknesses in resource mobilisation, future challenges of globalisation and internationalisation of R&D could threaten this strong performance, however. The governance of the research system could be improved, to allow for better co-ordination and coherent long-term investment strategies in R&D. In particular, there is room for improvement in the co-ordination between the part of the policy system that deals with scientific research and the part of the system dealing with industrial R&D and innovation.

6.2 Policy dynamics, opportunities and risks from the perspective of the Lisbon agenda

The main policy opportunities and policy-related risks are summarised in the following table. Several of the policy opportunities lie in increasing the attractiveness of the Netherlands as a location for higher education and research for students, researchers and investors in R&D, also from abroad. It contributes to resource mobilisation (via provision of qualified human resources and attracting foreign investors in R&D), knowledge production (by fostering excellent research) and knowledge circulation (by profiting from international knowledge). However, an emphasis on independent and pure scientific research and individual talented researchers also creates policy-related risks in terms of reduced responsiveness to knowledge demands from outside the research system, reduced exploitability of knowledge and diminished cross-sector knowledge circulation. Policy should find the right balance between excellence and relevance. This will require good co-ordination between the part of the policy system that deals with scientific research and the part of the system dealing with industrial R&D and innovation. This is particularly important in efforts to create focus in mass in research and innovation. A co-ordinated long-term strategy to guide investments in knowledge should be helpful in this respect.

Although policy responses are largely in line with the Integrated Guidelines for Growth and Jobs No. 7 in the Lisbon Strategy, a policy-related risk remains that efforts will fall short in raising the R&D intensity to 3% of GDP.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> The long-term strategy for investments in knowledge and innovation could allow for a better co-ordinated and coherent approach. The attractiveness of the Netherlands for students, knowledge workers and investors in R&D – also from abroad –, could be increased by creating a learning culture and research culture that fosters excellence. 	<ul style="list-style-type: none"> Efforts to raise R&D intensity fall short of ambitions (3% target).
Knowledge demand	<ul style="list-style-type: none"> Key societal needs could be addressed by development of societal innovation agendas and societal innovation programmes. Co-ordination between ministries could be made more effective (in efforts to develop a long-term strategy for research and innovation, and in developing societal innovation agendas and programmes). 	<ul style="list-style-type: none"> Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in lack of responsiveness to knowledge demands from knowledge users outside the research system.
Knowledge production	<ul style="list-style-type: none"> The Dutch research climate could be improved by more policy emphasis on “excellence” and talented researchers. 	<ul style="list-style-type: none"> Notion in research policy that excellent research will, by definition, be relevant for third parties, could lead to under-emphasis on demand-oriented R&D in research policy.
Knowledge circulation	<ul style="list-style-type: none"> Further improvement of coherence and continuity in policy regarding knowledge circulation and valorisation. The Netherlands could be made a more attractive international location for (investments in) research and innovation. Availability of a highly qualified labour force could be ensured by recent policy initiatives. 	<ul style="list-style-type: none"> Over-emphasis in research policy on independent and pure scientific research and individual talented researchers might result in under-emphasis on knowledge circulation and valorisation.

6.3 System and policy dynamics from the perspective of the ERA

The international context plays an important role in Dutch research policy. As a relatively small country, the Netherlands depends on having good linkages with partners around the world. International scientific collaboration is vital, not only for scientific reasons, but also because of economic, political and social reasons. Collaboration in large networks and international institutes and programmes offers economies of scale and creates access to advanced research facilities for Dutch scientists. The Netherlands also plays an active role in contributing to participation in European R&D collaboration. The Netherlands participates substantially in large international research organisations such as the European Space Agency (ESA), the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), European Organisation for Nuclear Research (CERN), European Molecular Biology Laboratory (EMBL), and the European Molecular Biology Conference

(EMBC). Dutch partners also participate above average in European R&D programmes (FP6, FP7, ERC).

