Knowledge-based economy 2002

R&D and innovation in the Netherlands

Authors:

Vinodh Lalta
Gerhard Meinen
André Meurink
Martje Roessingh

For further information: e-mail Stats.R&D@cbs.nl

Statistics Netherlands Science and technology statistics

Knowledge-based economy 2002

R&D and innovation in the Netherlands

Abstract

Statistics Netherlands started to publish an annual series on the *knowledge-based economy* in 1996. The focus of the publication series is on the process of technological innovation. Since 1998, using results of the *Community Innovation Survey* (CIS), the publication covers all stages of the innovation process: input, throughput and output. In the future we hope to paint the whole picture of the knowledge-based economy.

This paper summarises the findings of our most recent publication on the knowledge-based economy. Using the concept of *National Innovation Systems* (NIS) as a framework, it follows the input, throughput and output stage of the innovation process. The publication addresses questions like:

- which sectors are most active in innovation by co-operation?
- what role do universities and research institutes play in the process of knowledge diffusion?
- what role can education (in schools, universities, but once employed also in firms) play in the innovation process?
- is R&D merely restricted to large firms?
- what is the ranking of Dutch knowledge-based economy compared with EU and OECD member countries?

The paper concludes with five statistical tables of key figures.

Acknowledgements

The authors wish to thank Lieneke Hoeksma for translation services.

Knowledge-based economy 2002

R&D and innovation in the Netherlands

Introduction

Innovation through the creation, diffusion and use of knowledge has become a key driver of economic growth. However, the determinants of innovation performance have changed in a globalising knowledge-based economy. This change is partly a result of recent developments in information and communication technologies (ICT). Innovation can result from increasingly complex interactions at the local, national and world levels among individuals, firms and other knowledge institutions (Dynamising National Innovation Systems, OECD, 2002).

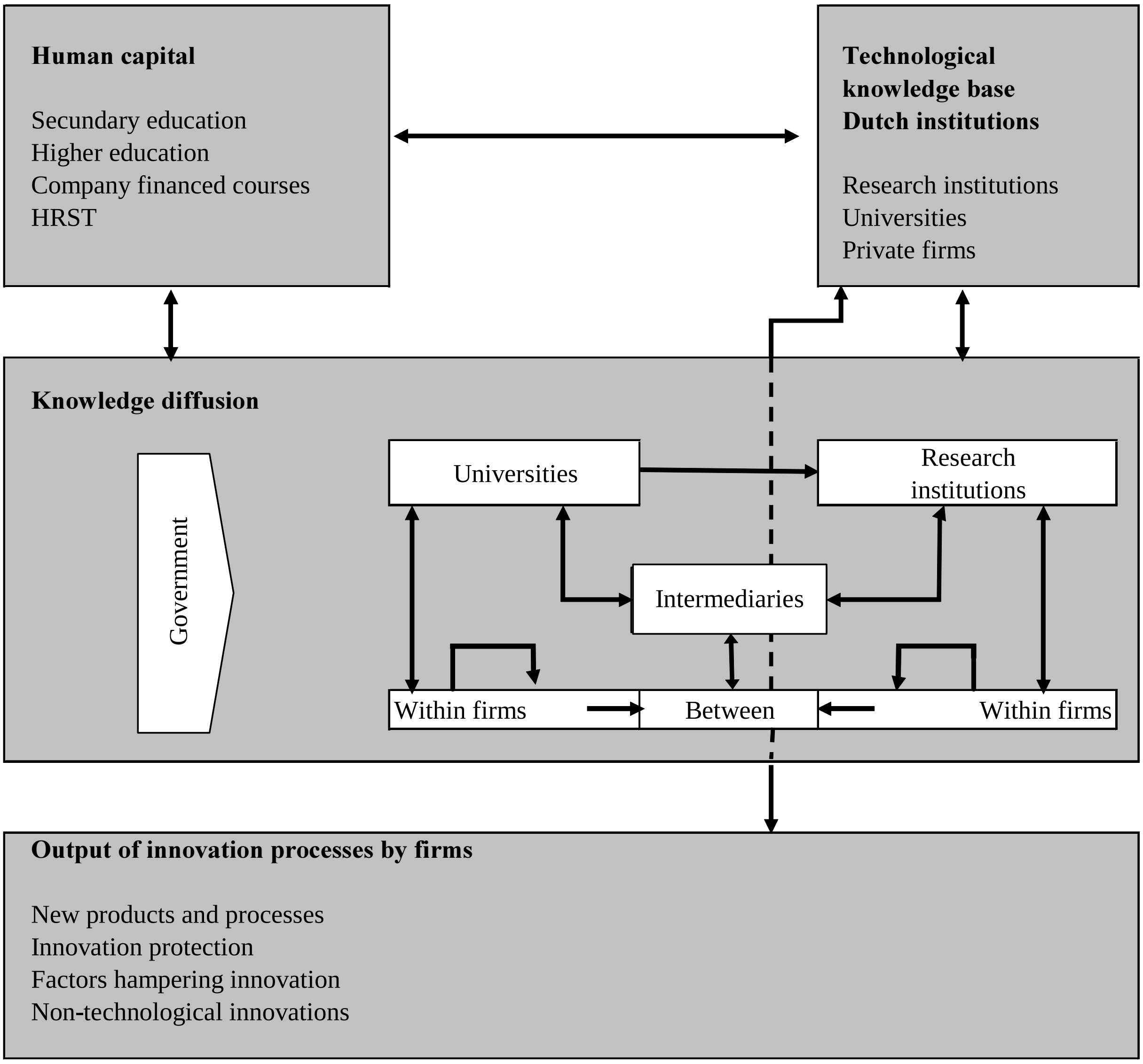
To understand economic development, the process of innovation must be taken into account. This process of ongoing creation and diffusion of new products and processes, implies that information and knowledge that agents already have, may be less important than their learning capability. Statistics Netherlands tries to describe different aspects of the Dutch knowledge-based economy using a variety of statistical indicators. For this purpose an annual series of a publication on the knowledge-based economy has started in 1996. From the first edition onwards, the national innovation system has been used as a framework. This way, the indicators available could be valued according to their merits for the Dutch knowledge-based economy as a whole. Furthermore, the national innovation system clearly showed for which areas additional indicators were needed. For example, in 1996 and 1997 the scope of the topics covered in the publication were concentrated solely on R&D indicators, as Statistics Netherlands did not collect innovation data. Since 1998 Statistics Netherlands reports on all three stages of the innovation process: input, throughput and output. The innovation survey contains information on several aspects of the knowledge-based economy, e.g. R&D expenditures, innovation in partnerships, the realisation of innovative products and processes, and factors hampering the innovation process. Since 2001 Statistics Netherlands has started a separate annual series the *Digital Economy* on specificly ICT-related issues (CBS, 2001 and 2002).

