

THE VALUE OF KNOWLEDGE  
THE ECONOMIC IMPORTANCE OF UNIVERSITY  
RESEARCH

REPORT 62

## Report

### Request for advice

The Ministers of Education, Culture and Science and of Economic Affairs asked the Advisory Council for Science and Technology Policy (AWT) to investigate the possibilities for gaining a better understanding of the importance of Dutch university research for the Dutch economy. This understanding may be either quantitative or qualitative in nature (see Annex 1 for the full request).

To answer the request for advice, the ways in which university research contributes to the economy must first be examined. In the AWT's view, this contribution is complex and intricate, since university research not only contributes to the development of knowledge for innovation, but also helps develop human resources. The AWT has used this fact as its point of departure in formulating its advice.

This report represents the AWT's views on the issue of weighing and measuring the economic returns generated by university research. It puts forward suggestions for improving the information about the economic importance of university research, and about what parties might bring about that improvement. It does not answer the question of how great (in quantitative or qualitative terms) the importance of university research is to the economy.

The AWT wishes to stress that university research serves a wide range of interests, not just economic ones. University research may be meaningful without being useful. It is of cultural value and offers people the opportunity to satisfy their natural curiosity. It contributes to cultural and social development, nature conservation and the quality of life. Although these contributions do not immediately spring to mind in connection with the economic importance of university research, they are nevertheless of great value.

This report comprises two parts. In this part, the AWT sets out its views on a number of key issues and the resulting recommendations. The second part of the report provides further clarification.

## Key issues

### **University research produces knowledge and competencies**

The economic importance of university research lies in its contribution to the development of the productive capacity of the Dutch economy. This contribution is provided in a number of ways.

Firstly, university research contributes to economic development since it results in publicly available knowledge ('knowledge as a product'). This knowledge can be used by businesses for innovation, but also by government agencies to improve their policies or reduce risks, for example in the field of health and safety. In addition, university research contributes to economic development because conducting research contributes to the competencies and skill development of the researchers ('knowledge as an asset'). Many of these researchers leave their universities, for example once they have completed their PhD studies, and use their new expertise and skills in their new jobs. University staff also participate in formal and informal networks, and in this way help to create innovations. In the AWT's view, the development of competencies through university research is at least as important for the Dutch economy as using the results of that research for innovations.

### **Knowledge and measurements are important**

The AWT believes that the question about the economic significance of university research is undeniably important. A large amount of university research is financed from public funds. Questions about the social returns generated by those funds therefore must not and cannot be avoided, even if measuring those returns is not easy and the measuring instruments are imperfect. The AWT sees three legitimate purposes for measuring the economic importance of university research:

- to account for the spending of public funds in the past;
- to optimise choices about how to use public funds in the future;
- to increase the public support for investments in university research.

### **All methods are partial**

As stated above, there are a number of ways in which university research generates economic value. There are no integral methods that take all those ways into account, and identify both the value of knowledge as a product and that of knowledge as an asset in sufficient depth. Like in the well-known story in which each of the blind men describes a particular part of the elephant (see below), each of the current methods identifies a certain aspect of the actual situation, while disregarding all other aspects. They each accentuate their own area of focus, have their own methodological limitations and require specific data.

### **The Blind Men and the Elephant**

by John Godfrey Saxe (1816-1887)

It was six men of Indostan  
To learning much inclined,  
Who went to see the Elephant  
(Though all of them were blind),  
That each by observation  
Might satisfy his mind

The First approached the Elephant,  
And happening to fall  
Against his broad and sturdy side,  
At once began to bawl:  
"God bless me! but the Elephant  
Is very like a wall!"

The Second, feeling of the tusk,  
Cried, "Ho! what have we here  
So very round and smooth and sharp?  
To me 'tis mighty clear  
This wonder of an Elephant  
Is very like a spear!"

The Third approached the animal,  
And happening to take  
The squirming trunk within his hands,  
Thus boldly up and spake:  
"I see," quoth he, "the Elephant  
Is very like a snake!"

The Fourth reached out an eager hand,  
And felt about the knee.  
"What most this wondrous beast is like  
Is mighty plain," quoth he;  
" 'Tis clear enough the Elephant  
Is very like a tree!"

The Fifth, who chanced to touch the ear,  
Said: "E'en the blindest man  
Can tell what this resembles most;  
Deny the fact who can  
This marvel of an Elephant  
Is very like a fan!"

