

# SUMMARY

Following a debate in the Dutch House of Representatives in the autumn of 2017, the Minister of Education, Culture and Science asked the Royal Netherlands Academy of Arts and Sciences to investigate ‘whether and to what extent links between publicly funded science and the private sector result in businesses having fewer incentives to invest in research & development themselves’. The Minister asked the following questions in this regard:

1. Are businesses in fact phasing out investments in research and development in the Netherlands, as was asserted during the debate?
  - 1.1 Can differences be detected between the different types of research (basic research, applied research and pre-competitive development activity)?
  - 1.2 Are businesses in the Netherlands capable of absorbing the knowledge developed by universities?
2. Is there a causal relationship between the size of business investment in research and development and the scale of public funding earmarked for research and innovation?
3. If there is a causal relationship between private and public investment, can this relationship be broken down by the different types of research (basic, applied, pre-competitive development)?
4. On what timescale are the observed trends unfolding and to what extent do the trends in the Netherlands differ from trends and developments in other countries?

## 1. Study along three lines

The Academy has examined the questions posed by the Minister of Education, Culture and Science along three lines, namely 1) Survey and analysis of data on investment in R&D; 2) Qualitative analysis of partnerships in R&D; and 3) Econometric modelling.

## **1.1 Survey and analysis of data on investment in R&D**

The first line of research consists of a survey and analysis of available data on public and private R&D investment based on data collected by Statistics Netherlands, the OECD, the Rathenau Institute and others. This quantitative analysis shows that there is a complex relationship between the source of R&D funding (public or private) and where and by whom R&D is carried out. Various factors play a role. First of all, both the government and the private sector fund research carried out within their own sector and outsourced to other sectors. Second, the government encourages R&D largely through tax measures, i.e. indirectly, making it more difficult to track funding streams than in the case of direct incentives. The complications to which this gives rise are considerable, since the sum involved is a multiple of the amount available through direct funding, for example through the 'PPP Allowance', which supports business-related research at knowledge institutions. The third factor is that both the funding and the execution of R&D are increasingly international affairs. These three factors and their interactions make this a highly complex situation. The analysis has sorted it out as much as possible, with some data necessarily being approximated.

## **1.2 Qualitative analysis of R&D partnerships**

The second line of research is a qualitative analysis that maps out how R&D partnerships have developed in four sectors in recent years, under the influence of the Netherlands' research and innovation policy. The Netherlands has a small, open economy with an internationally specialised sector structure in which a small number of knowledge-intensive sectors play a prominent role. The government's science and innovation policy has recognised the importance of this by showcasing key industrial sectors ('Topsectors'). The analysis describes the main outlines of four such sectors – 'agri-food', 'water', 'high-tech' and 'life sciences and health' –and describes the diverse nature of public-private R&D partnerships across sectors and how such partnerships have taken shape over the years. It is notable that regional clustering of R&D activities within a limited number of 'triple helix' campuses is a common trump card in these sectors, and that within these regional clusters, cooperation between public and private parties in R&D appears to benefit greatly from physical proximity.

## **1.3 Econometric modelling**

The third line of research is based on a new econometric model that uses long-term R&D data and incorporates findings concerning R&D funding and execution in the Netherlands and abroad from the first line of research. The simulations show the considerable extent to which public and private R&D expenditure are related and reveal whether, according to the econometric definition, public and private R&D are

‘complementary’, i.e. mutually reinforcing, or ‘substitute’, i.e. displace each other. The model produces reliable estimates that have been used to answer the questions submitted to the Academy.

## 2. Overall conclusions

After sorting out the complexities of the current situation as much as possible, it initially looked as if the private sector funds 52 percent of total R&D and government only 32 percent. On closer inspection, however, it was clear that an adjustment was required for tax credits that businesses receive from the government. Following this adjustment, net funding by businesses was found to amount to 45 percent and that of government to 40 percent of total R&D expenditure in the Netherlands. Foreign businesses and the European Union jointly invest almost 13 percent and private non-profit funds invest the remaining 2.5 percent.

