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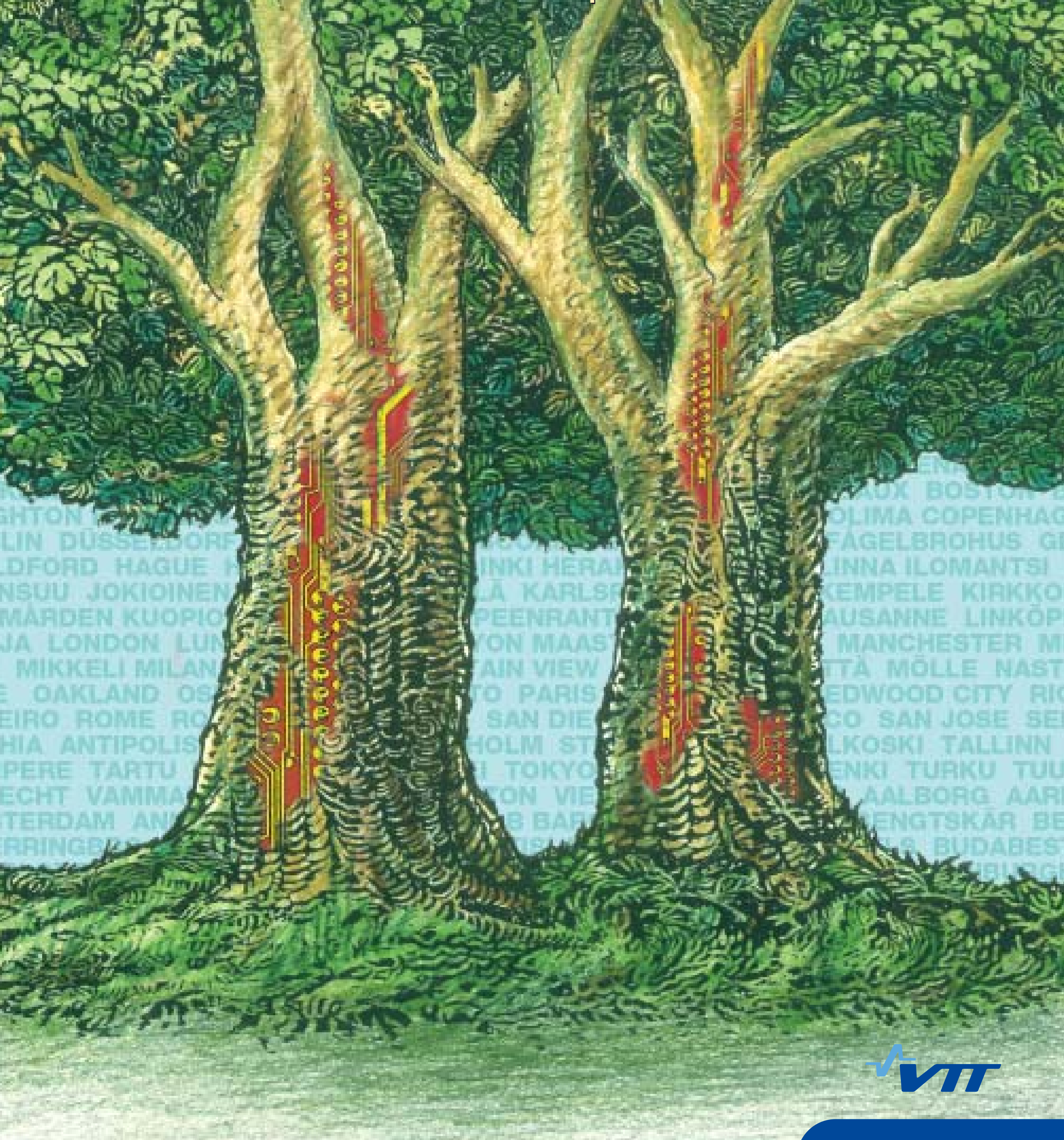
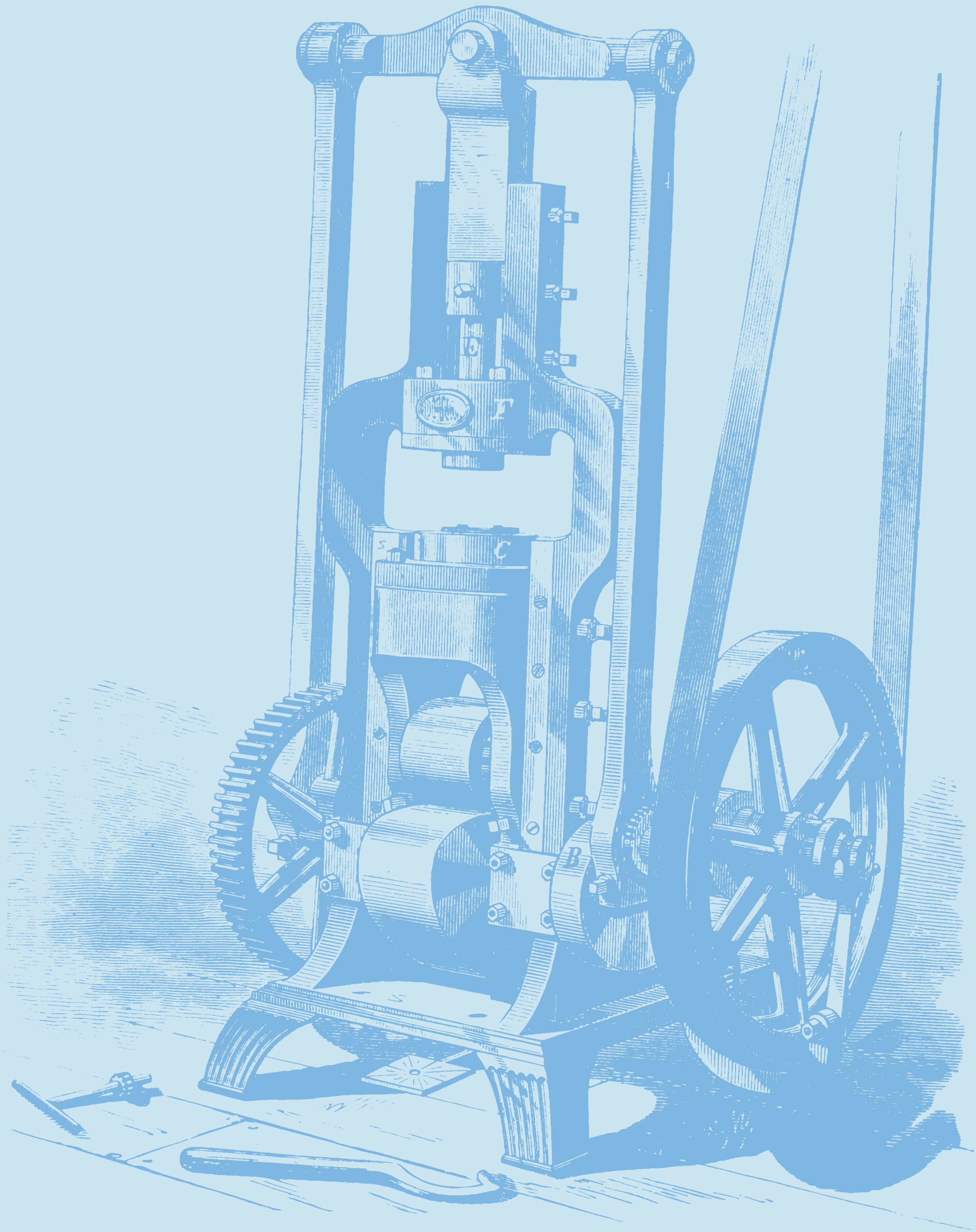
VTT SYMPOSIUM 228

Industrial innovation, economic performance and technology foresight:

Comparative perspectives on Japanese and Finnish developments





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Industrial innovation, economic performance and technology foresight:

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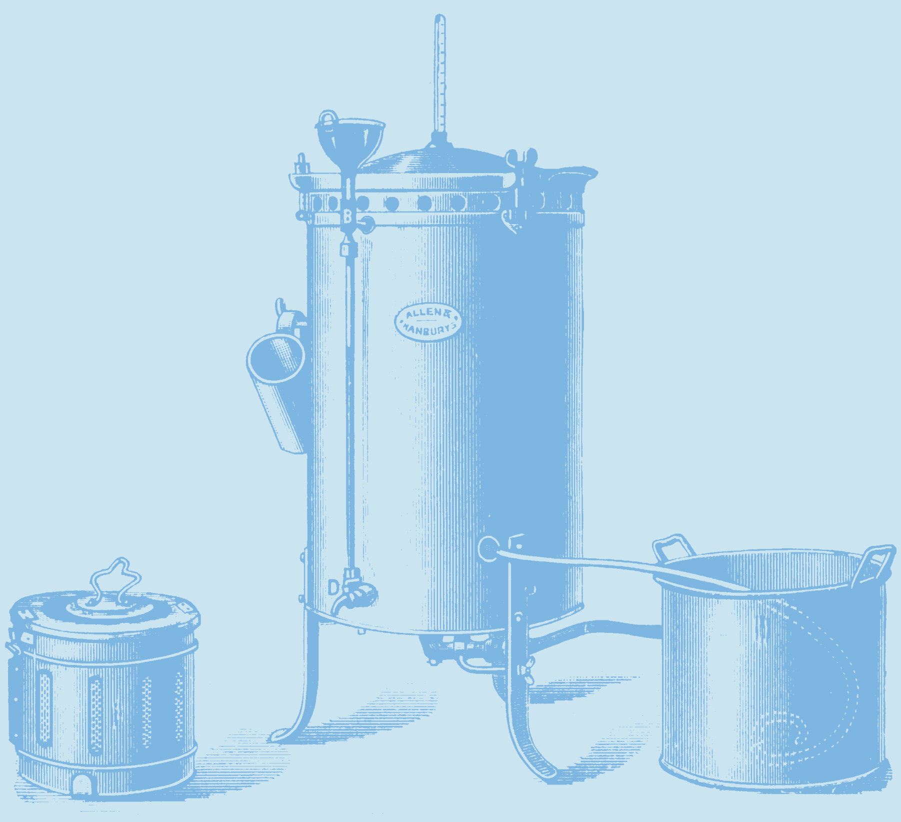
Flower Day Seminar 2002, Helsinki, Finland

Organised: VTT Technology Studies



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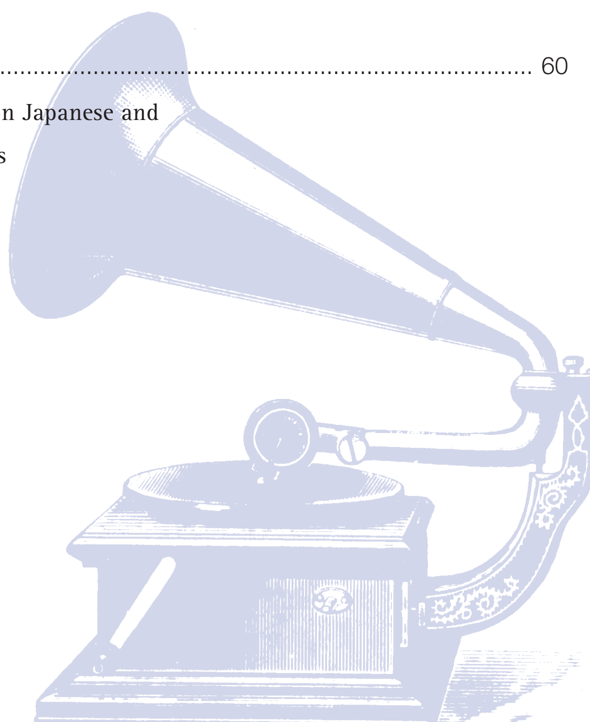


Preface

The traditional Flower Day seminar of VTT Technology Studies was held on May 16, 2002. The topic of last year's seminar was "Industrial innovation, economic performance and technology foresight – comparative perspectives on Japanese and Finnish developments". The aim was to consider innovation activities and technology foresight in Japan and Finland, from both past and future perspectives. Of special interest was the presentation by Professor Ryuji Shimoda, who was an invited keynote speaker from Japan, representing Tokyo Institute of Technology (Titec) and the National Institute of Science and Technology Policy (NISTEP).

The seminar participants consisted of some 130 representatives from different ministries, public financing organisations, private companies, as well as researchers from various areas. The presentations were followed by a lively discussion, starting inside the seminar hall, and continuing afterwards in a more relaxed atmosphere around cocktail tables. The musical performance was provided by the trio *Triangels,* whose music helped the participants forget the stormy weather outside. The seminar continued next day as an internal workshop, where some concrete ideas and future plans for Japanese-Finnish scientific and technical co-operation were outlined.

Besides the seminar, there were two special reasons to celebrate 2002, which was the 60th Anniversary of VTT and the 10th Anniversary of VTT Technology Studies. In his welcome address Professor Erkki KM Leppävuori, Director General of VTT, wished the Group success in producing qualified research services for public and private customers in national and international networks over the next ten years as well.

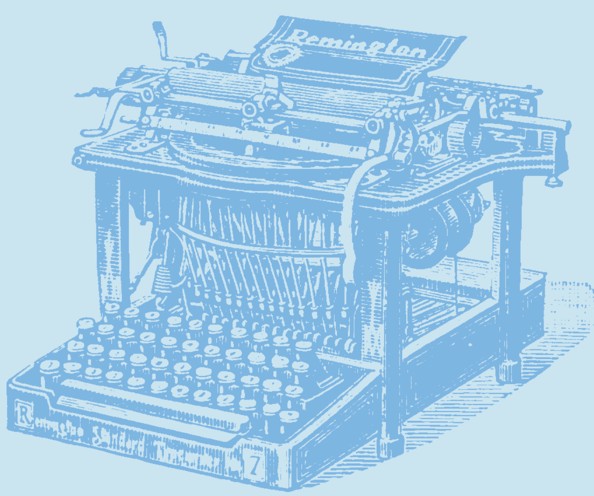
Editor

Introduction

1

Learning from past innovation patters in shaping the future - potential and limits

TORSTI LOIKKANEN
VTT Technology Studies



1. Background

Distinguished Ambassador N.N.; Dear researcher colleagues from Nistep, Japan; Ladies and Gentlemen.

This event is the traditional Flower Day seminar of VTT Technology Studies and also the 10th Anniversary seminar of the group. The seminar is organised in the context of Japanese-Finnish scientific and technical co-operation with the aim of contributing to Japanese-Finnish research co-operation in innovation studies and technology policy. The seminar title is *Industrial innovation, economic performance and technology foresight - comparative perspectives on Japanese and Finnish developments*. Let me briefly introduce you to the background, content and objectives of this event.

2. Learning from the past in shaping the future

In the seminar we consider the development of past and current patterns of innovations, the experiences of foresight exercises in technological development, and related benefits from technology foresight in shaping future innovation patterns and related decision-making.

The role of technology and innovation in Japanese development has been of great interest to many researchers in recent decades. According to Freeman and Soete (1997), two pioneers in the field of technology and innovation, Japanese success in the 1950s and 1960s was often simply attributed to copying, imitating and importing foreign technology, and the statistics of the so-called technological balance of payments were often cited to support this view. It soon became evident, however, as Japanese products and processes began to outperform American and European products and processes in more and more industries, that this explanation was not adequate even though the import of technology continued to be important. Japanese industrial R&D expenditures as a proportion of private-sector industrial net output surpassed those of the United States in the 1970s, and total private-sector R&D as a fraction of GNP surpassed the USA in the 1980s. The Japanese performance could now be explained more in terms of R&D intensity, especially as Japanese R&D was highly concentrated in the fastest growing private-sector industries, such as electronics. Since the early 1990s, as we know, Japan has suffered from low economic growth. This makes the dynamics of innovation even more important for Japan's future than in early years of success.

Developments in the Finnish economy during the 1990s were characterised by the emergence and rapid growth of the ICT industries, especially software and telecom. The primary factor behind this growth was the success of Nokia Corporation, now a global player in the field of telecom equipment (handsets and networks). Nonetheless, ICT also penetrated many traditional Finnish industries, such as the forestry, engineering and metal products, boosting the overall performance of the economy. While the recent good performance of the Finnish economy is impressive, available macro-indicators such as R&D statistics, high-tech production, exports, and productivity measures may conceal a range of other topical issues concerning the future.

One key issue is the sustained growth and diffusion of ICT both now and in the future. as well as the development of other promising technologies. In the Finnish context, the role of biotech, environmental and healthcare technologies have frequently figured in this discussion. Other areas of concern both in Japan and in Finland include environmental sustainability, increasing global competition, and especially the role of technology policy in the future. Are recent patterns of innovation compatible with increasing competition for market shares in rapidly growing product niches? Will the traditional industries be able to renew themselves in line with technological developments in the high-tech sectors? Are developments in the economy compatible with sustainable development?

