The Danish Industrial PhD Programme

Analyses show that the number of postgraduates employed in the private sector has a significant effect on company and national economic performance. For some time, Denmark has lagged behind international leaders in this area – a possible explanation for Denmark’s relatively slow economic growth in the past decade. An active innovation and research policy is being pursued to address this shortcoming. Among other initiatives, the well known Danish Industrial PhD Programme stands out as one of the oldest and most thoroughly tested policy instruments.

The Industrial PhD Programme was established in Denmark in 1970 and has been a growing success ever since. It is internationally recognised for its combination of industrial experience and academic research. Since 2002, it has been part of the Danish Council for Technology and Innovation’s umbrella of innovation promotion initiatives, and has been run on behalf of the council by the Danish Agency for Science, Technology and Innovation. The programme has been evaluated several times and in 2011 an impact assessment was conducted.

Description of the Industrial PhD Programme

An Industrial PhD is a three-year industrially focused PhD project where the student is hired by a company and enrolled at a university at the same time. The student divides his or her time equally between the university and company, working on the research project at both places.

This structure allows the integration of an academic research project into a practical industrial environment by placing the project firmly within the company organisation. It also allows the PhD student to experience and learn from two distinctly different working environments while creating a personal network that spans both. Thus, the programme has shown to be an effective network promoter between the universities and the private sector. Companies can make use of the frontline research of the universities, while universities get access to the domain of private research and industrial field work.

The programme is open to all types of enterprises, domestic and foreign, and candidates and universities from all countries. However, the student must be employed in a Danish company branch, even if the company is organisationally centered in another country. There are special travel subsidies available for going back and forth between the Danish division and a non-Danish university, in order to make an international collaboration possible.
User driven research

The programme is user driven and is open to applications from all fields of science. Participants are free to define the project theme, giving them free hands to benefit from any research they find applicable to their organisation. This allows companies to use a wide array of research fields to innovate, be it within production, organisation, services, etc.

On a net basis, the company finances more than half the PhD project. Furthermore, the PhD student is only allowed to work on the project in the company. This ensures the company has incentives to create and host a research project with practical applications.

The programme has experienced a significant increase in the number of submitted applications over the last decade, going from 88 applications in 2003 to 200 in 2011. The increase consists of projects from all fields of science, but particularly social sciences (including management and organisation research) and humanities form an increasingly larger share of the total. The programme has traditionally been used for technical and medical research topics, but an ongoing information campaign by the Danish Agency for Science, Technology and Innovation has brought up the numbers of applications from other fields, as companies, students and universities become more aware of commercial applications of the “soft” sciences. As of 2011, one out of four applications are for projects within the fields of social sciences and humanities, while the rest are from the fields of technical, medical and natural sciences.

Quick application processing and high approval rates

As a quality control, every proposal for an Industrial PhD project must be approved by a committee consisting of 25 experienced researchers from both the private and public sector. Applications are assessed according to academic and professional criteria. The committee is highly focused on making sure the research content and quality of the proposals match the requirements of a PhD education, and that a sound framework for the student’s education is provided.

Applications are processed within two months. Projects can start as soon as approval is given. So far all subsidy-worthy proposals have been funded, and the approval rate is typically around 60 per cent. If rejected, an application can be revised and resubmitted at a later application deadline, of which there are three every year. Grounds for any rejection are always supplied, so the applicants can revise sections as needed.

Subsidies and administration

The company receives a wage subsidy of about EUR 1,950 per month or EUR 70,000 for the entire three-year duration of the project, which usually corresponds to about half
the PhD student’s wages. The university enrolls the student and receives a subsidy of between EUR 34,000 and EUR 48,000 to cover its various costs. For the entire programme, DKK 124 million (EUR 16.5 million) has been allocated for new Industrial PhD projects in 2012. This is equivalent to approx. 125 new projects, or roughly 5 per cent of all PhD students in Denmark.

For ease of use, subsidies are paid out separately to the company and university, while the required reporting is held to a minimum. This allows for easier project administration and less bureaucracy, making the programme relatively less burdensome to smaller companies. About 40 per cent of all approved projects are from SMEs, which is considered a satisfying rate considering the high number of large hi-tech companies situated in Denmark.

For more information, go to www.industrialphd.dk

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CASE: A timber merchant with a scientist of its own

Since 1908, Juelsminde Træelasthandel A/S has supplied nails, screws and wooden boards to locals. They have done quite well without the interference of highly educated people in the operation. However, over the last 10 years, the company has grown rapidly. Today, more than 120 employees work in nine branches spread across large parts of Denmark. At the same time, the company has been hit by the recession. As a result, the timber merchant now needs the analysis tools and the knowledge that highly educated people can offer in order to develop favourably, according to Managing Director Preben Rauff.