The concept of National Innovation Systems (NIS) enables all stages of the innovation process to be monitored: input, throughput, and output (see for instance Nelson, 1993, for a description of the NIS concept). Figure 1 shows how the NIS concept is used in this publication to describe the innovation process. The top of figure 1 reflects the input stage: human capital and research efforts by firms, universities and research institutes. The middle part shows the throughput stage. This part is crucial for the feedback loops between the three stages of the innovation process. The bottom of figure 1 mirrors the output stage of the innovation process.

Governments exert a strong influence on the innovation process through the financing and steering of public organisations that are directly involved in knowledge generation and diffusion (universities, public research institutes), and through the provision of financial and regulatory incentives to all actors of the innovation system. They need a sound conceptual framework and an empirical basis to assess how the contribution of public policy to national innovation performance could be improved. Through a decade of academic research and policy analysis, the National Innovation Systems (NIS) approach has been developed to provide such framework and quantitative information.

The following section of this paper contains the summary and conclusions of the 2002 edtion of our publication on the knowledge-based economy. It follows the sequential order of input, throughput, and output of the innovation process expressed in figure 1. This paper concludes with five tables of key figures.

Figure 1.
National Innovation System (NIS) in the Knowledge-based Economy 2002



Source: TNO/CBS

Summary and conclusions

Input stage of the innovation process:

Human capital in the Netherlands

1. *Science-profile not very popular in higher education.* The scientific and technological labour potential (human resources in science and technology, HRST) includes the higher educated part of the population: persons with a vocational college or university degree. However, before students can enter vocational college or university, they have to complete senior general secondary education (in Dutch: *havo*) or pre-university education (in Dutch: *vwo*). For an increase in the scientific and technological labour potential, it is unfavourable that the *Science and technology* profile is not very popular, among secondary school pupils: only 14 percent of *havo* pupils and 21 percent of *vwo* pupils choose this profile.

2. *Fewer pre-university pupils start studies in technology and science.* In 2001, fewer *vwo* pupils chose technical studies than two years before; for those planning to go on to vocational college the percentage fell from 19 to 18 percent and for those who wanted to go on to university it decreased from 19 to 16 percent. The percentage of *vwo* pupils who chose to study science at university also went down: from 11 to 9 percent. These are worrying developments for the core of the human resources on science and technology. This is compounded by the fact that the number of *vwo* graduates as a percentage of all 18 year-olds has decreased in the past five years.

3. *Scenario study higher education.* Based on the opinions of consulted experts and on their own expertise, the CHEPS (Centre for Higher Education Policy) has described three scenarios for the future of higher education. These scenarios spotlight the aspects diversity, excellence and acknowledgement. The three scenarios are very diverse and each bring great changes for the knowledge infrastructure in the Netherlands.

4. *Growth in number of companies with vocational training highest in the Netherlands.* After their initial education, most students enter employment. They can then take company courses, which further expands the knowledge potential. A number of studies on in-company training have now been conducted at a European level, most recently for 1999, and before that for 1993. Compared with 1993, the share of companies offering their employees training has grown most in the Netherlands. The share of companies who send employees on courses has also grown most in the Netherlands, from 46 to 82 percent. Spending on courses has also risen considerably since 1993: from 1.8 to 2.8 percent of the total labour costs. The Netherlands ranked third in the EU on both the share of companies offering training and courses, and spending on training.

