Country Report

Transformation of Finnish Science and Technology Policy

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The paper discusses the transformation of Finnish science and technology policy from the mid-1960s until today. The basic argument of the paper is that, if there is a "Finnish model" of science and technology policy, it was not created in the years of rapid growth in the Finnish economy after the deep economic and societal depression of the early 1990s. The Finnish transformation process in a policy for science and technology is characterized by a gradual change of more than three decades through incremental improvements in policy doctrines, institutions, organizations and instruments. After a short period of diversity at the turn of the 1970s, the pervasive trend has been an increase in technology and innovation orientation of science and technology policy. The policy has been based on national specificities, but more on active adoption of policy doctrines and institutional and organizational models from the countries, like Sweden, which from the Finnish perspectives have been considered successful and legitimate

Keywords: science and technology policy, innovation policy, institutional and organizational change

Science and Technology Policy

The purpose of this paper is to give a brief historical overview and an outlining analysis of the basic developments of modern science and technology policy in Finland. The years of Finnish science and technology policy are divided in the paper into three major eras, which are named as R&D policy (late 1960s and the 1990s), technology policy (the 1980s), and innovation policy (the 1990s and early 2000s). The paper argues that even if the late 1990s and early 2000s have brought changes in the design of Finnish policy for science, technology and innovation, the foundations of the "Finnish model" (Castells and Himanen, 2002) were very much created already in the late 1960s, and consolidated in the early 1980s.

According to the traditional and

widely used OECD definition (1963; 1971), science and technology policy means the collective measures taken by a government in order, on the one hand, to encourage the development of scientific and technical research and, on the other hand, to exploit the results of this research for general political objectives. These two aspects are complementary: policy for science and technology (the provision of an environment fostering research activities), and policy through science and technology (the exploitation of discoveries and innovations in various sectors of government) are on a par in the sense that scientific and technological factors affect political decisions and at the same time condition the development of various fields (economy, social life, defense, etc.) that are not themselves scientific or technical. Thus science and technology policy is determined by the idea of a deliberate integration of scientific and technological activities into the fabric of political, military, economic and social decisions (Salomon, 1977).

In this paper, institutionalisation of science and technology policy is understood as a construction of an organizational field (Giddens, 1979), which means those organizations that, in the aggregate, constitute a recognized area of institutional life with the aim to serve the explicit and implicit interests and conceptions defined by policy-makers and other interest groups of the field. In science and technology policy these organizations are typically R&D performers, sectoral ministries, financing agencies, advisory bodies, professional associations, international and supranational organizations, etc. The process of institutionalisation of science and technology policy then consists of an increase in the interaction among organizations in the field, the emergence of sharply defined inter-organizational structures, an increase in the information load with which organizations in the field must contend, and the development of a mutual awareness among participants involved in a common enterprise.

In bigger industrialized countries, it was the Second World War that led to the greatest surge of government funding for R&D and to the emergence of science and technology policy (Salomon, 1977; Freeman and Soete, 1997). In the beginning, this took the form of massive support for some huge projects, of which the most famous is the Manhattan project in the U.S.A. After the Second World War, firstly in the leading industrial powers (USA, Soviet Union, UK, France, Germany), and gradually also in smaller industrialized countries, science and technology policy was given institutional recognition through governing bodies, support mechanisms and procedures, as well as a bureaucratic staff specifically concerned with these issues. These arrangements marked, as Salomon (1977) points out, an irreversible turning point in the relations between science and technology and the state: the establishment of science and technology as a national asset, and the direct intervention of governments in the direction and range of research activities.

In Finland, it was not until the 1960s that science and technology or research and development (R&D), and their economic significance crystallised as a topic of debate and became an area of government activity. This was later than in larger and more developed OECD coun-

tries. The late start has been counterbalanced by the fact that the development of science and technology policy proceeded quickly in the 1970s and particularly since early 1980s.

The ultimate justification of science and technology policy measures, and changes in the measures has been drawn from the needs of Finnish economy. In the early years of science and technology policy there were some levels of freedom with competing ideas and aspirations on policy frameworks and organizational structures. However, the significance of technology and innovation has steadily and irrevocably gained strength as fundamentals of policy actions. Even if Finland has built the mechanisms for science and technology on certain national specificities, it has adopted several policy doctrines and organizational models from more advanced countries either directly or through international organizations like OECD (Lemola, 2003).

