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Author(s)	:	Maarten Cornet, Free Huizinga, Bert Minne and Dinand Webbink
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Successful knowledge policies

This article discusses several policy options in the fields of education, research, and innovation that are likely to have beneficial, neutral, or negative effects on overall welfare in the Netherlands. For some options, the effects are unknown. Beneficial education policies are, for instance, policies aimed at increasing teachers' quality and early childhood education programs. Additional R&D tax credits for new firms have favourable effects on innovation. A further increase in the research incentives to universities is expected to raise scientific output.

1 Introduction

Knowledge policy is widely considered to be an important subject. The Dutch government conducts intensive policy on the foundations of the knowledge economy: education, research and innovation. In the literature and in policy circles, proposals for additional knowledge policies or reforms of existing policies are currently being discussed. Examples are the Knowledge Investment Agenda of the Innovation Platform, new innovation policies of the Ministry of Economic Affairs, an advice of the Council of Economic Advisors about research, education and entrepreneurship and an advice of the Education Council.

Little is known, however, about the effects of all these policies. The question whether knowledge policy works remains difficult to answer. Despite much research effort in the past decades, the manner in which the creation and application of knowledge comes about and the way policy can influence that process are still not well understood. It is difficult, therefore, to form a good judgement about the optimal size and form of knowledge policy.

During the last decades, important progress has been made in the international literature. New ways of empirical research into the effectiveness of various types of knowledge policy prove very valuable. Examples are the application of new micro-econometric techniques and the use of experiments or situations that, often by coincidence, happen to resemble experiments. These new methods have proven to be particularly fruitful in the field of education.

1.1 Contribution of this paper

This report uses these new insights to contribute to the Dutch policy discussion. For several policy areas within the fields of education, research and innovation, we indicate what information is available in the international literature and which conclusions may be drawn based on this information.

The proposals we discuss always consist of a relatively modest change in current policy. For example, we do not discuss the contribution to welfare of publicly financed education as a whole, but only of a change in certain aspects of it, or of a modest shift towards private financing. The judgement of the proposals is always made conditional on current policy. For example, if a lot of policy has already been implemented in a certain area, additional policy may be less effective. Also, if we conclude that a certain policy option is likely to have a beneficial effect on overall welfare, this conclusion only applies to a modest application of that policy. The paper does not make any judgement about large changes in policy.

The paper certainly does not discuss all possible policy options. The report focuses on options that currently play an important role in the Dutch policy debate and of which convincing evaluations are available in the international empirical literature. This paper, therefore, only deals with policy options about which experience has already been gained in the past. It does not discuss possible new policy options.

1.2 Much still unknown

The uncertainty about the effect of additional knowledge policy is still great. Relatively, a lot of information is based on research on policies abroad. Beforehand, it is not clear if these policies would lead to the same results in the Netherlands, for several reasons. Firstly, the socio-economic circumstances abroad are often different from those in the Netherlands.

Secondly, there are differences in the degree to which countries already have introduced various policies. The effectiveness of a certain policy instrument may decrease as more and more resources are spent on that instrument. If the introduction of a certain policy in a certain country has demonstrably positive effects, it does not follow automatically that an expansion of that policy in another country that already has implemented this policy is also useful.

In addition, policy proposals being considered in the Netherlands are almost never identical to those abroad. Seemingly small differences in the execution of the same policy idea can create important differences in outcomes. “The devil is in the details”, is a very appropriate saying when designing (knowledge) policy.

In the area of education, these problems are partly reduced because more studies become available that find similar results despite different circumstances and because an increasing amount of Dutch research exists. As a result, a reasonably convincing judgement can be made about the likeliness of success of policy in this field. Convincing judgements of policies aimed at promoting research and innovation can less often be made.

2 Methodology

When discussing the various policy options, we organise the available information about the expected outcomes via the following three criteria:

- Social return of the policy objective: What are the effects of reaching the policy objective on welfare?
- Effectiveness: To which degree does the actual policy instrument indeed generate additional social benefits?