5. *Dutch employees receiving company training at mean level of Europe.* Although many Dutch companies offer training to their employees, not all employees take such courses. In five countries (United Kingdom, France, Belgium, the Netherlands and Ireland), between 40 and 50 percent of the employees go on a course. Remarkably, the difference between men and women is largest in the Netherlands: 44 percent of male employees go on a course, as opposed to a mere 35 percent of women.

6. *Labour market problems and the role of education.* The theory on the role of education often concentrates on profits. The ROA (Research centre for education and labour market) discusses the role that post-initial education can play in preventing and lessening three problems on the labour market: risks as a result of qualifications becoming out of date, unemployment, and lack of staff. For each of these three, a framework has been made that makes it possible to look for solutions by pointing out labour segments in which training can be useful. In addition to a description of the framework, the ROA also gives an empirical interpretation of various possibilities for education. The data show that a number of factors hampering staff recruitment can be solved by upgrading or broadening the educational level of working and unemployed people. It may even be possible that, among people with intermediate vocational qualifications in the field of services and health care

and vocational college degrees in economics, a surplus of labour supply could arise. However, there is such a lack of supply in the areas of agriculture and technology (intermediate and higher vocational training) and teacher training, social and cultural welfare, and health care (higher vocational training), that additional training of working and unemployed people alone is not a solution.

7. *Dutch HRST continues to grow.* In 1998-2000, the number of people aged between 18 and 64 belonging to the scientific and technological labour potential (HRST) in the Netherlands grew by 6.4 percent. This pushes up the HRST as a percentage of the total labour force from 45 in 1998 to 48 in 2000.

8. *HRST: Netherlands remains third in Europe.* The northern countries of the EU (Finland, Sweden, Denmark, Germany and the Netherlands) have relatively high HRST shares in their populations. In 2001, Finland led with 32 percent and the Netherlands was third with just under 30 percent. The huge increase in Ireland, from 12 percent in 2000 to 21 percent in 2001, is quite remarkable. Portugal is at the bottom of the list with 10.5 percent. Unemployment among the HRST is highest in Spain with 7 percent. In the Netherlands, Luxembourg and Austria, unemployment in this group is less than 1 percent. The share of women in the HRST has become fairly stable; the Netherlands is in the middle group in this respect, with around 46 percent women in the HRST.

R&D expenditure at firms and institutions in the Netherlands

9. *Small rise in Dutch R&D expenditure.* In 2000 total R&D expenditure by universities, research institutes and firms amounted to 7.8 billion euro, only 3 percent higher than in 1999. This means that the upward trend since 1992, which recovered again in 1999 after a stagnation in 1998, was more hesitant in 2000. R&D expenditures equalled 1.94 percent of the gross domestic product (GDP). In 1999 this so-called R&D intensity amounted to 2.02 percent of GDP. The considerable drop in the intensity was caused by an unusually strong rise of GDP (+7.6 percent) that exceeded the growth of R&D expenditure.

10. *Dutch R&D intensity in an international perspective.* The Dutch R&D intensity in 2000 is back at the level of 1998. Although at 1.94 percent the intensity was still was above the EU average (1.88 percent), it dropped further behind the OECD average in 2000 (2.24 percent). The relatively good position of the Netherlands in the EU is mainly caused by the large contribution of the government that extensively supports R&D expenditures in research institutes and universities (the public sector).

11. *R&D intensity: public and private sector.* In 2000 the private sector accounted for the largest contribution to R&D intensity, with 1.11 percent of GDP. With this percentage, Dutch firms are still lagging behind the private sector in EU and OECD countries (1.21 percent and 1.56 percent respectively). The R&D intensity of 0.84 percent in the Dutch public sector – research institutes and universities – is clearly higher than average in the EU (0.67 percent) and the OECD countries (0.68 percent). However, in recent years the strong position of Dutch public R&D intensity has been eroded. Public R&D intensity has been diminishing since 1993, even quite severely in 1996-2000 with a fall of 0.10 of a percent point.

12. *R&D by research institutes.* Compared with other countries, until 2000 Dutch research institutes had a large share in the R&D total, namely 0.35 percent of GDP. In 2000 this was no longer the case: at 0.27 percent of GDP the research institutes' share equals the EU average, but still lags behind the OECD average (0.29 percent of GDP). In 2000 research institutes spent 1.1 billion euro on R&D. This 18 percent decrease compared with 1999 is mainly caused by a change in the administration of indirect government funding. From 2000, researchers at universities who are financed by the Netherlands Organisation for Scientific Research (NWO) are counted as university staff. NWO financed 3,050 researchers at universities for an amount of 212 million euro in 2000. Along with other causes this led to a fall of 3.3 thousand man-years of R&D staff at research institutes in 2000 compared with 1999, resulting in 14.2 thousand man-years in 2000. Provisional

results of the 2001 survey show an increase of R&D expenditure at research institutes by 8 percent on 2000.

13. *R&D by universities.* R&D expenditure at Dutch universities and affiliated research institutes amounted to 2.3 billion euro in 2000: a rise of almost 15 percent from 1999. About two-thirds of this rise is caused by the fact that from 2000 researchers at universities who are financed by the Netherlands Organisation for Scientific Research (NWO) are counted as university staff. Compared with other 'rich' countries Dutch universities invest rather heavily in research. In 2000 university expenditure amounted to 0.57 percent of GDP. NWO funding was incorporated in this amount for the first time, improving comparability with foreign universities. EU and OECD averages have more or less stabilised in recent years and are much lower at about 0.40 percent of GDP.