These broad issues require detailed empirical analysis in a range of different areas. The topic of this Flower Day seminar touches upon some of these issues based on a comparison of the lessons learnt from innovation studies and foresight exercises in Japan and Finland. Social, cultural and economic backgrounds and innovation systems in these countries are different. Consequently, interesting points of departures for common considerations are the alleged success of innovative activities in Finland since the early 1990s, and Japan's pioneering role in applying advance technologies and using technology foresights with impressive economic performance since the 1960s. Finding recipes for future success is a challenge for both countries and will be considered as a main topic of the Flower Day seminar.

In the seminar we will consider firstly the past development and the innovation pattern that emerged in Finland during the period 1985-1997. In this investigation we will hear about experiences based on the database of Finnish innovations (Sfinno) developed by VTT Technology Studies since 1997. Secondly, we will consider experiences of technology foresight by paying attention to the benefits of these exercises in the shaping of future innovation patterns. Japan has been an acknowledged pioneer in technology foresight and we discuss this item on the basis of a Japanese expert presentation. Thirdly, we will attempt to link past innovation patterns with the benefits of technology foresight to further our understanding in shaping the future patterns of innovations.

We will discuss how far foresight exercises support strategic choices of innovation policy in formulating priorities between alternative science and technology areas and related research funding, and how foresight promotes consensus building among relevant national actors. We will also discuss how far experiences of past innovation patterns support the shaping of future innovation patterns. Experiences of the past are a necessary but not sufficient basis for shaping future patterns and respective policies. Of course, there is nothing novel about this question. Learning from past experience when seeking to identify the future development path is present in our everyday life. This question is, however, of special relevance in technology and innovation policy, as will be discussed during the seminar.

3. Current state and prospects of technology foresight

Technology foresight – the future-oriented examination of technology development in its social and economic environments – is of growing interest both nationally and internationally. Finnish companies and industrial confederations carry out examinations of the framework of future development and execute technology foresights and road maps to support strategic decision-making when prioritising R&D and related resource allocations. Foresight examinations have been executed in the public sector, the Ministry of Trade and Industry, the National Technology Agency, other ministries and public institutes, the Future Committee of the Finnish Parliament, and at VTT and other research institutes. In many countries a number of foresight efforts have been carried out, and this topic has a high profile in the EU's 6th R&D Framework Programme.

In the international context, technology foresight was discussed a few days before this seminar in the conference "The role of foresight in the selection of research priorities" in Seville, Spain on 13-14 May 2002 (se in detail: http://prospectiva2002.jrc.es/). The conference programme consisted of several interesting lessons from objectives, procedures and outcomes in technology foresight and related areas from different countries and organisations. As expected, the conference could not provide any simple explanation of how technology foresight helps to select research and technology priorities. However, the conference did provide a good overview of recent developments in this area. Below I will survey some of the conclusions of the Seville conference and other recent events concerning the development of technology foresight in the context of innovation policy.

Technology foresight is not a mechanistic tool giving answers about the future, but rather a tool to manage with the future in diverse ways. Technology foresight is a complicated matter due to the fact that technological change is inherently uncertain and innovations relate to information asymmetries between the present and the future. The innovation process is not only influenced by future uncertainties but it also generates uncertainties. Consequently, foresight exercises are learning processes that help to identify factors and processes affecting the future path of technological development.

Technology foresight can improve our understanding of the impacts of technologies and their framework, support strategic choices between alternative technological development paths, promote the networking of experts, and contribute to the creation of common future-oriented insights and conditions for consensus. No doubt foresight exercises can also give support to the prioritisation of technologies and the allocation of R&D and related resources. And, more importantly, many foreseen technologies have been realised as well – as Japanese and other studies have shown.

Experiences also indicate that technology foresight is dependent on economic, social and cultural contexts at the national and regional level. For example, in Europe foresight efforts are often intended to reach a consensus among industry, government and the research community about promising technologies, related priority-setting and policy measures. According to Japanese experts, technology foresight in Japan is not a mechanism of building consensus and its direct influence on technology policy formulation and priority-setting has consequently been rather limited.

National and global regulation as well as related problem-oriented questions matter for technology foresight. For example, the global Kyoto Protocol provides a restrictive framework for future energy production (avoidance of non-sustainable fossil fuels, promotion of sustainable energy sources, etc.). In a similar vein, the ageing demographic structure in Western countries sets certain requirements on future technology development, e.g. technologies for managing at home instead of institutional care.

History no doubt matters for technology foresight exercises. This is a special item we will discuss in this seminar. The analysis of past innovation patterns and related policy is an indispensable element for foresight of future innovation patterns. In this respect, analysis of the Sfinno database of Finnish innovations developed by VTT Technology Studies gives one robust basis for technology foresight in Finland, as will be discussed later in this seminar.

Although we are still in an early learning curve in technology foresight exercises, their role is gradually becoming established as a supporting tool in future-oriented decision-making of industry, government institutions, and research communities. Besides technology foresight, decision-making on future-oriented strategic choices and priority-setting is affected by a number of other supporting elements as well.

4. Objectives and presentations of the seminar

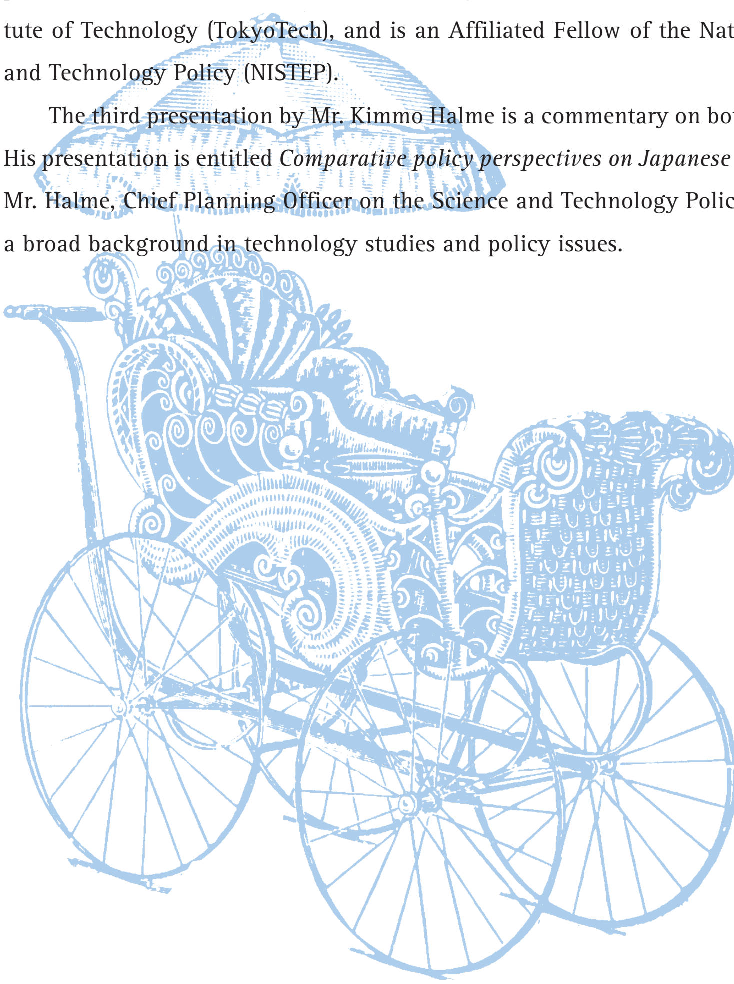
Comparative studies of innovation systems currently play an important role in mutual learning and benchmarking between industrialised countries, including such economies as Japan and Finland. This Flower Day seminar will touch upon some key issues of technology policies; lessons learnt from innovation studies and foresight exercises in these countries within the context of collaboration with NISTEP from Japan and VTT Technology Studies from Finland.

By looking at the past development and at attempts to foresee the future development, we will discuss in this seminar the lessons learned from Japan and Finland. We will consider the utilisation of results of innovation and technology foresight studies in selecting research priorities and subsequent R&D resource allocation. One objective of the seminar is to identify novel topics for innovation and technology policy studies in the future. Moreover, the seminar is expected to function as a benchmarking and learning forum for Japanese and Finnish experiences. On the basis of coming discussions we will be able to identify collaboration themes and to plan the next steps for our mutual co-operation in the future. The benchmarking of experiences may provide novel ideas, but in these exercises the pitfalls of benchmarking must be recognised. Countries such as Japan and Finland differ essentially in size, economic, social and cultural traditions and conditions. By keeping these differences in mind, we expect benchmarking to provide new insights for the further development of innovation activities and policies in both countries.

The first presentation by Mr. Christopher Palmberg is about the lessons learned from the research project on Finnish innovations (Sfinno). Mr. Palmberg, Lic. Econ., works as a Senior Research Scientist at VTT Technology Studies, and is an Affiliated Fellow of the Royal Institute of Technology, Stockholm, Sweden. The title of his presentation is *The origin, nature and success of Finnish innovations – summarising and synthesising the findings of the Sfinno project.*

The second presentation by Dr. Ruiji Shimoda is entitled *Innovation, Science and Technology Policy and Technology Foresight in Japan.* Dr. Ruiji Shimoda is a former Deputy Director of the National Institute of Science and Technology Policy (NISTEP), Japan, and in this seminar his presentation is about NISTEP views. Currently, Dr. Shimoda works as a Professor at Tokyo Institute of Technology (TokyoTech), and is an Affiliated Fellow of the National Institute of Science and Technology Policy (NISTEP).

The third presentation by Mr. Kimmo Halme is a commentary on both previous presentations. His presentation is entitled *Comparative policy perspectives on Japanese and Finnish development.* Mr. Halme, Chief Planning Officer on the Science and Technology Policy Council of Finland, has a broad background in technology studies and policy issues.

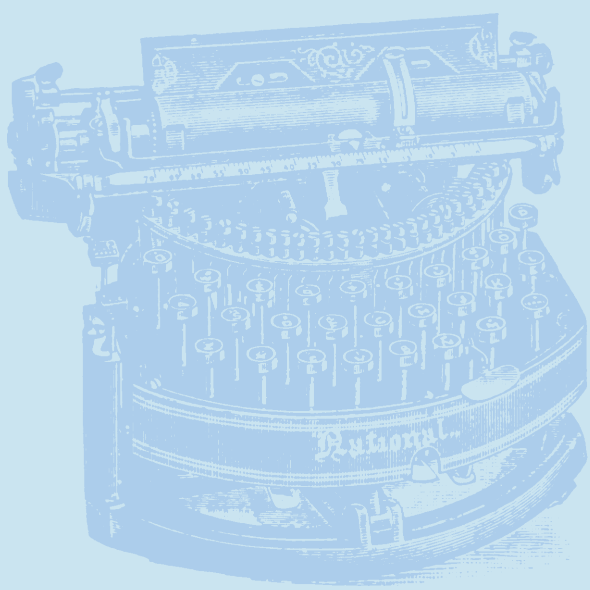


Sfinno

2

The origin, nature and success of Finnish innovations – summarising the findings of the Sfinno-project[1]

CHRISTOPHER PALMBERG and THE SFINNO-TEAM[2]



[1] Funding from the National Technology Agency is kindly acknowledged.

[2] The project and the results presented and discussed here build on contributions by Tarmo Lemola, Ari Leppälahti, Hannes Toivanen, Jukka Hyvönen, Petri Niininen, Tanja Tanayama, Tuomo Pentikäinen, Jani Saarinen and myself

1 Background

Technical change and innovation has played a major role in the renewal of Finnish industries, especially since the 1970s when the industrial base started to diversify from the traditional forestry-based industries towards engineering, electronics and ICT-related sectors. In the 1980s and 1990s the institutionalisation of Finnish technology- and innovation- policy, as well as the subsequent emphasis on concepts such as the national system of innovation and the knowledge-based economy, has also brought concerns about the innovativeness of Finnish industries to the forefront in the policy debate (Science and Technology Policy Council of Finland 1996, 2000; Tekes 2002).

Against this background, the innovation studies were defined as a core research field of the VTT Group for Technology Studies upon the founding of the group 10 years ago. Hence, the Finnish Innovations (Sfinno) research project financed by the National Technology Agency (Tekes), which I attempt to summarise and synthesis in this paper/presentation, in fact has its roots in some of the first innovation studies previously carried out by the group in the early 1990s (Lemola & Lovio1984; Lovio 1988; Lemola & Lovio1988; Kivisaari & Lovio 1993; Miettinen 1995; see also Saarinen 2002).

The Sfinno research project draws on Schumpeterian economics, the foundations of which were laid by the Austrian economist Joseph Schumpeter in the early 20th century. The point of departure for the project is the basic Schumpeterian insight that innovations, commercialised by new or old and established firms, are at the very core of the creative destruction and renewal of industries. This basic Schumpeterian insight is all the more relevant in the Finnish context due to the exceptionally fast pace of recent industrial renewal.

In aggregate statistics, this industrial renewal is reflected in the doubling of the share of high-tech exports of total manufacturing exports during the 1990s, to a share of 20 per cent in 1999. On the input side, both public and especially private R&D expenditures have likewise grown. As a consequence, the R&D share of GDP increased from 2 per cent in 1991 to 3.2 per cent in 1999. Finland is now in the league of the world's highest R&D-spending countries on a par with Sweden, the US and Japan. (Statistics Finland 2001).

Recently, the significant contribution of Nokia to these developments has been well accounted for (Ali-Yrkkö et al. 2000, Ali-Yrkkö & Hermans 2002). Another recent viewpoint has been to approach industrial renewal in Finland through case studies on a selected number of significant innovations, as well as through studies of specific sectors and various policy areas in the Finnish system of innovation (Miettinen et al. 1999; Schienstock & Hämäläinen 2001). Nonetheless, our knowledge of the origin, nature and development of innovation outputs, as the sources of industrial renewal across the whole spectrum of Finnish industries, remain meagre. In light of the above, the prime motivation for the Sfinno project has been to cater for the lack of systematically collected, context-specific data on innovations, and thereby also make recent industrial renewal processes in Finland more transparent.

The related identification of Finnish innovations altogether resulted in some 1,600 innovations commercialised by firms registered as domestic, mainly during the 1980s and 1990s (the identification of innovations was limited to the years 1985-98). The results and discussion contained in this paper/presentation therefore build on a range of studies with their common denominator in this database of Finnish innovations, as well as on a related extensive survey undertaken in the years 1998 and 1999 and covering 806 innovations. Hence, while the Sfinno-project has been ongoing since 1998, the aim of this paper/presentation is to recapitulate on some of the central findings of the project to date.

This paper is structured around four research issues that have been our focal point during recent years, as they have been motivated both by research questions reflecting developments and policy debates in Finland and by the particular empirical data collected. These four research issues concern the origin of innovations, the sources of innovations, the nature of innovations, as well as the success of innovation. From the outset it should be recognised that the project has very much been a collective effort, altogether involving nine researchers during various points in time, and resulting in some 20 research reports and conference papers (a list of published reports and papers is appended).

Moreover, a note on the methodological part of this paper is warranted for the sake of clarity to the reader. In particular, it should be noted that the figures and tables only include the manufacturing and software sectors, while the remaining sectors classified as service sectors are left outside the analysis. This is due to the main focus of the project being on technological innovations, whereby the service sectors are covered incompletely as the nature of innovation in services requires a broader definition of innovations than in ours (compared to the definitional discussion in the Frascati Manual by the OECD from 1997).

2 Origin of innovations

The innovations surveyed have been identified using reviews of relevant Finnish trade and technical journals, the annual reports of large R&D-intensive firms, as well as expert opinion. The experts represented the industrial federations, the National Technology Agency, the technical universities and the Technical Research Centre of Finland (VTT). An important step in this identification has been an empirically meaningful definition of an innovation.

With reference to Schumpeterian economics and commonly applied guidelines proposed by the OECD, we have defined an innovation as a *"technologically new or significantly enhanced product compared to the firm's previous products that has been commercialised on the market"* (the Oslo Manual from 1997). This implies that process innovations, developed solely for the firms' internal use, are less well represented. Moreover, our definition excludes intangibles, such as services and organisational innovations that are notoriously difficult to capture in quantitative studies.

One way to summarise patterns of innovation in the Finnish industries during the 1980s and 1990s is to anchor the innovations in time through their year of commercialisation. Since we have linked each innovation to the commercialising firm, the data also enables an analysis of the distribution of innovations by firm size cohorts and sectors to trace their origin in these dimensions.

Number of innovations over time

A first observation is that our methodologies for identifying innovations appear consistent from year to year since there is a steady increase in the number of innovations over time. Starting from 1996, the numbers decrease because there is a lag in the rate at which innovations are reported, especially in the trade and technical journals that have been our prime source of identification.

