An Economic Perspective on the Dutch National Research Agenda

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Introduction

The Dutch National Research Agenda consolidates a number of themes and routes that intend to help focus the scientific community on a number of core themes in the coming years. This implies that the research priorities are set with the objective of focusing and channelling research effort on what are perceived to be important scientific questions, societal challenges, and economic opportunities. The Dutch National Research Agenda aims to foster a better collaboration across different institutes and scientific disciplines and to increase the likelihood to stay at the research frontier by concentrating world-class research on a limited number of themes. An important question is whether or not setting such priorities makes sense to achieve the goals of scientific excellence, societal impact, and economic development. This essay discusses, from an economic point of view, the possible effects of such an agenda for science, society, and the economy. We first review the theoretical advantages and disadvantages of routing research effort. Next, we describe a number of trends and their implications. Finally, we address the implementation of a research agenda, with specific attention to the appropriate level of coordination and to its organisation.

Advantages of having a national research agenda

There are several theoretical arguments for building a national research agenda and routing scientific research into a number of themes. These arguments are mostly related to what economists refer to as market failures. These failures arise when engaging in research activities.

Economies of scale

The Dutch National Research Agenda aims to focus research activities on a limited number of scientific themes. This way of concentrating research effort is possibly valuable if there are economies of scale related to the production of knowledge. First, scale can be important for research activities because of fixed costs. Researchers often require expensive equipment, such as public labs, telescopes, or wind tunnels. The 2025 Vision for Science, which documents the government's ambitions with respect to science policy, has announced the establishment of a permanent committee responsible for the coordination of investments in large-scale research infrastructure (Ministry of Education, Culture and Science, 2014). Research infrastructure is of interest both for conducting basic and applied research. In a recent letter to Parliament (No. 2016Z04755/2016D10344), the Dutch Minister of Economic Affairs addressed the introduction of a specific strategic agenda for applied research facilities.

Second, scale can be important because knowledge spillovers are crucial. Concentrating research effort on specific themes can foster scientific production because of an increased exchange of knowledge and creative ideas.

Contributing to the progress of science is complex and requires a team of complementary workers who each contribute with their specific skill and knowledge. A sufficient number of researchers is needed for gaining from such patterns of specialization or to allow interdisciplinary work, while fragmentation of research activities leads to suboptimal outcomes. Setting research priorities may help create a sufficient mass per theme to benefit from this complementarity. This increases welfare if the 'market' for research does not reach the optimal level of concentration. The 'market' refers both to the private sector (with the objective of profit maximization) and the scientific community (with the objective of producing knowledge).

It is not immediately clear why the market would not reach an efficient scale and why the government would do better by setting research priorities. A lack of critical mass in universities may result from the fact that they have been operating within national boundaries and national institutions that limit incentives for performance. This may cause scattering of research activities and underutilization of complementarities in research.

The importance of scale likely differs across research disciplines. For example, biomedical sciences require on average more costly research infrastructure than social sciences. Expenditures on research equipment are estimated to cover around 15-25 percent of total research budgets in capital-intensive disciplines (e.g. biomedical sciences, physics, and engineering), and around 5-10 percent in other disciplines (Rathenau Instituut, 2009, p. 46/47). Developments in the availability of more data and new techniques to utilize and store these data are also likely to increase fixed costs in social sciences.

Information problems

A second type of market failure that could legitimize a centralized routing of research effort is incomplete information. This refers both to information problems with respect to the most valuable research activities and to coordination problems among potential research collaborators.

Information on the most promising research activities
Directing research effort by the government is likely to be beneficial if the government has a better view on the most important or promising research areas. Yet the government faces the same information problems as the market, making picking the set of most promising projects an extremely difficult task. Fundamental research is inherently uncertain and, if anything, one would expect researchers to be better informed than the government. This also relates to the involvement of citizens, who in addition are likely to be less well-informed than researchers. An advantage of bringing together the preferences of scientists, citizens, firms, and the government could be that information is shared which could help to create a social basis for investing in science. In addition, principal agent problems could be mitigated.

Information problems and directing research efforts are closely related to the way public research funds are allocated. In the Netherlands, around 70 percent of the public funds are allocated based on institutional funding, and around 30 percent of the public funds are allocated in competition to pre-screened research projects. The latter type of funding helps to solve information problems. The screening of research proposals increases the likelihood that resources are devoted to the most promising projects (assuming that quality differences across proposals are well observable). This type of funding is also well-suited for directing resources to specific groups of researchers or research areas. Institutional funding, after all, implies that the government leaves control to universities or public research institutes concerning the allocation of funds to fields of research. A disadvantage of project-based competitive funding is that the screening process can be costly because of the required time for judging and writing (non-granted) research proposals. In addition, it may have adverse consequences for investments in risky, long-term research activities (e.g. Manso, 2011; Azoulay et al., 2011). A single best funding type does not exist. Empirically, there does not seem to be a clear relationship between a country's share of project-based competitive funding and its research performance in terms of publications or citations (Van Dalen et al., 2015, p. 10).

