An Analysis of Firm growth Effects of the Danish Innovation Consortium Scheme (Denmark)

1. Introduction

This evaluation was conducted by the Centre for Economic and Business Research (CEBR) at the Copenhagen Business School in 2009/2010. It examines the economic impact of the Danish Innovation Consortium Scheme which is a subsidy scheme operated by the the Danish Council for Technology and Innovation (RTI) in cooperation with the the Danish Agency for Science, Technology and Innovation (DASTI).

In a counter-factual analysis, the evaluation examined 220 firms which had participated in at least one Innovation Consortium using a firm-register dataset. The focus is on firm level developments in two success parameters: gross profit and employment. Innovation Consortia subsidise and facilitate cooperation between private firms and research and knowledge institutions, thus contributing to the dissemination of knowledge and research results from the research sector into the business sector.

As noted in the evaluation report "Although this analysis is an evaluation of a specific subsidy scheme, its results might be of general interest, as schemes similar to the IC scheme have been implemented in a number of countries. However, general knowledge of their effects which can be integrated into cost-benefit analyses of these schemes is still rare". As such the evaluation is of interest to policy makers involved in the formulation of innovation support, whilst its simple yet comprehensive and robust analytical approach would be likely to interest policymakers and evaluators more broadly. The evaluation report is available on-line and in English, in contrast to previous evaluations of the scheme.

2. Description of the evaluated measure

The objective of the IC Scheme is to translate research-based knowledge, developed within public research institutes, into a form that can be taken up and developed by Danish companies and which may stimulate future innovations for the benefit of those companies and the wider Danish economy. This is achieved through the financing of a consortium arrangement involving two or more Danish companies, a public research institute and technological service institutes (knowledge dissemination agents) based around a joint research project. The outcomes of the IC based joint project should result in the completion of high quality research of relevance to Danish companies. In particular, the research project should ensure that the "new knowledge derived is converted into competences and services specifically aimed at companies and that the acquired knowledge is subsequently widely disseminated to the Danish business community". More broadly, the IC Scheme aims to strengthen cooperation between companies, public research institutions and technological service institutes in order to develop new generic technology platforms, in terms of both product and service development, over the subsequent 5-10 years.

Small and medium-sized businesses are highlighted as a specific audience for the outputs, although the IC Scheme is open to all sizes of firm. The Scheme is open to both Danish and non-Danish companies.

Enterprises must contribute with 50% of the funding. Typically an Innovation Consortium has a total budget of €2.5m - €5.5m and lasts 3-4 years.

According to the most recent (04/2010) information on the ERAWATCH website (http://erawatch.jrc.ec.europa.e), the Scheme has the following policy aims:

- establish improved co-operation between knowledge institutions and industry;
- establish more knowledge based co-operation between companies;
- increased and improved R&D resources in industry;
- improved innovativeness of Danish economy;
- more excellent public research with relevance for Danish companies;
- commercialisation of research results;
- development of improved competencies and services technological service institutes;
- transfer of new knowledge to Danish companies, and especially to SMEs.

The evaluation study background information states that "An innovation consortium is a flexible framework for collaboration between companies, research institutions and non-profit advisory/knowledge dissemination parties. An innovation consortium must consist of at least two companies that participate throughout the entire project, one research institution and one advisory and knowledge dissemination party. Additionally, an innovation consortium may involve or attach other types of partners that are considered relevant to the project."

The main target groups are Danish companies and research institutes (including Higher Education Institutions - HEIs) with the added participation of knowledge dissemination partners (so-called TSS institutes – private, government-approved institutes which receive base funding from the government for knowledge transfer activities).

Given the nature of the IC Scheme, the main challenges faced by the (limited remit of the) evaluation were:

- How to quantify and measure the effects of scheme participation?
- How to ensure that any such effects were attributable to the scheme – i.e. how to control for non-participation?
- How to assess these changes across the range of firms involved in the scheme?