14. *R&D by firms.* The Dutch business enterprise sector spent 4.5 billion euro on intramural R&D in 2000, 5 percent more than in 1999. The rise in R&D expenditure in the public sector (1.7 percent) in 2000 was therefore smaller than that in the business community. Just over 57 percent of expenditure on intramural research and development can be attributed to firms (1999: 56 percent). International comparison, however, shows that the share of the private sector in total Dutch R&D expenditure is relatively low. Both in EU and OECD countries, an average two-thirds of total R&D expenditure originates from firms. The growth of R&D expenditure is the result of increased expenditure in manufacturing (+4 percent) and in services (+14 percent). R&D expenditure in the other branches of industry account for a mere 4 percent of total private R&D spending. The large drop in R&D expenditure in this group (-23 percent) therefore has a limited effect on the development of total R&D expenditure by firms. Preliminary results indicate a further increase of R&D expenditure in 2001 by just over 4 percent compared with 2000.

15. Increasing lag in R&D. The R&D intensity of Dutch firms has decreased from 1.14 percent in 1999 to 1.11 percent in 2000, amounting to a lag on the EU and the OESO averages of 0.10 and 0.45 of a percent point respectively. Rating countries solely based on R&D intensities requires some differentiation. Firstly, a specific national industry structure can be of great influence on the total R&D intensity of firms. Furthermore, large multinational companies have a considerable impact: in the Netherlands, for example, a group of Dutch multinationals with R&D expenditure strongly concentrated in the Netherlands at the beginning of the nineties, have become considerably more internationally oriented. For this group of enterprises, the foreign R&D contributions increased from 10 percent in 1990-1993 to 21 to 44 percent in 1997-2001.

16. *Research: work of man.* Staff costs are the largest cost item for research, accounting for at least half the budget. This is the case for research institutes (64 percent), as well as universities (58 percent) and firms (53 percent). Research institutes, universities and firms deployed a total 88.5 thousand man-years for research, an year-on-year increase of nearly 2 percent for the third year in a row. In the private sector, research capacity in terms of man-years grew by just over 5 percent in 2000 compared with 1999, to 47.5 thousand. The number of man-years for R&D in the public sector, (research institutes and universities), however, fell from 41.8 thousand in 1999 to 41.0 thousand in 2000.

17. *Scientific disciplines.* Research by firms is science oriented. After all, in the questionnaire, the definition of R&D includes a specification that it should constitute applications of science or medical science. Within research institutes the share of science related research is also predominant: 85 percent in 2000, both in terms of R&D expenditures and the number of man-years for R&D at research institutes. At universities, the share of R&D man-years in the field of science, defined as nature, technical disciplines, agriculture and health, has grown yearly by a few tenths of a percent. The field of science took up about 76 percent of the research budget in 2000 and provided work for well over 71 percent of the scientific staff.

Throughput stage of the innovation process

Strategy of firms in acquiring knowledge and innovating

18. *Innovation strategy.* For private firms, product, service or process innovation is not a goal in itself. The eventual purpose of innovation is continuity. Over a third of Dutch firms with 10 or more employees performed innovation activities in the period 1998-2000. The innovative capacity of these innovators is related to their ability to combine information from internal and external sources. Firms contact other firms and organisations to obtain the knowledge necessary to be able to innovate. In order to gain more insight into the strategy of innovation processes, the innovation survey included a number of supplementary questions: What are the sources of information for innovators? Are innovation projects performed by the innovators themselves or in conjunction with others? What is the total input in the innovation process (measured as innovation expenditures)? To what extent did innovation activities play a role in reaching certain goals?

19. *Sources of information and co-operation.* Once an innovation project has been started, specific information is needed. Often this information and knowledge is available within the company itself, but external sources may also be necessary. Many external sources are not available free of charge, or for only a small charge. In such cases product or process innovations can be developed in co-operation with a third party. Of all firms engaging in innovative activities, nearly a quarter developed technologically renewed or improved products or processes together with others in the period 1998-2000.

20. *Innovation expenditure: nearly 10 billion euro.* Companies with 10 or more employees spent a total 9.7 billion euro on innovation activities. This exceeds the amount spent in 1998 by a mere 0.6 percent. Almost half of this amount was spent on intramural R&D (4.5 billion euro). The acquisition of equipment (2.2 billion euro) and extramural R&D are the next most important components of the innovation expenditures (1.1 billion euro). Other components accounted for just under 1.8 billion euro.

21. *Effects of innovation.* Innovation is not a goal in itself; it is intended to lead, for example, to modifications in the range of products, to improvements in the production process or to compliance with government regulations or standards. In the innovation survey firms are asked to indicate the degree of impact (effect) of innovation activity on the realisation of these product-oriented, process-oriented or other goals. The most important effects of innovation turn out to be: improved quality of goods or services, an increased range of goods or services, an increased market or market share and an increase in production capacity.

