

Productivity, R&D and Spillovers in the Netherlands

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Abstract

Investment in research and development (R&D) is an important determinant of technical change and productivity growth. The present empirical study shows that investment in R&D has an important effect on productivity at the level of individual sectors in the Netherlands. A sector's productivity depends not only on its own R&D, but also on R&D in other sectors, both at home and abroad. The study establishes that domestic R&D is more important for Dutch productivity than foreign R&D. Moreover, it provides support for the idea that investment in R&D and human capital speeds up the assimilation of (foreign) technologies.

Introduction

The recent strong performance of the Dutch economy is often attributed to consensus among employers, employees and the government. The Dutch model for cooperation may indeed have produced declining unemployment, booming investment and high growth. Whether the recent successes will continue and, for example, whether the growth will remain above average, remains yet to be seen. The current crisis in Asia, which appears to be spreading to other countries and regions, is not the only reason why the era of high growth may come to an end. One might worry that the successes themselves will eventually and inevitably undermine the support for further reform and for the policy of wage moderation. Reform of labour-market institutions and the social security system may have delivered long-lasting gains, but reform in itself does not necessarily raise productivity (growth). A different side of economic policy is supposed to deliver just that, and emphasises productivity-enhancing public investment in infrastructure and education. Consensus on this side of economic policy, however, is much more difficult to achieve.

Public investment is at the heart of the current political debate. Typically, a few large projects concerning public infrastructure receive the bulk of the attention. Other forms of investment that may raise productivity in the future are much less debated. One of the reasons is perhaps the idea that the source of technical progress and productivity growth in the Netherlands lies abroad – that technology

is invented elsewhere and is only imported into the Netherlands. Though this idea is true at a general level of analysis, it should not obscure the fact that even a small country like the Netherlands can raise productivity (growth) by investing in R&D. Efforts to introduce new technologies or to adapt already existing foreign technologies do pay off.

This is, at least, one of the conclusions from an empirical study, initiated by CPB, that analyses the effects of domestic and foreign R&D on Dutch sectoral productivity.¹ The study finds that domestic R&D is an important determinant of productivity in Dutch sectors. The study also tries to uncover technology spillovers. It assumes that R&D raises the quality of intermediate goods and that better, more advanced, intermediate goods help to raise productivity. The conclusion then emerges that domestic spillovers, embodied in intermediate goods, are potentially at least as important as foreign spillovers. Since national flows of intermediate goods are larger than the international flows, domestic spillovers are, in practice, far more important. In other words, the scope of spillovers is more (intra)national than international – largely because the trade of intermediate goods is local rather than global.

The conclusion that R&D has a significant and important impact on production and productivity is hardly a surprise. Many studies have already established – in a variety of ways – that the return on R&D is typically high and that R&D effectively raises productivity. The Netherlands is no exception to this rule. The other conclusion is perhaps more surprising. It contrasts an influential article by Coe and Helpman (1995). They conclude that foreign spillovers are important, especially for small economies. However, this result does not seem to be robust. Not only the current study, but also Keller (1997) and Verspagen (1997), arrive at an opposite conclusion. In fact, there seems to be more support for the idea that spillovers are predominantly local in scope rather than global. It is revealing in this setting that even information technology is rooted in one single place: Silicon Valley.

Policy and research questions

A general concern is that investment in innovative products and production methods is too low in the Netherlands. Dutch R&D expenditures are low by international standards. This is true even when accounting for differences in the sectoral structure. Table 1 compares sectoral R&D intensities in various countries. The Netherlands has a weak international ranking in R&D-intensive sectors, such as chemicals and metals. An exception is the strong position of the Netherlands in food. However, the overall picture is that Dutch sectors are at the lower end of the distribution.

