Should the government stimulate enrolment in science and engineering studies?

Joëlle Noailly[a,*], Dinand Webbink[a,], Bas Jacobs[c]

Abstract

In many countries there is a deep concern about shortages of science and engineering workers (S&E). This paper focuses on the effectiveness of policies aimed at stimulating the supply of S&E workers in the Netherlands. Despite the 'common wisdom' of severe and increasing shortages, we do not find evidence for a tight labour market of S&E workers. Instead, the data suggest that S&E workers have become less scarce since 1996. Stimulating enrolment in S&E studies may not be an effective policy for increasing R&D activity in the Netherlands because the majority of Dutch S&E freshmen does not end up working in R&D. They drop out during their S&E study or choose for other jobs. In addition, the internationalisation of the market for S&E workers tends to counter the effects of supply-side policies because the growing supply of foreign S&E graduates puts downward pressure on wages. As a result, demand side policies may be more effective because they are directly targeted at fostering R&D.

Keywords: Higher education, Science and Engineering Labour Market, R&D Policy.

[a] CPB Netherlands Bureau for Economic Policy Analysis, The Netherlands [c] Erasmus University, Rotterdam, The Netherlands

[*] Corresponding author: Joëlle Noailly, Email: J.Noailly@cpb.nl, Tel:+31-70-3383498, Fax:+31-70-3383500, CPB Netherlands Bureau for Economic Policy Analysis, P.O. Box 80510, 2508GM The Hague, The Netherlands. We gratefully acknowledge comments from Free Huizinga, Hessel Oosterbeek, Marc Pomp, Maarten Cornet and Rob Euwals and participants at seminars at CPB and the Ministry of Finance.

1. Introduction

In many countries there is a deep concern about the supply of science and engineering (S&E) graduates. Employers regularly voice concerns about current or future shortages of science and engineering graduates and occasionally threaten to relocate R&D activity to other countries where the supply is more abundant. As formulated in the Lisbon Agenda, the European Union has set targets to increase the number of scientists with 700,000 in 2010. Many countries have translated these targets in national programs to increase the supply of S&E graduates. For instance, the Dutch government launched the 'Delta plan beta/technology' aimed at an increase of the number of S&E graduates with 15% in 2010.

This paper focuses on the effectiveness of policy interventions aimed at increasing the supply of S&E workers. Such policies raise two main questions: 1) Is there a shortage of S&E workers? and 2) How does stimulating enrolment in S&E studies contribute to increasing R&D activity? This paper addresses these two questions for the case of the Netherlands.

Several studies have addressed the problem of shortages of scientists and engineers. Freeman (2005) shows that in the United States the job market has worsened for young workers in S&E fields relative to many other high-level occupations. A recent study compares wages of S&E graduates with wages of other higher educated graduates for various countries (Machin and McNally, 2007). They find that S&E studies had the highest returns in Britain, Germany and the US but not in France. Goolsbee (1998) and Romer (2000) present arguments for supply-side policies. Goolsbee (1998) shows that promoting R&D activities will result in higher wages of R&D workers if there is a structural shortage of R&D personnel. Romer (2000) suggests that innovation policy in the United States has erred by subsidizing the private sector demand for scientists and engineers while the existing institutional arrangements in higher education seem to limit the supply response.

The remainder of the paper is organised as follows. Section 2 gives some background on the Dutch situation. Section 3 shows the results of the empirical analysis of the changes in the labour market of S&E workers. Section 4 discusses the economic arguments for policy intervention in the labour market for S&E graduates. Section 5 concludes.

2. Background on the S&E market in the Netherlands

Shortages of scientists and engineers have been on the Dutch policy agenda for many years. International comparisons show that the supply of S&E graduates[1] in the Netherlands is very low. With approximately 7 S&E graduates per 1,000 of population aged 20-29, the Netherlands scores much lower than countries such as the United Kingdom, France and Ireland, which have more than 20

[1] S&E fields of study include life sciences, physical sciences, mathematics and statistics, computing and engineering.

graduates per 1,000 of population (European Commission, 2003). On the other hand, the share of S&E graduates in higher education in the Netherlands is equal to the share in the US. The Netherlands, with 20% of freshmen enrolling in S&E fields, score together with the United States, Denmark and Norway below the OECD average of 26%, and far behind for instance Germany (33%) and South-Korea (42%) (OECD, 2004).

Since 1975, the number of students in higher education has more than doubled. All the trends in higher education suggest a shift of interest of first-year students away from S&E fields towards social sciences and in particular economics. In fact, a closer look at the figures shows that the lower shares of S&E graduates mainly originate from a composition effect due to the increased enrolment of female students. Changes are much smaller if we consider male and female graduates separately. The total share of male S&E graduates has dropped from 32% in 1975 to 30% in 2001. For female S&E graduates this share remained stable at 10%.