Knowledge flows between enterprises and other actors

22. *Demand for knowledge by firms.* Firms generating or absorbing sufficient knowledge and implementing this in new products, services and processes, increase their chances for survival. Sometimes this information can be obtained free of charge or at a low cost. Such knowledge can also be obtained by independent research. Two alternatives for independently generating knowledge are: innovation in partnerships and outsourcing research.

23. *Use of sources of information.* Sources of information used by innovative firms can be divided into three main groups: sources within the industrial column, external advisors and public sources. Just as in the results of previous innovation surveys, the industrial column is mentioned most frequently as source of information: 96 percent of all innovators mention this source. Within the main group ‘own industrial column’, the own firm is mentioned by almost 90 percent and is thus the source of information used most frequently for innovation. Moreover, 46 percent of the innovators rate this source as very important. Customers and suppliers follow at a distance as important sources of information.

24. *Innovation co-operation.* Active participation in joint R&D and other innovation projects with other organisations, whether or not in under an official collaboration agreement is another

possibility to obtain additional knowledge. Mostly, the costs and benefits of partnerships of this kind are shared. In the period 1998-2000, innovation in partnership occurred less frequently than in the period 1996-1998. The share of innovators with co-operation arrangements on innovation activities fell from 25 to 24 percent. In 85 percent of the cases, a partnership is formed with a Dutch partner. Compared with 1996-1998, the percentage of innovators with a foreign partner decreased in 1998-2000 (from 52 percent to 46 percent). As was the case with sources of information, organisations in the own industrial column are the most important partners in innovation. No less than 90 percent of the innovators with a co-operation arrangement on innovation activities mention enterprises within their enterprise group, suppliers, customers or competitors as partners.

25. *Outsourced research stabilises.* To acquire knowledge, firms can choose to outsource their research. The amount spent on this so-called extramural R&D by firms in 2000 was virtually the same as in 1999: 1.2 billion euro. This meant the end of the strong increase of extramural R&D expenditure, which doubled in the period 1995-1999. Almost two-thirds of extramural R&D by firms was contracted in the Netherlands. In 2000, the Dutch public sector – universities, (semi-) government institutes and private non-profit (PNP) institutes together – received 0.4 billion euro from firms to perform R&D.

26. *Research institutes: financing and outsourcing of research.* The flows of financing to and from research institutes show which sectors and firms use the knowledge from research institutes and to what extent. As far as the (semi-)government institutes in the group of research institutes are concerned, almost two-thirds of the research funds in 2000 originated from central government (1.1 billion euro). Firms follow at a great distance as main financiers of research: with an amount of 0.2 billion euro, the private sector finances 14 percent of intramural and extramural R&D. Among the research institutes, the PNP institutes mainly have an intermediary role. In 2000, the PNP sector spent 191 million euro on R&D by third parties, compared with 65 million euro for intramural research.

27. *Universities: continued increase in contract research.* Universities received 972 million euro from the so-called third flow of funds in 2000. These funds from contract research and contract education exceed the amount for 1999 by almost 6 percent. The benefits from contract research amounted to 547 million euro in 2000: an increase of 8 percent on 1999. Firms financed 148 million euro of this amount in 2000, compared with a mere 113 million euro in 1999. The share of firms in research at universities increased from 19 percent in 1997 to 27 percent in 2000.

28. *Spin-offs and intellectual property rights.* Two relatively new ways of taking more advantage of knowledge from universities and research institutes are stimulating university spin-offs, and exploiting intellectual property rights by public knowledge institutes. A spin-off of a knowledge institute is "…a new firm using recently acquired knowledge, developed in this knowledge institute, as a substantial contribution for the foundation of this new company". MERIT research shows that spin-offs originate from universities (58 percent) about just as often as from research institutes (56 percent). As far as exploiting intellectual property rights is concerned, this is done by applying for and granting intellectual property rights and trading in these rights by means of licences or sales. Initialised by the Ministry of Economic Affairs, the OECD initiated a study in fifteen countries on the strategic use of intellectual property by knowledge institutes. In the Netherlands licences are granted for only one in five university patents. Therefore some 80 percent of university patents are not otherwise used.

29. *Government: financial support for research.* The government stimulates innovation activities in firms, for instance by offering financial facilities. More than a quarter of the 18 thousand Dutch innovative firms in the period 1998-2000 received some kind of public financial support for innovation activities. The largest and best-known instrument is the R&D Act, a fiscal arrangement under which innovators can receive a contribution towards the wage costs of own employees

carrying out R&D activities. In 2001, the total amount of these subsidies was 435 million euro. Just over 100 million euro of this amount was paid to firms with fewer than 10 employees.

Output stage of the innovation process

Results of the innovation process in the Netherlands

30. *Innovated products, services or production processes.* Almost one third of all firms with 10 or more employees realised product or process innovations in the period 1998-2000. New products, services or production processes are the most tangible results of the innovation process. Not all firms undertook innovation activities resulting in innovation in the period 1998-2000. If these firms are included as innovators, the proportion of innovators in the period 1998-2000 is 34 percent for Dutch private firms with 10 or more employees. This innovation rate is 6 percent points lower than in the period 1996-1998. For the manufacturing industry, the percentage of innovating firms was 54 percent in the period 1998-2000, compared with 30 percent and 24 percent in the services sector and other industries respectively.