Coordination of research activities

Another potential reason to direct scientific research investments would be if coordination problems lead to insufficient collaboration. First, public and private research institutes may have conflicting goals that hamper combined research initiatives. For example, researchers at public institutes aim to publish new research fast (the standard of disclosure) because publications are important for their reputation and career perspectives. This fosters transparency and openness of research. Private research institutes, however, are more likely to keep new knowledge to themselves, at least until intellectual property rights have been acquired or profitable products have been launched in the market. These conflicting incentives could hamper successful collaboration and the valorisation of basic research. The enhancement of public–private collaboration is one of the main purposes of the Dutch top-sector policy that was launched in 2011. Currently amounting to a total investment of around 1 billion euros, this policy consists of several subsidy and organisational measures targeted at pre-selected sectors that have been labelled crucial to the Dutch economy. Among the identified sectors are high-tech systems and materials, life sciences and health, and the agro and food sector. By aligning the goals of private firms and public research institutes the policy has the potential to stimulate collaboration and the diffusion of knowledge. A potential drawback of earmarking resources for specific sectors, however, is that it is likely less focused on basic research and long-term research goals. Building on areas that have been successful in the past brings about the risk of conservatism. An additional risk is that it could hamper research on general purpose technologies. Such technologies might not be especially important from the perspective of a single sector, but could be of great importance for long-term economic development.

Second, research institutes can choose their own priorities, without taking into account the priorities or goals of the other institutes. This may lead to dispersion of resources and activities ('stepping on toes'). Independent priority setting by actors in the Netherlands, such as universities, the Netherlands Organisation for Scientific Research (NWO), and the central government, does not seem to have led to a set of clear research priorities at the national level (Rathenau Instituut, 2010, p. 59). Priority setting by the government may help coordinate research activities and reduce dispersion.

Third, coordination by the government could foster interdisciplinary research. Spillovers across different areas of specialization can be particularly valuable for challenging, fundamental research topics, for exploring new fields of research, or for solving social problems.

Externalities

Some research comes with larger externalities than other activities. For example, research on mitigating the effects of climate change will likely have positive spillovers for many people and for future generations, whereas other research output has smaller spillovers. In case of large differences in spillovers across research themes and social problems, funding these themes can help to internalize positive spillovers to the benefit of society at large.

Scientific researchers are not always likely to take up research topics with the largest externalities. First (more relevant for the private sector), large externalities imply that individual researchers or research groups can only reap a relatively small part of the benefits of their research efforts. Therefore, private firms have relatively low incentives to focus on social challenges that do not foster profits. For example, innovative clean technologies can yield benefits in terms of a better protection of the environment, which are not taken into account by individual firms. Second (more relevant for the public sector), publication incentives affect the research agenda. A long list of publications yields reputation and career perspectives. This encourages the dissemination of knowledge, but may hamper research that benefits society at large. 'Publish or perish' implies that researchers choose topics that most likely will result in publication in academic journals. Those articles do not necessarily deal with topics in which science can contribute most to solving social problems. The government could help directing research to solving social challenges that are not brought about by the market. Such a strategy by the government is, however, not completely straightforward. Short-sightedness and (potentially conflicting) interests of politicians could lead to socially suboptimal choices.

The entrepreneurial government

Next to correcting market failures, it has been argued that the government should have a more prominent role in the innovation system. Through the big bets it makes on new technologies it creates and shapes the markets of the future and can help solve social problems. In the United States, for example, the government has played an important role in realising breakthroughs in areas such as space research, biopharma, and the internet (Mazzucato, 2013). Specific government-funded projects and collaboration between scientists and entrepreneurs have led to substantial economic payoffs in the private sector and to new opportunities for society. It is not a priori clear, however, what the outcomes would have been in case of a different use of public resources because there is no counterfactual policy.

Disadvantages of directing scientific research

Disadvantages of directing scientific research are mostly related to government failures due to information problems and to the negative consequences of a low level of flexibility and diversification. These could facilitate a suboptimal allocation of resources across research fields or projects. In addition, setting strong priorities by the government could undermine the attractiveness of the Netherlands for scientific talent.