Comparatively low R&D investments do not necessarily vindicate public policies to stimulate R&D. Growth the-

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Table 1 R&D intensity in some OECD countries , 1992 R&D expenditure as a percentage of value added¹

	Netherlands	Germany	Japan	US	UK	Sweden	Denmark	France
Chemicals								
Petroleum	8.6	8.3	13.2	10.4	11.7	15.7	10.4	8.0
Metals	4.6	6.2	5.6	10.9	6.0	9.7	5.6	7.1
Food	1.9	0.5	1.9	1.3	1.4	1.5	1.3	1.1
Textiles	0.8	0.7	5.0	0.5	0.4	0.8	0.6	0.6
Wood	0.8	2.4	–	1.7	2.9	0.9	1.4	3.6
Public Utilities	0.2	–	1.0	0.2	1.6	–	0.2	1.5
Other Services	0.1	–	–	–	0.5	–	0.8	0.1
Construction	0.1	–	0.6	–	0.1	–	0.2	0.3
Paper	0.1	0.4	2.4	1.1	0.3	2.2	0.2	0.4

Sources: OECD; ISDB and ANBERD databases.

¹ The sector classification in this table does not correspond exactly to the one used in the studies.

The sign '–' indicates that data are not available.

ory, on the other hand, suggests that there may be a case for government intervention. These theories place emphasis on the externalities associated with R&D, express the concern for under-investment and suggest that public policy should bring the private return of R&D in line with the social return, thus stimulating economic growth and raising welfare. Drawing upon these theoretical insights and the results of empirical research into the effect of R&D on productivity, Jones and Williams (1997) assess the size of the market failure (i.e. the difference between the social and private return on R&D investment). Accepting 30% as a lower-bound estimate for the social rate of return, they claim that the United States should quadruple expenditure on R&D.³ This conclusion is rather stark – perhaps too much so. It shows, however, that growth theories, together with the observation that the Netherlands spends comparatively little on R&D, are serious in their suggestion that the government should stimulate R&D investment to spur on the development of new technologies.

A sceptic, on the other hand, might argue that the gains from government interference could be overestimated. Policies to stimulate R&D may very well run into the usual problem that it is easier said than done. For example, governments may not want to subsidise R&D across-the-board, and thus face the difficult task how to select potentially successful projects. Conceivably, instruments to promote R&D imply serious problems, eroding or even dwarfing their potential gains. Another important issue is that the scope of R&D spillovers is not necessarily national, but could very well be international. This seems to be relevant for a small open economy and especially for the Netherlands, where multinational firms have a sig-

nificant share in aggregate R&D expenditures. If domestic R&D spills over mainly to foreign firms, it is no longer clear that the promotion of R&D is an optimal policy.

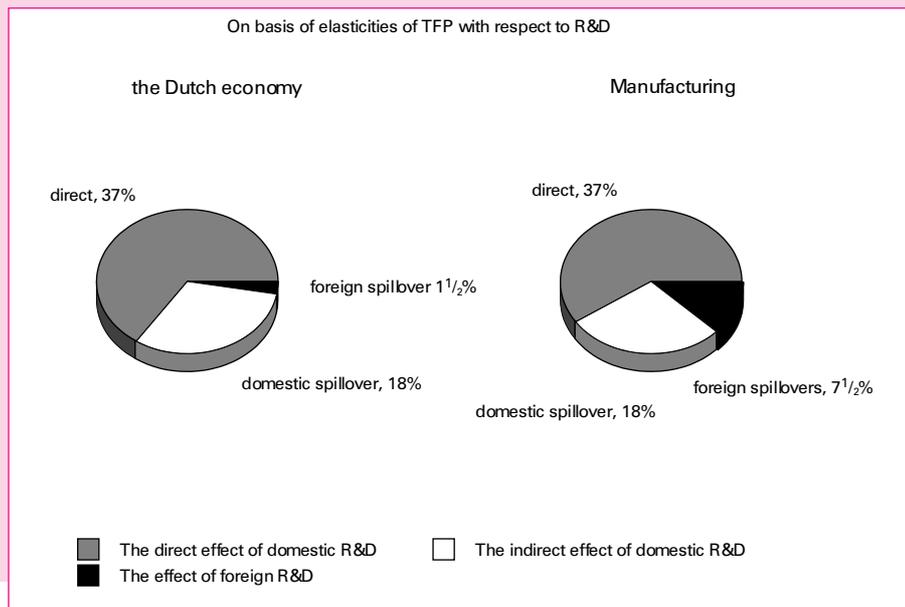
Strong international spillovers do not, however, imply that the public and the private sector should just wait for things to happen. A government may want to speed up the assimilation of foreign technologies. Not only a well-trained labour force, but also domestic R&D itself, may facilitate the introduction of new products and new production techniques that have been developed elsewhere.