Development of Finnish Science and Technology Policy

A Brief Prehistory of Finnish Science and Technology Policy

Up until the early years of the 20th century, Finland had only one university. It developed from Turku Academy, founded in 1640, and was transferred to Helsinki in the early 19th century. At the turn of the century the structure of higher learning began to develop rapidly. The Helsinki School of Economics and the Technical School of Helsinki were founded in 1911, the formers Swedish-language counterpart being founded four years later. The Swedish-language Åbo Akademi was established in 1917, and the University of Turku opened in 1920. To satisfy the needs of Northern Finland a university was established in Oulu in 1959. In the 1960s seven more universities were established. Currently, Finland has 20 universities - ten multidisciplinary institutions, six specialist institutions and four art academies - all of them run by the state and engaged in both education and research.

Government research institutes as a whole have formed a significant component of Finland's research system. Important government research institutes (Geological Survey Centre of Finland, the Agricultural Research Centre, the State Forest Research Institute, the Water Research Institute, the Geodetic Institute, and the Meteorological Institute) date back to the 19th century or the early years of last century. The Technical Research Centre of Finland (VTT), which for decades has been the largest government research institute in Finland, was established in 1942, during the World War II. Now the number of government research institutes is around 30, and they all report directly to their sectoral ministries. In Finland, government research institutes have been the key instrument of sectoral research or research serving the needs and activities of the ministries.

Before the 1960s there were only a few separate agencies for funding, planning and coordination of research in Finland. The Central Board of Sciences and Letters, which was established in the beginning of the 20th century, handled primarily a few matters relating to research carried out in the universities. In the 1950s "research policy" was represented by two state research councils, one for the humanities and the social sciences,

and one for the natural sciences, and sporadically by a ministerial committee on science. In 1961 the number of research councils was raised to six (for the humanities, natural sciences, medicine, agriculture and forestry, technology, and social sciences).

The Formation of Basic Structures in the 1960s and 1970s; the Era of R&D Policy

Finland: a Latecomer

In Finland, the 1960s was a decade of numerous institutional and organizational reforms in economic and social policy as well as in most other sectors of the public administration (Paavolainen, 1975; Immonen, 1995). The modernization of Finnish society was accelerated by positive economic development and changes in political power structures. The last-mentioned was the growing role of the parties of the Left (Social Democrats and Communists) and the beginning of Center-Left cooperation in the late 1960s. In Finland, the 1960s opened up a lot of opportunities for collective and private initiatives, and created new procedures for cooperation and competition. Actors and interest groups concerned with science and technology were particularly well prepared to make use of these new opportunities. Thus in a short period, science and technology policy became a significant and widely accepted part of the Finnish "modernization project". This was later than in larger and more developed OECD countries, but the late start was counterbalanced by the fact that development of science and technology policy proceeded quickly.

The main reason for the rapid emergence of science and technology policy was economic. In the whole industrialized world, the early 1960s were an era of intensified internationalization and liberalization of trade. This placed new strains on Finland's production structure, which was one-sided (high dependence on the forest industry), and its level of technology, which was low compared with Finland's main competitors. Research and development was considered an important instrument of industrial renewal. Catching up with industrially and technologically more advanced countries, like Finland's neighbor Sweden, became the factor, which significantly shaped Finnish activities and structures in science and technology for decades. The Keynesian growth policy, which had also gained a foothold in Finland, advocated government intervention in supporting and promoting the innovative activity of firms.

Construction of Basic Mechanisms

Three important changes occurred in the institutions and organizations of Finland's science and technology policy in the 1960s. Firstly, the development of higher education in general played a significant role in the early years of science and technology policy. The renewal of universities was started in the 1950s, and the development process continued throughout the 1960s and 1970s. There were three associated reasons for the central position of universities in the Finnish modernization process. One was a growing awareness of the importance of higher education and basic research for economic and industrial de-

velopment, and accordingly, greater demand for employees with a university education. The second one was a regional dimension, i.e. political pressure to establish new universities outside the capital city of Helsinki. The third reason was the fact that the large post-war generation began to reach maturity, and enlargement of the institutions of higher education was a social and political necessity.