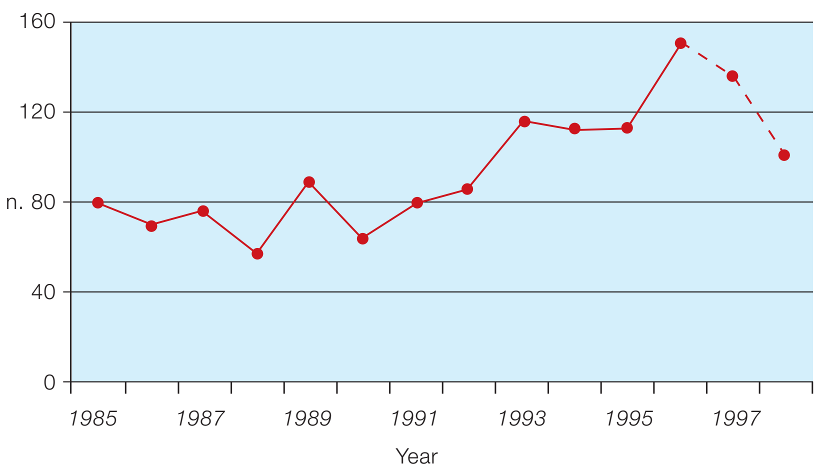


Figure 1. The year of commercialisation of the innovations

More substantially, the pattern shown in the figure is compatible with the growth of private sector R&D-expenditures, especially if we assume a linear progression from R&D inputs to innovation outputs. A somewhat surprising result is that the severe economic depression of the early 1990s in Finland does not strike through the data very strongly, except for the smaller temporary slumps in the years 1988 and 1990. Evidently, the core of innovating firms, which we propose that our data captures, have innovated consistently throughout the period, even though employment decreased dramatically and firm exit rates were high.

Origin of innovations by firm size

The distribution of innovations by firm size cohorts is a particularly topical issue in Finland due to the dominance of a few larger firms (especially Nokia), both in terms of R&D-expenditures and high-tech exports. Recently, there has also been increasing interest in promoting the start-up of new technology-based firms through various incubator schemes, seed-financing and venture capital provisions, as well as regional initiatives.

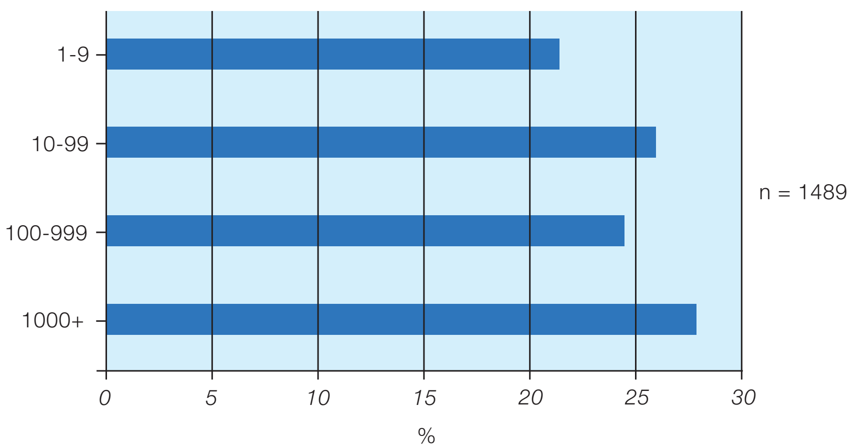


Figure 2. The distribution of innovations by firm size

An interesting result is that a surprisingly large share of innovation originates from the smallest firm size cohorts, comprised of firms with less than 100 employees (48 per cent of the innovations). This is also valid in comparison to firm-level innovation surveys conducted by Statistics Finland (the Finnish contribution to the Community Innovation Survey of the EU), as well as in comparison to the structure of patenting in Finland, according to which larger firms tend to dominate relatively more (Leppälahti 2000). When changes in the distribution of innovations across firm size cohorts are analysed over time, the results show a growing share of innovations originating from smaller firms (Palmberg et al. 1999).

Origin of innovations by sectors

An analysis of the distribution of innovations across sectors provides information about the compatibility between diversification and industrial renewal, as captured by aggregate statistics, and micro-level structural change from the viewpoint of commercialised innovations.

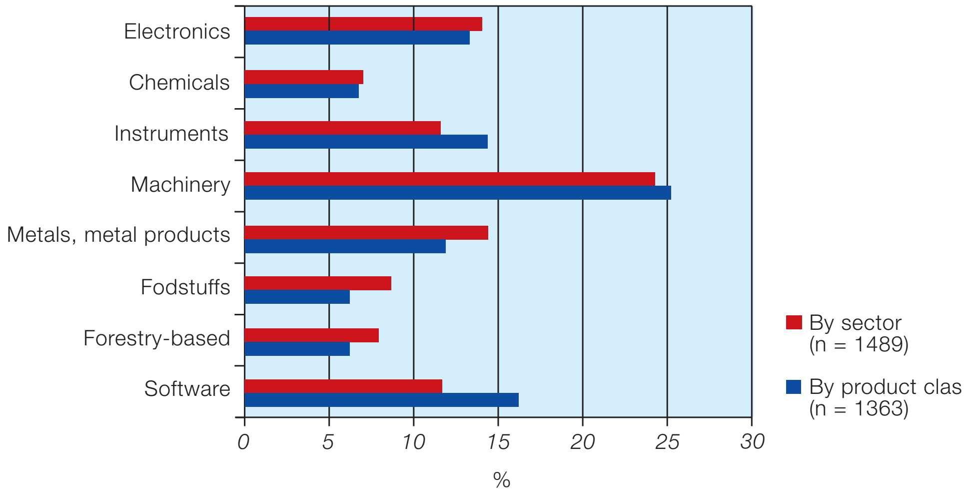


Figure 3. Origin of innovations by sectors and product class

By and large, the largest share of innovations are concentrated in the machinery sector, but also in the electronics, metals and metal products sectors that are significant in terms of aggregate data on production and exports. Nonetheless, the more traditional chemicals, foodstuffs and forestry-based sectors are also well represented despite the fact that the data excludes process innovations developed solely for the firms' own use.

Software innovations

An interesting result is the large share of innovations originating from the software sector. In fact, software is also the only product class that shows a clear increase in the number of innovations over time. According to the related study on software innovations, firms tend to be smaller and more technology-oriented in their innovative activities compared to firms in the manufacturing industries. They also more frequently involve participation in public research programs commissioned by Tekes. A particularly interesting result is that almost 50 per cent of the innovations originate from firms outside the software sector. (Toivanen 2000).

Taken together, the results suggest that the increasing share over time of software innovations developed by small firms has been one of the key characteristics of industrial renewal in Finland. The fact that software innovations are not only confined to the software sectors indicates that software content of innovation in the manufacturing industries is increasing, and thereby might also change the nature of innovations processes across all sectors - a parallel could be drawn to a discussion on the development of the information society, and the alleged emergence of the 'new economy' (Statistics Finland 2001; Saarinen 2002). On the other hand, this issue requires complementary data and more research, for example on the contribution of Nokia to the developments discussed here.

3 The sources of innovations

The distribution of innovations by sectors and firm size cohorts reveals general patterns of innovation in Finnish industry, but falls short of capturing the variety in the actual sources of innovation. It is, for example, a well-established fact that sectors differ in terms of the vitality of the underlying sciences and technologies, their customer-orientation, the nature of competition, regulations, as well as in other institutional characteristics (Palmberg 2001). These differences are of obvious importance both for the way firms organise innovation, as well as in the formulation of specific policy measures.

The sources of innovations by sectors

The survey data identifies four basic sources of innovation, categorised in terms of whether the innovations are induced by competitive factors (price competition or rival innovations), regulations, standards or environmental issues, having their origin in demand- and customer-related factors, or the vitality of the underlying sciences and technologies (scientific breakthroughs or new technologies).

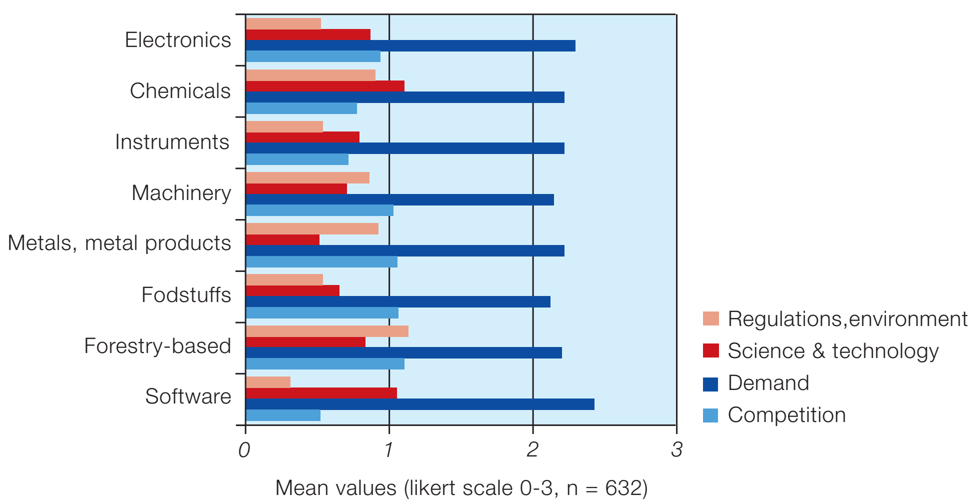


Figure 4. The sources of innovations by sectors (mean values based on 0-3 likert scale)

One of the most salient results of the survey is the role played by demand-related factors and customers for the origin of innovations: close to 90 percent regarded market niche or customers as important or very important sources of innovations. This result applies equally both across sectors and firm size cohorts (Palmberg et al. 1999) and is compatible also with the results of firm-level surveys conducted by Statistics Finland (the Community Innovation Survey), as well as research organisations abroad.

Apart from the domination of demand-related factors and customers, there is a relatively clear distinction between innovations originating from the R&D-intensive electronics, chemicals, instruments and software sectors on the one hand, and the traditional and less R&D-intensive machinery, metals, metal products, foodstuffs, and forestry-based sectors on the other.

In the R&D-intensive sectors, innovations tend to be science- and technology-based. The respondents also assign greater importance to collaboration with universities, research organisations and upstream suppliers. This result is compatible with the volume-wise concentration of technology programs in the biotechnology field, by both the Academy of Finland and Tekes in the 1990s, as well as several electronics and ICT-related programs initiated after the founding of Tekes in 1983. In the traditional sectors, innovations tend to be induced by competition, as well as regulations and environmental issues. Moreover, collaboration appears to be relatively less important. (Palmberg 2002a).

By and large, close to 90 percent of all innovations have nonetheless involved some type of collaboration. In general, domestic partners are regarded as more important than foreign ones. (Palmberg et al. 1999). This is interesting since it suggests that domestic networks still matter for the development of innovations, despite globalisation as well as the growing participation of Finnish firms in the collaborative framework programs commissioned by the EU. It may also point towards a strategic emphasis on domestic partners in projects involving the actual commercialisation of technologies, while collaboration with foreign partners is more common in pre-competitive research. (Luukkonen & Niskanen 1998, Luukkonen & Hälikkä 2000).

Sources of innovations by firm size

When the different sources of innovations are viewed across firm size cohorts, less significant differences emerge. Innovations originating from different sources are relatively equally distributed across all firm size cohorts. This general observation is interesting, since it suggests that firms need to internalise and act upon many different sources of innovations simultaneously, especially if they are active in many different product fields.

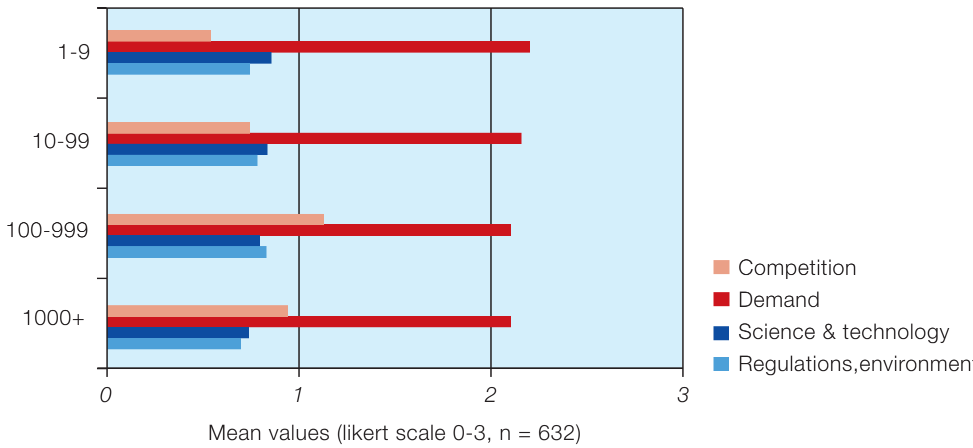


Figure 5. The sources of innovations by firm size (mean values based on 0-3 likert scale)

One noteworthy result is also that innovations originating from smaller firms appear to be less prone to face competitive factors, compared to the larger firms with more than 100 employees where the share of innovations induced by price competition and rival innovations is larger. This is probably due to the fact that most larger Finnish firms operate relatively more on the global markets where competition is fiercer, and especially so in the more traditional machinery, metals, metal products, and forestry-based sectors.

4 Nature of innovations – nature of innovation processes

The prime advantage of data on individual innovations is that analyses can incorporate the qualitative differences between different types of innovation as indicators of the nature of innovation processes and related knowledge bases. These qualitative differences are of importance both in terms of the management of innovation and the design of innovation policy measures for the promotion of specific types of innovations. The focus here is on the degree of radicalness and complexity of innovations.

Incremental versus radical innovation

The survey distinguishes between innovations that have implied changes to firms' existing products, as well as innovations that are entirely new to the firms. Moreover, the survey distinguishes between innovations that are merely new to the Finnish market, as well as innovations that are also new to the global market. In combination, these distinctions capture the degree to which the firms extend their knowledge base in the technology and market dimension. A radical innovation is thus defined as an innovation that is entirely new both to the firm and the global market. An incremental innovation is merely an improvement on the previous products of the firm, which is new only to the Finnish market.[3] Altogether, some 50 percent of all innovations covered by the survey are radical according to this definition.

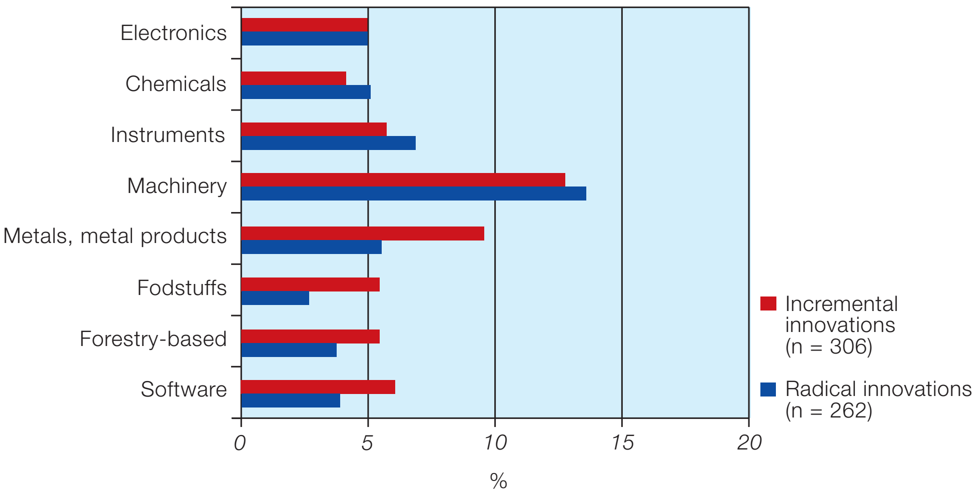
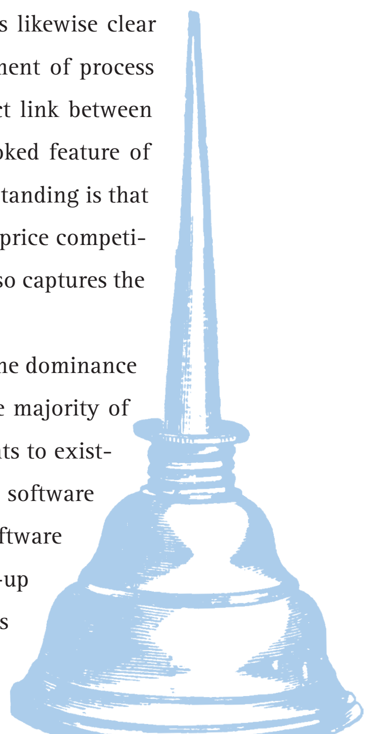


Figure 6. The distribution of incremental/radical innovations by sectors

The sectoral distribution of incremental/radical innovations also follows a distinct pattern. Radical innovations are more common in the R&D-intensive chemicals and instruments sectors, while incremental innovations dominate in the less R&D-intensive traditional metal, metal products, and foodstuffs sectors. On closer inspection of the data, it is likewise clear that incremental innovations typically involve the development of process technology especially in the traditional industries. The direct link between product and process innovations is, in fact, a much overlooked feature of industrial renewal in these sectors, where the common understanding is that process innovations exclusively aim for efficiency gains and price competitiveness in available products (Palmberg 2002). It probably also captures the greater maturity of these industries.