Name of measure: Innovation Consortium (IC) Scheme

Type of measure: Science –Industry cooperation; Technology Transfer

Budget: €16m (annually)

Start/end date: 1995 – ongoing

Geographical coverage: Denmark (national level)

3. Design of the evaluation study

The evaluation study actually had no specific terms of reference, although the scope and objectives were determined by the Danish Agency for Science, Technology and Innovation. This evaluation originated from an idea for a methodology by the Head of the Centre for Strategic Research and Growth of the Danish Agency for Science, Technology and Innovation which he promoted to the Scheme's co-sponsor, the Danish Council for Technology and Innovation, RTI. It built on a relationship that had developed between the Danish Agency for Science, Technology and Innovation and the evaluators (who had already undertaken an earlier evaluation of the IC Scheme).

In this instance, the Head of the Centre for Strategic Research and Growth of he Danish Agency for Science, Technology and Innovation arranged to supply the raw data on the participating companies to the evaluators and provided a four-year sponsorship with the remit to develop a methodology which could be used to determine the economic impacts of the IC Scheme and then to implement this. Initially, there was some hesitancy at the higher levels of the Danish Agency for Science, Technology and Innovation and the ministry concerned (Ministry of Science, Technology and Innovation) since the evaluators were being given *carte blanche* to develop a pilot methodology: the fear was that this untried approach might result in a negative outcome for the impact of the scheme – however, in further discussions the evaluators and the Head of the Centre for Strategic Research and Growth were able to demonstrate that the methodology would be appropriate and that the outcome concerning the performance of the scheme (whether positive or negative) would be valid and would serve as the basis for future policy action. The fact that the approach was also acting as an exploratory pilot for a relatively untested analytical approach, which, if successful, could be more widely applied in further evaluation studies, also proved a convincing argument. In this sense, the case study is also interesting since, although there is a constant search to develop and refine new evaluative approaches (particularly in the context of the assessment of longer term impacts), there is often little opportunity, due to rigidly structured Terms of Reference or due to budgetary constraints, for evaluators to engage in such exploratory exercises. The willingness of the programme sponsor to engage in more exploratory activities (which were nonetheless based on sound methodological approaches) was a welcome departure from the more typical evaluation practice.

Thus, in the absence of specific terms of reference, the main objective was to examine the economic impact of the IC Scheme on the participating companies. The variables selected to do this related to two growth parameters, namely gross profit and employment. More specifically, the methodology sought to determine absolute and percentage growth in gross profit and the number of employees both before and after participation in the programme and to analyse the changes in the growth pattern. Given the limited remit of the evaluation, these indicators appear entirely appropriate. In addition, the counter-factual methodology involved the identification of a control group of non-participating firms which were similar to the participants in terms of size, industry sectors and region of location (propensity matching). The underlying assumption was that growth in gross profit and employment in participants and non-participants would be equal in the absence of programme participation (the counter-factual), and hence differences between the two groups of firms could be interpreted as the causal impact of the programme on participating firms.

For the purpose of the study, employment was defined as the number of employees in a given point in time (XYZ months/ years prior to participation in the IC scheme), while gross profit was defined as annual net sales from which was subtracted annual costs of variable inputs (raw materials, energy, intermediate goods purchases, etc.). It was argued that gross profit was the most precise measure of the firms' value creation although it was recognised that part of this may be passed on to consumers through improved product characteristics, retained in the firm to increase its value, or take the form of positive externalities, such as knowledge and/or innovations, that benefit other firms or society.

It was not known from the interviews whether the data required for the evaluation were taken into consideration during the design of the programme, although this seems highly unlikely given the exploratory nature of the evaluation methodology. However, it should be noted that Denmark enforces a particularly rigorous set of data collection requirements for Danish firms – much of it linked to tax regulations. The fact that the evaluation data requirements were not apparently considered during the design of the programme did not appear to result in any data gaps in the subsequent evaluation or have any other negative consequences.

The Danish Agency for Science, Technology and Innovation operates a typical rule of thumb for evaluation budgets, allocating between 0.5-1.0% of programme budget to the evaluation process. In this instance, the cost of the study was approximately €40K.