- Cost - benefit ratio: How does the expected social costs associated with the policy instrument compare to the social benefits?

We call a policy instrument *potentially successful* if there are strong indications that the policy objective raises overall welfare and that the specific policy instrument indeed reaches that objective at a favourable cost - benefit ratio. If the policy objective does not raise welfare in the first place, or if the policy instrument fails to reach its objective or only at a relatively high cost, we call the instrument *unlikely to be beneficial*. If the instrument on balance does not affect welfare much, we give it the judgement *neutral*. If insufficient information exists to draw well-founded conclusions, we give the verdict: *effect unknown*.

When calculating the cost of policy, it is important to include all costs. The total cost is often substantially higher than the amount of money that is needed to execute the policy. For instance, the cost of a policy that provides subsidies is considerably higher than the amount of subsidies paid out. First, there are the costs of developing and executing of the policy. Second, there are cost of inefficiencies associated with taxation. These can be substantial, about 15% to 35% of the tax collected. Third, subsidies may lead to lobbying activities that may be socially costly, due to the resources devoted directly to the lobbying activities and due to possible socially undesirable effects on the policy process.

2.1 Empirics dominant angle

To make judgements about the three criteria above, we use three kinds of information:

- Indicator studies. These are studies which compare Dutch performance and costs in education, research and innovation with those of other countries based on certain indicators.
- Theoretical arguments about the effects of policy
- Empirical studies about the effects of policy

The three kinds of information complement each other. Indicator studies are a useful starting point for a diagnosis of how the Netherlands is faring compared to other countries and which policy topics may be usefully subjected to further analysis. Each country tries to conduct optimal policy given their specific economic, historical and political background. Differences in approach and outcome can supply interesting and useful information about possible directions for Dutch policy.

Theoretical arguments are valuable to understand how education, research and innovation systems work and to indicate where and why the government can usefully intervene. The

arguments can, therefore, help to interpret empirical information. However, theoretical arguments mostly indicate that under several circumstances certain effects may be expected. In order to judge whether a theory correctly represents reality, empirical validation is necessary. In addition, theory often points to different mechanisms that can augment or counteract each other. The determination of the overall effects is, therefore, almost always an empirical matter, even if the theoretical arguments by themselves are sound.

Although indicator studies, theoretical arguments and empirical research about the effects of policy are all useful and indeed being used, the results of empirical studies form the dominant approach in this paper. The central question is what empirical research tells us about the relevance of the various policy objectives for welfare, about the effectiveness and the cost - benefit ratio of introducing or intensifying specific policy instruments, given the current policy mix in the Netherlands.

2.2 Preference for experiments and for Dutch studies

It is important to remark that not all empirical studies are equally convincing. Empirical research is fraught with pitfalls, and the manner in which a study is designed is of great importance to its persuasiveness. Probably, the most important pitfall is the fact that the finding of a correlation between the introduction of a particular policy and a certain outcome does not tell us anything about the causal nature of that correlation. For instance, suppose that empirical studies find that companies that receive relatively much R&D subsidy also invest relatively much in R&D. This does not mean that R&D subsidies are effective in promoting R&D investment. It could also be the case that the subsidy has no effect on investment al all. The cause of the positive correlation could simply be that firms who inherently invest much in R&D also receive a large share of the R&D subsidy because it is much easier for them to apply and qualify for the subsidy. In this case, the causal relationship between the receipt of subsidies and investment in R&D is the opposite of the one assumed by policy makers.

This problem of a possible reverse causation plagues many empirical studies. The best method to deal with this problem is to conduct an experiment in which policy is applied at random on a limited number of firms or people. In the case of an R&D subsidy, a certain group of firms would be identified, and the subsidy would randomly be given to a limited number of them. If it turns out that the firms that received the subsidy increase their R&D investment more than the other firms, it is very likely that the subsidy indeed raises R&D investment. As stated above, studies that use experiments occur more often. In this paper, the results of those studies are given a lot of weight.