The case of the software sector is interesting in view of the dominance of incremental innovations. This appears to indicate that the majority of firms in the software sector develop incremental improvements to existing software - probably a salient feature of innovation in the software sector in general (Toivanen 2000). On the other hand, the software sector is also characterised by many small and young start-up firms that are, almost by definition, involved in new activities since they typically are entrants on the market.



[3] This definition of innovations is in accordance with the OECD Oslo Manual (see OECD 1997).

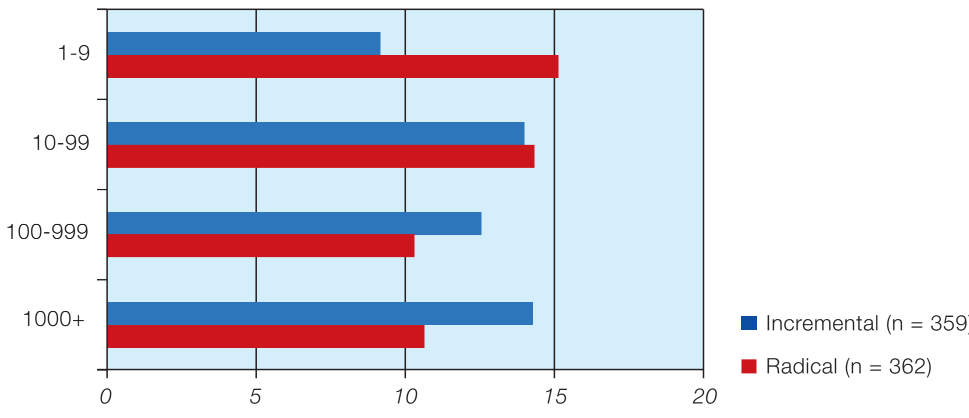


Figure 7. The distribution of incremental/radical innovations by firm size

The tendency for smaller firms to introduce radical innovation is also clear from the viewpoint of the distribution of incremental/radical innovations by firm size cohorts. This tendency offers some interesting insights into the nature of innovation in smaller firms, especially since their share is higher in the R&D-intensive sectors characterised by science- and technology-based innovations. In particular, it suggests that smaller firms are confronted with the need to become engaged in radical innovation more frequently, perhaps due to their focus on the commercialisation of innovations in a narrow market niche.

With reference to this result, it is easy to motivate the need for public initiatives focusing on the specific challenges of start-up firms. These challenges relate to the funding of innovations, but also to complementing their knowledge base in terms of the commercialisation of innovations on the global market. Recent examples of such initiatives in Finland are presented in Oksanen & Niskanen (2002).

Incremental innovations predominate among the largest firms. Hence, larger firms appear to rely on the commercialisation of incremental variations of certain core technologies. Given the evident link between product and process innovations especially in the traditional industries where the share of large firms is higher, these core technologies probably relate foremost to in-house process technologies.

High versus low complexity innovations

An assessment of the complexity of innovations is based on the description of the innovations. Our assessment of the complexity of innovations was aimed at distinguishing between innovations according to the degree to which they involve the combination of different types of components or modules (a telecom switching system is a good example of the former, while glue-laminated timber is a good example of the latter). The underlying assumption was that higher complexity innovations also involve more complex knowledge bases, in terms of the integration of a greater range of different types of technologies, compared to lower complexity innovations. (See the taxonomy by Hyvönen in Palmberg et al. 2000). Altogether some 50 per cent of the innovations are of the high complexity type according to this definition.

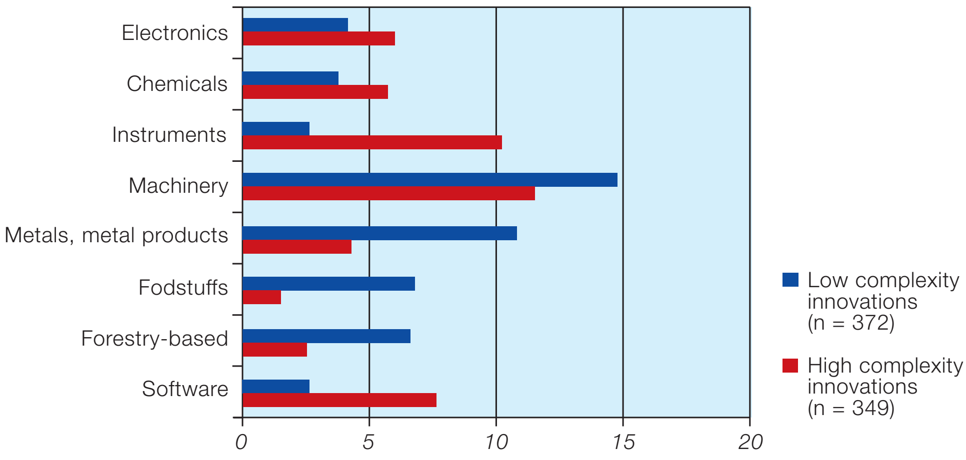
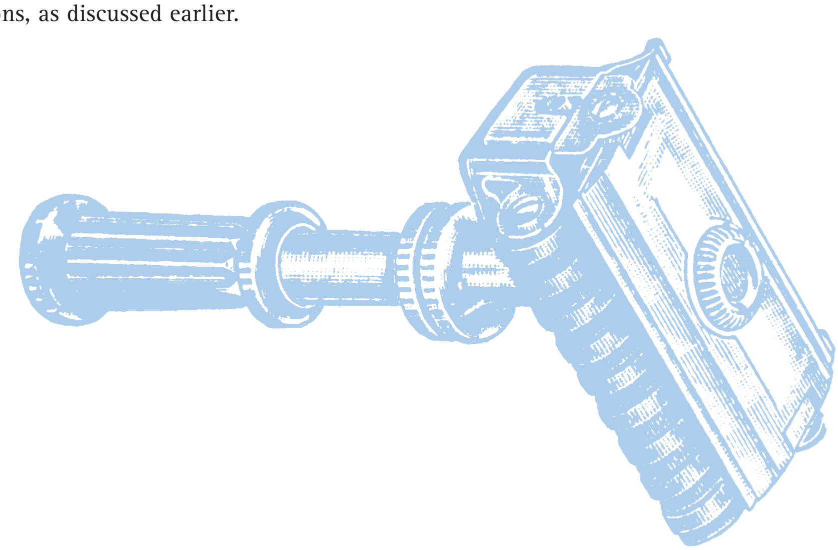


Figure 8. The distribution of high/low complexity innovations by sectors

The distribution of high complexity innovations by sectors coincides with the distribution of radical innovations especially in the case of the instruments and chemicals sector, wherein pharmaceuticals constitute a large share. Moreover, there is a clear pattern in the sense that the less R&D-intensive traditional industries also tend to be characterised by innovations of lower complexity compared to the R&D-intensive industries and the software sector. Nonetheless, in the traditional industries, the predominance of both incremental and low complexity innovations typically conceals sophisticated process innovations that appear to be very closely related to product innovations, as discussed earlier.



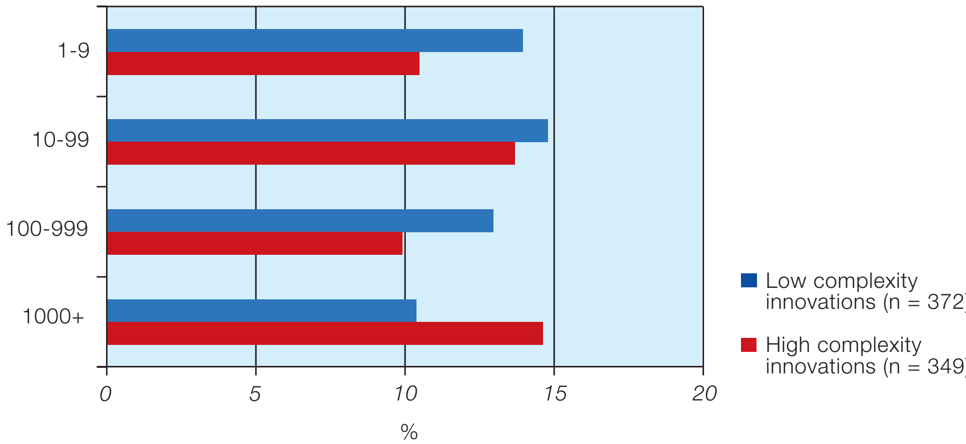


Figure 9. The distribution of high/low complexity innovations by firm size

From the viewpoint of firm size, low complexity innovations quite clearly dominate amongst the smaller and medium-sized firms, while larger firms are more inclined to develop high complexity innovations. One interpretation of this result is that larger firms are also more diversified in their technological knowledge base, and hence have better resources to combine different types of technologies into both incremental as well as high complexity innovations (Tanayama 2002). Correspondingly, smaller firms by necessity have to focus on radical innovation in a limited number of technologies and market niches.

The determinants of the different nature of innovations

The qualitative differences between different types of innovations, and their implications both for the management of innovation processes and the design of specific policy measures, motivate the need for in-depth studies of the actual determinants of these differences. The data, foremost, reveals innovation-specific determinants for such differences related to the nature of innovation. However, the foregoing discussion also suggests that firm and sector-specific factors should be taken into account even though these are not directly subject to managerial control or policy measures.

With reference to the different sources of innovation, one salient result is that both radical and high complexity innovations are associated with scientific breakthroughs and new technologies, or science- and technology-related innovations. Accordingly, these types of innovations also involve, to a significant extent, collaboration with universities and research organisations. They are also associated more frequently with public funding. By contrast, incremental, low complexity innovations are associated with price competitive markets and the threat of rival innovations. An interesting result is that favourable demand conditions, in terms of growing markets, enhance the development of high complexity innovation, while at the same time providing greater scope for incremental innovations drawing on certain basic technologies within firms (Tanayama 2002).

The role of public funding by sector

The role of public funding for the development of innovations is clear since as many as 60 per cent of all innovations involved unilateral R&D funding, while some 25 per cent of all innovations involved participation in public technology programs. This result thereby also reflects the institutionalisation of Finnish technology, and innovation, policy in the 1980s and 1990s, and the related initiation of public technology programs for the support of collaborative R&D in different fields.

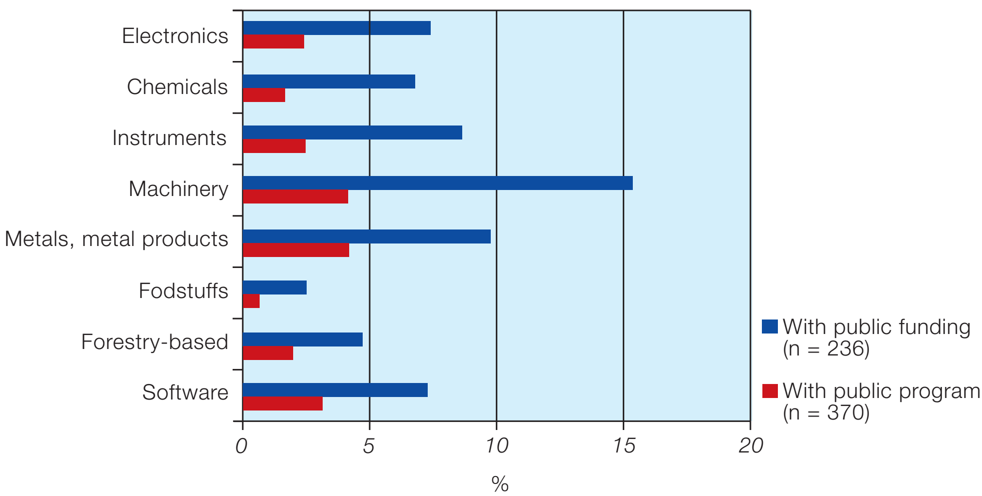


Figure 10. The distribution of innovations involving public R&D funding and public technology programs by sectors

As could be expected, there is a slight polarisation in the distribution of innovations between public R&D funding and those that involve public technology programs, in the sense that the R&D-intensive sectors have a higher share of such innovations compared to the less R&D-intensive ones. This polarisation thus appears to reflect the firms' demand for public funding to complement their own R&D. Moreover, the more frequent involvement of software innovations in public technology programs is also clear from the figure above. In fact, software innovations appear to be relatively more connected to public initiatives compared to other innovations, an observation also confirmed by related qualitative data on software innovations (Toivanen 2000).

The role of public funding by firm size cohorts

The distribution of innovations involving public R&D funding and public technology programs by firm size cohorts is also in line with developments in the technology, and innovation, policy field in Finland.

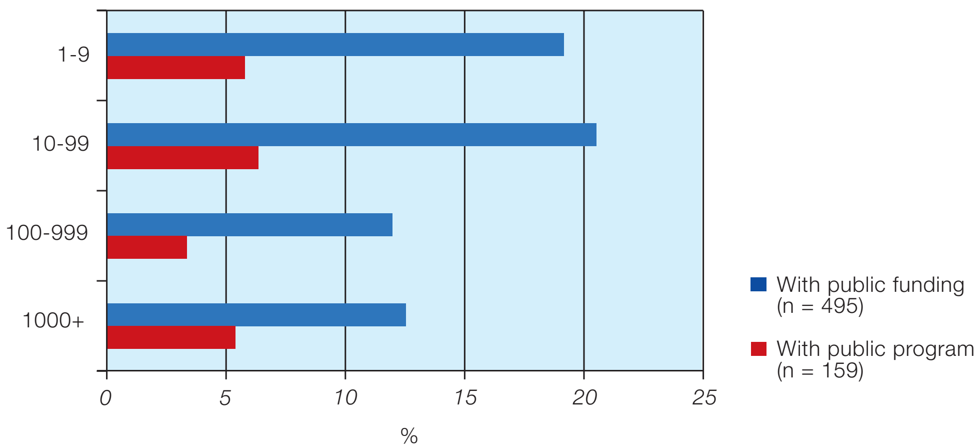


Figure 11. The distribution of innovations involving public R&D subsidy and a public technology program by firm size

The largest share of such innovations is found among the smaller firms that have also been the primary policy focus of recent incubator schemes, technology parks, seed financing and venture capital provisions. The small size characteristic of firms in the software sector, which benefited from public technology programs, is also reflected in this result.

5 The success of innovations

The Schumpeterian insight that innovations are at the very core of the creative destruction and renewal of industries also implies that the question of the success of innovations, and their further diffusion on the market, is important. A particularly topical point of debate has concerned the degree to which policy initiatives are sufficient with respect to the efforts by smaller firms to take their innovations all the way through from the basic idea, to commercialisation, and eventually to break-even (Science and Technology Policy Council of Finland 2000).

The success of innovations is a research field in which the merits of data on innovations is especially interesting, since analysis can pinpoint specific features of the innovation process that contribute to success, and thus benchmark 'best practices', as well as identify possible avenues for policy initiatives to that end. However, one problem in this context is the definition of success. On the one hand, successful innovation should be reflected in the profitability of firms with a lag, due to increasing market share. On the other hand, larger firms in particular are typically involved in many product fields and innovation processes simultaneously, whereby higher firm profitability will obviously also conceal less successful innovations and vice versa. There is also a distinction to be made between sustained success and profitability of firms in the longer run, and short-term profitability through the introduction of particularly successful innovations generating monopoly rents.

Innovations and the success of firms

The relationships between the nature of innovation processes and the success of firms were investigated in a related study for a sub-sample of the data, as financial data on all innovating firms was unavailable. The success of firms was defined as profitability, or total sales minus fixed operating expenses. Given that the organisation of innovation processes is often deemed as crucial in terms of success, the focus was on the relationships between vertical and horizontal collaboration and the profitability of firms. Other innovation-specific variables included whether the innovation was patented, entirely new to the global market, as well as the degree of complexity of the innovation. (Niininen & Saarinen 2000).

Acknowledging the fact that the relationships between innovation processes and the success of firms might be a distant one especially in the case of larger firms, the results strongly indicated that there is a positive relationship between collaboration and the profitability of firms. We can thereby verify a range of studies, conducted abroad, that likewise emphasise the connection between collaboration during the innovation process and success (see Cobbenhagen 2001).