Although the overall evaluation methodology was developed over a four year period (the agreed term of the cooperation agreement) under the aegis of the Danish Agency for Science, Technology and Innovation, the study itself was performed between September 2009 and April 2010. It should be noted that the Danish Agency for Science, Technology and Innovation does have an internal evaluation unit which provides advice on evaluation needs although it does not appear to conduct internal evaluations in its own right.

4. Implementing the evaluation: methodology and process

The evaluation was undertaken by an external consultant – the Centre for Business and Economic Research (CEBR) at the Copenhagen Business School. As noted, there was no formal selection process in place since the evaluator had been directly commissioned at the instigation of the Head of the Centre for Strategic Research and Growth at the Danish Agency for Science, Technology and Innovation in order to develop and pilot a methodology for the specific purpose of determining the economic impact of the programme. The evaluators had also been responsible for the 2005/06 evaluation of the IC Scheme.

It is interesting to note that the evaluation approach was very simplistic considering that the IC Scheme is a knowledge transfer instrument which potentially involves interaction between the various members of the consortium at a variety of levels. However, the Scheme has been subject to a number of evaluations (in 1998, 2001, 2005, 2007 and 2008). These reviewed different attributes of the Scheme, such as participant satisfaction (i.e. management and administrative process issues) and participant interactions (network effects) along with assessments of which type of consortium appeared to work well and whether certain types of firm performed better than others. The evaluation in question was the first economic impact assessment and was conducted because a sufficient population of participants had built up and the time frame was long enough to undertake a robust post-participation assessment.

A key element of the evaluation methodology was the existence of a comprehensive and accurate database of the participating firms. This was derived from three sources:

- The data on programme participants was assembled by CEBR based on the paper records provided by the Danish Agency for Science, Technology and Innovation. These had been prepared for an earlier evaluation (Forsknings-og Innovationsstyrelsen, 2007 and 2008). These data were referred to as 'IC data'.
- Data from a private information provider, Kobmandsstandens Oplysningsbureau - KOB (now Experian A/S) – a credit ratings agency. This dataset was derived from the financial reports that firms of a certain size and ownership structure are obliged to file by the Danish public authorities. Thus, the dataset typically contains multiple observations for a given firm (one for each annual account). These data were referred to as 'firm-year observations'. The data contains information on a number of accounting related variables including employment and gross profit and on industry type and location.
- Information on firm transitions (e.g. mergers, liquidations or bankruptcies) included in the 'cvr-register' of the Danish Commerce and Companies Agency. These data were used to analyse survival probabilities of participating firms.

From an initial 405 firm observations in the IC data over the period 1995-2003, the evaluators were able to identify a sample of 220 firms which fulfilled the required criteria for analysis. Firms were excluded for a variety of reasons: lack of data on programme participation start date; lack of firm-identification numbers; multiple

participation (firms participating more than once were treated as a single participant); lack of information on the KOB database; and lack of accounting information in the KOB data before the start of the programme (required for the before-after analysis).

The first step of the analysis involved the identification of a control group of comparison firms from the total universe of firms available in the data, independent of missing observations or zero reporting. The second step involved the comparison of the performance of participant firms with the performance of firms in the control group. Great attention was paid to ensuring that the data was 'clean', i.e. derived from firms that had reported regularly, and which did not raise suspicions of significant organizational or accounting issues. For example, firms reporting zero gross profit in the KOB database were assumed to represent non-reporting firms since, if there is any economic activity, zero gross profit is an event having (almost) zero probability.

The control group was identified through a 'matching-on-observables' (e.g. Woolridge, 2002). Here, a control was identified for each firm participating in the scheme which had characteristics as similar as possible to the participating firm prior to its participation in the programme. This approach represented an evolution of the evaluator's previous evaluation of the IC Scheme (Forsknings- og Innovationsstyrelsen, 2007 and 2008), which used randomised private sector firms for comparison purposes. Due to the potential for better matching the comparison data, the revised method was considered to be an improvement, a decision which seems entirely appropriate for reducing data variance.