In addition, we give more weight to studies that are performed in the Netherlands, because it is not clear whether policy measures will have the same effects in different countries. Unfortunately, in many cases there are not enough convincing Dutch studies available for a solid evaluation of Dutch policy. Therefore, this paper is based also, and sometimes even mostly, on studies performed abroad.

3 How does the Netherlands compare?

Dutch students perform well on internationally comparable tests and often find a job after leaving school. Spending on education by the government and by students and their parents is relatively low. Dutch students leave school at a relatively early age on average, and dropping out of school occurs relatively frequently. The level of education of the population is low relative to other rich countries.

Indicators of the Dutch research and innovation system also paint a mixed picture of relative performance and cost. The Netherlands does not perform systematically better or worse than other countries, such as the US, the Scandinavian countries or neighbouring countries. The Netherlands performs well on the number and quality of scientific publications. Dutch companies generate a lot of patents. However, the cost of scientific publications is high, and the service sector creates relatively few innovative products as a share of total sales.

A main issue for further attention in the area of innovation is the low private R&D spending as a percentage of GDP. In the area of education, the relatively high drop out rate is remarkable and an issue of concern.

4 Potentially successful education policies

Education is a crucial factor in the knowledge economy, for the individual and for the whole community. Empirical research shows that countries with a better educated labour force produce more. An increase in the average education level by one year is estimated to yield about 8% more production. Also, one additional year of education raises individuals' life time earnings on average by 5% to 10%. In addition, there are returns in the areas of health, safety and the environment. This makes clear that an increase in the level and quality of education in the Netherlands may raise welfare. It also explains the great importance the government attaches to a good education system and the central role of the government in financing and implementing education.

Is there, given the current level of government education policy, still a role for additional policy measures? The answer is yes. Recent economic research provides solid evidence for the importance of good teachers in education. Raising teacher quality can generate high social benefits. In addition, empirical research shows that early childhood education, especially for young children who have fallen behind, can generate high benefits for society as a whole. Early childhood education raises the chances for success in later education. Also, early investment in education of children who are potentially lagging behind reduce the dependence on welfare programs later on, and increases public safety and social cohesion. The same is true for investments that help young people get a so-called starters diploma (the level of education minimally needed to successfully enter the labour market).

Recent empirical research does not paint a uniform picture of the marginal social return to higher education. The consensus view at the moment is that the social return of higher education is about equal to the private return, at the current level of subsidies for higher education. Studies exist, however, that find higher social returns.

In light of this role for the government, we judge the potential for success of a number of policy options in education. This judgement is based on empirical research, especially solid empirical research with proper control groups.

The first potentially successful option is raising teacher quality. Research shows that raising teacher quality can lead to substantial improvement in student performance. Solid evidence is provided in a recent study in which half a million students in the US state of Texas were followed for several years (Rivkin et al., 2005). Repeated observations of the same students allow for a very precise determination of the contributions of the teacher and of the school. The results show that large differences exist between the contributions of teachers to student performance. Improving teacher quality, therefore, can lead to better performance of the students.

How can policy contribute to teacher quality? The current institutional setting in education contain few incentives geared towards raising teacher quality, so that potential benefits to society may remain underused. Teacher salaries are mostly determined by tenure, and much less by performance. Recent studies that use proper control groups show that continued education for teachers and financial performance incentives are potentially successful means to raise teacher quality and performance at relatively low cost (Angrist and Lavy, 2001; Lavy, 2002). No hard empirical evidence is yet available about the effectiveness of other possible policy options in this area.

A second potentially successful option is early and pre-school education aimed at students at risk. In the US, several projects have been carried out with children from disadvantaged backgrounds. By lottery, it was determined which children were allowed to participate in educational programs and which were not. The experiences of these children in and after school were followed, sometimes even for 30 years. The results show that this type of education policy has large social benefits (Currie, 2001). These benefits consist of improvement in the opportunities for employment and reduction in criminal activity.