Interestingly, customer-orientation turned out to be especially important for the profitability of smaller firms, while supplier orientation had a bigger effect on the profitability of larger firms. There was also a positive relationship between patented innovations and the profitability of firms, suggesting that intellectual property rights over innovations are important in this context. Another interesting result was the positive relationship between shorter commercialisation and break-even times, and the profitability of firms. (Niininen & Saarinen 2000).

The relationship between commercialisation and break-even times as well as the profitability of firms confirms previous research on successful innovations by suggesting that firms do not succeed on the basis of higher profitability alone. They also need to enhance their throughput times for innovations processes to ‘beat the market’, as well as return their R&D investments quickly to give room for other innovations in the development pipeline. In this respect, it is clear that different sectors and firm size provide different types of opportunities.

Commercialisation times

One novel and particularly interesting result of the Sfinno project is the fact that commercialisation times, defined as the time taken from the basic idea to the commercialisation of the innovations, are surprisingly short with an mean average of 3.5 years across the sectors and firms included in the analysis carried out in this paper. This result is important also from a policy viewpoint, since it underlines the importance of efficient public funding schemes, which have to be organised in a way that supports rapid decision making that is compatible with trends in the market place in particular sectors and firm. (Palmberg 2002). Moreover, the commercialisation times have decreased when comparing innovations that reached commercialisation in the 1990s with those commercialised in the 1980s (Saarinen 2001).

Table 1. Commercialisation times by sectors

Sector	n	Commercialisation times (means)
All	708	3.52
Missing	173	3.82
Electronics	54	3.61
Chemicals	44	6.59
Instruments	70	4.15
Machinery	143	3.08
Metals, metal products	81	3.14
Foodstuffs	42	2.47
Forestry-based	44	2.61
Software	57	2.54

By and large, there are relatively small differences in the mean commercialisation times by sectors, the only noticeable exception being the chemicals industry with a mean commercialisation time clearly higher than the average. The higher mean in the chemicals sector is readily explained by the fact that pharmaceuticals innovation in particular are characterised by longer development cycles due to regulations and extensive clinical research prior to commercialisation. This also increases R&D expenditures. The other noteworthy exception is the software sector, with mean commercialisation times clearly lower than the average.

In the case of software, the lower mean probably reflects dynamic markets, in the sense that product life cycles are short, intellectual property rights are weak, and firms need to innovate continuously (Toivanen 2000). Apart from the software sector, a general observation is also that the traditional, less R&D-intensive sectors are characterised by lower mean commercialisation times. This result is in line with the tendency of innovations induced by competition to be incremental in nature, since product life cycles in sectors such as foodstuffs and the forestry industry are likewise short (Palmberg 2001). With reference to the above, there hence appears to be a requirement for particularly rapid policy responses in the software sector as well as in the traditional sectors where competition is especially fierce.

Table 2. Commercialisation times by firm size

Firnm size cohort	n	Commercialisation times (means)
All	677	3.52
1-9	158	3.25
10-99	196	3.23
100-999	160	3.46
1,000+	163	4.40

By firm size, there is a clear tendency for innovation processes in the larger firms to be characterised by higher mean commercialisation times, while the opposite is true in the case of the smaller firms. Again, there seems to be a connection between high complexity innovations and longer commercialisation times in the case of the larger firms, since higher complexity innovations prolong innovation processes. Larger firms also have greater financial and marketing resources to time product launches intentionally, for example in anticipation of booms and downturns on the market. In the case of smaller firms, the need to beat the market might be greater since they often are entrants on the market. This seems to be true especially for micro firms with less than 10 employees.

Break-even times

Break-even times are defined here as the time taken from commercialisation of the innovation to the break-even point. Nonetheless, the interpretation of what constitutes the break-even point is not clear-cut. It might be interpreted as the year in which the innovation generated positive cash flow in a shorter-term perspective. However, it might also be interpreted as the year in which the accumulated sales of the innovation exceeded the accumulated investments in a longer-term perspective. In addition, the fact that break-even times are surprisingly short, with a mean average of 2.3 years, favours the former interpretation that break-even times reflect the time taken to generate a positive cash flow, while the accumulated break-even over the whole life cycle of the innovations occurs at a later point in time. (Palmberg 2002).

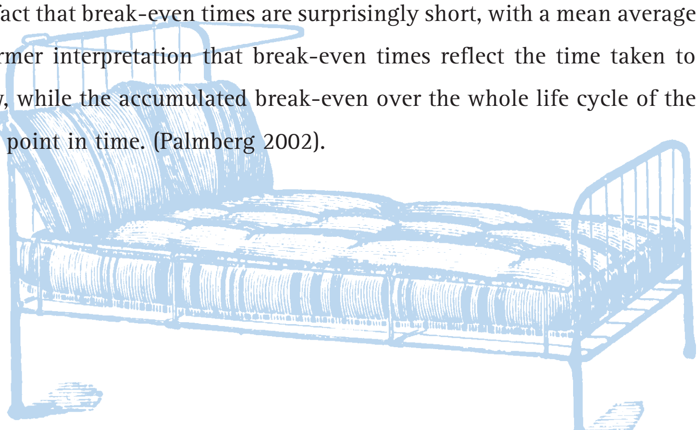


Table 3. Break-even times by sectors

Sector	n	Break-eventimes (means)
All	450	2.26
Electronics	33	2.66
Chemicals	28	3.07
Instruments	56	2.55
Machinery	98	2.08
Metals, metal products	54	2.72
Foodstuffs	29	1.51
Forestry-based	27	1.81
Software	39	1.92
Others	86	2.14

Again, there are relatively small differences in the mean break-even times across sectors. Even though there is no significant correlation between commercialisation and break-even times in the whole data, the longer commercialisation times in the chemicals sector is also reflected in longer break-even times in that sector. A similar observation holds in the case of the foodstuffs and software sectors, in which shorter commercialisation times apparently also reflect shorter break-even times. This confirms the discussion above regarding the nature of market dynamics and innovation in these sectors due to shorter product life cycles.

Table 4. Break-even times by firm size

Firm size cohort	n	Break-eventimes (means)
All	436	2.30
Missing	13	1.00
1-9	92	2.19
10-99	129	2.22
100-999	116	2.60
1,000+	99	2.15

By firm size, the mean break-even times also show relatively small differences, suggesting that firm size, as such, is not a determinant for the rate at which innovations generate positive cash flows. In this set-up, the only noteworthy result is the fact that break-even times for innovations from larger firms have a lower mean than the average. This result is interesting when compared to commercialisation times, the mean of which is higher for firms with over 1,000 employees compared to the average.

Elaborating further on the discussion on why larger firms tend to share longer commercialisation times for their innovations, the fact that larger firms also have better marketing resources could explain why their innovations fare better on the market in terms of shorter break-even times. Taken together, larger firms appear to be in a better position compared to smaller firms, since they manage to reach break-even faster, even though their innovations are more complex and characterised by higher mean commercialisation times.

Successful innovations - the determinants of commercialisation and break-even times

As hinted above, success might also be defined from the viewpoint of innovation processes rather than at the firm level. In a forthcoming study, this viewpoint is approached through modelling the actual determinants of shorter commercialisation and break-even times of innovations, as a measure of their success in a relative sense (Palmberg 2002). In this context, commercialisation times are taken to measure the 'efficiency' of the innovation process in terms of the ability of firms to beat the market ahead of competitors. Break-even times are taken to measure the short-term profitability generated by innovations as a reflection of their ability to generate temporary monopoly profits on the market.

These relatively narrowly defined measures of successful innovations are also motivated by the evident association between time-based innovation strategies, in which efficiency and short-term monopoly profit considerations are an explicit strategic aim, and the success of firms in the longer run (Niininen & Saarinen 2000). Nonetheless, based on the discussion above, it is also important to incorporate obvious sector- and firm size-specific determinants of differing commercialisation and break-even times. It is likewise important to incorporate the qualitative differences in the nature of innovations, for example related to the degree of complexity and radicalness from the firm and market viewpoint.

The results of this study indicate that customer-orientation is a key driver both for shorter commercialisation and break-even times, when firm size and sector-specific effects are controlled. Science- and technology-based innovations are characterised by longer commercialisation and break-even times, and the development of complex innovations prolongs commercialisation times. Exported innovations that are new to the market shorten break-even times, as could be expected. Furthermore, competitive factors (price competition and rival innovations), which are especially prevalent in the traditional less R&D-intensive sectors, shorten break-even times. (Palmberg 2002).

6 Conclusions, implications for policy and future research

The various studies related to the Sfinno project have broken new ground, not least in Finland, where the tradition of innovation studies is young and just emerging. A very general point worth highlighting is the simple fact that the database on Finnish Innovations has provided a unique resource for innovation studies, merely due to the novelty of the data. The Sfinno project has been the first attempt in Finland to systematically identify and map a large number of innovations from various viewpoints, as made evident in this paper. Thus, hopefully, it contributes by complementing previous fairly scarce and scattered case studies of innovations or particular sectors in a direction that enables more coherent generalisations to be made (compare to Kivisaari & Lovio 1993; Miettinen 1995; Miettinen et al. 1999).

The project as a whole has also generated previously unavailable viewpoints on the origin, nature and success of innovations that I set out to summarise and discuss in this paper. These should be of direct relevance and benefit also to the policy discussion and to concrete initiatives. In terms of summarising and concluding, based on the research undertaken in the project until now, I will discuss here four broader policy-relevant issues that also suggest avenues for further research based on the work already done.

The first conclusion to be made is that the results on the origin of Finnish innovations by sectors, product classes, and firm size, by and large, are in concordance with the growth of R&D expenditures in industry during the 1990s, as well as the increasing share of high-tech exports, and the expansion of the electronics and ICT-related sectors more generally. There is a corresponding growth in the number of innovations over the same time period, while the largest share of innovations have their origin in the electronics, instruments, and machinery sectors (Pentikäinen et al. 2002).

Nonetheless, the new viewpoint that our results bring to the fore is the surprisingly large share of innovations that have their origin in smaller firms with less than 100 employees, even though the major share of R&D expenditures is typically concentrated in a couple of large firms (Statistics Finland 2000). The large and growing share of software innovations originating from small firms, both in the software and other sectors, points to a new pattern of innovation in which the software content of innovation in manufacturing is increasing and providing new innovation opportunities across all sectors.

Taken together, the entrepreneurial and software-oriented nature of innovation is in line with the recent discussion on the characteristics of the information society in the Finnish context (Castells & Himanen 2001, Statistics Finland 2001). On the other hand, the fact that the coverage of the database only extends to 1998 raises the question to what degree these developments have persisted amidst the present turmoil, especially in the ICT-related sectors (Koski et al. 2002). Moreover, it is unclear how much Nokia, as the dominant firm in the R&D field, has contributed directly to the large share of small software-oriented firms in the data, for example as an advanced customer or through outsourcing. Among other things, from these viewpoints the database should be updated to capture the most recent patterns of innovation in Finland.

The second conclusion concerns sectoral differences in patterns of innovations. It is clear that the R&D-intensive electronics, instruments, and machinery sectors, which are characterised to a greater extent by science & technology-related sources of innovations, tend to be more radical, and appear to be relatively more often publicly funded. However, an important result is also that a non-significant share of the innovations has its origin in the more traditional metals, metal products, foodstuffs and forestry-based sectors.

The main point to be made is that the sources of innovation in these types of sectors relate more to market-related features, such as competition, regulations, standards and environmental issues. These sources of innovations appear to be more frequently appropriated through in-house activities, such as the development of process technology and the recombination of available technologies. They result in incremental innovations that draw relatively less on public funding. From a policy viewpoint, these differences open up a discussion on the context-specificity of policy options that are tailored to cater for diversity in the sources and sectoral patterns of innovations.

It is clear that the complementary public funding of firms' R&D is compatible with the occurrence of science & technology-based radical and complex innovations in the R&D-intensive sectors. However, in the traditional industries the relatively greater importance of competition, regulations, standards, and environmental issues as sources of innovations suggest a need to broaden the policy viewpoint beyond R&D funding towards a range of other issues that are also subject to public sector intervention. These issues include regulatory change and environmental sustainability, the establishment of standards, and the public procurement of technologies (Kivisaari & Lovio 2000). The effects of regulations, standards, and environmental issues for the origin of innovations is an issue worthy of further in-depth studies since the data at hand does not offer very clear insights into the more precise effects of these issues on the rate and success of innovations.

Another observation is that the nature of innovation in many traditional sectors is at odds with the common interpretation of R&D intensity as an indicator of the levels or sophistication of technologies drawn upon during innovation (Palmberg 2001). Even though the innovation outputs are of the incremental and low-complexity type, the underlying knowledge bases that firms need to master are multi-faceted and demanding. Many innovations in the traditional sectors involve the application of advanced technologies from other sectors, or the novel recombination of available ones. An important result is the close link between product and process innovations in these sectors. Hence, in-house process innovations, developed for the firms' own use, are not merely a means of increasing efficiency and price competitiveness. They also contribute directly to industrial renewal by way of their importance to continuous and incremental product innovations.

The third conclusion relates to the role that collaborative partners play during innovation. The fact that domestic collaborators are seen as more important than international collaboration is significant in the light of the globalisation of the world economy, as well as the increasing participation of Finnish firms in collaborative framework programs commissioned by the EU. In a general sense, the high domestic content of the innovations is in line with the initial results of an ongoing study on the internalisation of large firms' R&D, according to which some 44 per cent of the R&D expenditure of the 16 largest firms in Finland was used abroad - a surprisingly low figure given that the firms are multinationals (Lovio 2002). The importance of domestic collaboration also suggests that the Finnish context is still important, for example in terms of technology programs, science parks and incubator schemes, as well as various regional initiatives.

A more specific result running through the whole Sfinno-project is also the clear importance assigned to customers as sources of innovations and collaborative partners. Moreover, customer orientation is also important for the success of firms with respect to their profitability, as well as for reducing commercialisation and break-even times. While this result comes as no great surprise in the light of a broad range of innovation studies conducted both in the US and Europe, it likewise opens up a discussion about the more precise interpretation of customer-orientation.

Customer-orientation is, of course, a necessary prerequisite for the commercialisation of innovations, since customers as the users of innovations determine their diffusion and ultimately their success. However, customer-orientation probably also takes many forms in different types of firms and sectors, the variety of which would demand much closer attention than has been possible in the quantitative setting of the Sfinno project. Is the impact of customers as the users of innovations greatest during the early discovery stage, or the commercialisation stage? Does the importance assigned to customers, and customer demand in a more general sense, reflect temporary fluctuations in the market or the involvement of firms in long-term collaboration? Does customer-orientation capture inter-sectoral flows of innovations, or the concentration of advanced users in particular sectors? Is the role of design a crucial, and hitherto much neglected, aspect of innovation? These are some questions of relevance also from a policy viewpoint.

The fourth, and final, conclusion emerges directly from the result that both mean commercialisation and break-even times are surprisingly short. From a policy viewpoint, these results suggest the existence of relatively narrow 'windows of opportunity', elevating the question of timely policy intervention to the forefront. Concretely, the results point to the importance of streamlining public funding decision-making in line with the need of firms to shorten the commercialisation times of innovations. Moreover, the sectoral differences in the mean commercialisation times warrant specific considerations, as it is clear that different sectors are characterised by different dynamics in terms of product life cycles, related market dynamics, and the nature of competition.

In so far as shorter commercialisation and break-even times are also taken as indicators of the success of innovations, preliminary results suggest the existence of important trade-offs between the complexity of innovations, the different sources of innovations and their commercialisation and break-even times. The commercialisation of science & technology-based complex innovations takes longer, while less complex, customer-oriented innovations developed for competitive markets generate break-even more rapidly. The implications of these trade-offs for the success of innovations need to be considered both within firms and from the viewpoint of specific policy measures. Moreover, the relationships between the marginal returns to R&D, the success of innovations, their effects on the market share and profit margins of the firms, and society at large, both in the short and long term, requires further debate and research beyond this project.