S&E graduates receive an education that largely prepares them for R&D jobs. R&D expenditures in the Netherlands are relatively stable and low, reflecting a specialisation of the country away from R&D intensive sectors (pharmacy, computers, etc). Since the beginning of the 1980s, the Netherlands spend approximately 1.9% of GDP on public and private R&D.

In December 2003, the Dutch government published a set of actions in the 'Delta plan beta/technology', which aims at a 15% increase in enrolment in S&E fields by 2007 and a 15% increase in outflow of S&E graduates in 2010. Some of the core measures include stimulating enrolment in S&E field with lower tuition fees, projects aimed to raise interest for technology and projects to enhance the graduation rate in S&E studies, promoting research jobs and relieving barriers to immigration for knowledge workers.

3. The labour market position of S&E workers in the Netherlands

We investigate whether the Dutch labour market for S&E workers is very tight and whether recent developments suggest a worsening of the shortage of S&E graduates. We compare wages of S&E graduates with wages of other higher educated graduates in the Netherlands using data from the Dutch Wage Structure Survey (LSO). The Wage Structure Survey contains individual data on wages, education, industry, job characteristics, gender and age. We use data from the surveys of 1979, 1985, 1996, 1997 and 2002 and focus on individuals between 16 and 64 years old.

We estimate standard Mincer wage equations in which the logarithm of the hourly wage is the dependent variable and the explanatory variables are age, age-squared and type of higher education. We present estimation results on the sample of male graduates. We only focus on the evolution of relative wages across graduates and not on the evolution of absolute wages. Indeed, it could be that wages for S&E graduates have increased over the years. However, if wages of other graduates have increased faster, this reflects that the position of S&E graduates on the labour market has deteriorated

compared to other graduates. Table 1 shows the estimated wage differential of male S&E graduates at the university level and at the higher professional level.

The top panel of Table 1 compares the average wages of S&E graduates with the wages of all other graduates. At the university level S&E graduates earn on average 2 to 3% more than other graduates in 1996 and 1997. After 1997 there is no significant difference between the wages of S&E graduates and other graduates. At the HPE level the relative position of S&E graduates improved strongly in the beginning of the 1980s. However, after 1985 this difference declined and S&E graduates earn on average 7% more than other HPE graduates.

Table 1 Wage differences between S&E graduates and other graduates 1979-2002 (male)

	1979	1985	1996	1997	2002
Compared to all other graduates					
University S&E graduates	0.02	0.05	0.03*	0.02**	-0.01
	(0.024)	(0.053)	(0.015)	(0.009)	(0.011)
	N=617	N=191	N=3349	N=6715	N=4776
HPE S&E graduates	–0.03**	0.08***	0.07***	0.07***	0.07***
	(0.013)	(0.022)	(0.008)	(0.006)	(0.007)
	N=1356	N=453	N=8024	N=13361	N=8856
Compared to economic graduates					
University S&E graduates	0.015	0.048	–0.10***	–0.10***	–0.13***
	(0.027)	(0.061)	(0.011)	(0.010)	(0.012)
	N=617	N=191	N=6586	N=6715	N=4776
HPE S&E graduates	–0.06***	–0.10***	–0.02**	–0.03***	–0.04***
	(0.018)	(0.031)	(0.007)	(0.007)	(0.008)
	N=1356	N=453	N=13745	N=13361	N=8856

Source: LSO 1979, 1985, 1996, 1997, 2002, own computations.

Note: Each cell shows results of regression of log wages on a dummy for being an S&E graduate. Controls: age, age squared. Standard error in brackets. */** indicates significance at the 10% / 5% level

The bottom panel of Table 1 compares the wages of S&E graduates with the wages of economic graduates. This comparison might be more informative because students in S&E studies and students in economics by and large come from the same pool of high school graduates. In addition, in recent years the supply of economic graduates has strongly increased whereas the supply of S&E graduates has gone down. In 1979 and 1985 there is no significant difference in the hourly wages of S&E and economic graduates. In later years however, S&E graduates earn less per hour than their economic counterparts, up to 13% less in 2002. Hence, wages for economists have grown faster over the last 20 years than wages for scientists and engineers.[2] A separate analysis for graduates working in the private sector shows that the relative wage position of S&E graduates in R&D compared to all

[2] For 1996 and later years we made a distinction between fields of S&E studies. For all fields of S&E education, the relative wage position has deteriorated since 1996 (not shown in table).

other graduates deteriorated even more than the wage position of other S&E graduates. Looking at wage differences of S&E graduates in R&D compared to economic graduates, we find similar patterns as in Table 1.