The Sixth no sooner had begun  
About the beast to grope,  
Than, seizing on the swinging tail  
That fell within his scope,

"I see," quoth he, "the Elephant  
Is very like a rope!"

And so these men of Indostan  
Disputed loud and long,  
Each in his own opinion  
Exceeding stiff and strong,  
Though each was partly in the right,  
And all were in the wrong!

Moral:

So oft in theologic wars,  
The disputants, I ween,  
Rail on in utter ignorance  
Of what each other mean,  
And prate about an Elephant  
Not one of them has seen!

Using several approaches simultaneously provides considerably more information than that obtained using only a single method. However, in practice, this is not always possible: lack of data can severely limit measurements. But even using a combination of approaches and measurements, the information remains incomplete, and many causal relations still have to be guessed after.

As a rule, it is easier to measure knowledge products than competencies. If a direct relationship can be established between the outcome of certain university research and specific innovations, the economic value of that university research can generally be measured. If there is sufficient reliable information, the additional surplus that is realised on the market where those innovations are sold can be quantified. However, this is generally not the case: generally speaking, university research is fundamental in nature, and innovations are not based on specific university research projects. Increases in competencies are not generally reflected as visibly in changes on specific markets, are consequently even more difficult to quantify and as such are even easier to overlook.

### **The value of 'hard' measurements is limited**

Although it is evident that a clearer understanding of the economic importance of university research is necessary, the AWT wishes to stress that the value of measurements is limited. The government currently attaches a great deal of importance to quantitative methods (econometric studies and benchmark studies), in view of the supposed 'hardness' and 'objectivity' of such information. However, usual measuring methods are insufficient. The economic value of university research cannot be measured as a single factor: it is too complex, and the available information is insufficient. Specific aspects of this problem are as follows:

- All manner of forms of research are difficult or impossible to assess in quantitative terms. Examples include pilot studies into new themes, and research aimed at preventing damage or at identifying and reducing risks.

- All manner of effects of research are overlooked, such as the economic importance of competencies developed in university research (e.g. problem-solving capacities), of the contribution of the humanities and social sciences, of knowledge for non-technical aspects of innovation. The effects on the climate for establishing businesses, on culture, on the quality of life and on the satisfaction of curiosity are also disregarded.

Since the usual measuring methods overlook many factors, their use draws a disproportionate amount of attention to the measurable output of university research (quantities of published research results and patents, particularly in the technical sciences) and to their market value. The absence of less easily measurable factors colours the view of the contribution of university research to the economy in practice. This biased view gives rise to the suggestion that particularly applied technical and scientific research has economic value. A more comprehensive and reliable view can only be obtained by carrying out qualitative studies (case studies) to supplement the quantitative measurements.

### **Measuring has side effects**

The AWT also wishes to stress the possibility of unintended consequences of measuring that may have an adverse effect. Quantifying the economic value of research investments has a stimulating effect. If certain indicators are used to measure the economic value of university research, and if universities are judged on those indicators, those universities will focus on maximising the indicators, at the expense of anything that cannot be measured. This may have undesirable consequences. If, for example, the economic value of applied research is easier to measure than the value of curiosity-driven research, then measuring and using that measuring data for steering purposes will soon compel many universities to conduct applied research, at the expense of curiosity-driven research.<sup>1</sup>

### **Recommendations**

In light of the general positions outlined above, the AWT believes that it is important to increase the focus on making the economic importance of university research more visible. An important consideration in this respect is to maintain a broad perspective, and particularly not to lose sight of the role of university research in the development of competencies, of knowledge as an asset. With this in mind, the AWT wishes to submit four concrete recommendations.

For each of the recommendations, the Ministry of Education, Culture and Science, and also the Ministry of Economic Affairs, should have a driving and commissioning role. The Ministry of Education, Culture and Science intends to

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<sup>1</sup> This phenomenon also occurs in the context of employment contracts: if the tasks belonging to a job include some that are easy to measure and some that are not, it is not advisable to conclude an incentive contract based on the measurable output. In such cases, appointment based on a job description serves better.

assign the task of science system assessment to the Rathenau Institute. Based on that task, Rathenau might be used to programme and coordinate improvements in data collection methods. Rathenau could also be asked to take responsibility for providing a more integral analysis of the economic importance of university research, one which accurately reflects its various aspects.