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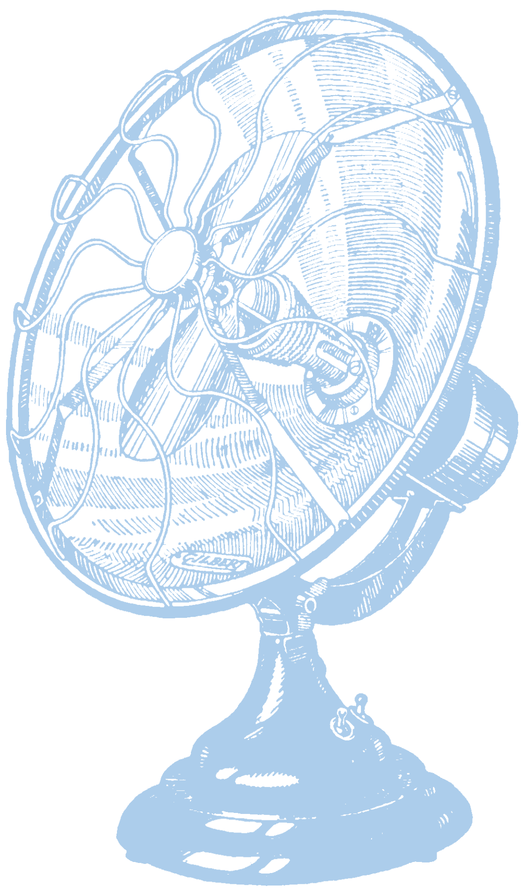

Japan

3

Innovation, science and technology policy and technology foresight in Japan

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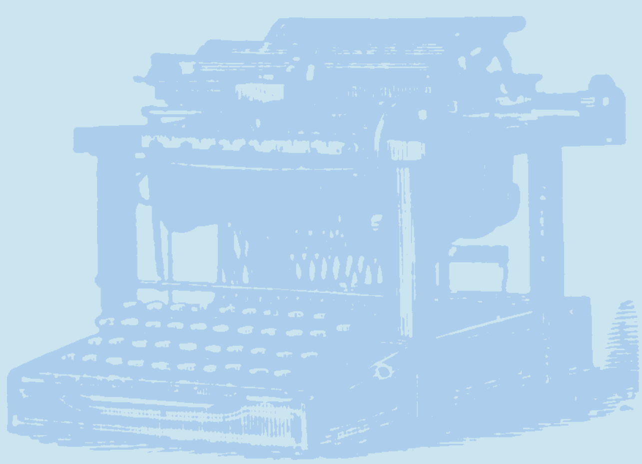


1 Introduction

First, I would like to express my sincere appreciation to the VTT Group for Technology Studies for inviting me to this seminar. It is quite an honor to be a speaker here. As was introduced, I was the Deputy Director-General of the National Institute of Science and Technology Policy (NISTEP) up to the end of March. Now, I have a new assignment at the Tokyo Institute of Technology. My main duty there is to promote cooperation between university and industry. At the same time, I still have an affiliation with the NISTEP as its Affiliated Fellow. I am here today in that capacity.

1.1 About the theme of the presentation

My presentation is on "Innovation, Science and Technology Policy and Technology Foresight in Japan." The same term of "technology foresight" may be used in Europe and in Japan. However, aims and actual exercises of "technology foresight" may not be the same.

Delphi-method has been used in the Japanese technology foresight activities. First, several hundreds of promising technology are identified by panels of experts. The questionnaire on each topic is prepared. Questionnaires usually involve expected date of realization or commercialization of the respective themes of technology, obstacles to their realization, useful government policy measures and so on. Then, questionnaires are sent to experts in respective technological fields. The replies are collected, and the summaries are fed-back to the same experts. Again, their replies are collected and analyzed. By doing so, we may draw a kind of consensus of the expert groups' view on certain technological subjects. The final results are provided to industry, government and researchers.

Introduction:
Technology Foresight in Japan

- Since 1970, 5 year interval
- Deiphi-method
- Questionnaire made by panel of experts
- Questionnaire sent to experts, collected and fed-back to the same expert
- Convergence of views expected
- Results provided to industry, government and researchers

On the other hand in Europe, as I understand, "technology foresight" exercises try to reach consensus among representatives of the research community, industry and the government on areas of promising technologies, policy measures and their priorities.

As for Japanese technology foresight exercises, the results have been offered to government organization dealing with science and technology policy planning, and to their advisory committees as well as to private firms. However, the exercise itself is not a mechanism of building consensus among government, industry and research communities on policy measures or priority setting. Therefore, when it comes to its direct influence on technology policy formulation and priority setting, the role of technology foresight has been rather limited.

Based on this recognition, what I would like to present mainly here is how Japanese technology policy has been formulated and how consensus among government, industry and academia has been formed during the period of Japanes impressive economic growth since the end of World War II with emphasis on advisory committees.

1.2 The explanation of the outline of today's presentation

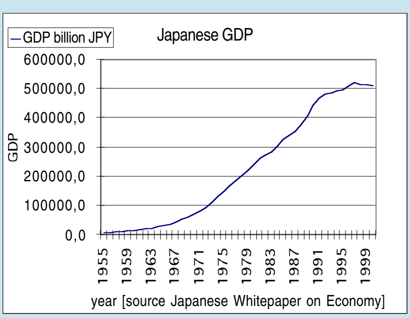
This is the outline of my presentation.

1. Introduction
2. Japanese economic performance after WW II.
3. Japanese economic development and Science, and Technology Policy after the end of World War II.
   3.1 Science and Technology Policy Development after the war.
   3.2 Mechanism for policy formulation
   3.3 Administrative structure of post-war science and technology policy.
4. The present condition of Japanese S&T.
5. Recent Developments in Japanese Science and Technology Policy.
   5.1 Recent developments
   5.2 Second-Term S&T Basic Plan
6. Concluding Remarks

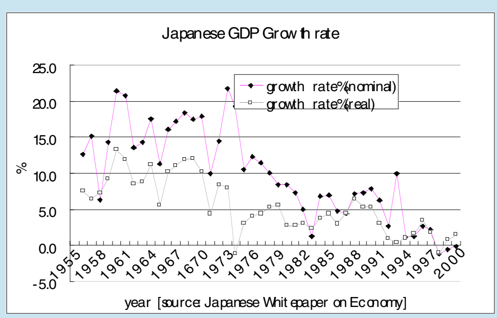
2 Japanese economic performance after WW II

First, I would like to follow the main indicators of Japanese economic performance after World War II. (Data are drawn from the government's "White Paper on Economics". *Keizai Hakusho*)

2-1. Japanese GDP growth

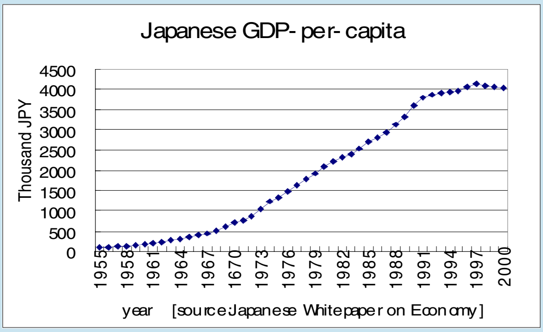


2-2. GDP Growth rates

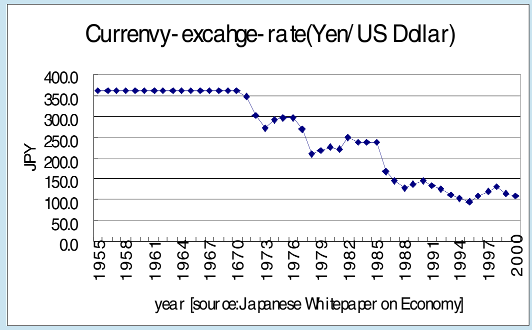


These charts show Japanese economic growth and growth rates.

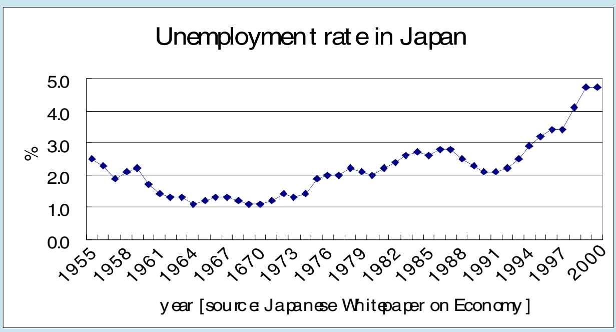
2-3. GDP per-capita



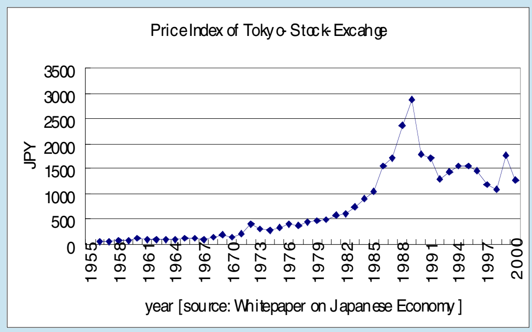
2-4. Currency exchange rate



2-5. Unemployment rate



2-6. Stock market index (Tokyo Stock Exchange)



2-3 shows GDP per-capita. Whereas chart 2-4 shows currency exchange rate. Until 1971, the rate was fixed at three hundred sixty (360) yen to one dollar.

Chart 2-5 shows the unemployment rate. You may understand that unemployment rate in Japan has been relatively low. Finally, chart 2-6 shows the stock market index, an average price for the Tokyo Stock Exchange.

The economic growth and its performance were quite remarkable except for the recent decade.

3 Japanese economic development and Science and Technology Policy after the end of World War II

The main interest of this seminar may be Japanese economic growth since 1960s. In order to understand its development, it may be appropriate to begin with the technological situation, science and technology policy development since the end of the war.

3.1 Science and Technology Policy Development after the war

3.1.1 1945-1969; from reliance on imported technology to emphasis on technology development in Japan

Technology flow from foreign countries was interrupted due to the war. The Japanese technological level at the end of the war was far behind those of advanced western countries. Therefore, importing state-of-the-art technology from advanced countries was an important policy issue in order to raise the Japanese technological level.

At that time, however, foreign hard currency was in short supply. It was difficult for private firms to import foreign technology because they were not able to pay or promise to pay their fees and royalties in hard currency in the future. Therefore, related laws and regulations were instituted. Technology import became subject to government permission. Once the permission was granted, the allocation of hard currency for the payment was guaranteed by the government. Priority for government permission was placed on the technology which the government considered useful for the modernization of Japanese heavy and chemical industries and for those industries which export their products. This system is considered an important mechanism for the importation of foreign technology, and useful for industrial innovation in Japan in the 50s and 60s.

In addition, in order to obtain hard currency, the promotion of export was important. Improvements in the quality of products was keenly required. Accordingly, efforts to improve quality were instituted, such as the introduction of the JIS System (Japan Industrial Standard) to standardize products in 1949. Lectures on quality control and awards for high quality products and quality control activities were introduced.

The Korean War broke out in 1950. Demand induced by this war was brought to Japan. The Japanese industry rapidly modernized its production facilities. At the same time, technology import was done actively, leading to the economic development in the latter half of the fifties (1950s).

The government support began for the introduction of new technology in production lines and for research and development of private firms. In 1950, subsidies to research for industrial technology by private firms was started. Preferential tax treatment for research equipment and equipment for new technology commercialization was also started. In 1951, low-interest loans to private firms from the Central Bank were offered for investments in the industrialization of new technologies.

As to government administration, the Agency of Industrial Science and Technology (AIST) was established in 1948. In 1956, the Science and Technology Agency (STA) was established.

S&T policy measures shortly after the war

- Technology import subject to gov't permission
- Japan Industrial Standard (JIS) in 1949
- Research subsidy to firms in 1950
- Low-interest loans to firms in 1951
- Government organizations
  - Agency for Industrial S&T(AIST) in 1948
  - Science and Technology Agency(STA) in 1956
- JICST(Japan Information Center for S&T) in 1957
  - Collecting research articles and publishing their abstracts

A number of national research institutes were established. In addition, the Japan Information Center for Science and Technology (JICST) was established in 1957. The JICST collected domestic and international S&T literature and research articles and published their abstracts. The abstracts were made available to firms, research institutes and academics.

When ten years passed since the end of WW II, Japan reached the age of the technological innovation, and the introduction of new technology and investment in production factories were done actively.

In 1960, a new government economic plan *(Kokumin Shotoku Baizou Keikaku)* was decided to double national income per capita within a decade. It was thought an ambitious objective at the time of planning. Actually, the goal was achieved without having to wait for ten years. Corresponding to this plan, an effort was made to raise the required science and engineering workforces. Also, R and D activities was strongly encouraged to catch up with the technological levels of advanced countries.

1960s is the important period when Japanese economy was gradually incorporated into the world economy. Restrictions on imports and foreign investment in Japan were gradually lifted. In 1967, Japan abolished most restrictions on foreign direct investment.

Corresponding to these developments, strengthening competitiveness of the Japanese industry became high on the policy agenda. Expectations on technology development in Japan became high among industry and the government.

In 1961, the Law for the Establishment of Cooperative R&D Associations in Industrial Technology *(Koukougyou-Gijutu-Kenkyuu Kumiai Hou)* was enacted. In 1966, the System for Large-Scale Industrial Technology R&D Projects (so-called *Oo-Puro* in Japan) was initiated by the AIST. In 1967, preferential tax treatment for R&D by private firms was instituted, which allowed special tax deduction for the portion of increased R&D expenditure.

3.1.2 The 1970's: the period for adjust ment to rapid economic growth and to changing world situations

Although Japanese economic growth in preceding years was impressive, there were many problems. The most severe ones were those of pollution, air, water and others, which caused harm to health and welfare of the people surrounding factories and elsewhere. In the 1970s, coping with the pollution problems and with rapidly changing international circumstances were high on the agenda.

In response to pollution, the Environment

3-1-2. Major issues in 1970s

- Coping with pollution problems in Japan
- Coping with Oil Crises
  - Japanese heavy dependence on imported oil
- Coping with new US Economic Policy: Appreciation of Japanese Yen
  - Competitiveness of Japanese industry at stake
- Liberalization of high-tech industries

Agency was established in 1971. Regulation on pollution was strengthened. Corresponding to this, technologies for reduction of harmful emissions were developed. Investment in equipment for emission control was increased drastically. At the same time, regulation on exhaust gases from automobiles was strengthened. Technologies were advanced to cope with regulations. This is a good example of the cases where regulations promote technology development.

Other important events in this decade were the oil crises of 1973 and 1979. Japan's energy sources depend heavily on oil mostly from the middle-east region. Coping with the energy crises became an important issue. Development of energy-saving technology was progressed in the private industry. Moreover, in the automobile industry, R&D to reduce harmful emissions as well as increase energy efficiency was progressed. These efforts by the industry culminated in a remarkable increase in energy efficiency.

As to the governmental R&D programs, the New Energy Technology Development Program (so-called Sun-Shine Projects) and Energy-saving Technology Development Program (so-called Moon-Light Project) were started by the AIST.

In 1971, the US adopted a new economic policy and the appreciation of the Japanese yen was inevitable. There was growing concern that the Japanese industry would lose its competitiveness due to the high value of the Yen. Thanks to the efforts of the private industry, the Japanese industry maintained or even increased its competitiveness.

In 1971, a policy to liberalize the computer industry was adopted. Accordingly, foreign firms were allowed to have stock up to fifty percent in 1974 and 100 percent in 1975. Against this background, government subsidies were appropriated to development for computers from 1972 and to development for Large-Scale Integrated Circuit (VLSI) from 1976. These subsidies were given to technology development research associations.

In the late sixties, the Japanese GDP became second to the US in the world except communist countries. In the middle of 1970s, Japanese expenditure on R&D (including both private and government sectors) exceeded those of France and the UK respectively. As to the technology trade, since 1972 revenue from newly contracted technology export from new contracts exceeded payment to technology import of new contracts. This fact suggested the improvement of the Japanese technological level.

3.1.3 The 1980s and first half of 1990s: emphasis on basic research

Against the background of the increase of technological capability and competitiveness of Japanese firms, policy emphasis was placed on basic research.

Japanese S&T policy emphasis on basic research is a reflection of the friction with the United Sates in trade and science and technology relations. The increase of the US trade deficit with Japan and frictions in high technology product trade such as machine tools, telecommunications equipment, semi-conductors, super computers and satellites, lead to the condemnation by the US of Japanese alleged unfair practices on support to industry and unfair treatment of foreign products on the Japanese market. These frictions and condemnation lead to abstention from measures which might appear to be a direct support to industry in the Japanese technology policy.

In addition, during S&T friction between Japan and the US in the late 1980s, the US claimed that US access to Japanese science and technology systems was limited because most R&D in Japan was done in the private sector while Japanese access to the US systems was free because most of research in the US was done in universities. Although this argument may lack reasoning, this argument was the reflection of the perception that Japanese contribution to the international community in basic research was little, and that Japan was a free-rider on the results of basic research done by advanced countries.

To cope with this development, the Exploratory Research for Advanced Technology (ERATO: *Souzou-Kagaku-Gijutu*) began. (Within this program, several research subjects were initiated and basic research was conducted by a team of researchers derived from industry, academics and government sectors under the leaderships of projects leaders.) At the same time, the Next-Generation Industrial Technology Development *(Jisedai-Sangyou-Gijutu-Kaihatu)* Program was started in 1981. In this program, the development of fundamental technologies, which would become the basis for the next generation industry, was contracted to the technology research associations.