Unequivocal policy advice does not emerge from this discussion, but the empirical questions are clear. First, what is the impact of domestic R&D expenditure on the performance of the Dutch economy? Second, are spillovers important and are they predominantly domestic or international? Third, is there support for the idea that a well-trained labour force speeds up the assimilation of new techniques in the production process and the introduction of new (investment) goods? The study provides some provisional answers to these questions. Before discussing the empirical results, we need to clarify one element of the study: the concept of spillovers.

Spillovers

The literature discerns several channels along which R&D spills over from one firm or sector to the other. In this context, Griliches (1979) also distinguishes rent and knowledge spillovers. Rent spillovers are related to intermediate inputs. R&D activity of input producers increases the quality of inputs. Prices do not have to reflect fully the quality improvements: the benefits of R&D activities are not fully appropriated. Upstream industries then benefit

Sources of technical change



two groups are likely to have different characteristics.

The study finds that domestic R&D is an important source of technical change. The elasticities of total factor productivity with respect to the stock of R&D demonstrate this dramatically. The elasticity is 0.35 for R&D by a sector, 0.18 for R&D by other Dutch sectors, and 0.015 for R&D by foreign sectors. The elasticities for domestic R&D are sizeable; the two elasticities add up to more than one half, so that a 1% increase in Dutch R&D leads to a more than

from R&D effort by downstream industries; rents of R&D spill over according to input-output relations. Accordingly, a measure for rent spillovers can be constructed by weighting the R&D activities in other sectors with the intermediate deliveries by these sectors. The rationale for this procedure has been explained and discussed in detail by, for example, Griliches and Lichtenberg (1984).

Pure knowledge spillovers are benefits of R&D activities of one firm that accrue to another. More precisely, R&D in one sector may directly affect productivity in another sector. Knowledge spillovers can arise in many different ways and are not necessarily by-products of intermediate deliveries. For example, a firm can learn and increase its productivity by observing the activities of other firms that do not necessarily belong to the same sector (learning by watching).

The study focuses on one view; it assumes that the benefits of R&D are embodied in intermediate inputs. More specifically, intermediate deliveries are used to weigh sectoral R&D activities and to construct two aggregate variables: one for R&D activities in other domestic sectors, and one for R&D activities in foreign sectors. These two variables are used to capture domestic and foreign spillovers, respectively.

Results

The study assesses empirically the role of domestic and foreign R&D in the process of technical change. Data for eleven sectors are pooled to estimate the impact on total factor productivity of R&D by the sector itself, by other Dutch sectors and by foreign sectors. The study combines an analysis on a sectoral level, common in the empirical literature, with an approach emanating from Coe and Helpman (1995). Regressions have also been run separately for two broad groups: manufacturing and services. In this way, the study takes into account the fact that these

a 1/2% increase in total factor productivity. Thus, even though the Dutch are always keen to point out that the Netherlands is a small country in a big world, the Netherlands can raise its productivity substantially by investing in R&D. This should not come as a surprise. The elasticities fall within the range of results that other, similar studies have produced; they are at the upper end of this range, but are not unexpectedly high.