The AWT sees this as a task not only for the government, but also for the universities themselves. It is partly their responsibility to make the economic value of their research understandable. For example, the AWT believes that visits should include systematic attention for the secondary effects of research findings and new competencies, as well as network formation and relations with user groups. Currently, visits primarily assess the performances of researchers using academic criteria. However, they also offer the opportunity to trace the economic importance of university research from the source.

At present, little systematic attention is devoted to this possibility. The AWT calls for a system to be developed for this purpose.<sup>2</sup>

## **Recommendation 1**

### **Research the economic importance of the university research process.**

*Do not only consider the economic value of the research results, but also that of the research process. Specifically examine the importance of university research for the development of competencies and networks.*

This recommendation is further broken down below into two sub-recommendations.

#### *Recommendation 1a: research the development of competencies.*

*Ensure more research into the dissemination and application of knowledge and skills gained in university research. Examine the mobility of university researchers, the functions they attain outside university and the further use of the expertise gained at university.*

A large part of the economic importance of university research lies in its contribution to the development of competencies by researchers, particularly PhD researchers. Many researchers conduct research at a university for a number of years before continuing their careers elsewhere. In their new working environment, they apply the competencies developed at their universities in a productive manner.

At present, there is barely any information about the mobility of university researchers, about the dissemination through mobility of competencies acquired at universities and about the economic value of the productive application of those competencies outside the universities. The AWT recommends

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<sup>2</sup> Experiences in this area that were gained during the research visit to Wageningen Agricultural University in 1998 and the pharmacy research visit of 2003 may serve as the basis.

better mapping out of flows and application of the human resources flowing into and out of university research.

*Recommendation 1b: research networks.*

*Ensure more research into the functioning of networks, focusing on i) the functioning of universities in their own (regional) networks and ii) the contribution of university research to specific clusters of economic activity.*

Since a large proportion of the economic effects of university research is realised in networks, it is advisable to obtain information about the functioning and the effects of those networks. The empiric knowledge about the formation of networks is currently fragmentary and incomplete. The studies should focus on networks of groups of businesses, social organisations and university research groups, and on identifying what networks there are in the Netherlands, how they function, how exchanges of knowledge function within those networks, what the position is of university research groups in the networks, and what the networks produce. Universities might be asked to investigate this matter, for example in connection with research visits.

Any measurements of cooperation generally use questionnaires to ask about information sources in innovation and about partners in innovation, or else count joint publications, joint patent applications etcetera. These indicators provide little information about the functioning, stability, quality and effects of network formation. Information about these aspects can be obtained from examining variables such as the scope, openness, transnationality, cohesion and focus of networks. Qualitative information about the nature of contacts and contracts and mechanisms for allocating revenues and expenses and for spreading the risks might also be examined. This calls for meso- and micro-level studies, which will provide information about the structure, organisation and functioning of networks, as well as for specially tailored methods.<sup>3</sup> Dialogic has developed a proposal for the AWT for a 'slide rule' to measure the exchange of knowledge between businesses, social organisations and knowledge institutes. This slide rule uses ten different categories of exchange.<sup>4</sup> In the case of several of these categories, the amount of Dutch information

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<sup>3</sup> Examples include visualisation methods. For initiating this type of analyse, see, for example, *Science and Technology Indicators 2003 Report*, by the Netherlands Observatory of Science and Technology (NOWT) and A.P. de Man & G.M. Duysters, *De positie van Nederlandse bedrijven in innovatienetwerken* [*The position of Dutch businesses in innovation networks*], research series published by the Ministry of Economic Affairs, no. 5, March 2003

<sup>4</sup> Dialogic uses the following categories: mobility of people; cooperation in R&D; contract research and consultancy; cooperation in education and training; trade in intellectual property; spin-offs and business; shared facilities; publications; participation in conferences and professional networks and administrations; other informal contacts and networks. See F. Bongers, P. den Hertog, R. Vandeberg & J. Segers, *Naar een meetlat voor wisselwerking. Verkenning van de mogelijkheden voor meting van kennisuitwisseling tussen publieke kennisinstellingen en bedrijven/maatschappelijke organisaties* [*Towards a slide rule for interaction. Exploration of the possibilities for measuring knowledge exchange between public knowledge institutions and businesses/social institutions*] (AWT, 2003).



available at present is poor. The AWT recommends that this proposal be used as a point of departure for obtaining further information.