In addition, Japan proposed the Human-Frontier Science Program at the G-7 Economic Summit meeting. Fellowship programs (such as STA and JSPS) were also enlarged to invite more foreign researchers to study in Japanese universities and national laboratories.

3.1.4 Relations between Technology Policy and Economic Growth

Speaking of the relationship between science and technology policy, industrial policy and economic growth, a concept of so-called "Japan, Inc." is not an appropriate one. The economic growth and competitiveness of private firms was rather the result of efforts by private firms. Japanese private firms with international competitiveness were actively competing in the Japanese domestic market where several rival firms exist. Shipbuilding, steel, automobile, electronics industries are the typical ones with extensive competition in the domestic market.

In the case of the automobile industry, there exist Toyota, Honda, Nissan, Mitsubishi and Mazda. However, it may be difficult to say that the competitiveness of these firms is the result of government policy. Their competitiveness is much more the result of their own efforts. In this connection, however, the existence of financial market which allows long term investment by firms, the existence of a large domestic market, the stability of government policy, the existence of talented labor forces and education systems should be noted.

3.1.5 Relations between Technology Foresight and Economic Growth

Speaking of relationship between technology foresight and economic growth, the following may be said. Technology Foresight exercise presented the consensus of experts on technology for future promising technologies. Results were provided to government, researchers and industry. The industry used them for its own R&D planning. However, the direct impact on policy formulation or their priority setting seemed little.

3.2 Mechanism for policy formulation

Now, I would like to discuss how government policies were formulated during these years. The recent situation will be discussed later.

3.2.1 Governmental policy

Basic governmental policies should be based on laws. Moreover, a governmental budget should be approved by the national parliament. And, most policy measures require budget allocations.

In Japan, the Prime Minister is chosen from the members of the parliament, and the Prime Minister organizes the cabinet. The cabinet proposes a budget plan to the parliament. The cabinet also proposes legislation to the parliament to be deliberated and decided. Because the party with the majority of the seats forms the cabinet, the cabinet can expect that their proposal to the parliament are certainly agreed to and decided by the national parliament. In addition, it is quite usual that consultations and negotiations are made between the cabinet and ruling party before its proposal to the parliament.

The proposals to the parliament are originally prepared by government ministries and agencies headed by ministers appointed by the Prime Minister. Thus, it can be said that the influence of ministries and agencies is substantial in the formulation of policies. Therefore, how each ministry or agency makes its policy proposal is very much important for actual policy formulation.

3.2.2 Formulation of policy proposal in ministries and agencies

The fundamental building blocks of Japanese ministries and agencies are divisions *[Ka]*. Usually a bureau consists of several divisions and each ministry or agency usually consists of several bureaus. Formulation of policy is based upon a bottom-up approach. The original proposal is formulated by the division, and proposed to the bureau and to the agency-wide or ministry-wide level.

Each division has its own jurisdiction or responsibility. In economic ministries, each division has responsibility for a specific industry. Firms in a specific industry organize their own industry association or organization. The industry association and division of the ministry frequently exchange information. Divisions of the Ministry of Education or Science and Technology Agency exchange information with universities or national research institutes. By doing so, divisions are well aware of the situations and problems of their respective industries or constituencies. In addition, relevant information in foreign countries is collected through diplomatic establishments abroad, the governmental organization (such as JETRO) and industry associations. The information gathered is reflected in policy formulation.

The original policy proposal is drafted by a division with the knowledge of the problems in their constituencies. This proposal is, then, usually presented to relevant advisory committees.

3.2.3 Government advisory committees

As to economic policy, there existed the Economic Council in the Prime Minister's Office. As to industrial policy, there was the Industry Structure Council in MITI. As to the science and technology policy, there were advisory committees in respective ministries and agencies such as in MITI, Ministry of Education and the STA. The Council for Science and Technology in the then Prime Minister's Office served as an advisory committee for the whole governmental science and technology policy.

3.2.4 Role of advisory committees

An advisory committee is usually composed of representatives from such organizations as may be influenced by the implementation of proposed policy. The members include representatives from industry associations or business communities, academics, (in some cases from labor unions as well), and ex-officers of the ministries and agencies.

Deliberation in the advisory committees is made based on the information and materials provided by the division or bureau of the respective ministry or agency working as its secretariat. The report of the committee, which contains policy proposals, is usually drafted by the secretariat. It can be said that consultation and coordination among organizations that may be influenced by the implementation of proposed policy has been attempted through deliberation in the committee and drafting of the report.

However, a substantial argument is not always made in the meetings of advisory committee. There is much consultation in advance of the actual committee meetings. In some cases where proposed policy has major political and financial implications, consultation with financial authority and/or ruling parties is made before final approval by the committee.

The functions of the advisory committees may be summarized as;

- Giving a kind of political legitimacy to policy proposals,
- Coordinating the various interests of stakeholders, and
- Building consensus among stakeholders.

Consensus building will facilitate smooth implementation of proposed policy.

Decision in the Japanese government advisory committees is usually made on a consensus basis. Accordingly, one member practically had a veto power in the committee. Therefore, consultation and coordination among members of the committees, and in the case of the CST among ministries and agencies, was essential. This was especially true when the interest of respective ministries or agencies is at stake. Therefore, as for policy that might be against the interest of related ministries or agencies, it would not be decided. Under such systems of policy formulation, setting a strategic goal was almost impossible when it ran against the interest of the members concerned. Accordingly, bold policy initiatives were hard to be decided.

3.3 Administrative structure of post-war science and technology policy in Japan

3-3. Administrative structure of post-war S&T policy in Japan-1-

Cabinet
- Prime Minister's Office --Council for S&T
  - Science and Technology Agency
  - Environment Agency
  - Other Agencies
- Ministry of Education
- MITI - AIST
- Other Ministries

3.3.1 Postwar S&T administration system

Now, let me explain the Japanese S&T administration system. (There were established Agency of Industrial Science and Technology (AIST) in 1948, Science and Technology Agency in 1956, and Council for Science and Technology (CST) in 1959.) Most of the important S&T administration in Japan was established before 1960.

3.3.2 Japanese S&T administration system

Japanese Science and Technology Policy was being carried out by respective ministries and agencies. (Ministry of Education is responsible for education and research at universities, Welfare Ministry for research for improvement of health, Ministry of Agriculture, Forestry and Fisheries for research for agriculture and fisheries, MITI for research for industry, mining and energy. Ministry of Transport carried out research for transportation and Ministry of Post and Telecommunications research for telecommunications.)

Publicly funded research was mainly performed by national research institutes, public research corporations and universities. Some of the research was contracted out to private sector institutions. Respective ministries and agencies formulated policies reflecting their respective constituencies. Science and Technology Agency mainly represents the interest of national research institutes and researchers, MITI the interest of industry and Ministry of Education the interest of universities.

3.3.3 Budget related to S&T

How much influence respective ministries and agencies have in Japanese S&T policy. Let us see a budget allocation as an index. S&T related budget is compiled by the STA. According to this data, roughly speaking, Ministry of Education has one half, Science and Technology Agency one quarter, and MITI one eighth of the Government S&T budget.

3.3.4 Role of Science and Technology Agency

The role of the Science and Technology Agency is to promote S&T policy efficiently and effectively keeping consistency on the whole government S&T policy. Accordingly, the STA formulate basic policies for promotion of science and technology, coordinating government research activities, and carries out research in advanced areas of S&T.

(Note: The jurisdiction of the STA excludes social sciences, humanities, and research at the universities.)

3.3.5 Council for Science and Technology

The Council for Science and Technology (CST) was established in 1959 as an advisory body to the Prime Minister for formulation of comprehensive government science and technology policy. The Prime Minister was designated as its chairperson. Members were Cabinet Ministers related to S&T and experts derived from academia and industry.

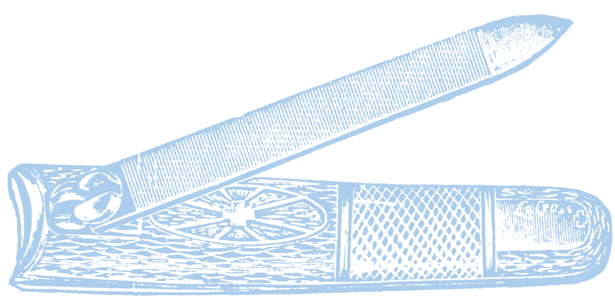
Tasks of the Council are to deliberate;

- Formulation of general, basic and comprehensive policy of science and technology,
-Setting of objectives for long-term or comprehensive research, and
- Formulation of policy measures to attain the above objectives.

Findings and recommendations were reported to the Prime Minister. Science and Technology Agency served as the secretariat to the CST. When matters related to university research was to be discussed, the Ministry of Education joined the secretariat.

The plenary session of the CST, where The Prime Minister presides as a chairperson, was usually held only once or twice a year. The CST established subcommittees and panels of experts. Members of those subcommittees were representatives of the research community, industry and other institutions including government related organizations.

Although it has the Prime Minister as its chairperson, the CST was an advisory committee and there was restriction in its function. In addition, all major issues were usually discussed and approved in advance of representatives of related government ministries and agencies before plenary meetings.



4 The present condition of Japanese S&T

Now, I would like to explain some of main indicators of recent Japanese S&T activities.

R&D expenditure and number of researchers

- R&D expenditure as a ratio to the GDP
  - Japan 3.12%, USA 2.65%, EU 1.87%
- Number of researchers (x thousands)
  - Japan 740, USA 988, EU 892
- Distribution of researchers among sectors

	gov't res.inst.;	universities;	industry ;	private res.inst.
JAPAN:	4.2%	35.0%	58.7%	2.1%
US:	5.5%	13.6%	79.9%	1.0%
EU:	14.9%	35.9%	48.4%	0.8%

Source: Japanese S&T White Paper -FY2000-

R&D performers

- R&D spending by sectors

	gov't res.inst.;	universities;	industry ;	private res.inst.
JAPAN:	9.3%	20.0%	66.4%	4.3%
US:	10.1%	11.4%	75.4%	3.1%
EU:	15.2%	20.6%	63.4%	0.7%

Source: Japanese S&T White Paper -FY2000-

4.1 *R&D expenditure and researchers*

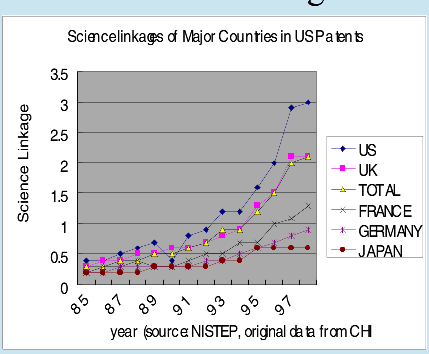
The "ratio of R&D expenditure to the GDP (gross domestic product) of Japan, the US and EU selected countries".

Japanese R&D investment is high in comparison with other countries.

As for the performers of R&D activities, there exist universities, research institutes, (both governmental and private), and industry. The distribution of researchers among sectors is shown in the table.

R&D performers -slide shows which sectors spend what percentage of R&D expenditure. Industry has a dominant position in Japan. The US has high share of industry probably because the US government contracts its military technology development to its industry.

Science Linkage

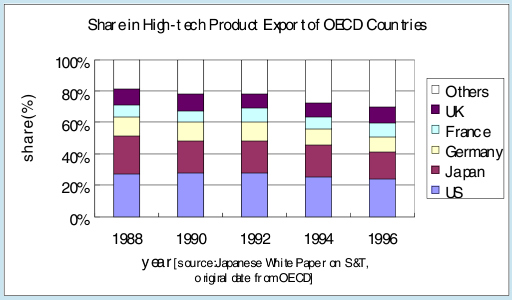


4.2 *Science linkage*

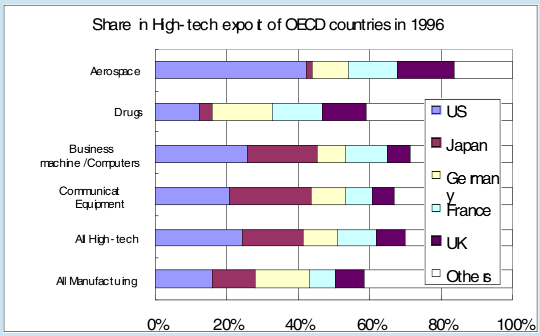
Science linkage is an indicator based on the analysis of registered US patents. US patent examiners compile reports and cite relevant patents or research papers in their reports. Science linkage is the intensity of citation of research papers, and seen as an indicator of industry linkage with sciences.

NISTEP analyzed the patent registration data of the United States according to applicants' nationalities. The report found that linkage is high in the US, and that, although the science-linkage of patents filed by Japanese nationals in US patents is relatively weak, this linkage has become stronger year by year.

Share in High-tech export -1-

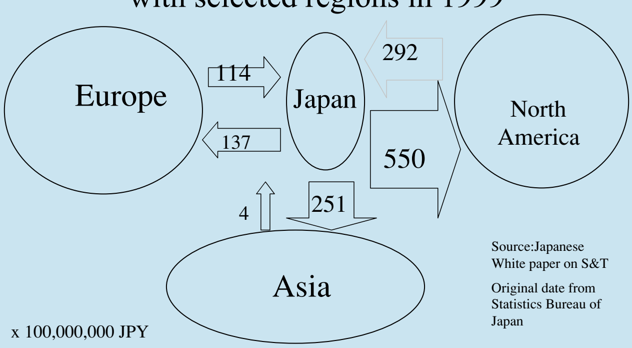


Share in High-tech export -2-



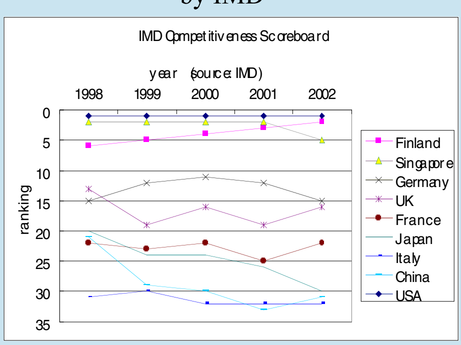
Japanese technology trade

with selected regions in 1999



Competitiveness of selected countries

by IMD



4.3 Hi-tech export

High-tech export 1 -slide shows the market share of high technology products export by OECD countries in recent trends. The amount of export of high technology products may be seen as an indicator of the competitiveness of respective industry based on S&T in the country. Japan gradually loses its share.

High-tech export 2 is on sector specific data.

The share of Japan is relatively high in communications equipment, precision machinery, and electric machinery. The US is maintaining an overwhelming position in aerospace industry. As for medical drugs, Germany, England, and France compete fairly well with the US.

4.4 Technology trade

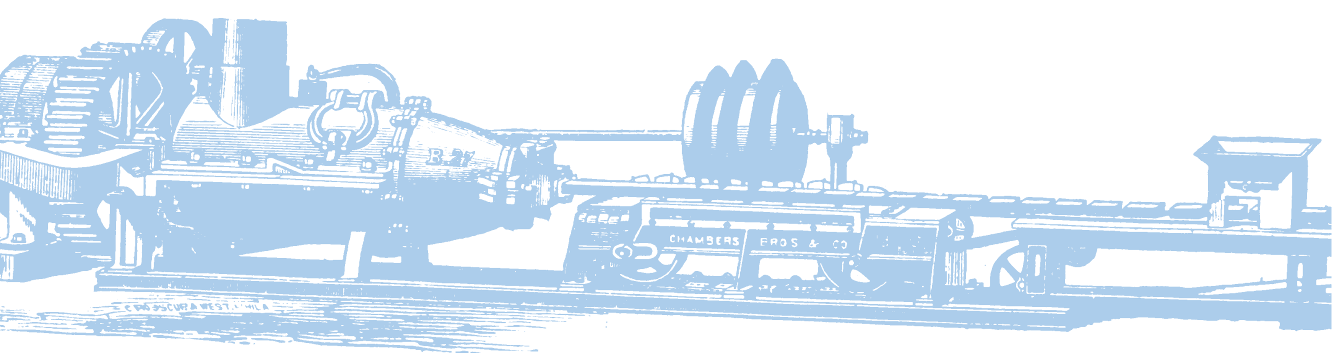
Japanese technology trade with selected regions -slide shows the "Japanese technology trade with selected regions".

With Europe and North America, both exports and imports are substantial. With Asian regions, exports from Japan are substantial. Historically speaking, Japan had more technology imports than exports before the middle of 1980s, then both became about equal up until 1993. After that, the exports surpass the imports.

4.5 Competitiveness of selected countries by IMD

IMD, a business school in Switzerland, publishes a report on the competitiveness of countries every year. The US has been no.1 in recent years. Finland becomes close to the US in ranking. Japan, which used to be high in rank, is now 30th in the latest ranking.

