Session 4	The Role of National Research Policy in an Era of Global Innovation Networks	
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Increasingly innovation is taking place within global networks of different types of companies, universities and other research organizations. Still, however, and I believe for the foreseeable future, universities and many research institutes are dependent for most of their funding on governments sources. I would like to focus my presentation on the issues created by this asymmetry and use examples from Sweden.

In 2003 industry-spending on R&D in Sweden represented 2.7 percent of GDP, one of the highest shares in the world. This reflects the fact that many large companies, which have expanded their manufacturing and service operations globally have continued to carry out a large portion of their R&D in Sweden.

Fewer than ten companies in the telecommunications and industrial equipment, motor vehicle and pharmaceutical industries dominate R&D-spending. Until 1988 all of them were Swedish-owned. Since then Asea and Brown Bovery merged to form ABB, Saab Automobiles was acquired by GM and Volvo Cars by Ford, Pharmacia merged with Upjohn and the merged company was later acquired by Pfizer, and Astra merged with Zeneca to form AstraZeneca. In all these cases and many other similar cases, the headquarters of the acquiring or merged companies are today located abroad. As a consequence, the Swedish R&D-units have to compete for resources within global companies. The situation is, however, not so different in those companies which are still Swedish-owned. They have acquired or established R&D-units abroad, which are also competing for resources with the Swedish units.

The consequences of these developments have so far in most cases been positive for the R&D-activities in Sweden. Even so, there is concern for the future. As a result the importance of Sweden offering an attractive environment for R&D in global companies, be they Swedish-owned or foreign-owned, has therefore become generally recognized and is now a major objective for research policy. The recent initiatives by most large research funding organizations in Sweden to concentrate more of their funding on creating internationally competitive research environments (and in some cases including innovation activities in companies) is the clearest expression of this recognition.

Fairly well functioning mechanisms for research cooperation between domestic universities and companies have been developed (e g the Competence Centers program run over ten years and recently ended but replaced by the new VINN Excellence Centers program operated by VINNOVA). A major challenge for the future is how to develop strong enough research and innovation environments for attracting also foreign firms. There is also a need to increase the interaction with those internationally competitive medium-sized

firms in Sweden, which so far have had little contact with universities. Many of these are foreign-owned.

As the capacity of large firms to create new jobs in Sweden has declined, increasing attention has been given to the creation of new innovative firms with growth potential and expansion of existing small and medium sized firms.

The successful creation and growth of new companies based on research at universities is a very difficult task. The infrastructure for supporting this task has gradually evolved in Sweden over the last 25 years, starting with the creation of the first science park Ideon in the immediate vicinity of Lund University. Although many companies have since been created the most successful have so far not grown beyond the size of 300-400 employees and the total number with more than 100 employees are probably fewer than 20 or 30. It should be emphasized that young knowledge-based firms may indirectly contribute to wealth-creation more than their employment level would suggest.

An important question is whether the importance of research-based new companies will play a more important role in the future than they have done so far. The great interest in the creation of university spin-offs currently shown all over the world does indeed suggest that this may be the case. The jury is, however, still out and the high expectations may ultimately prove to be wishful thinking.

A new VINNOVA-program for funding of "product-related R&D-projects" in firms with fewer than 250 employees provides some interesting data on the roles played by universities. The overall requirement in the program is that the projects shall "strengthen the company's capacity to compete on the global market and thereby contribute to the generation of economic growth and new jobs in Sweden". Please note that the emphasis is on competitiveness in the global market.

During the first half year of the program, 33 companies, out of 316 who applied, received grants for R&Dprojects, varying in size but on average 300,000 € per project for a project period of 6-18 months. The companies must finance half of the cost of the project, which may or may not utilize external research resources. Only one third of the companies have no significant interaction with university research. As many as 14, or more than 40 percent, of the companies, were created on the basis of unique knowledge or technology from Swedish universities and almost all seem to regard continued cooperation with these universities as crucial in their innovation activities. The original ideas that formed the basis for the creation of another three companies came from abroad, but for two of them Swedish universities and companies are crucial partners in developing the technology to a commercial stage. The remaining six companies were established without direct links to university research but today work closely with one or more research groups at Swedish universities. 13 of the companies were established prior to 1997, another 9 between 2000 and 2002, and the remaining 11 in 2003 or later. The strong concentration of the selected companies among young and still fairly small companies is striking as is the close cooperation of two thirds of the firms with universities. A large portion of the young companies still have some way to go to achieve profitability, although the fact that they were selected in this exceedingly tough competition shows that they are indeed considered very promising.



Recently the infrastructure for support of university start-ups has been significantly strengthened with the creation of the Innovation Bridge, which operates a national incubation program and provides seed-funding for research-based start-ups.

A major discussion point in Sweden right now concerns the right to the inventions made by university researchers and teachers. Today, the rights belong to the researchers unless a special agreement has been signed to the contrary, something which occasionally happens in the case of joint research with companies. A change in the law implying a transfer of the rights to the universities is currently being debated. Some have argued that it is difficult for universities to establish an effective system for commercialization of research if the ownership rights are scattered among the individual researchers. Others argue that the fact that researchers have the right to their own inventions facilitates interaction with industry and gives the researchers strong incentives to care about the commercial potential of their research.

An interesting example of the handling of intellectual property by university researchers can be found in the field of Forest Biotechnology. A company, Woodheads AB, was created by 46 researchers at five universities to handle their intellectual property in the field of tree functional genomics. Through a Material Transfer Agreement with a predetermined fee structure, another company SweTree Technologies (STT) has the right to all inventions emanating from this large body of research in the fields of plant and forest biotechnology, representing a research investment of 45 M€ over a ten-year period. STT was originally established in 2001 by Woodheads AB with seed financing from (what is today) the Innovation Bridge. It has later raised 8 M€ in capital in two investment rounds from three forest companies and other investors.

New research-based companies in a small country like Sweden are usually dependent on establishing themselves on the global market at a very early stage. Cooperation with larger firms in R&D, manufacturing, marketing and after-sales services is often necessary. Many of these partners will be foreign firms. Even if the young companies prove successful in their research and technology development, there is no guarantee that the main economic value created through their innovations will be located in Sweden. The best any policy in relation to such companies can hope for is to increase the <u>probability</u> that a fair share of the value creation will take place in Sweden. As yet we have, however, too little systematic knowledge of how such research-based companies plug into the "global innovation eco-system" to develop effective policies.

As already mentioned, a major difficulty in formulating effective research policies, which aim at promoting innovation, lies in how to assess the relative importance for the future of universities and other research organizations as sources of seeds for innovation, and especially for radical innovation. There may be big differences here between fields, with biotechnology and nanotechnology, for example, more dependent on universities than other fields. Does this mean that these science-driven fields will come to represent a growing share of all radical innovations and other fields also gradually become more science-driven in their innovation style? Or will other fields continue to show a different innovation style with companies, non-academic inventors and "users" playing the major role as sources of innovations? The answer to these questions will have a big impact on how public investments in research can best contribute to innovation and value creation in the domestic economy.