For the participants, comparisons were made of the growth in employment and gross profit in the time period before participating in the IC Scheme with the growth in employment and gross profit in the years after having participated. The cut-off year which separates the pre-participation period from the after-participation period was denoted the 'base year'. A base year was also defined for the controls, defined as the year the given control was selected – i.e. the year in which it most closely resembled one of the participants in its base year. Thus it was possible to compare the growth in gross profit and employment between before and after the base year for the control firms.

The analysis considered the growth of either of the two success parameters (gross profit and employment) before and after the base year, and measured growth both as absolute and percentage annual increases. Changes in growth were analysed before and after the base year, with comparisons between participants and controls. Again, this improved upon an earlier methodology where the evaluation was based on a comparison of the levels of participants' and control firms' success parameters, examining whether participants had grown faster than non-participants. The latter failed to account for the possibility that participant firms might generally have higher growth independent of whether they decide to participate in the programme or not. However, any inherent growth difference between participants and controls would be expected to manifest in the years before the base year and can be controlled for in the revised analysis since rather than comparing pre-participation levels of success parameters with post-participation levels, a comparison is made of pre-participation growth (or increases) with post-participation growth (or increases). This controlled for innate growth differences.

The use of absolute growth measures (e.g., 'ICs increase participants' gross profit by on average xDKK') allowed for integration into cost-benefit analyses, whilst inclusion of relative (percentagewise) growth gave greater weight to smaller firms in case of absolute programme effects being larger for larger firms.

The analysis only considered firms for which data was available for at least three years before the base year and five (in a second iteration: ten) years after the base year.

Absolute growth increases were based on the average of each firm's annual increases in the success parameter in the three year period before the base year and on the average annual increase in the success parameter in the five (ten) year period after the base year. Thus, two observations were available for each (participating and control)

firm: one describing average increases before the base year, and one describing average increases after the base year.

Consequently, any differences in the increase of annual growth could not be interpreted as the result of different pre-base year developments, nor by reference to differences in the two group's characteristics given the similarity of participants and controls. Moreover, the models included additional control variables to take account of potentially remaining differences. Therefore, the adopted approach makes it more likely that positive differences between participants and controls must be attributed their participation in IC schemes.

As part of the evaluation, an alternative sampling process was performed through a slight modification of the selection parameters and detailed checks for the robustness of the results were also performed.

The analysis also omitted very large firms. Some of the firms participating in the IC Scheme demonstrated profits of many billion DKK and had several thousand employees. Thus, the potential effects of participation in the IC Scheme would be expected to be virtually undetectable in such firms. Therefore, the analysis only considered approximately the smallest 75% of all firms in the sample.

The results indicated that there were positive potential gross profit effects due to programme participation. More specifically, it was found that participants in the IC Scheme experience annual increases in gross profit in the first five years after the start of their participation; these are on average DKK3.7m (almost €0.5m) above that which would be expected in the absence of programme participation. It was assumed that participants would have experienced the same developments in gross profit growth as the controls in the absence of the programme and that the additional €0.5m per year in the first five years after participation is due to the impact of participating in an IC.

Over a ten year-period, the average potential effect gross profit effect was smaller, approximately DKK2m (€0.27m) per year. Moreover, the difference was no longer statistically significant. It was postulated that the potential effects of programme participation are realised in the years immediately after starting to participate in the programme and that the average of the annual increases over a period of time become smaller the longer the time period under consideration.

Assuming that the participants' counterfactual growth in the absence of IC Scheme participation was appropriately measured by the growth of the control group, the authors assess the effect of the programme as increasing the annual gross profit per year of smaller firms by about DKK20m (€2.68m) over the five to ten years subsequent to participation.

In terms of the results for the impact of the IC Scheme on employment, there were no significant results for the sample of firms in which large firms were included. On the other hand, smaller participating companies (i.e. those with fewer than 150 employees in the year prior to IC participation) had an additional annual employment growth of approximately 11 employees (a result that was statistically significant at the 5% level).