Secondly, and perhaps most importantly, a significant reorganization took place in the Finnish science and technology administration, when new mechanisms for planning, coordination, and financing R&D were created. A ministerial committee on science, the Science Policy Council, was established in 1963. The council was meant to be a coordination body for R&D. The most visible event in the reorganization was a reform of the research councils so that they might constitute a central body. This would be better able to direct R&D funds and to coordinate research across administrative boundaries than the old council system. The base of the new system was composed of the six research councils established in 1961. The conditions for science policy planning were improved by setting up a central board of research councils to develop and coordinate research irrespective of disciplinary boundaries. The reform included the establishment of new research posts, and what was particularly significant, new grants for project research. The name "Academy of Finland" was given to the new system.

Thirdly, preparations were started with the aim of improving the conditions of industrial R&D, the activities of technical research institutes, and technical universities and faculties. A new fund under the authority of the Bank of Finland, the Finnish National Fund for Research and Development (Sitra), was established in 1967 to support industrial R&D. In addition, the Ministry of Trade and Industry began in 1968 to support the research and product development of firms, and it also received an additional appropriation for goal-oriented technical research. Contrary to the reorganization of the research councils (the Academy of Finland), these were completely new measures to Finland, a fact which helped to implement them in a very short time.

From Diversity to Dualism

As both organization research and evolutionary theories have demonstrated, institutions and organizations display considerable diversity in approach and form in the initial stages of their life cycles (DiMaggio and Powell, 1983; Nelson and Winter, 1982). Once major organizations become well established, however, there is an inexorable push towards homogenization and path-dependent development in which choices made in early years preclude future options. This is true of the construction of Finnish science and technology policy. In the mid-1960s there were several competing ideas and aspirations on how to organize the development of Finnish science and technology (Immonen, 1995).

The basic idea among a group of civil servants in the Ministry of Education and the Academy of Finland was to concentrate on the development of university research or science policy by strengthening the formal position and resources of the Ministry of Education

and its operational agency, the renewed system of research councils. As a counterbalance to this, representatives of technical and industrial research developed a model which would have given a more significant role to the Ministry of Trade and Industry.

One option was to build directly on the universities without a central national financing agency like the new Academy of Finland. Promoters of this model put more emphasis on the development of university education than on the development of university research. The representatives of government research institutes were working for a solution which would have strengthened their position in Finnish R&D and its coordination. This model involved an idea that universities should concentrate on education, and accordingly, the role of government research institutes in basic research should be increased.

One alternative was to give more power to the old Academy of Finland, or to the Finnish elite of science. In addition, support was given to a model in which the Science Policy Council would be developed in the direction of a centralized science and technology agency independent of sectoral ministries.

After a selection process which lasted a couple of years in the late 1960s and early 1970s, the result was a dualistic structure or a polarization into policy for science, on one hand, and policy for technology, on the other hand. The original idea of the early architects of science policy to create the machinery around the organizations for science came true. However, the interest groups behind technical and industrial R&D managed in a short time to organize countermeasures, as a consequence of which already in the late 1960s the policy for technology gained a strong position in Finnish science and technology policy. Technology dominance gained further strength in the 1970s, 1980s and early 1990s.

The Years of Rationalization and Planning

In the last years of the 1960s, questioning and challenging the prevailing idea of science and technology as absolute sources of social and economic welfare was characteristic of science and technology policy in a number of OECD countries. Science and technology were suddenly attacked jointly by advocates of conservative and radical viewpoints (Salomon, 1977). Also in Finland, the late 1960s and early 1970s were a period of student revolt. However, this had less impact on the development of science and technology policy than in other larger countries. The radical student movement dominated the life of university campuses in Finland in these years, but its focus was strongly on education and particularly on the reform of university administration on the basis of the "one man one vote" principle. This focus was largely due to the fact that science and technology policy was in its early phase of development. The volume of R&D in general was modest in Finland, the role of military or other prestige research was almost insignificant, and there were only weak links between industry and universities.

Quite the contrary, in Finland the years of "questioning and challenge" were very much the years of "rationalization and planning". The economic and political climate at the turn of the 1970s

was very favorable for planning in general. The Finnish policy for science, led by the Science Policy Council and the Ministry of Education, and assisted by the Academy of Finland (research councils), was very active in implementing new planning mechanisms. Towards the end of the 1960s the research councils were encouraged to draw up science policy programmes in their own sectors for the development of conditions favorable to science. Research work was to be taken into account in its entirety, regardless of whether it was being carried out in government research institutes, in the private sector, or at universities. However, the results of the first planning round fell short of expectations.