A third potentially successful option is reducing early drop out from school. Reduced early drop out reduces the dependence on welfare programs later on and the likelihood of criminal behaviour. Taking stock of studies with an experimental design (including proper control groups) shows two promising directions. First, projects that use financial incentives for students, teachers and schools prove to be effective. Positive experiences have been gained in the UK, the US and Israel (Cunha et al., 2005; Angrist and Lavy, 2004; Lavy, 2002; Dearden et al., 2005). Second, promising results have been achieved by long-lasting and intensive programs with coaches, aimed at the social development of students at risk (Dynarski et al., 1998; Heckman, 2000).

A fourth potentially successful option is implementing a social loan program for higher education. The main purpose of a social loan program is improving the efficiency of the use of public funds in higher education. In addition, it will increase the flexibility of student financing of higher education. This may, for instance, be useful if tuition levels will be allowed to vary more in the future, for example to pay for education programs with a higher quality. A social loan program makes it possible to further apply the principle of letting the beneficiary pay, without reducing access to higher education.

In the current system of financing higher education, many subsidies aim to guarantee universal access to higher education. Student loans are more efficient for this purpose than subsidies, such as student grants. In Australia, a social loan program was introduced in 1989 called the Higher Education Contribution Scheme (HECS). Before the introduction of HECS, there were no private contributions to higher education in Australia. Through HECS, the private contribution rose to 23% of the average direct cost. Various evaluation studies show that participation in higher education did not fall after the introduction of HECS (for a survey, see CPB, 2001).

Two remarks are in order, however. Recent US research (Field, 2006) points to loan aversion among students. If loan aversion is also relevant in the Netherlands, subsidy elements in the financing of higher education may still be in order, for instance for disadvantaged groups. Second, there is a lot of uncertainty about the social returns of education. As a result, the optimal level of public subsidies for higher education is difficult to quantify.

A policy option with the judgement ‘neutral’ concerns additional subsidies for ‘Life-long learning’. The evidence is mixed as to whether additional subsidies lead to additional schooling. An education tax deduction for employees 40 years of age and older in the Netherlands turned out to result only in a postponement of participation in education (Leuven and Oosterbeek, 2004). By contrast, a recent Dutch study found that the education tax deduction for employees does lead to more schooling (Leuven and Oosterbeek, 2006). It is also relevant that the private sector has already developed institutions to help employees get more education, such as funds set up by certain industries.

The policy option that allows private institutions to enter the higher education market on a level playing field with the current publicly financed institutions gets the verdict ‘effect unknown’. The goal here is to bring about a better match between demand and supply of higher education and to improve its efficiency and innovation. The empirical literature gives some support for a positive effect of competition among suppliers of education on the performance of students (for a survey, see burger et al., 2004), but the studies only cover primary and secondary education abroad. It is not clear whether the results may be applied to higher education in the Netherlands. In addition, the literature points to several disadvantages such as more segregation. Opening up the higher education market to new suppliers touches on many aspects of the organization of higher education, such as the level of tuition, selective admission and the profit motive. It is difficult to assess the welfare effects of all these aspects. Exploring promising elements on a small scale, such as the current experiments with differentiation of tuition levels and selective admission, seems a sensible approach.

A number of policy options are not likely to be beneficial. Decreasing class-size is not likely to improve welfare, because a relatively small improvement in student performance is counterbalanced by very high costs. In the past several years, several studies of the effects of reducing class-size have been carried out based on experiments with proper control groups. The most well-known is the Star-experiment in the US state of Tennessee, where students and teachers were randomly assigned to small and big classes (Krueger, 1999). In addition, several studies were done based on so-called natural experiments. In these cases, class sizes varied by coincidence, for instance because of cost rules (see, for instance, Angrist and Lavy, 1999). In general, a reduction in class-size is found to lead to a small improvement in learning achievements. A Dutch study, however, found no effect of class-size on student performance (Dobbelsteen et al., 2002). Reducing class-size, however, is very expensive, as it requires many more teachers. Since there is already a projection of a teacher shortage, reducing class-size may increase bottlenecks and costs for schools in hiring teachers.