## **Recommendation 2**

### **Examine the mechanisms that determine the creation of value.**

*Use a wide range of methods to acquire information about the economic importance of university research. Substantiate quantitative studies with reliable institutional analyses to acquire a better understanding of the factors that might serve to explain the economic Importance of university research.*

It is more important to improve the understanding of the mechanisms that determine the extent to which university researchers create economic value than it is to perfect the measuring methods. Anyone who can measure accurately but lacks sufficient understanding of processes and incentives cannot make the necessary adjustments. Someone who understands the incentive structure is still reasonably able to make adjustments and optimise even if accurate measurements are impossible. This requires an understanding of institutions and social processes.<sup>5</sup> This not only concerns the incentives for individual researchers (such as only being judged on top-level publications: this in itself does not steer researchers toward creating user value). It also concerns incentives at a higher level, that of programme development, budget allocation and project selection (mechanisms of *research guidance*), both within institutions and at financiers such as the Netherlands Organisation for Scientific Research (NWO) and other funds. Institutions determine the manner in which diverse interests are channelled, and so for example how research agendas are determined, whether people will be working together and if so who, and where to charge the costs and distribute the returns.

## **Recommendation 3**

### **Do not base policies too strongly on the outcome of quantitative methods.**

*Caution should be observed in basing policies on quantitative measurements of the economic value of university research. All econometric studies and lists of indicators should be sufficiently broad and must reflect the Dutch situation accurately.*

Current quantitative methods have many shortcomings, owing on the one hand to the limited understanding of the complex character of the secondary effects of university research and on the other to the limited amount of data available. This calls for prudent use and particular caution in drawing conclusions from results and translating those conclusions into policy.

Nevertheless, indicators and econometric studies may be of some use (in the land of the blind, the one-eyed man is king). The AWT therefore believes that efforts should be made to improve the quantitative methods, and in this connection has two concrete recommendations.

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<sup>5</sup> In this context, the AWT defines institutions as the formal and informal rules that govern the interaction between people.

*Recommendation 3a: safeguard the availability of indicators that are relevant to the Dutch situation.*

The AWT regards the ongoing international standardisation of lists of indicators as an important factor in their further development. The AWT appreciates the importance of international comparability of data, and of coordinating the collection of data at the European level. However, since more and more national data producers are becoming suppliers to international organisations, their own options are becoming limited. This may in due course result in deterioration at the national level. In the AWT's view, this means that additional efforts are needed at the national level to ensure sufficient variation and to ensure that the data reflects the Dutch situation.<sup>6</sup>

In this connection, the AWT recommends that special attention be devoted to two aspects:

- Social and cultural indicators, in view of the importance for the Netherlands of being an attractive place for businesses and knowledge workers to settle.<sup>7</sup> Social and cultural indicators are particularly necessary in reports measuring the progress in the development of the Netherlands as a knowledge society. Although there are currently several rankings of settlement factors, these focus primarily on economic aspects, and are also (with the exception of ICT aspects) barely integrated in measurements for the Lisbon objectives.
- Non-technological aspects of innovations, in view of the major importance of the services sector for the Dutch economy and the growing proportion of non-technological innovations. Although the AWT appreciates the efforts of the Statistics Netherlands (CBS) innovation questionnaire in this field, it believes greater efforts are required. Dutch indicator lists should devote more attention to processes of non-technological innovation and the use of the humanities and social sciences in those processes.

*Recommendation 3b: develop econometric models tailored specifically to the Dutch situation.*

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<sup>6</sup> An example of a specific characteristic of the Netherlands is its relatively extensive intermediary structure. A great deal of the research aimed more directly at applied use in the Netherlands is performed by TNO, the Agricultural Research Service (DLO), the large technological institutes (GTIs), etcetera. These institutes finance a great deal of their budgets with market funds. In this respect, the Netherlands differs not only from countries such as Belgium, Great Britain and Sweden, where this type of research is performed by universities, but also from countries such as France and Germany, where the intermediary institutes receive much more basic funding from the government. This makes it difficult to draw international comparisons, such as between indicators that measure the economic usefulness of university research. Consequently, differences in these indicators should not be taken as the basis for drawing conclusions without further consideration.