The next planning round, which was initiated by the Central Board of the Research Councils (1972) and extended by the Science Policy Council (1973), was very much influenced by the OECD (Luukkonen-Gronow, 1975). The grounds of national science policy, and the social significance of scientific research were in line with the analysis, conclusions, and recommendations of the Brooks Report (OECD, 1971). On the basis of general social policy, the Science Policy Council identified areas of research in which the need for information based on research is at present the most urgent and in which research work should be initiated primarily with public financing (Science Policy Council, 1973).

The programme introduced the first Finnish plan for increasing the financing of R&D. This ambitious plan was to become one of the most visible activities and aspirations of the Science Policy Council and the Finnish science and technology policy in general. If this programme of growth had been realized, it would have increased the GNP-share of R&D input from 0.9 percent in 1971 to 1.7 percent in 1980. It was a big disappointment to the Finnish R&D communities that the programme was not implemented. In 1979 R&D expenditure amounted only to 1.1. percent of GNP, which was then one the lowest figures among the OECD countries.

In most OECD countries, the ideas of the Brooks Report for new social objectives of science and technology were broken in the midst by the 1973 oil crisis (Salomon, 1977). It was true also in Finland that the lively and visible programming of science policy brought in only limited, short-lived changes in universities and research institutes. Economic recession followed by the oil crisis was one obvious reason for the breakdown of the euphoria in science policy planning, but in Finland the planning process itself encountered many difficulties. The topdown planning with emphasis on social needs and an interdisciplinary approach was seen as a threat in disciplinary-oriented R&D communities. Science policy planning also aroused political tensions, which weakened the credibility of central planning procedures. As a result of all these developments the popularity of planning and the prominence of science policy orchestrated by the Ministry of Education declined significantly in Finland in the late 1970s (Michelsen, 1993, Immonen, 1995).

Strengthening of Technology Orientation in the 1980s: the Era of Technology Policy

The Early Years of Microelectronic Revolution

The factors behind the transition from research and science orientation to technology orientation in the 1980s were economic and social. The "oil crisis" of the mid-1970s led also in Finland to a slow-down in the rates of economic growth and to high levels of unemployment and inflation. The ambitious attempts to accelerate scientific and technological development did not succeed. These were even the years of "microelectronics revolution", which was recognized as offering new productive and other opportunities, but which, it was feared, would exacerbate social problems in Finland. In particular, it was feared that increased use of automation in industry and services would cause mass unemployment and greater social inequality.

The late 1970s saw an explicit shift in the OECD countries from the promotion of science to the stimulation and support of industrial innovation. In particular, science and technology policy was actively focused on the development and application of new technologies, primarily information technology, materials technology and biotechnology (Salomon, 1985; 1987). Encouraged by Japanese economic and technological success, governments became increasingly involved in planning, financing and managing large national programmes in the new technologies (Freeman, 1987; OECD, 1985; 1988). University-industry cooperation as well as inter-firm cooperation was strongly intensified directly between R&D performers and in the execution of the national technology programmes.

This was very much the development path which also Finland adapted. Active exploitation of the opportunities opened up by new technologies for the benefit of economic growth and employment became the core of the Finnish science and technology policy in the 1980s. If the earlier phase of science and technology policy had been characterized by the construction and renewal of the institutions and organizations of the R&D system, a distinctive feature of the new policy was increasing government involvement in the promotion of industrial innovation. A belief in rational policy-making came back, but science with social objectives was replaced by technology with competitiveness of industry as the main guideline.

New Organizations and Instruments

The architect of the new policy was a broadly based committee appointed by the government (Technology Committee, 1980). "Broadly based" meant experts representing political decision-makers, the government sector, employers, employees and researchers. The committee's key conclusion was that not even rapid development of automation would place any restriction on social development in the 1980s. On the contrary, information technology and its application would be a resource opening up new opportunities. Indeed, the committee's principal recommendations included the strengthening of science and technology policy both quan-

titatively (increased resources) and qualitatively (allocation of resources to the fields of high technology) (Lemola and Vuorinen, 1988).