31. *Contribution to turnover by innovative products.* The innovation rate only indicates whether a firm has undertaken innovation activities or not. More insight is gained by the share of new or strongly improved products in total turnover. It turns out that for firms with product innovation, the share of products for which technological innovations or improvements were realised in the period 1998-2000 was on average one quarter of turnover in 2000. For the manufacturing industry and other industries, it was somewhat higher at 31 percent and 28 percent respectively, for the services sector it was lower, at 21 percent. The shares in turnover of innovated products in 2000 are in line with those in 1998. At the end of 2000, 42 percent of all product innovators had also realised turnover with products that were new for their market; on average these new products accounted for 14 percent of their turnover. This percentage, too, is almost the same as in 1998, which is quite remarkable as the turnover shares of product innovators in the services sector are also included in 2000.

32. *Effects of innovation.* The innovation survey 1998-2000 included a question which gives insight into the effect of innovating products, services and production processes. Firms with product or process innovations are asked to rate the influence of these innovations on achieving certain goals. For 84 percent of the innovating firms, product innovations led to improvement of product or service quality. In the manufacturing industry this percentage was even higher (89 percent). Furthermore, three-quarters of the product innovators report an increase in production capacity. For product innovators in the manufacturing industry this share is higher (84 percent) than for firms in the services sector (68 percent).

33. *Factors hampering innovations*. Innovation projects may be hampered in such a way that they are seriously delayed or are not started at all. More than one third of innovators reported one or more of such hampering factors in the period 1998-2000. For 28 percent of these innovators the hindrance was such that an innovation process did not even start. Serious delays were reported by 62 percent of the firms and lastly 45 percent of firms said their innovation activity suffered other serious problems.

34. *Types of hampering factors encountered by innovators.* Internal firm factors hamper the innovation process almost as often as external ones. Compared with previous innovation surveys, more innovators reported several factors. The two main internal hampering factors are: a lack of qualified staff and perceived economic risks. Outside the firm, the main hampering factor is lack of appropriate funding sources. The hampering factors reported most frequently also appeared to have the most negative impact on the innovation process.

35. *Non-innovating firms consider technological innovation unnecessary.* Approximately two-thirds of Dutch firms with 10 or more employees did *not* undertake any (technological) innovative activities. Almost 90 percent of these non-innovators considered technological innovation

unnecessary. Nearly half this group mentioned the current market conditions as the main reason not to innovate. Previous innovation was mentioned much less often as a reason for innovation being unnecessary.

36. *Patents and other protection methods*. Firms can protect their inventions or innovations in many different ways. More formal methods are patents (applied for or registered), registration of design patterns, trademarks or copyrights. Besides these intellectual property rights, innovations can be protected by strict confidentiality, complexity of design or lead-time advantage on competitors. Thirty percent of all firms with 10 or more employees applied at least one of these protection methods. For innovators this percentage is of course higher (57 percent) than for non-innovating firms (17 percent).

37. *Non-technological innovation.* The distinction in this publication between innovators and non-innovators is largely based on whether or not firms implement technological product or process innovations. As this definition focuses on technology, it is not surprising that it is mainly firms in the manufacturing industry that are marked as innovative. However, technological innovations are often realised in combination with non-technological innovations, in the areas of strategy, management, organisation, marketing, or purely aesthetic product changes. To take account of these and other factors, the internationally harmonised questionnaire for the innovation survey 1998-2000 included a question on a number of non-technological innovations. It turned out that 45 percent of Dutch firms with 10 or more employees undertook non-technological innovations in this period. This is much lower than the percentages reported in previous innovation surveys. For firms without technological innovation, in particular, the number of firms with non-technological innovations was substantially lower. In 1996-1998 almost half of non-innovators reported non-technological innovations, in the period 1998-2000 this was fewer than one third of the non-innovators.

38. *Non-technological and technological supplement each other.* If we consider *all* innovative activities (i.e. technological and non-technological) more than half of Dutch firms with 10 or more employees undertook some form of innovation. More than one fifth of Dutch firms only undertook non-technological innovations, and just over 10 percent were active only on the field of technological innovations. To conclude, almost one quarter of Dutch firms undertook both technological and non-technological innovations in 1998-2000. In other words: almost half of all firms undertaking some type of innovative activity in 1998-2000 undertook technological as well as non-technological innovation activities.

References

CBS (2001, 2002), *Digital Economy* (in Dutch), Statistics Netherlands, Voorburg.
OECD (2002), *Dynamising National Innovation Systems*, Paris.
Nelson, R. (1993), A Retrospective, in R. Nelson (ed.), *National Innovation Systems: A comparative analysis,* (pp. 505-523), Oxford University Press, New York / Oxford.