And so, he has hired MSc in Economics and Business Administration Søren Graungaard Pedersen as an Industrial PhD student. Søren Graungaard Pedersen is developing new strategies for the company. The timber merchant has also hired another academic, an MSc in Public Administration, who is to ensure that the strategies are implemented.
“Quite simply, I expect that hiring these two will give us a better end result and better control of the company,” says Preben Rauff.

**Good flow is worth money**

Søren Graungaard Pedersen spends half of his time working on the ‘hands on’ part of the research project at the timber merchant’s. He spends the other half doing research at the university.

Søren Graungaard Pedersen analyses the flow of goods at the timber merchant’s from purchase to sale. He suggests ways in which to streamline work so that it is carried out rationally at all stages and at all branches. As an example, stock control is optimised so that as little money as possible is tied up in goods in stock, and so that as little transport as possible is needed from one branch of the timber merchant to the other.

Optimum stock control and a thoroughly planned flow are worth money, because costs are reduced and liquidity grows. This is important when you run a business. Especially during a recession.

**No more ‘but, we always do it this way’**

“If we are to point at anything positive in relation to the current recession, it is that today people are more ready for change. After all, if we do not change anything, we may not have a workplace tomorrow,” as Preben Rauff puts it. “Our industry is very much characterised by people doing what they have always done. Maybe it is time to think out of the box from now on.”

There are not many highly educated people in the timber trade, and this does not surprise Preben Rauff. Only rarely do academics and timber people cross paths, and it is quite possible that a certain amount of mutual scepticism exists.

“I think that some business owners fear that people will come into their company who speak a different language. The cultural differences may put some people off,” says Preben Rauff. Personally, however, he enjoys being challenged by the two academics.

“They sharpen my ability to lead the company in the right direction,” he concludes.
Impact of the Industrial PhD Programme

Due to its long history and general popularity, the Danish Industrial PhD Programme has been analysed and evaluated several times in its existence. The two most recent analyses, carried out under the Danish Agency for Science, Technology and Innovation's evaluation strategy, deal with the programme's effects on Industrial PhD graduates and participating companies. The two analyses have been prepared by the Oxford Research Company and the Centre for Economic and Business Research (CEBR) at Copenhagen Business School in 2007 and 2010-11 respectively.

The 2007 Oxford analysis – impact on graduates

The Oxford analysis follows Industrial PhD students and graduates in the period 1994-2004 using personal level register data. It studies developments in salaries, employment, employment place and mobility changes. Employment is measured in terms of employment rates at a given point in time, employment place is a measure of the PhD candidates place of employment before and after project end. Wage is measured in terms of average wage costs, which can be interpreted as a proxy for productivity per PhD employee.

In terms of methodology, the analysis considers the level of employment, wage levels and places of employment for Industrial PhDs compared to regular PhDs (regular PhDs are individuals with a traditional university PhD education). A matching procedure is applied to identify a control group of regular PhD students who are similar to the Industrial PhD students in terms of education, sex, age and region.

For employment, the results of the analysis are:

- Over a nine year-period, starting in the year of end of the Industrial PhD project, Industrial PhD graduates have a higher average employment rate than regular PhDs.

- One year after the end of the project, the employment rate for Industrial PhDs was 90.1 pct. and 84.4 pct. for regular PhDs.

- Nine years after the end of the project, the employment rate for Industrial PhDs had increased to 96.1 pct. and 91.5 pct. for regular PhDs.

For wages, the analysis shows:

- 22 pct. of Industrial PhDs have an annual income between 550,000 DKK and 1 million DKK. Only 18 pct. of regular PhDs have an income in this interval.
- 24 pct. of Industrial PhDs have an annual income between 450,000 DKK and 550,000 DKK. Only 18 pct. of regular PhDs have an income in this interval.

- A greater share of regular PhDs have an annual income below 450,000 DKK than Industrial PhDs.

The 2011 CEBR analysis - impact of the Industrial PhD Programme on individuals and companies

Since companies employ the Industrial PhD student and are project owners, the impact on companies is also highly relevant. Accordingly, in 2011 a research-based impact analysis of the programme was concluded by the Centre for Economic and Business Research (CEBR) at Copenhagen Business School. The analysis follows approx. 430 individuals and 270 companies which have participated in the programme.

At the individual level, Industrial PhD wages and occupations are compared to regular PhDs and other university level graduates. Here, the results of the 2007 Oxford analysis are confirmed. The 2011 analysis finds that:

- Industrial PhDs earn approx. 7-10 pct. higher wages than both regular PhDs and comparable university graduates when adjusting for age.