Many factors might play a role in the observed wage difference between S&E graduates and other graduates. For instance, S&E students may 'have more difficulty in negotiating high wages'. However, as many differences between S&E graduates and other graduates, such as the ability to negotiate wages, will probably not change over time, it seems not likely that selectivity is important for explaining the observed changes in wage differentials. Changes in demand and supply of S&E graduates seem the most plausible explanation for our findings. Different specifications (on the sample of females only, excluding graduates with a PhD degree, including fringe benefits) yield similar results.

Using data from the Dutch Labour Survey, we also looked at a large range of labour market indicators: wages, vacancies, unemployment rates, labour market participation and weekly working hours. We find that none of the labour market indicators suggests a tight labour market for S&E graduates. Overall, our results show that the wage position of S&E graduates has deteriorated compared to other graduates. This goes counter the 'common wisdom' of scarcity of S&E graduates in the Netherlands.

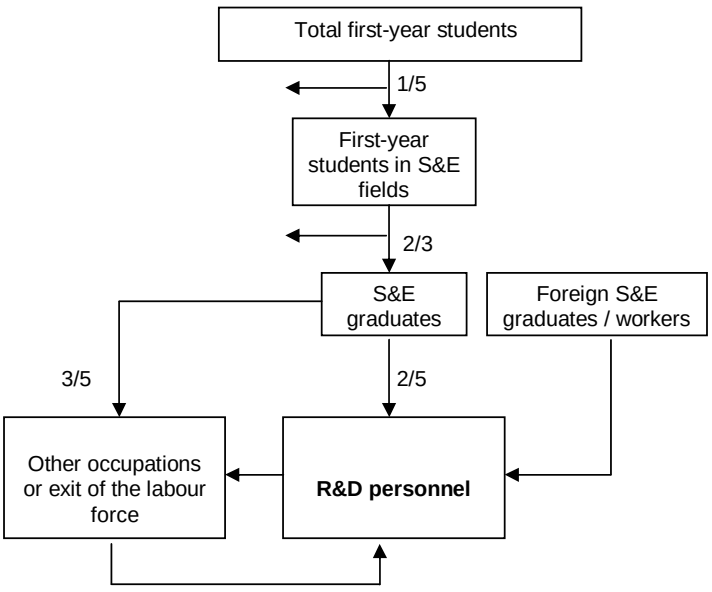
4. Implications for policies aiming to stimulate enrolment in S&E studies

In order to increase R&D activity, the government can choose between supply-side or demand side-policies. Demand side policies are directly targeted at increasing R&D activity (through subsidies, tax credits for R&D personnel, etc), while supply-side policies increase the number of scientists and engineers (education subsidies). The effectiveness of policies to promote R&D depends on: 1) how much the equilibrium level of R&D responds to policies, i.e. whether the elasticities of demand and supply for R&D are not equal to zero, and 2) the extent of government failures.

The supply elasticity of R&D refers to how much the supply of R&D workers increases when wages for R&D workers increase relative to other occupations. As such, there is no credible evidence on the elasticity of the enrolment in S&E studies. A recent study by Ryo and Rosen (2004) shows that the supply of S&E workers adjusts with some delay to changes in relative wages suggesting that the elasticity of supply of S&E graduates is not equal to zero. In the Netherlands the price elasticity of the demand for higher education is the Netherlands seems quite low (CPB, 2003), although evidence on whether this low elasticity also applies to subsidies which aim to make S&E education more attractive relative to other studies is lacking. Regarding the demand elasticity of R&D, Cornet (2001) finds that the demand for R&D is to a certain extent quite elastic. A unit demand elasticity of R&D with respect to wages of R&D seems empirically plausible. Then a 1% decrease in wage costs generates a 1% increase in demand for R&D workers.

The effectiveness of demand and supply-side policies also crucially depends on the government failures involved in both subsidies on the wage costs for R&D workers and subsidies on S&E education. Based on empirical evidence, it is not clear which policy suffers most from government failure. There is, however, one important difference. Demand side policies are directly targeted at increasing R&D whereas supply side policies, such as school projects aimed at changing educational decisions, are not. Many steps have to be taken before supply side policies translate into an increase of R&D. Figure 1 illustrates the supply chain of R&D production from students' enrolment to R&D personnel. Along this chain many uncertainties arise: What is the effect of stimulating enrolment on actual enrolment? How many of the newly attracted students will drop out? And, which share of graduates ends up in an R&D job? Using some descriptive statistics, we can get some insights on the extent of the 'leakage' along the supply chain. Indeed, only one out of five first-year students enrol in S&E fields and approximately two third of freshmen in S&E studies eventually graduates. Among these graduates, only 2 out of 5 actually end up working in R&D, while the remaining students choose for other occupations. In 2002, 34% of all university S&E graduates aged 25-55 worked in core R&D occupations. This is almost 7%-points less than in 1993.