The recommendations of the Technology Committee led to the formation of the National Technology Agency (Tekes) in 1983 after the Swedish model, the Board for Technical Development (STU, later NUTEK). Tekes became the key planner and executor of the new technology-oriented policy. The tasks formerly carried out by the Ministry of Trade and Industry (i.e. R&D loans and grants, appropriations for goal-oriented technical research) were assigned to Tekes. National technology programmes, which had already proven their worth in Japan (Freeman, 1987), were developed to serve as a new and important instrument by which Tekes could control R&D activities. The first programmes were focused on information technology.

The national technology programmes became an important catalyst for national cooperation. An important new feature in these programmes was that the earlier bilateral co-operation between universities and industry, and between technical research institutes and industry was transformed into multilateral national cooperation. Firms, research institutes and universities began to implement programmes together. Cooperation other than that associated with the programmes was also expanded. In particular, this concerned co-operation between universities and firms. The programmes have not been generated by a centralized strategic planning mechanism. Initiatives for new programmes have come from universities, research institutes, firms, and industry associations.

Tekes also became a national instrument to create the pre-requisites for the development of international co-operation. Finland's participation in Eureka co-operation was one of the first steps taken. This programme began in 1985, and from the very outset Finland has been one of Eureka's most active members (Ormala *et al.*, 1993). Tekes played an important role during the period when Finland was preparing for participation in the EU's research framework programme (Luukkonen *et al.*, 1999). EU research programmes were opened up to the Finns, and to other EFTA countries, in 1987.

Another significant change within the national science and technology policy in the 1980s was the creation of new programmes and organizations associated with technology transfer, diffusion and commercialization. Nation-wide networks of technology parks and centers of expertise were set up in Finland. The technology parks have initiated spin-off projects and incubators. Technology transfer companies were established to commercialize the results generated in universities and research institutes. Public and private venture capital operations also increased, although the venture capital market in Finland is less developed than in many other European countries, not to mention in the United States. Some of these arrangements were created at the national level, but many came into being on the basis of local and regional initiatives, albeit with national funding. As a symbol of the technology orientation of the 1980s, the Science Policy Council was transformed in 1987 into the Science and Technology Policy Council.

From a National Innovation System to a Knowledge-based Society: the Era of Innovation Policy

From Recession to Recovery

Economic development in Finland in the 1980s was more robust than in most other industrialized countries (Vartia and Ylä-Anttila, 1996). The share of knowledge-intensive production grew, technical development was rapid, and productivity growth was faster than the average of the OECD countries. Whereas the total growth of the metals and engineering industry in the 1980s was 50 percent, the electronics industry grew by 150 percent. Consequently, the share of high-technology products in industrial exports rose from 4 percent in the early 1980s to 11 percent in 1990. Furthermore, Finland rose to become the world's biggest exporter of high-value paper products. The value-added of paper industry exports was considerably higher than that of Finland's rivals. Moreover, the growth rate of Finnish patenting in the United States up until the end of the 1980s was one of the fastest in the world. In this respect, Finland was outperformed only by Japan, South Korea and Taiwan. Finland was widely labeled "Japan of the North".

However, the Finnish economy was suddenly plunged into an exceptionally severe crisis in the early 1990s (Vartia and Ylä-Anttila, 1996; Tainio *et al*, 1999). Finland's gross domestic product declined 20 per cent in the years 1991-93, the stock market collapsed, the value of the Finnish markka plummeted almost 40 per cent from the level prevailing at the beginning of the decade, foreign debt and the budget deficit grew rapidly, unemployment approached 20 per cent at its height, and the country's banking system was thrown into deep crisis. In just a few years Finland tumbled from being one of the richest countries in the world to below the average level of the industrialized countries.

Finland recovered from the last recession almost as quickly and surprisingly as it had plunged into it (Pajarinen *et al.*, 1998). This was largely achieved on the back of rapid growth in exports. At the end of the 1990s, exports accounted for a larger share of GDP than at any point in Finland's economic history. Traditional industries such as paper, metals and engineering, and chemicals all increased their exports, but the strongest growth was in the ICT cluster. A major part of the growth of the ICT cluster and Finnish industry in general is explained by one company, Nokia. Today, the ICT cluster is by far the largest export industry and accounts for close to 30 percent of total manufacturing exports. The share almost tripled during the 1990s. In 1990 the share of the other major export sector, the paper industry, was some 30 percent. Nowadays it is less than one quarter. In its exports Finland is one of the countries most specialized in telecommunications equipment. (Ali-Yrkkö, 2001; Paija, 2000; Ali-Yrkkö *et al.*, 2000)