Perhaps more surprising is that domestic spillovers are large (see also the box). The indirect effect of domestic R&D (0.18) makes up one-third of the total effect ($0.37 + 0.18 = 0.55$). If investors in one sector disregard the positive effect of R&D on productivity in another sector, the incentive to invest is too low. Indeed, the downward bias in the rate of return on R&D is then substantial. Also remarkable is the fact that domestic spillovers are larger than foreign spillovers. This conclusion depends importantly on the starting point of the analysis that R&D is embodied in intermediate goods. Sectors rely more on Dutch intermediate deliveries than they do on foreign deliveries. In other words, the volume of national trade is larger than that of international trade; spillovers are, for this reason, more local than global. This also implies an important difference between manufacturing and services. The latter sectors rely mainly on domestic supplies, whereas the former sectors also depend on foreign trade. Indeed, for manufacturing, the indirect effects of domestic and foreign R&D are more similar. The elasticity for R&D in foreign sectors is much larger and is almost 0.075.

The discussion thus far has concerned only the direct effect of R&D: discovering and adopting new and better production methods allows more efficient combinations of the traditional, productive factors, capital and labour. However, in-house (basic) R&D may also foster learning

and in this more indirect way raise productivity. It may help to be an “early bird” in picking up technological developments in the rest of the world or in assimilating (foreign) techniques smoothly into the production process. Thus, R&D within and outside a sector could very well be complements: the effects of R&D investments are larger when R&D investments elsewhere are larger. In an effort to capture this idea, the cross-products of R&D within and outside a sector have been included in the regression equations. Including these variables produces contrasting results. For example, the cross-products do not have a significant impact on productivity in manufacturing, whereas they do in services. Thus, the support for the idea that R&D speeds up the adoption of new (foreign) techniques, is not overwhelming. The idea seems to apply to services. However, this is not entirely convincing evidence, since in these sectors investments in R&D are relatively low and sometimes virtually nil.

The data do not refute the idea that human capital speeds up the adoption of state-of-the-art production techniques. Using sectoral data about the formal education level of employees – ranging from primary school to university – we have constructed an aggregate measure for the formal skills of employees. Again, a rude test for the interaction between human capital and R&D is to include the cross-product of a sectoral measure for skills and one of the three measures for innovative investment (R&D in a sector, in other Dutch sectors and in foreign sectors). The regressions produce the result that the cross-product of human capital and sectoral R&D has a statistically significant impact on productivity. This suggests that R&D and human capital are complements: R&D is more effective the more skilled the labour force is. The result does not depend on the sectoral breakdown. Separate regressions for manufacturing and services confirm the interaction between human capital and sectoral R&D. Similar findings are uncovered for the other two cross-products: that of human capital and R&D in other Dutch sectors and that of human capital and R&D abroad. These cross-products also have a significant effect on the sectoral measures for productivity. The (weak) empirical support for interaction between human capital and R&D elsewhere sits comfortably with the view that human capital facilitates the assimilation of new and better technologies in the production process.

Conclusions

The process of technical change and productivity growth is the subject of ongoing research. Still unclear for a small open economy is the exact role of domestic R&D and human capital and also the significance of domestic and foreign technology spillovers. Many questions still arise and are left open. The study at hand sometimes gives an unequivocal answer, but more often only suggests plau-

sible answers. Clear is the fact that even the Netherlands – a small open economy – can spur on technical change and raise productivity by investing more in R&D. The effect of domestic R&D is found to be large. Domestic spillovers are important. This does not suggest that foreign R&D and foreign technologies do not have an impact on the Dutch economy. They do, especially in manufacturing (and less so in services). It does, however, suggest that actions to raise the private return on R&D, and thus to increase R&D expenditure, are potentially beneficial.

The empirical results show a strong interaction between human capital and R&D. It appears that human capital and sectoral R&D are complements: R&D is more effective the more skilled the labour force is. In addition, the results support the idea that a better trained labour force enables a faster diffusion of (foreign) technologies and in this way raises productivity.

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¹ The study will soon appear in the CPB Research Memorandum series. A related paper was presented at the conference “Productivity and standards of living: measurement, modelling and market behaviour” in Groningen, 23-25 September 1998. The latter paper focuses more on the role of human capital in the adaptation of (foreign) technologies.

² For an overview of estimated returns, see Nadiri (1993).