Policies designed to increase the number of science graduates are also not likely to succeed. The goal of these policies is to boost R&D investment in the Netherlands. An increase in R&D indeed raises welfare because private companies generally invest less in R&D than is socially desirable. However, stimulating enrolment in science education does not appear to be an effective instrument for promoting R&D. Over half of the science graduates does not end up working in an R&D job. In addition, there does not appear to be a shortage of science graduates. Several indicators of the labour market, such as the number of vacancies, the relative level of wages and the labour participation rate do not point to such a shortage. Increasing the number of science graduates is not helpful if there already enough of them. Moreover, supply of foreign science graduates is also available (see also, Freeman, 2005).

More generally, there is no empirical evidence that supports a causal link between the supply of science graduates and the amount of R&D investment. And there is no solid evidence that shows that government policies currently in place to promote science education indeed raise the number of science graduates.

Based on the empirical literature, there is also little support for expanding the use of computers and ICT in education. Four of the five solid empirical studies available at the moment find no improvement in student performance, and sometimes even a deterioration. In these studies, the effects are found by comparing the performance of students who use ICT to the performance of students in a proper control group. The control group is established by design in an experimental setup or by coincidence (Angrist and Lavy, 2002; Goolsbee and Guryan, 2005; Rouse and Krueger, 2004; Leuven et al., 2005). A fifth recent study does find an improvement in student performance after ICT investments in schools (Machin, MacNally and Silva, 2006). The fact that, so far, few convincing results of ICT investments have been found may partly be because schools and teachers still have to learn how to apply the new technology usefully.

Finally, empirical evidence points to the importance of the possibility for parents to choose the school for their children and of the centralized administering of tests and exams. These elements already exist for a long time in Dutch primary and secondary education. Abolishing or reducing them may well harm welfare. For instance, forcing parents to send their children to a school in their own neighbourhood (based on zip codes) may well have unintended side effects. In the US and the UK, housing prices rose in districts where schools received positive evaluations by the education inspectorate or similar institutions (Figlio and Lucas, 2004; Machin and Gibbons, 2001). Parents with sufficient wealth are able to move to those areas. The limiting of school choice to one's neighbourhood is in this case undone parents' ability to choose the neighbourhood.

The importance of central tests and exams is shown in research for the US and the UK. Student performance is higher in school systems that use central testing (Bishop, 1997; Woesman, 2003).

5 Potentially successful research and innovation policy

Research and innovation are important sources of prosperity. Can additional government policy in the areas of research and innovation raise welfare? The answer is also here: yes. Empirical evidence shows that at the current level of policy, additional R&D investment still has a high social return. Estimates of the social return of additional R&D are around 50% to 100% above the private rate of return. However, empirical evidence also shows that it is difficult to design policy that actually raises R&D investment. R&D subsidies, for instance, often turn out to also finance projects that would have been carried out by the private sector anyway.

In light of this role for the government, we judge the potential for success of a number of policy options in the areas of research and innovation. This judgement is based on empirical research, especially solid empirical research with proper control groups.

A first potentially successful policy option is an expansion of the provisions for starting innovating companies within the so-called Law Promoting Research and Development (in Dutch: Wet Bevordering Speur- en Ontwikkelingswerk (WBSO)). These provisions allow innovative start-ups a deduction in wage taxes and premiums for R&D employees. Empirical research finds that one euro spent by the government on this provision generates between 50 and 80 cents of additional R&D employment (Cornet and Vroomen, 2005). This study uses a circumstance that closely resembles an experiment. Combined with the high social return to R&D, this research result makes it plausible that this policy option raises welfare.

The judgement about a limited *general* expansion of the Law Promoting Research and Development is neutral. Empirical research indicates that the law in its current scale has a positive effect on welfare. So, abolishing the law would reduce welfare. However, the empirics on the effects of limited expansion are too uncertain to call. There is no available evidence at all on the effects of a substantial expansion.