Expressed as a percentage of GDP, contributions to R&D funding by the private and public sectors have remained more or less constant over the past fifty years. Public (direct) R&D funding has decreased slightly and now hovers around 0.7 percent of GDP. Private R&D funding is almost constant at 1 percent of GDP, with a dip in 2008/9 due to the financial crisis. The most significant increase has been in foreign R&D investment, which now stands at 0.3 percent of GDP. In 2016, total R&D intensity amounted to just over 2 percent of GDP, i.e. 2.03 percent, for the first time.

In addition to funding R&D in the Netherlands, Dutch companies invested more than €2.685 billion in foreign R&D in 2016, more than a third of Dutch private sector R&D funding in the Netherlands. This trend has been growing since 2008, indicating that more and more private R&D is taking place abroad.

When measured against Germany and other countries that invest relatively large amounts in R&D, private investment in the Netherlands is particularly modest. The industrial structure of a country affects the size of private R&D investments. Germany has a relatively large manufacturing industry and makes significant investments in R&D. One explanation for the relatively low private R&D intensity of the Netherlands is the dominance of its service sector. This gives rise to two questions. First, to what extent can the Netherlands expand its R&D-intensive sector structure further, either within existing sectors or with new sectors? Second, to what extent can national investment in innovation be categorised as R&D investment, including in the service sector, even though such investment does not officially fall within the relatively strict definition of R&D investment in the Frascati Manual, and this question does not argue in favour of broadening the definition of R&D at international level?

The econometric analysis shows that there is a strong correlation between public and private R&D investments as well as a considerable degree of mutual reinforcement. In other words, 'links between publicly funded science and the private sector' generally do not lead to less but to more private investment in R&D. Foreign public R&D does seem to be a possible displacement factor for domestic private R&D, however. When foreign public R&D increases, Dutch private R&D tends to rise more slowly, and may even decline. This puts the rapidly growing 'balance of foreign R&D' in the Dutch private sector in perspective.

As public investment increases, so too does private investment, but the effects may vary from sector to sector. In the 'life sciences and health' sector, for example, new business momentum can key into the knowledge developed at universities and university hospitals. In other sectors, for example in 'water' and 'high-tech', the outsourcing of knowledge-intensive activities by large knowledge-intensive multinationals will be hugely profitable for SMEs that specialise in specific niches. There, the private sector can easily tap into publicly funded knowledge development and vice versa. These sectors can benefit even more from the strengths of regional knowledge clusters and campuses and in doing so can offset the appeal of foreign public investment in R&D.

### 3. Answers to the questions

The data and insights obtained through the above lines of research offer a sufficient basis for the Academy to answer the Minister's questions.

*Question 1: Are businesses in fact phasing out investment in research and development in the Netherlands, as was asserted during the debate?*

Businesses have not phased out their investment in research and development in the Netherlands. This answer also holds true after adjusting for the tax credits that the government makes available to businesses to stimulate R&D. A subtle distinction must be made here, however, between incoming and outgoing funding streams. First of all, foreign companies and the European Commission (through the Framework Programme for Research and Innovation) are boosting their investment in Dutch R&D (13 percent of total R&D investment in 2016). Second, Dutch businesses are investing ever growing amounts abroad (more than a third of private R&D investment in the Netherlands). The balance between these incoming and outgoing funding streams has been increasingly negative since 2008/2009 and came to more than € 1.3 billion in 2016. It is unclear whether this increase in private R&D investment abroad is leading to the phasing out of Dutch domestic R&D investment. The available data do not make this any clearer but do qualify the answer to the first question, namely: 'Businesses

are not phasing out their investment in research and development, but because of attractive public R&D funding abroad, an ever-growing share of Dutch private R&D investment can be used to carry out R&D abroad'.