Finland - a National Innovation System

An important milestone in the political formulation of the "new" science and technology policy was the 1990 review of the Science and Technology Policy Council (Science and Technology Policy Council, 1990). The report made the concept of a national innovation system

an important instrument of Finland's science and technology policy. It was a question of a direct Finnish application of the observations and conclusions made by evolutionary economists in the late 1980s. The Finnish application was developed after the publication of the pioneering book by Freeman (1987), but before the publication of the books by Lundvall *et al.* (1992) and Nelson (1993). Most of the influences came from the OECD's Technology and Economy Program which had been launched in 1988 (OECD, 1992), and to which Freeman, Lundvall and Nelson, among others, contributed. The transfer of knowledge to Finland and the Finnish application were made by the secretariat of the Science and Technology Policy Council.

The Finnish interpretation of the concept "national innovation system" has stressed that a national innovation system is a whole set of factors influencing the development and utilization of new knowledge and know-how. The concept allows these factors and their development needs to be examined in aggregate. A national research system along with education form the intrinsic parts of a national system of innovation. The general atmosphere prevailing in society also has a profound influence on the production and application of new knowledge as well as on close interaction and cooperation between different actors. Internationalization influences the activities of an innovation system in many ways, but the internationalization process also emphasizes the need to improve conditions for creating innovations nationally. As mentioned earlier, these ideas were developed just before the recession, but they appeared relevant arguments to the science and technology policy of recession years, too. This is a good example of how in public policy, solutions often come first and the problems later.

Towards a Knowledge-based Society

In the mid-1990s, when recovery from the recession was already underway, another concept began to be integrated into that of the national innovation system: the knowledge-based society (Science and Technology Policy Council, 1996). This concept came from the OECD Jobs Study, an extensive programme which had been launched in the early 1990s (OECD, 1994; 1996; 1998). The transfer of the concept and the Finnish application of " the knowledge-based society" were made by the secretariat of the Science and Technology Policy Council in a similar way as in the case of the national innovation system.

From the point of view of Finnish science and technology policy, the crucial aspects of the OECD approach were the stress put on learning, and the linkage of employment and innovation policies. The latter was particularly important in Finland in the mid-1990s. The economy was growing quickly but the unemployment rate was still as high as 15 percent. The OECD recommendations adopted in Finland were based, on the one hand, on the observation that knowledge-intensive growth is of undeniable significance for the national economy and, on the other, on the experience that macroeconomic or labor market measures do not alone ensure adequate preconditions for knowledge-intensive growth. Above all, the promotion of knowledge-intensive growth requires various innovation policy measures relating to R&D,

education, competitive conditions, laws and regulations for the protection of intellectual property, national and international cooperation networks, and technology transfer and exploitation.

The unusually rapid development of Finland's ICT industries at that time offered a positive environment for the implementation of measures drawn from the knowledge-based arguments. It was only natural that in policy objectives special attention was paid to the information communications technologies and more broadly to the competitiveness of the infrastructure necessary for the application of information technology and for the knowledge-based society. The most significant single act was the government's recommendation in 1996 to increase investments in R&D so that the GDP-share of R&D expenditure would rise to 2.9 percent by the year 1999. As a result of this decision, state funding for research rose in the years 1997-1999 by a total of 250 million euros, which meant an increase of about 25 percent in the state's annual research appropriations from the 1997 level. The funds necessary for these additional appropriations were obtained mainly from the partial privatization of state-owned companies.

Most of these additional funds were channeled through Tekes to industrial R&D and national technology programmes. The second biggest part has gone through the Academy of Finland to universities for basic research. With private-sector R&D expenditure growing even faster than that of the public sector, R&D expenditure of GDP had in Finland achieved the level of 3.4 per cent in 2001 (Science and Technology Policy Council of Finland, 2003). In R&D intensity Finland ranks second in the OECD countries after Sweden. However, it is worth mentioning that Finland's total R&D expenditure is not more than 0.6 percent of the OECD total.