Table 1
Intramural R&D-expenditures and personnel, 1996-2000

	Unit	1996	1997	1998	1999	2000
Expenditure						
Total	*mln euro*	6,344	6,807	6,869	7,564	7,813
Firms		3,342	3,715	3,721	4,263	4,457
Manufacturing	*%*	79.2	75.7	74.9	76.1	75.9
Services		16.4	18.5	16.9	18.0	19.7
Remaining sectors		4.4	5.8	8.2	6.0	4.4
(Semi-)government [1])	*mln euro*	1,186	1,232	1,284	1,317	1,078
Science and engineering	*%*	.	85.8	86.2	86.7	86.9
Other subjects		.	14.2	13.7	13.3	13.1
Universities	*mln euro*	1,816	1,86	1,865	1,983	2,278
Languages, humanities, arts	*%*	6.1	6.3	6.2	6.2	5.3
Science, engineering		72.8	71.8	73.2	73.8	67.7
Law, economics, social science		17.8	18.6	17.4	17.4	15.5
Can not be attributed to a field of study [2])						9.3
Institutions affiliated to universities		3.3	3.3	3.2	2.7	2.2
Personnel (full time equivalents)						
Total	*abs*	80,823	83,967	85,485	87,022	88,462
Firms		39,501	42,409	43,872	45,181	47,509
Manufacturing	*%*	74.1	71.3	70.7	72.3	70.1
Services		20.1	23.1	21.1	21.8	25.4
Remaining sectors		5.8	5.6	8.1	5.9	4.5
(Semi-)government [1])	*abs*	16,924	17,147	17,448	17,539	14,231
Science and engineering	*%*	.	83.5	83.7	83.6	85.8
Other subjects		.	16.5	16.3	16.4	14.2
Universities	*abs*	24,398	24,411	24,165	24,302	26,722
Languages, humanities, arts	*%*	5.1	5.2	5.2	5.3	4.4
Science, engineering		56.6	56.8	57.0	56.8	50.3
Law, economics, social science		15.4	15.2	15.0	15.3	13.1
Can not be attributed to a field of study [2])		18.7	18.6	18.7	18.8	28.9
Institutions affiliated to universities		4.2	4.2	4.2	3.8	3.3

NB Expenditure and the number of full time equivalents at research institutions (semi-government) show a sharp fall and at universities show a sharp rise in 2000 compared to previous years. This is mainly caused by the fact that since 2000 research funded by the Science Board (NWO) is added to universities instead of to researchinstitutes as was the case in the years before 2000.

1) The breakdown to fields of science for 1996 is unknown.
2) In 2000 the breakdown by fields of science of the research funded by the Science Board is not possible due to a lack of suitable information.

Source: Statistics Netherlands.

Table 2
Financing of R&D in the Netherlands, 2000

	Domestic organisations (performers)				Performers in foreign coun-tries	Intramural R&D expendi-ture	Total R&D expenditure in the Netherlands
	Firms	(Semi-) govern-ment	Private-Non Profit institutions	Univer-sities			
	1	2	3	4	5	6=1+2+ 3+4+5	7
	mln euro						
Total domestic organisations (principals)	387	386	22	569	427	1,791	7,813
Enterprises	373	232	2	149	425	1,181	4,457
Private-Non-Profit institutions	2	12	12	163	0	191	65
(Semi-)government	11	135	6	252	2	406	1,013
Universities	-	6	1	5	0	13	2,278
Foreign principals (exclusive EC)	669	63	3	0		735	
Total orders from own and foreign countries	1,056	449	25	569	427	2,526	
Government contribution for R&D in the Netherlands	242	1,117	38	1,845			
State-financed [1])	223	1,065	35	1,766			
EC	19	52	3	79			
Total contribution of third parties	1,297	1,566	63	2,414			

1) Excluding WBSO 2000. (WBSO is an arrangement for firms to pay less income tax for R&D-personnel.)

N.B. Regarding the sum for R&D-expenditure by principals (see left column) paid to performers (see running headline); this must b construed horizontally as expenditures and vertically as receipts.

Source: Statistics Netherlands.