- Industrial PhDs are more likely to be found at the top levels of their organisation than regular PhDs.

- Industrial PhDs are more likely to be found in positions requiring high-level specialist knowledge than regular university graduates, but less so than regular PhDs.

At the company level, developments are analysed within four success parameters: the number of patents applications, gross profit growth, total factor productivity, and employment growth. A control group is selected from companies not participating in the programme but with the same characteristics as the participating companies. The selection of the control group is based on the propensity score matching method, while the basis for comparisons is the year before the first Industrial PhD project was initiated. Under identifying assumptions, these models isolate the causal impact of the programme on companies hosting Industrial PhD projects.

The impact analysis shows that companies hosting Industrial PhD projects almost double the number of patent applications per year in the years after initiating the first project (significant to the 10 pct. level) compared to non-participating companies:
Furthermore, companies hosting Industrial PhDs display an improvement in gross profit development by DKK 2 mil. a year for a cumulative effect of DKK 30 mil. in the first five years after initiating the first project (significant at the 5 pct. level) compared to companies not hosting Industrial PhD projects:

No significant effects on total factor productivity can be detected. However, Industrial PhD hosts show improvement in employment growth by more than two employees per year in the first five years after initiating the first project (significant at the 1 pct. level):
FIGURE 4.2.10: Number of employees developments, high-quality matches

Average values relative to year 0

Companies with Industrial PhD projects
Companies without Industrial PhD projects

Years before/after year 0
Industrial PhD Programme Q&A

1. Is the quality of Industrial PhD projects the same as regular PhD projects?

The Industrial PhD Programme follows Danish regulations on PhD education. Accordingly, Industrial PhD projects are subject to the same academic quality assessments as regular PhD projects, including evaluation of the thesis. Additionally, a committee of 25 professionally and academically qualified researchers assesses all project proposals on behalf of DCTI to ensure that only projects of sufficient quality are granted subsidy.

2. What is the main purpose of the programme: research, education or innovation?

The programme has three main purposes:

- To educate researchers with insight into aspects of private sector use of research and innovation
- To create growth in the Danish private sector by furthering cooperation between enterprises and universities
- To facilitate interchange of knowledge between universities and Danish enterprises

The programme structure allows all three purposes to be fulfilled at the same time.

3. Is there any interaction between the company and the supervising university, apart from the supervision of the PhD student?

During the project, the Industrial PhD student is required to divide his/her working time between the company and university, and this requires collaboration between the two parties if the project is going to work out well. The initial project proposal – which the company and university have to agree on - has to provide details on the practical arrangements. The Industrial PhD Programme Committee then assesses if the proposal is sufficiently detailed and achievable to be approved. Further interaction during the project depends on the individual needs and wishes of the participants.

4. Is it possible for an Industrial PhD project to be part of a larger research project?
Yes, it is possible. However, the Industrial PhD project must not receive any subsidies from other public sector sources, including any public sources funding the larger research project.

5. Are EU regulations regarding government subsidies observed?

Yes. The Industrial PhD Programme observes EU’s General Block Exemption regulations for research and development initiatives.

6. How does the university contribute to the project?

As a minimum the university is responsible for ensuring the project’s academic quality and proper compliance with PhD education rules and regulations. The initial project proposal also has to explain what essential competences the university brings to the project for approval (see also question 3). This is necessary, since the student is to spend half his/her time working on the project at the university. A common approach is to collect data in the company which is then analysed and interpreted at the university under supervision from a qualified supervisor.

7. Are there any equally attractive alternatives to the Industrial PhD Programme with regard to subsidies, e.g. co-financed PhDs and regular PhDs?

Currently, the Industrial PhD Programme is the only Danish public subsidy programme for individual PhD projects outside the auspices of Danish universities. Companies and universities can agree on their own terms to co-finance individual PhD projects. However, the question of intellectual property rights (IPR) is central to how attractive a co-financed project is to the company. Since the Industrial PhD student is employed in the company, it gains certain IPR under Danish law, making the programme more economically attractive. This will not be the case with regular PhDs who are employed at the university.

It should also be noted that the Industrial PhD Programme is financially prioritised and has been able to provide subsidy for every grant-worthy proposal so far. This stands in contrast to the often limited funds available for PhD education at universities.

8. Which sectors make the most use of the Industrial PhD Programme?

Engineering, biotechnological, pharmaceutical and specialist consulting sectors.