<sup>7</sup> See, for example, R. Florida and I. Tinagli, *Europe in the Creative Age*, Carnegie Mellon, 2004.

Most econometric models for measuring the economic returns on investments in university research originate in the US. However, more information is needed about the Dutch situation. Consequently, econometric models should be tailored to the nature of the Netherlands as a small, open economy, and those models should then be estimated using Dutch empirical data.

#### **Recommendation 4**

##### **Make more use of 'success stories'.**

*Increase public support for university research by publicising successes.*

One of the purposes of registering economic returns from university research is to increase the support for that activity. In this connection, evocative stories highlight aspects that cannot be presented as hard figures, or not easily, such as the way in which university research contributes to health care or a flourishing cultural climate. There are a variety of ways to do this. Case studies could be used as show cases much more than they are now. The operation and effectiveness of successful initiatives that appeal to the imagination could be actively publicised. The work of successful scholars and scientists could be highlighted in the media. Another possibility is to publicise 'success stories' at a high political level.<sup>8</sup>

##### **Finally: from measuring to steering?**

The request for advice (see Annex 1) links the issue of the importance of university research for the economy to a steering question: to what extent is targeted steering desirable and/or possible in order to influence the importance of university research for the economy? This steering question in itself falls outside the scope of this report. Based on the above, combined with previous statements by the AWT, however, it is possible to say something about this issue.<sup>9</sup>

The nature of the Netherlands as a small, open economy limits the possibilities for increasing the economic returns from published Dutch research results by steering research. *Spillovers* of knowledge mean that the economic returns from research are used both in the Netherlands and abroad. Therefore, the ultimate returns for the Netherlands depend on what academic knowledge flows into and out of the Netherlands. This applies in particular for ground-

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<sup>8</sup> For example, the report entitled *Wellspring of Prosperity: Science and Technology in the U.S. Economy*, Committee of Advisors on Science and Technology, 2000, commissioned by the then Vice President of the US, illustrates the manner in which science has contributed to the quality of life (see [www.ostp.gov](http://www.ostp.gov)). Another example is the speech that Tony Blair gave in 2002, entitled 'Science matters' (see [www.number-10.gov.uk](http://www.number-10.gov.uk)), in which he used everyday examples to illustrate the great impact of science.

<sup>9</sup> See *Dutch Compass for the European Research Area. Strategic framework for the internationalisation of research and innovation policy*, AWT report no. 57, 2004. The differentiation of four categories of research used in this section originates from that report.

breaking research where it is not possible to say in advance whether it will be usable in the innovation processes of businesses or public-sector players, and if so how. The development of this research is ultimately determined by international competition, which is all about excellence at world-class level. In this connection, the government, and more specifically the Ministry of Education, Culture and Science, should not control the subjects of research projects, but rather should create circumstances in which groups in the Dutch knowledge infrastructure can optimise their participation in international competition.

In the case of research for cross-border issues (European or global: aging population, climate change), too, coordination is needed more than steering. Coordinating research at the European level will increase the quality through greater competition and reduce fragmentation by concentrating strengths. Here in particular, it is the task of the government to maintain the knowledge base for proper absorption of globally produced knowledge and to tailor the Dutch mechanisms for financing research to their European counterparts.

However, controlling the subjects of research is important in issues with a specifically Dutch connotation, such as research for businesses. The economic importance of university research will increase if the Dutch knowledge infrastructure can offer greater excellence to knowledge-intensive innovative businesses that are established in the Netherlands. This will require the government to bring more focus to that research than is currently the case, in line with the strengths of the commercial sector. It is the responsibility of the Ministry of Economic Affairs and the Ministry of Education, Culture and Science, in consultation with the commercial sector, to make the necessary choices about focal points.<sup>10</sup>

Similarly, it will add to the economic importance of Dutch university research if that research ties in more closely with social issues confronting the Netherlands (for example, water management or intensive use of space). This too will require that focal points in the research be identified and stimulated. The government, in this case the specialist departments with the Ministry of Education, Culture and Science fulfilling a coordinating role, should make its own specifically Dutch choices in this respect.

However, it is important to try to map out and if possible measure the functioning and effects of the formation of those focal points and of knowledge absorption and use. That is still not done enough. This advice offers a number of points of departure for improving that situation.

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<sup>10</sup> A step in this direction was recently taken when the Innovation Platform identified a number of key areas.