The policy efforts to create focus and mass in the Dutch research system are a response to the recognition that the Netherlands needs to have a few clusters and centres of excellence that are relevant at a European and international level. Where overlaps exist between FP7 thematic priorities and national “key areas”, “national research priorities” (ICT, genomics and nanotechnologies) and selected “societal needs”, synergies are sought. The mutual reinforcement of European and national research is becoming a more central element in policy thinking. Furthermore, the Netherlands is active in most (53) ERA-NETs. Opportunities for cross-border collaboration with neighbouring regions (North-Rhine Westphalia and Flanders in particular) are also being explored.

Present ERA-related activities focus at the EU level on mobility, joint programming, the opening up of national programmes and joint European research infrastructures. Regarding European mobility of researchers, the research council has several grants for international travels and visits from abroad. NWO also participates in the European Science Foundation Collaborative Research Programmes Scheme (EUROCORES) of ESF. The openness of national research programmes to European and international researchers is possible in several programmes. For instance, in a growing number of cases subsidies in for talented researchers by NWO are open for researchers in foreign universities and research institutes. Joint programming with other Members States is still in its infancy, although initiatives are being developed with neighbouring regions (Flanders and North-Rhine Westphalia in particular). Finally, a national roadmap has been developed on the further development of research infrastructures in an ERA context. The Committee National Roadmap Large Scale Research Facilities took the European Roadmap for Research Infrastructures (ESFRI) as starting point for its advice on which large research facilities should be included in the first Dutch Roadmap.

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List of Abbreviations

AWT	Advisory Council of Science and Technology Policy (<i>Adviesraad voor het Wetenschaps- en Technologiebeleid</i>)
AZ	Ministry of General Affairs (<i>Ministerie van Algemene Zaken</i>)
BERD	Business Enterprise Expenditure on R&D

CBS	Statistics Netherlands (<i>Centraal Bureau voor de Statistiek</i>)
CEKI	Inter-ministry Committee on Economy, Knowledge and Innovation (<i>Commissie voor Economie, Kennis en Innovatie</i>)
CPB	Netherlands Bureau for Economic Policy Analysis (<i>Centraal Planbureau</i>)
EC	European Commission
ERA	European Research Area
EU	European Union
EZ	Ministry of Economic Affairs (<i>Ministerie van Economische Zaken</i>)
FES	Economic Structure Enhancement Fund (<i>Fonds Economische Structuurversterking</i>)
FP7	Seventh Research Framework Programme (European Commission)
GBAORD	Government Budget Appropriations or Outlays on R&D
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
HERD	Higher Education Expenditure on R&D
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technology
IGL	Integrated Guideline
IP	Innovation Platform (<i>Innovatieplatform</i>)
K&I	Inter-ministry “Knowledge & Innovation” programme department (<i>interdepartementale programmadirectie Kennis en Innovatie</i>)
KNAW	Royal Netherlands Academy of Arts and Sciences (<i>Koninklijke Nederlandse Akademie van Wetenschappen</i>)
LTI	Large Technological Institute (<i>Technologisch Topinstituut – TTI</i>)
NOWT	Netherlands Observatory of Science and Technology (<i>Nederlands Observatorium van Wetenschap en Technologie</i>)
NRP	National Reform Programme
NWO	Netherlands Organisation for Scientific Research (<i>Nederlandse Organisatie voor Wetenschappelijk Onderzoek</i>)
OCW	Ministry of Education, Culture and Education (<i>Ministerie van Onderwijs, Cultuur en Wetenschap</i>)
OECD	Organisation for Economic Co-operation and Development
PPP	Public-Private Partnership
PRO	Public Research Organisation
QANU	Quality Assurance Netherlands Universities
R&D	Research and Development
REKI	Council for Economy, Knowledge and Innovation (<i>Raad voor Economie, Kennis en Innovatie</i>)
SME	Small and Medium Sized Enterprise
TNO	Netherlands Organisation for Applied Research (<i>Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek</i>)
VSNU	Association of Dutch Universities (<i>Vereniging van Universiteiten</i>)

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Abstract

The main objective of ERAWATCH country reports 2008 is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports are produced for each EU Member State to support the mutual learning process and the monitoring of Member States' efforts by DG Research in the context of the Lisbon Strategy and the European Research Area. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The reports are based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

This report encompasses an analysis of the research system and policies in The Netherlands.

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