The 1990s did not bring any significant changes to the basic organizations of Finnish science and technology policy. The biggest institutional transformations resulted from Finland's accession to full membership of the EU in 1995. Active involvement in EU research programmes has been the most significant trend of internationalization in Finnish research, and participation in EU framework programmes has become an integral part of the country's science and technology policy (Luukkonen *et al*. 1999; Luukkonen and Hälikkä, 2000). Another essential institutional change has been the increasing role of regional innovation policy. In the mid-1990s Finnish regional administration underwent a number of reforms that improved the regions' ability to carry out the tasks related to innovation policy. It was largely the EU's regional policy in general and the key instrument of this policy, i.e. the EU's structural funds, which accomplished this transformation.

Discussion: Main Features in the Institutionalization of Finnish Science and Technology Policy

Giving a date to a long historical process is always more or less arbitrary. However, this paper has taken the stance that Finnish science and technology policy was largely created in the mid-1960s, which was later than in the bigger and more advanced OECD countries. The basic motivation to start or to speed up the development process came from the

fact that Finland had in the 1960s an urgent need to increase productivity and to widen the industrial base. On the other hand, there was in Finland a strong political will to modernize institutional and organizational structures. This R&D friendly social context opened up opportunities to public and private actors to promote their interests, and to adopt and implement organizational innovations. Even if with conflicting interests, all actors were driven by a desire to improve performance of the Finnish society.

Practically all major organizational reforms which were made from the 1960s onwards were built on existing organizations. The number of universities has grown, but their functions and position have been stable. Only minor changes have taken place in the system of government research organizations. The administration for science (the Ministry of Education, the Academy of Finland) has been developed through incremental changes. The establishment of Tekes in 1983 was basically an assigment of tasks formerly carried out by the Ministry of Trade and Industry to a new government body. The only exception to the general rule is Sitra, which was copied from Sweden and founded as a fully new Finnish organization in a new organizational environment. The most visible latest institutional change has been the emergence of regional innovation policy, which has been largely accomplished by EU's regional policy.

Instead of founding new organizations, science and technology policy has implied new policy instruments. One of the most significant single innovations of science and technology policy all over the world has been project financing of R&D. This innovation was established by the National Science Foundation in the United States in the early 1950s. In Finland, project financing was implemented in the late 1960s simultaneously but separately for basic research and industrial R&D. It was the project financing which intensified the other side of science and technology policy; exploitation of R&D for political objectives. Later the toolbox of science and technology policy has diversified. A great number of new instruments were created in the 1980s around technology diffusion, technology transfer, and commercialization of the results of R&D.

Polarization into science policy and technology policy has more or less remained from the 1960s, but the significance of technology and innovation has steadily gained strength as fundamentals of policy actions. In 1979-1980, there were active efforts to make institutional changes and put more stress on social aspects in science and technology policy. However, and almost ironically, the result was intensification of existing technology oriented development pattern.

The gradual shift towards technology and innovation is to be explained from the fact that the ultimate justification of policy measures has always been drawn from the needs of Finnish economy. In the 1960s, during the years of intensification of internationalization and liberalization of trade, basic arguments for science and technology policy came directly from a need to widen the industrial structure and raise the level of technology. In the late 1970s and 1980s, when science and technology policy was actively focused on the development and application of new technologies, the reason was economic recession along with the decision to start utilizing economic

opportunities opened up by microelectronics revolution. Correspondingly, the recession in the early 1990s together with an unusually high unemployment rate lead to the adoption of technology intensive growth as the guideline of science and technology policy.

National specificities in Finland´s history, culture, administrative traditions, political contexts, industrialization process etc. certainly reflect as divergence or originality in certain policy dimensions. However, from the early years of Finnish science and technology policy, Finland has largely adopted its policy doctrines and institutional and organizational models from the countries and organizations which from the Finnish perspectives have been considered successful and legitimate. Sweden was a significant source of inspiration and imitation up until the late 1980s. For the formulation of policy guidelines, the role of OECD has been central for decades (Lemola, 2002).

There has been considerable stability over years in the basic elements of the Finnish science and technology policy. The biggest transformation has been the growth of regional innovation policy in the late 1990s, which has been largely accomplished by EU's regional policy and the instrument of this policy, the EU's structural funds. It has been this stability and continuity through incremental improvements in organizations and policy mechanisms rather than single reforms implemented in the 1990s in the name of a knowledge-based society, which characterizes the "Finnish model" of innovation policy.

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