Table 3
R&D-intensity by industry

	1999			2000		
	Value added	Expen-ditures	R&D intensity	Value added	Expen-ditures	R&D intensity
	mln euro		*%* [1]	*mln euro*		*%* [1]
Manufacturing	61,131	3,242	5.30	65,084	3,385	5.20
Food products and beverages	12,041	250	2.08	12,156	258	2.13
Textiles and leather	1,368	17	1.24	1,372	14	1.01
Paper and paper products	1,633	16	0.98	1,717	12	0.67
Publishing and printing	5,549	14	0.25	5,768	8	0.14
Petroleum products	5,015	37	0.74	5,738	30	0.52
Basic chemicals	4,166	239	5.74	5,390	268	4.96
Chemical products	3,263	678	20.78	3,262	627	19.21
Rubber and plastic products	1,923	42	2.18	1,896	30	1.59
Basic metals	1,491	60	4.02	2,092	62	2.97
Fabricated metal products	4,646	54	1.16	4,553	42	0.91
Machinery and equipment	4,425	339	7.66	4,774	440	9.21
Electric and optical equipment	5,259	1,308	24.87	5,783	1,432	24.77
Transport equipment	3,076	155	5.04	2,968	118	3.99
Other manufacturing	7,276	34	0.47	7,615	45	0.59
Services	182,323	2,083	1.14	195,518	1,954	1.00
Wholesale and retail trade	53,266	206	0.39	56,418	177	0.31
wholesale trade	26,776	156	0.58	28,958	131	0.45
retail trade	13,862	51	0.37	14,036	47	0.33
Transport, storage and communication	23,852	105	0.44	25,191	109	0.43
Financial intermediation	21,931	100	0.46	24,789	97	0.39
Real estate, renting and other business activities	71,128	1,593	2.24	76,149	1,502	1.97
computer and related activities	6,412	107	1.67	7,158	242	3.38
research and development [2]	981	1,278	130.28	990	1,123	113.39
legal and economic activities	13,094	22	0.17	14,127	29	0.20
architectural and engineering activities	3,831	158	4.12	4,076	87	2.14
other business activities	15,145	27	0.18	16,235	21	0.13
Sewage and refuse disposal and other service activities	12,146	79	0.65	12,971	69	0.53
sewage and refuse disposal services	2,255	12	0.53	2,542	4	0.17
Private Non-Profit institutions (PNP)	-	67		-	65	
Remaining sectors	42,766	255	0.60	48,233	195	0.41
Agriculture, forestry and fishing	9,354	87	0.93	9,699	53	0.55
Mining and quarrying	6,936	86	1.24	10,018	86	0.86
Electricity; gas and water supply	7,139	21	0.29	7,344	22	0.29
Construction	19,337	61	0.32	21,172	35	0.16
Subsidised education	13,536	1,983	14.65	14,362	2,278	15.86
Remaining groups	52,404			56,051		
Balance items	21,910			23,351		
Total [3]	374,070	7,563	2.02	402,599	7,813	1.94

[1] R&D-expenditure as percentage of the value added.
[2] Including research institutions and PNP.
[3] Total of value added is equal to Gross Domestic Product (market prices).

Source: Statistics Netherlands.

Table 4
Intramural R&D-expenditures within firms in 2000

	Total	of which		Firm size (number of employees)		
		Labour costs	Remaining costs	10-49	50-199	200 +
	mln euro					
Total	4,457	2,361	2,096	265	590	3,602
Manufacturing	3,385	1,696	1,690	78	345	2,961
Food products and beverages	258	158	101	2	18	239
Textiles and leather	14	9	4	x	x	8
Paper and paper products	12	8	3	0	5	6
Publishing and printing	8	5	3	3	2	3
Petroleum products	30	18	11	-	x	x
Basic chemicals	268	145	122	x	x	x
Pharmaceuticals, medicinal products	396	158	237	1	4	391
Other chemical products	231	131	100	8	25	198
Rubber and plastic products	30	22	9	4	16	10
Basic metals	62	35	27	1	2	59
Fabricated metal products	42	32	10	5	17	20
Machinery and equipment	440	196	243	19	109	311
Electric and optical equipment	1,432	672	760	25	43	1,364
Transport equipment	118	73	46	3	11	104
Other manufacturing	45	33	12	7	10	28
Services	877	554	323	168	224	485
Wholesale trade	131	64	67	15	55	60
Retail trade	47	18	29	-	0	46
Transport, storage and communication	109	66	43	5	2	101
Financial intermediation	97	70	27	1	17	80
Computer and related activities	242	167	75	67	52	122
Research and development	110	72	38	43	66	-
Business and management consultancy act.	29	23	6	8	6	15
Architectural and engineering act.	87	56	31	25	19	43
Other business activities n.e.c.	21	14	7	1	3	17
Sewage and refuse disposal	4	4	0	1	2	1
Remaining sectors	195	112	84	19	21	155
Agriculture, forestry and fishing	53	27	26	15	15	23
Mining and quarrying	86	46	41	0	0	86
Electricity; gas and water supply	22	13	8	-	2	20
Construction	35	25	9	4	4	27

Explanatory note :
x = confidential.

Source: Statistics Netherlands.

Table 5
Firms with innovative activities (innovators) in 1998-2000 [1])

Firm size (number of employees)	Total		of which with realised innovations end 2000		
			total	of which with	
				product innovations	process innovations
	abs.	*%* [2)]	*abs.*	*%* [3)]	
Total	18,346	34	17,081	88	58
10 - 50	13,496	30	12,614	88	55
50 - 200	3,535	48	3,270	88	63
200 or more	1,315	66	1,196	89	78
Manufacturing	5,974	54	5,603	87	71
10 - 50	3,785	46	3,564	85	70
50 - 200	1,591	71	1,471	89	68
200 or more	598	85	568	95	82
Services	9,983	30	9,269	90	49
10 - 50	7,805	28	7,288	91	46
50 - 200	1,607	40	1,482	88	57
200 or more	570	54	499	85	76
Remaining sectors	2,390	24	2,209	84	61
10 - 50	1,906	22	1,762	84	59
50 - 200	337	29	317	83	66
200 or more	147	64	129	84	67

1) Including firms that have undertaken (technological) innovative activities in 1998-2000 where no innovations were realised yet at the end of 2000.
2) These percentages show the number of innovators at the end of 2000 in relation to all companies with 10 employees or more.
3) The percentages in this column show the number of innovators that realised this type of innovation in relation to all innovators with realised innovations.

Source: Statistics Netherlands.