Figure 1. The supply chain from university or higher vocational education to R&D personnel



Source: Statistics Netherlands, own computations using the Dutch Labour Survey 2002.

These steps suggest that subsidies on enrolment in S&E studies may not be well targeted for increasing R&D activity. Indeed, an appreciable share of subsidies aimed at increasing R&D production might leak away along the supply chain. Demand side polices, in contrast, may be more

effective. They focus directly on an increase in R&D-activity and can be used for attracting Dutch or foreign S&E workers or for capital investments. In addition, the time between the subsidy and the increase in R&D is much smaller for demand side policies than for supply side policies. For the latter to be effective it takes at least several years because graduating from S&E studies takes time. Demand side policies can not only increase R&D activity but can also increase the attractiveness of S&E studies.

Another reason why supply-side subsidies may be less effective than demand-side subsidies is due to the internationalisation of the labour market for S&E workers. Although foreign S&E workers currently represent only a small share of total R&D personnel in the Netherlands (4% in 2000, EC, 2003), this share is increasing very rapidly (7.3% per year over the 1994-2000 period, above the EU-average of 5.8%). In general, opening up international labour markets for R&D workers will make it easier for firms to actually find such workers if demand increases. This increases the effectiveness of a subsidy on the demand for R&D. Another consequence of the internationalisation, is that domestic S&E workers have to compete with a growing influx of much cheaper foreign S&E workers, which makes it less attractive to enrol in S&E studies and this undermines the effectiveness of supply side policies. If internationalisation of R&D production causes the market clearing wages for R&D workers to fall below that of other professions, the only effective way to stimulate S&E graduates to choose R&D jobs is to subsidies those *jobs*. This basically comes down to a demand side subsidy.

5. Conclusions

In this paper we discussed the potential effectiveness of stimulating enrolment in S&E studies, as the Dutch government currently is doing. Our conclusion is that this may not be an effective policy for increasing R&D activity. First, we find no evidence for shortages of S&E workers in the Netherlands. None of the labour market indicators suggests a very tight labour market for science and engineering graduates in the recent past. Instead, the data suggest that the labour market position of S&E graduates has been weakening since 1996. Goolsbee (1998) and Romer (2000) show that subsiding R&D is not effective if the supply of S&E workers is limited. However, in the Dutch case the supply of S&E workers does not seem to be the problem. Second, supply side policies may suffer from appreciable government failure. There might be a large “leakage” of subsidies since a substantial number of S&E graduates does not end up working in R&D. Third, the internationalisation of the market for S&E workers may also counter the effects of supply-side policies because the growing supply of foreign S&E graduates puts downward pressure on wages. As a consequence, this suggests that policies to foster R&D in the Netherlands directly (demand side policies) may be more effective than supply-side policies.

References

CPB, 2003, Macro Economic Forecasts 2004, SDU Publishers, The Hague.

Cornet, M.F., 2001, De maatschappelijke kosten en baten van technologiesubsidies zoals de WBSO, CPB Document 8.

European Commission, 2003, *Third European report on science and technology indicators; Towards a knowledge-based economy*, DG Research, Brussels.

Freeman, R.B., 2005, Does globalization of the scientific/engineering workforce threaten U.S. Economic Leadership?, NBER Working Papers 11457, National Bureau of Economic Research.

Goolsbee, A., 1998, Does government R&D policy mainly benefit scientists and engineers?, *American Economic Review*, 88(2): pp. 298-302.

Machin, S. and S. McNally, 2007, Tertiary education systems and labour markets, Centre for the Economics of Education, London School of Economics.

OECD, 2004, *Education at a glance*, Indicators publications, Paris

Research voor Beleid, 2005, De internationale mobiliteit van kenniswerkers in het hoger onderwijs; Een kwantitatief onderzoek (International mobility of knowledge workers in higher education), Nuffic, The Hague.

Romer, P.M., 2000, Should the Government Subsidize Supply or Demand in the Market for Scientists and Engineers? NBER Working Paper No. 7723

Ryoo, J. and S. Rosen, 2004, The engineering labour market, *Journal of Political Economy*, 112(1), S110-S140.