9. How old are Industrial PhDs on average when graduating?

36 years old, according to an analysis conducted in 2011 by the Centre for Economic and Business Research (CEBR) at Copenhagen Business School.
10. **How is the gender distribution?**

Roughly 3 out of 5 Industrial PhDs are male.

11. **How large is the share of non-Danish Industrial PhD students?**

In 2010, 12 pct. of all new Industrial PhD students were from outside Denmark. The number has been increasing at a steady pace for the past decade.

12. **Is it possible for a non-Danish university to be the sole supervisor for a Danish Industrial PhD project?**

No. A non-Danish university can be the main university supervisor, but a Danish university has to be attached as a third party to the project. An Industrial PhD project also always includes a company supervisor.

13. **Which criteria determine the selection of an Industrial PhD?**

The candidate for the Industrial PhD education must hold a master’s degree or equivalent, and must have obtained a weighted grade point average of at least 8.2 on the Danish 7-point grading scale and a thesis grade of at least 10. The master’s degree also has to be relevant for the project.

If the candidate does not live up to these requirements, other qualifications such as publication of peer-reviewed papers, research experience and research-based patents may also be deemed sufficient compensation for insufficient grade levels.

14. **Is it possible for the company to fire the Industrial PhD student? If so, what does the student do?**

It is possible, but unless the company can prove that the student has not fulfilled his/her obligations, DASTI will demand repayment of any paid out subsidies. If the student has fulfilled his/her obligations and the project is at least two years old, DASTI may finance the rest of the education at the university. If the project is not two years old, then the only option for the student is to find another company to host the project.

15. **Is there a danger that too many PhDs are educated and that the demand on the employment market is too low? How do you ensure that Industrial PhD graduates are employed?**

An analysis from 2007 shows that whereas about 80 pct. of regular PhD graduates are employed in the public sector, 85 pct. of Industrial PhD graduates are employed in the private sector. The employment rate for Industrial PhDs is also several percentage
points higher than regular PhDs. This shows firstly that there is a very real need for Industrial PhDs in the private sector, and secondly that they do not generally compete for the same job positions as regular PhDs. Accordingly, there is no basis for assuming a 'crowding-out' effect of more Industrial PhDs.

16. Is it possible for the company to keep research from the Industrial PhD project for itself?

No, all results from research projects fully or partially funded by the public sector have to be made public. However, it is possible to delay publication for a few months to allow patenting. Assessment and publication of the Industrial PhD thesis can also be delayed for the same reason, but only up to three months.

17. Are there any special challenges related to an Industrial PhD project?

It can be a challenge for the student to divide his/her time between the company and university, since these are two very different working environments with different interests. However, the benefit for the Industrial PhD student is that he/she becomes more proficient at guiding a project involving several parties and working in multiple areas, both of which are an integral part of a career in research.

CASE: Research making you sweat

PenSam is a Danish pension fund with 360 employees and over 350,000 members. When members get more exercise and eat better food, it starts a virtuous circle. The members become more healthy and energetic. At the same time, their sick days are reduced to the benefit of their workplace and colleagues. And finally, the pension fund saves money, since less members retire early. But how does one best motivate people to pursue a healthy lifestyle? Sociologist Nina Charlotte Schiøtz has been hired to answer that question.

“We know from projects PenSam initiated before I started that it is possible to motivate people. Now we have to organise that knowledge, so more people can benefit,” she says.

PenSam’s members are from a range of industrial sectors, including social and health care workers, firemen, cleaning assistants and porters. The fund’s members generally experience more health issues than the average Dane. This results in an increased rate of early retirement.
**Digital media motivate**

According to PenSam, its earlier projects have been ‘cardboard-and-paper campaigns’, where employees have visited certain workplaces. The campaigns did work, but they were also rather expensive. My research project is about new campaigns using digital media to motivate members,“ Nina Charlotte Schiøtz explains. In the campaigns, members are divided into groups competing against each other. Text messages and Facebook groups help sustain the motivation.

It is the second time PenSam makes use of the Industrial PhD Programme. The company only found out about the programme by chance, says Managing Director Helen Kobæk: “As a company executive you don’t consider hiring PhDs as the first thing to do. But when we discovered the programme, we quickly realised it could be valuable to us.”

**Good for business**

PenSam does not profit directly from the project, Helen Kobaek emphasises.

“But I expect we will experience a net value gain in the long run, because we will be able to start up effective prevention projects afterwards. At the same time, we get to know more about using digital media in connection with prevention efforts.”

Nina Charlotte Schiøtz sees the Industrial PhD as the ideal fit:

“It’s very appealing to be in the private sector because it focuses on getting things done. On the other hand I like the research sector, because it allows you to examine something thoroughly. As an Industrial PhD I get to do both.”