A second potentially successful policy option is an expansion of public support for funds that supply small amounts of venture capital loans. Studies indicate that the capital market for this type of loans is too thin from a social point of view. Empirical studies in the UK show that government policy can improve the functioning of this market (DTI, 1999). Two important

components of such a policy are that private investors decide whether a company receives a loan and that these private investors share in the risk (Boot and Schmeits, 2004).

A third potentially successful policy option is easier access to the Netherlands for well educated foreigners. These foreigners bring substantial knowledge capital along with them. This knowledge capital also has a radiating effect on other people and firms that can learn from these well educated. Studies show that these radiating effects are to a large extent local. Short distances are important to benefit from other people's knowledge. Earlier experiences with opening up the Dutch labour market to foreigners indicate how this policy may be implemented.

A fourth potentially successful policy option is to make government funding of university research more conditional on research performance. It concerns the so-called first flow of money, in Dutch: de eerste geldstroom. About 40% of this government funding is currently allocated according to fixed shares, without a direct connection to research performance. Experiences in the UK with the Research Assessment Exercise indicate that strengthening the research performance incentives for universities leads to a rise in the quantity and quality of research output and to a concentration of research funds at the best research universities.

The effects of a recent initiative to give innovation vouchers to firms is still unknown. These vouchers can be used by small and medium-sized enterprises to pay for a research project performed by public research institutions, such as universities and TNO. The vouchers were randomly handed out to a number of firms, so the policy had the form of an experiment. Empirical research shows that the innovation vouches indeed lead to more research orders placed at the research institutions. 80% of the vouchers lead to orders that would not been placed without the voucher (Cornet et al., 2005). However, it is still unknown whether these research orders in turn lead to the ultimate goal: more innovation by small and medium enterprises. An evaluation of this issue will be conducted in the fall of 2006.

There is a range of policies with the general verdict 'effect unknown' that try to stimulate research and innovation in specific areas of economic activity, rather than in general. Examples are policies aimed at stimulating a specific technology, a specific industry or a specific geographical region. The empirical literature does not provide much evidence one way or the other to determine whether such policies are potentially successful. Solid evaluation studies are lacking. Case studies can tell us how the area of the economy supported by policy has developed - with examples ranging all the way from rapid growth to complete collapse - but do not make a hard case for a causal link between this development and the policy involved.

Theory does provide some guidelines to policy makers for making good choices, both with regards to the selection process and to the distinguishing characteristics that make an economic

activity a likely candidate for socially beneficial public support. The selection process should be open and transparent, with independent experts selecting the areas to be supported based on the expected contribution to welfare. An example of a distinguishing characteristic is the impossibility to keep certain innovations a secret or to patent them, which undermines the incentive for firms to invest in these innovations.
Empirical research does not provide evidence as to whether these guidelines are sufficient to enable policy makers to properly select areas of economic activity to be supported. In addition, the possible advantages of making good selections need to be weighed against the costs. These costs include the direct cost of the public support, such the amount of money spent in the from of subsidies, and the indirect cost such as the cost of organising, supervising and monitoring the selection process, the direct and indirect costs of possible lobbying and the costs of economic inefficiencies induced by raising additional tax money.

Finally, the literature provides guidelines for two other aspects of research and innovation policy. The first deals with the relationship between these policies and the government budget policy. The literature indicates that government support should be based solely on the merits of the project to be supported, not on the availability of funds in the budget. Choosing the latter as a criterion leads to the risk that projects that are unlikely to be beneficial are funded anyway, because of an excess of funds, or that projects that are potentially successful are not funded, because of a shortage of funds.

The second aspect concerns the relationship between research and innovation policy and employment. Successful research and innovation policy raises the quality of jobs. In the long run, there is, however, no effect on the quantity of jobs. The additional employment generated by a specific project replaces employment elsewhere in the economy. Empirical research shows that the level of productivity has no effect on unemployment (See, for instance, Broer et al., 2000).

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