Thus, overall, no potential programme effects were detected for the samples which included large firms, but there were positive potential effects on gross profit and employment for relatively small firms.

In terms of the organisation of the evaluation process, the contractor and the commissioning body had extensive contacts, particularly through the development stages of the pilot methodology. For example, the programme management made all the relevant information on the participating companies freely available to the evaluators and assisted in the provision of data for the construction of the databases for the counterfactual analysis. Thus, the evaluation methodology was essentially a co-development between the commissioning agency and the contractors. The design process for the methodology included seminars with relevant ministers and officials and a large workshop at the Copenhagen Business School at which the methodology was discussed by interested parties.

5. Effectiveness and efficiency of evaluation

According to all those interviewed, the study had completely fulfilled the evaluation objectives, although these were relatively restricted in this particular case. Thus, evaluation was certainly effective, although it must be borne in mind that the development of the methodology itself took place as part of a four-year research project sponsored by the contracting Agency and was applied (in different iterations) over two evaluations. Moreover, much of the data collection required (see below) had been undertaken either externally (i.e. the KOB database and cvr-register) or internally as part of the programme management process, rather than by the evaluators themselves (although they did carry out a through cleaning of the data).

The methodology itself is highly dependent on the availability of high quality, comprehensive and consistent data covering a time period which encompasses the pre- and post-participation time frame. In the Danish case, such data is readily available (as noted above) thanks to the taxation requirements imposed on Danish firms. However, it should also be noted that the original data sample did contain some inconsistencies and gaps despite the rigid requirements for this data. The fact that the availability of high quality of company information in the Danish example could be regarded as a 'gold standard' might preclude the adoption of this evaluation methodology in other Member States, unless alternative approaches to obtain the necessary information were used.

The evaluators noted that it was difficult to assess the counterfactual *behavioural* effects of non-participation in the IC Scheme. This was not measured in the study itself. For example, it might be the case that participation in the ICs acts as a stimulus in the implementation of firms' strategic decisions and innovations, which explain the positive developments observed. Nonetheless, the impact on annual gross profit is still significant, irrespective of the underlying causality.

The method also suffered some limitations with respect to the samples that included large firms. Any changes in gross profit and employment would need to be relatively substantial in such firms in order to detect any programme impact. However, as this is a measurement issues, it does not imply that the programme did not have any effects on participating companies – these may have been masked.

The evaluators suggest that regular updating of the company data would offer the opportunity to conduct further analyses to determine which firms benefit most from programme participation and also which ICs work better than others (the evaluator noted that there was a large degree of variation in terms of how well individual firms performed under the Scheme). Additional data would also enable sector-specific analyses (the study did attempt this but the number of cases precluded statistical reliability). In addition, the use of patenting data (unavailable in the study under consideration) would also allow exploration of firms' innovation output activities: it was noted that such data was likely to become available for future analyses. Again, the evaluator noted that the types of indicators selected were very indirect and that more direct indicators of innovation performance might be desirable in future evaluations.

It should also be noted that, being limited to an assessment of a restricted set of economic impact variables, the evaluation did not specifically address the underlying reasons of why the scheme worked or whether it represented value for money. However, the authors tentatively concluded that the difference in benefits accrued by scheme participants (estimated as DKK20 million/€2.68 million over ten years) more than offset the programme subsidies (estimated at DKK3 million/€0.4 million per recipient firm) even if only a fraction of this benefit was a direct result of participation.

6. Conclusions and lessons learned

The evaluation was successful in that it developed a methodology highly consistent with the objectives set by the commissioning body (the Danish Agency for Science, Technology and Innovation) which addressed an albeit narrow set of questions, i.e. to assess the economic impact of the IC Scheme on participating companies. This level of consistency was achieved by the close relationship and level of interaction demonstrated between the evaluators and the contractors and through the opportunity to apply the methodology in two separate evaluations, allowing further refinement of the approaches used. The personal engagement and high level of interest of the key sponsor (the Head of the Centre for Strategic Research and Growth within the Danish Agency for Science, Technology and Innovation) could also be highlighted as a major contributory factor to the success of the methodology. Overall, the entire process was described as "very smooth" by the evaluator.