Government failure

It is difficult for the government to determine the social returns of specific research topics or projects. If anything, researchers are more likely to be well-informed about the most promising and practicable research projects. Given the information problem, it seems sensible to involve researchers and firms in the process of priority setting. Still, this does not guarantee optimal choices. Researchers and users may favour 'hot topics' which have received a lot of attention recently (for example because of recent breakthroughs) or which have the greatest chance of getting published in top-ranked academic journals. This may lead to hypes but also to conservatism if most of the resources are devoted to current strengths and not to long-term research goals. In addition, firms' focus can be on especially commercially interesting topics, or topics that appeal to the imagination, such as technological breakthroughs at the expense of a knowledge base about foreign languages to fight terrorism. It is difficult for the government to recognize such kinds of strategic behaviour and to maintain a broad portfolio of research areas (within the limits of the budget). In addition, the process of information gathering is costly and may have unintended effects, such as lobbying and rent-seeking behaviour. Moreover, apart from the theoretical optimal choices, it may be difficult to realise an optimal allocation in practice due to agency problems. The government seems to be unable to completely control activities and incentives of universities and researchers.

Low level of flexibility and diversification

Resources that are devoted to specific topics are not easily transferred to other topics. Hence, dynamic adjustments to new information or actual developments are difficult to establish. This could be an important drawback since it is not straightforward that current strengths are permanent strengths. A policy of diversification has the advantage of flexibility. This also allows for small-scale experiments in different fields to obtain more insights in the perspective of future research and investments. Consequently, targeted additional resources can be devoted to those topics that have shown to be most promising. In this way effective selection processes could contribute to better research choices.

Inflexibility is strengthened if influential researchers or politicians have special interests in a continuing focus on particular research themes. Researchers are likely to continue their own research programme or extend it with new elements. This can lead to 'overshooting' if it prevents resources from being transferred to more promising and new research areas. In addition, extending specific topics may lead to lower quality because researchers are scarce. If the availability of researchers with relevant expertise in a single research topic is limited, additional resources are likely provided to less productive researchers.

An additional risk of too little diversification is that it undermines the general knowledge base needed for absorbing knowledge from abroad. Striving for excellence in specific fields may come at the expense of building knowledge in other fields. A sufficient level of knowledge in those latter fields, however, is still needed to be able to use research produced by others.

Adverse effects on attracting or binding talent

Attracting and binding scientific talent is an important element of science policy in the Netherlands (Ministry of Education, Culture and Science, 2014). Dutch science seems to be quite attractive for foreign researchers. Dutch universities are placed relatively high in worldwide university rankings, such as the Shanghai Ranking. Universities are internationally oriented, and English serves as a *lingua franca* in educational and research programmes. In addition, a PhD track in the Netherlands is attractive because of the position of the PhD student as an employee. In a globalizing research market with increasing international competition, the Dutch government aims to be a continuing breeding ground for talent. Setting strong research priorities, however, could reduce the attractiveness of research positions. Researchers may be less inclined to come to (or stay in) the Netherlands if they are not autonomous in setting their own research agenda. Empirical evidence has shown that researchers value academic freedom highly. Scientists seem to be willing to pay for being allowed to pursue and publish an individual research agenda (Stern, 2004, p. 835). Hence, limited opportunities to set up an own research agenda could lower the attractiveness of an academic career in the Netherlands.

Developments in the market for science

There are economic reasons for directing scientific research. At the same time, directing research efforts has several drawbacks. It is not a priori clear whether the advantages outweigh the disadvantages. However, recent developments in the market for scientific research, such as rapid knowledge accumulation, increased internationalization, specialization, and teamwork, seem to make the case for concentration of research activities more plausible.

The worldwide scientific output has increased rapidly over time. Since the 1960s, the annual growth rate in publications has averaged 5.5 percent (Jones, 2011, p. 104/105). This implies that the annual number of journal articles published has doubled every 13 years. Because the total stock of knowledge is strongly accumulating, researchers naturally respond by narrowing their area of expertise. This may help to explain the importance of teamwork in academia (e.g. Black and Stephan, 2008). Increasingly teams, instead of individuals, generate scientific contributions. Mean team size had risen at rates of 15-20 percent between 1960 and 2010. The shift towards teamwork has been observed in almost all subfields of research (e.g. Wuchty et al., 2007; Jones, 2011). In science and engineering mean team size increased from approximately 3.1 in 1990 to 4.2 in 2005, compared to an increase from around 1.6 to 2.1 in the social sciences. There is also empirical evidence that collaborative efforts produce higher-quality research output. Team-authored papers published between 1995 and 2005 received more than twice as many citations as single-authored papers. This holds for science and engineering as well as the social sciences (e.g. Wuchty et al., 2007; Jones, 2011).