*Subsidiary question 1.1: 'Can differences be detected between the different types of research (basic research, applied research and pre-competitive development activity)?'*

It is not possible to answer to this question. One of the distinguishing features of the Netherlands is the relatively large contribution that the private sector makes to public research at universities and public knowledge institutions. At the same time, data available from Statistics Netherlands show that in recent years, businesses have been outsourcing their own research or, more importantly, undertaking research together with public knowledge centres and universities. The available data do not allow us to determine which fractions of this research match the definitions of basic, applied or pre-competitive development.

*Subsidiary question 1.2: 'Are businesses in the Netherlands capable of absorbing the knowledge developed by universities?'*

The answer is 'yes', but it differs from one sector to the next. In the 'life sciences and health' sector, a relatively large proportion of the knowledge developed at universities and university hospitals ends up being exploited in new or existing businesses. The same is true in the 'agri-food' sector, albeit to a lesser extent. This appears to be in line with the relatively large scale of medical and health research in the Netherlands. In the 'water' and even more so in the 'high-tech' sector, innovative SMEs that function as suppliers to large companies are particularly keyed into, or even play a leading role in, knowledge development. There may even be cases where the opposite question is more appropriate: 'Are universities in the Netherlands capable of absorbing the knowledge developed by businesses?'

*Question 2: 'Is there a causal relationship between the size of business investment in research and development and the scale of public funding earmarked for research and innovation?'*

Based on the detailed econometric analysis, the answer to this question is a clear 'yes'.

Both in terms of funding and execution, private and public R&D investments are mutually reinforcing ('complementary' in the econometric definition). The simulation shows that an increase in public R&D investment in the short and medium term will have a positive effect on both public and private R&D knowledge. The simulation also shows that any displacement of private R&D, such as that described in the econometric literature, will only occur after thirty years. Mutual reinforcement between public and

private R&D is greatest when initiated by the public sector; in other words, private follows public in this area.

Mutual reinforcement between public investment in research and private R&D also means that public investment in R&D attracts international investment. Dutch public R&D has a powerful crowding-in effect on international research and on international researchers. Evidence of this can be found in the large influx of foreign PhD candidates and students and in the rise in foreign R&D investment in the Netherlands, in particular Dutch success in obtaining European research funding. The latter should no longer be taken for granted, however, because other countries are catching up. While Dutch public investment in R&D has had a crowding-in effect on foreign R&D investment, public investment abroad appears to be having an increasingly pronounced crowding-out effect on Dutch domestic private R&D investment. In this context, it is important to distinguish between the ‘types’ of R&D that ‘go international’: the ‘stay-at-home’ R or the ‘footloose’ D.

*Question 3: ‘If there is a causal relationship between private and public investment, can this relationship be broken down by the different types of research (basic, applied, pre-competitive development)?’*

The Academy is unable to give a satisfactory answer to this question based on the available data. The limited data available show that businesses are performing less and less basic research and that the proportion of pre-competitive development activity undertaken by businesses within the context of R&D is growing significantly. It is, however, unclear whether this also applies to research conducted by or on behalf of Dutch businesses abroad. Nevertheless, answering this question is crucial for developing a long-term policy that attracts and embeds R&D in the Netherlands, as proposed in the letter to Parliament from the Minister and State Secretary for Economic Affairs and Climate Policy on mission-driven innovation (July 2018).

*Question 4: ‘On what timescale are the observed trends unfolding and to what extent do the trends in the Netherlands differ from trends and developments in other countries?’*

The econometric analysis has provided insight into the short-, medium- and long-term effects of private-public funding. The answer to question 2 has already indicated that public and private R&D are very complementary and that any displacement effects will only be felt in the long or very long term. We did not explicitly investigate the extent to which this conclusion also applies to other countries. In the interests of attracting and retaining R&D investment from abroad, national research policy must take the long view and offer a high level of certainty and clarity to private companies and public knowledge institutions.

## 4. Conclusion

The three different research lines are consistent in showing that private and public R&D funding and execution are mutually reinforcing. This outcome justifies continuing public investment in R&D not only as a driver for private R&D investment but also as a driver for economic prosperity and productivity. In short, the 'links between publicly funded science and the private sector' give businesses more incentives to invest in research & development themselves.