With regard to the approach itself, the programme manager noted that the evaluation had delivered a high degree of utility: it had provided essential answers to specific questions that were required for political justification and budgetary requirements and it had provided a clear quantitative evidence of the programme's success. Moreover, it had led to the development of a methodology that was both replicable and transferable.

As noted it was highly dependent on the availability of good quality comprehensive data on both the participating firms and on the control group of firms required for the counterfactual analysis. This also makes the requirement for such high quality information a potential limiting factor to the adoption of the approach in other contexts. In the absence of existing data sources, it would be necessary to expend more evaluation resources in order to develop the necessary data. Moreover, it would not be routinely updated as is the case in Denmark. However, it should be noted that the evaluator let it be known that the use of the method was also being explored as a potential methodology for evaluating Eureka programme participation. It was also noted that the same approach was being applied in other Danish innovation support schemes such as the Industrial PhDs Scheme, International Collaboration Projects and the Innovation Assistance Scheme.

A careful selection process was utilised in defining the group of control firms, which ensured that these were very similar to the participating firms in terms of their characteristics prior to their involvement in the Scheme. This reduced (but did not entirely remove) the possibility that extraneous factors might be responsible for any observed deviations in the economic growth variables between the two groups as a consequence of participation in the Scheme.

Since the evaluation methodology was relatively straightforward, its use by other evaluators would not be particularly limited by a need for advanced or specialist competencies.

By admission, the evaluation did not address a number of issues that are typically significant for this type of innovation support measure, such as participant satisfaction, uptake statistics and the rationales for participation, management and administrative process issues, knowledge transfer aspects, impacts on other IC participant partners, outputs (e.g. publications, patents[1]) and their associated quality issues, etc. The contractor estimated that it only delivered about 20% of the total

[1] The use of patent analysis may not have been appropriate since it would suffer from similar constraints with regards to firm size, i.e. small companies would tend to exhibit low levels of patenting activity, whilst patenting by large companies would be difficult to attribute to the specific research activities performed as a result of participation in the scheme. In addition the broader view that patenting forms a poor proxy indicator of innovation activity due to the variety of underlying motivations and behaviours it entails, also applies.

amount of information required for the full evaluation of the IC Scheme; however, this was fully recognised. Thus, separate accompanying evaluations have also been conducted, using different evaluators and over different timeframes into these specific aspects.

This approach carries lessons for the evaluation of programmes more generally in that it offers the opportunity to conduct separate, more targeted evaluation studies, performed by different evaluators with distinct capabilities and expertise rather than undertaking a single one-off more comprehensive evaluation. This is particularly useful in cases where timing issues may be important as it avoids having to make a trade off between carrying out an early-stage evaluation to obtain the management/process information which might indicate the need to change the way in which the scheme is administered, or a mid-term evaluation in which emerging networking and knowledge transfer/output effects might be assessed or finally a longer term evaluation in which various aspects of impacts might be assessed.

To summarise, the main conclusions are:

- The evaluation was highly focused on a limited set of impact variables and thus was fully tailored (in terms of methods and timing) to assess the programme effects in this context.
- The evaluation's success was in part attributable to the consistency between the evaluation approaches and the requirements of the programme sponsor.
- The close relationship and high level of interaction between the programme sponsor and the evaluators led to the formulation and implementation of an effective and useful evaluation (useful in the sense that the study contributed to policy learning).
- The success of the principal study methodology was predicated on the existence and availability of comprehensive and robust firm-level data.
- The study was able to utilise this data to produce reliable comparison data sets of participants and non-participants.
- Given the preconditions outlined above, the methodology appeared to offer good scope for its application to the evaluation of other similar schemes.
- The broader evaluation approach using variable timings and appropriate methodologies offers lessons for future evaluations.

Interviewer and case study author: Paul Cunningham, Manchester Institute of Innovation Research

Case study completed: October 2011