The market for scientific research has become increasingly globalized. ICT developments have fostered the international flow of ideas. The European Research Area (ERA), established in 2000 with the aim of creating a unified research area across Europe, has created a single market for scientific research. The unification of higher education degrees after the Bologna declaration in 1999 has fostered the international mobility of researchers within Europe (Curaj et al., 2012). In addition, many universities in Europe and Asia have experienced various reforms during the last decades, which enabled them to become important players in the global higher education market (Clotfelter, 2010, p. 12/13). The internationalization of PhD positions is a worldwide trend. In highly developed OECD countries, the average share of foreign PhD students has increased from 16 percent in 2006 to 23 percent in 2012. In the Netherlands, the share of foreign PhDs is relatively large, around 40 percent. The total number of foreign PhD candidates employed by Dutch universities increased from around 2,300 to almost 4,000 between 2005 and 2013 (Van Elk et al., 2016, p. 5).

These developments have led to an increased competition for funding and talent and have also stimulated specialization of research activities. Specialization helps to create excellence because it allows exploiting comparative advantages in specific research areas and a better allocation of researchers across institutes. If researchers with a particular specialization work together, various types of knowledge and ideas are likely to be exchanged and used in the creative and innovative process. International collaboration has increased in recent decades and the higher average citation impact of team publications is typically even larger when co-authorship is taking place within an international team of researchers (Adams, 2013, p. 559).

Specialization and the tendency of increasing scale imply that a fewer number of research topics, and hence choices for particular research fields, can be addressed (by a fixed number of researchers and a given budget). Especially for small countries, with relatively limited resources, concentration of research topics seems important to perform excellent research. In an international market, specialization also seems to be a less risky avenue because research crosses national borders easily. At the same time, the need for absorptive capacity for research from abroad is increasing. Focusing on particular research areas implies less diversity and fewer activities in other areas. While striving for world-class research in specific fields, it seems important to take into account potential consequences for the general knowledge base needed to understand and use research from abroad.

The implementation of a national research agenda

The practical implementation of a national research agenda relates to questions about the appropriate level at which research activities should be coordinated as well as some organisational issues, including the choices for particular research areas.

Level of coordination: national or supranational research agenda

An important question is whether coordination should take place at a national or a supranational level. Arguments for supranational (European) coordination are related to the identification of global research topics and to mitigating free-riding behaviour. There is an increased focus on global research themes that ask for international cooperation, such as climate change, demographic changes, or the transition of clean energy. This suggests that supranational coordination is beneficial, since research agendas at national levels could still conflict and lead to dispersion or inefficient use of resources at the higher level. In addition, if scientific knowledge has the characteristics of a public good (non-rivalry and non-excludability), country A can benefit from knowledge produced by country B, and vice versa. This may lead to 'free-riding' by national governments and a decrease in global investments in science. Supranational coordination of research activities is then needed to realise the socially optimal investment levels. Developments in ICT increase accessibility to codified knowledge, which could increase the use of scientific knowledge produced by other countries, and hence the need for supranational coordination.

On the other hand, there are several arguments for national coordination of research themes. First, despite ICT developments distance still matters in the diffusion of knowledge. Whereas codified knowledge can be exchanged relatively easily (for example through the internet), tacit knowledge requires personal contact. Hence, free-riding on research from abroad is not straightforward and geographic proximity can be helpful or even necessary in capturing the benefits from knowledge spillovers (e.g. Audretsch and Feldman, 1996; Belenzon and Schankerman, 2013). Second, country-specific challenges may require country-specific research investments. For example, research on water safety could be of special importance for the Netherlands. National research investments can be used to solve country-specific problems rather than global challenges. Finally, and more generally, the development of the knowledge economy may encourage setting national science priorities. Knowledge has become increasingly important for productivity growth. It is thus of crucial importance for countries to be capable of developing new technologies, and/or understanding and absorbing scientific or technological developments in other countries.

Organisation of a national research agenda

Several choices can be made with respect to the implementation of a national research agenda. An important choice is whether or not to actively cooperate in international frontier research or to focus on specific national challenges, such as for example water safety. In the latter case a country can benefit from research performed by other countries (free-riding), whereas investments in science are specifically targeted towards national topics. This case obviously also requires investments in education and science to ensure sufficient 'absorptive capacity' to be able to use new scientific insights produced by others. The advantage of the first case is that it contributes to access to international scientific networks and links with the international science base, and it fosters cross-country collaboration. This can also result in additional research funding from abroad. In this respect it is noticeable that the European Union is likely to become an increasingly important player in research activities. At this level it is easier to create efficient and sufficient mass, competition, and specialization, which is further stimulated by the steady increase of European research funding in recent years (up to 80 billion euros in Horizon 2020).

Finally, two remarks seem in place when it comes to implementing a national research agenda. First, it seems functional to ensure that, next to targeted research activities, there remains sufficient potential for open and fundamental research. This type of research is intrinsically valuable, may attract researchers, and has the potential of substantial long-term contributions. Second, even after the implementation of a national research agenda, it remains important to learn more about optimal ways of spending research budgets. In this respect it is valuable to monitor the research agenda, and – more generally – to invest in evaluations of specific institutions or science policy measures.

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