Japanese R&D investment is high. There are substantial numbers of researchers. On the other hand, its economy is suffering from a long depression and industry seems to lose its competitiveness. These facts indicate that there should be problems in the S&T system or other systems.



5 Recent Development in Japanese Science and Technology Policy

Now, I turn my subject to recent developments in Japanese science and technology policy.

5.1 Recent development

The first important element is the Japanese sluggish economy in recent years. Second is decreased R&D investment by private sector in three consecutive years in 1993-1995. Against this background, S&T Basic Law was enacted in 1995. S&T Basic Law provides a general framework for governmental science and technology policy. In accordance with the provision of the law, a five-year governmental S&T Basic Plan was formulated in 1996 and a new Plan in 2001. As for the latest basic plan, its main points will be explained later.

5.1.1 Administration reform in 2001

Reorganization of government ministries and agencies was in place by January 2001. Its aim is to strengthen the leadership of the Prime Minister and the Cabinet, and the establishment of ministries with wider area of responsibility. Another aim includes the introduction of policy evaluation and increase of transparency in policy formulation and implementation. The other aim is to achieve efficiency and functionality in government operations including establishment of (UK type) agencies for the implementation of part of government activities.

As for S&T policy, there is major reorganization as well. The Council for Science and Technology Policy (CSTP) was established within the Cabinet Office. A new ministry, Ministry of Education, Culture, Sports, Science and Technology (MEXT) was established by combining the Ministry of Education and the STA. Most of national research institutes are reorganized into UK type agencies, or what we call *Dokuritu-Gyousei-Houjin*.

National universities will be reorganized into similar types of organizations (*Kokuritu-Gakkou-Houjin*) within two to three years.

5.1.2 Council for Science and Technology Policy

The Council for Science and Technology Policy is assigned tasks of deliberating issues on;

- Formulation of basic policy for comprehensive and orderly promotion of science and technology,
- Formulation of basic policy for allocation of resources related to science and technology, and
- Evaluation of large-scale research projects and programs of national importance.The CSTP is made up of the Prime Minister as its chairperson and fourteen members. Among the fourteen, more than half are representatives from the industry and research community and the re-

maining are drawn from cabinet ministers. Currently, a Cabinet Minister is appointed responsible for science and technology policy.

Since its establishment, a plenary session where Prime Minister presides is held monthly. This shows clear contrast with its predecessor, the CST, which had its plenary session once or twice a year. The CSTP established several committees on various subjects. The members of these committees are representatives from research community and industry.

Another major difference with the former CST is its secretariat. The CSTP has its own independent secretariat within the Cabinet Office.

5.2 Second-Term S&T Basic Plan

5-2. Second-Term S&T Basic Plan

- S&T Basic Law was enacted in 1995
- S&T basic law provides general framework for governmental S&T policy
- In accordance with the law, the first five-year governmental S&T Basic Plan was formulated in 1996
- A new five-year Plan was formulated in 2001

Now, let me explain the main points of the new S&T Basic Plan. It was decided by the government in March 2001.

The plan depicted the goal of Japan as a nation;

- Creating and utilizing new knowledge and wisdom to contribute to the world,
- Maintaining international competitiveness and sustainable growth, and
- Securing a life of comfort, safety and high quality.

Based on this goal in mind, basic policy is formulated. The two main points of the policies are (i) strategic priority setting on S&T and (ii) reform of the S&T system.

5.2.1 Strategic priority setting on S&T

In the priority setting section of the plan, (i) promotion of basic research, (ii) priority setting in accordance with national and social needs, and (iii) support for emerging fields is stressed. Areas with highest priority are life sciences, information technology, environment science and technology, and nano-technology and materials.

5.2.2 Reform of the S&T system

In the Reform of the S&T system section of the plan, (i) R&D system reform and (ii) strengthening industrial technology and system reform of industry-academia-government cooperation are stressed.

As to reform of the R&D system, the following issues are listed.

- Expansion of competitive funding,
- Introduction of indirect expenses (or overheads) in government competitive funding
- Appointment of researchers on fixed terms
- Reform of evaluation system.

As to—strengthening industrial technology and system reform of industry-academia-government cooperation, the following measures are listed.

- Formation of an environment amenable to technology transfer from universities and national laboratories,
- Promotion of commercialization of research results of universities and national laboratories,
- Formation of an environment to vitalize high-tech venture firms.

6 Concluding Remarks

In concluding my presentation, I want to make some remarks on the economic situation and science and technology policy in Japan, and future roles of technology foresight and science and technology policy research.

6.1 Economic situation and science and technology policy in Japan

Looking back on the historical development of Japanese economic growth in the post war period, the competitiveness of the firms was mainly achieved through combinations of measures such as introduction of new technology and investment in new production facilities, well-trained work forces and efficient methods of management. The role of policies was mainly to form an amenable environment for the activities of private firms. There were almost always models of promising industry or new technologies elsewhere in the world to be pursued by Japan. Policies in Japan were formulated mainly to catch up these models in a more efficient and effective manner.

Up until the 1980s, this strategy seems to have worked effectively for Japanese firms as well as for the government. However, the success of this strategy became difficult in 1990s. The following reasons may be listed.

- Competitiveness of Japanese industry has been eroded (i) by the catching-up of Asian countries, and (ii) by the learning by competing firms in other industrialized countries of Japanese management methods,
- No clear models outside of Japan,
- Unsuccessful endeavor so far to develop new technology and new industry in Japan, mainly because of adherence to past successful experiences, lack of good managers, inadequacy of

risk-taking by banks and financial institutions and so on, and
- Increasing difficulty in predicting emerging industries such as IT and biotechnology industries.

On the other hand, institutional setting in the US such as its venture capitals, together with its excellent research universities, seems to have brought its economic successes in recent years.

6.2 Role of technology foresight and science and technology policy research

In the age when no model exists elsewhere in the world, Japan has to devise its own clear strategy. Strategy should be based on accurate information, sound analysis and judgment. Flexibility in modifying strategy in changing circumstances is also required. I believe that the establishment of new science and technology policy administrations in Japan, with the CSTP at its center, is the right direction for effective policy planning and implementation in this regard.

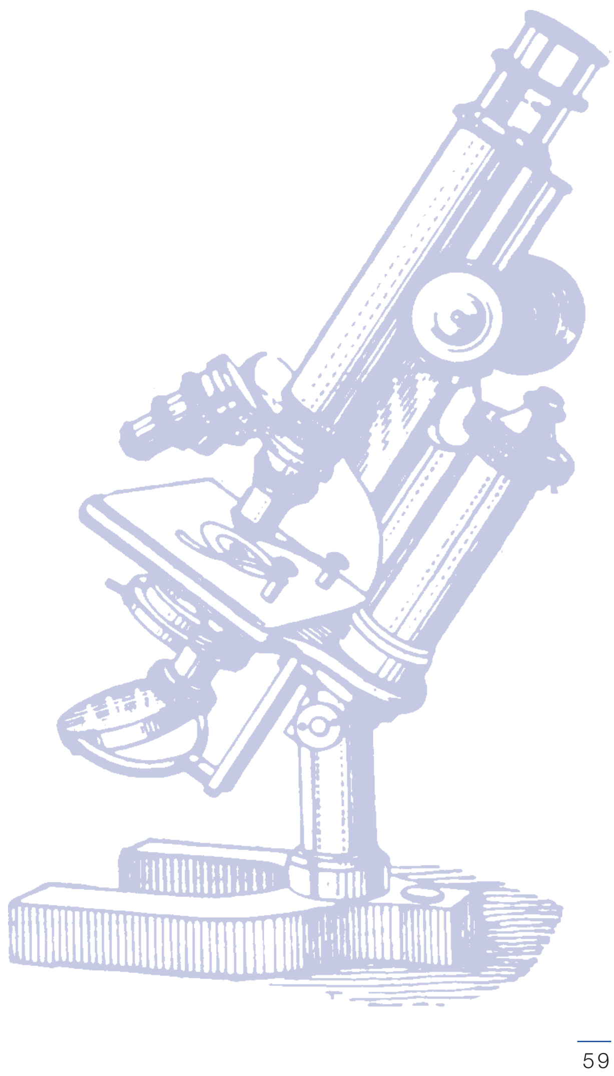
Speaking of the role of technology foresight, results of technology foresight will continue to be a useful and valuable input in policy formulation. In addition, the importance of technology foresight as a mechanism to form consensus among experts concerned will not be changed.

As for the past policy formulation, information from industry association or interest groups and stakeholders formed its foundation. Now, however, information derived from these sources may not always be accurate or appropriate in rapidly changing circumstances. In addition, policy makers or executives of private firms may not be able to make proper judgments because of their adherence to past experiences of successes.

In the matured democratic societies, policy formulation should be done in an open and fair manner, accountable to citizens. Policy formulation by closed consultation only among interest groups may no longer be politically valid. Evidence and reasoning is required. In this regard, science and technology policy research is expected to provide useful evidence and reasoning into policy formulation. From these viewpoints, in the NISTEP's Medium-term Research Plan which was adopted last year, two areas, namely 'Research on adaptation processes of technology to economic and societal needs' and 'Research on comprehensive relationship between S&T and society', are being highlighted as a major research direction in the coming five years.

I would like to conclude my presentation by emphasizing, first, the importance of policy research carried out by such organizations as the VTT Group for Technology Studies and the NISTEP, and, second, the importance of international cooperation in policy research in comparative perspective as is actually seen in this seminar.

Thank you very much.



Comments

4

Comparative policy perspective on Japanese and Finnish development – comments

KIMMO HALME
Science and Technology Policy Council of Finland

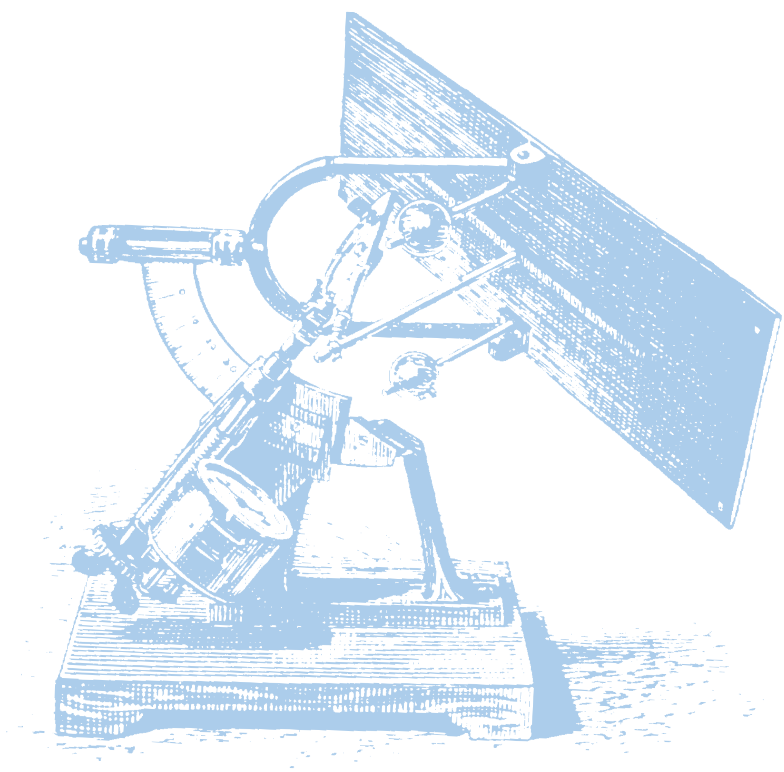
A) Origin, nature and success of Finnish innovations – Sfinno project

- A few words on the Sfinno project itself. In my view, the Sfinno database is a unique collection of information on Finnish innovations. Imagine that, with a certain set of criteria, all significant innovations that originated from the country during the period 1985-98 have been mapped, analysed and complemented with historical background information. Something that would have been difficult, if not impossible to achieve in a bigger country. Certainly a database with a magnitude of lessons and worth extensive exploitation in technology studies.
- There are many issues in the Sfinno project which could initiate an interesting discussion. I will only point out a few of them.
- With regard to the increase in the number of innovations, this positive trend is almost parallel with the development of R&D investments and ICT, and one would expect them to have some causalities. But what kind and how? Is there a delay and does it vary according to types and fields, etc. And of course, is the trend continuing?
- We see uneven developments between industrial sectors and their input into R&D and innovation. A trade-off has sometimes been made between knowledge-intensive and more traditional industries. Many studies suggest that innovation policies should pay greater attention to the specific type of industry, technology or the operation of the company and its way of innovating. On the side of generic policies, we may perhaps see more targeted 'customer designed' innovation policies in the future.
- I am not so surprised at the high number of software innovations in this database, for several reasons. First of all, there has been a significant increase in the number of new software development companies in Finland lately. Also, an increasing share of all innovation investments is of intangible nature. The share of services and service innovations is also increasing. One could see it in a way that complex knowledge and know-how is often materialised through software, regardless of the field of application and the type of knowledge. It is a way of wrapping-up the expertise in a directly exploitable form.
- It has also been mentioned that up to 90% of innovations are related to niche markets, or demand. I would assume this is very typical to Finland, and probably very untypical to Japan. Moreover, it would be most interesting to have a counterpart of the Sfinno database established in Japan and see how our ways of innovating differ. A comparative Sfinno-Japinno project. For example, it is a well-known fact that Japan has been highly successful in turning inventions quickly into globally distributed brand products – certainly a skill that we Finns have very much to learn from. What kinds of knowledge, foresight & selection processes has it included, what kind of mechanisms are needed to support it, etc.

B) Innovations, Science and Technology Policy and Technology Foresight in Japan, Professor Shimoda

- The presentation provided an extensive view of the past developments, description of the current situation and analysis of future challenges.
- With respect to *foresight,* Japan has started early, it has been carried out comprehensively and systematically and its results have been successfully integrated into the policy formulation mechanisms. My understanding is that foresight has been instrumental to the policy direction of Japan, at least in the past. Finland, on the other hand, is a latecomer to foresight (at least extensive foresight), the work has been carried out haphazardly and the results have been integrated mainly at the policy implementation level. The situation is changing, however, and new approaches are being developed.
- *In overall economic terms,* the Japanese GDP has been steadily growing over decades and only in recent years has it begun to decrease. Finnish GDP growth has gone through more defined recession periods, most clearly around 1993. This had a deep impact on the economic and employment structures. The rapid change to a more knowledge-based economy accelerated in the recovery period at the end of the 90s. We are still suffering from an unemployment rate that is twice that of Japan, and a large part of it is structural unemployment.
- Both countries are now looking for promising paths of future development, but with somewhat different motivations. The current economic development of Japan urgently calls for new openings – just like the Okinawa biotech university plan. During the last few years, the Finnish development has been one glorious path, but knowledge-based organic growth has its resource limits – and borders.
- From an *S&T policy perspective*, Japan has basically always been a world player. Finland has been a ‘technology importer’ for a much longer period. During the seventies, the focus was mainly on traditional industrial policy, catching up with technology, but at the same time building and expanding our university institutions. During the eighties, policies placed greater focus on developing the mechanisms for technology development, such as Tekes. The nineties were the time for systemic development and innovation policy. What is the focus for this decade – perhaps in the globalising of our S&T system?
- There are surprisingly many similarities in the S&T systems of Japan and Finland. The private-public financing structure is almost exactly same. The new institutional structure, after last year’s reform, is very similar to ours. Even many of the policy aims, such as the determined emphasis on developing higher education and research, the increasing of competitive R&D funding, strong evaluation, etc.
- Still, I would say that despite many evident similarities, there are also major differences. Japan is not only relatively competitive, like Finland, it is also a major economy, research generator

and serious partner in view of its sheer size and volume in many fields. Secondly, although structures, figures and even policy objectives look alike, we each have our unique history and ways of operating and co-operating. How much does it matter for future orientation – at the very minimum, it provides an interesting possibility for comparative studies and mutual learning.



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Industrial innovation, economic performance and technology foresight – comparative perspectives on Japanese and Finnish developments.

Abstract

This publication documents the presentations given at the Flower Day Seminar in May 2002.

The seminar was organised in the context of Japanese-Finnish scientific and technical co-operation with the aim of contributing to Japanese-Finnish research co-operation in innovation studies and technology policy.

In the seminar, the following topics were considered: the development of past and current patterns of innovations, the experiences of foresight exercises in technological development, and related benefits from technology foresight in shaping future innovation patterns and related decision-making.

Keywords
innovation, technology foresight, science and technology policy, Sfinno, Japan, Finland

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The traditional Flower Day seminar of VTT Technology Studies was held on May 16, 2002. The topic of the seminar was "Industrial innovation, economic performance and technology foresight – comparative perspectives on Japanese and Finnish developments".

The seminar was organised in the context of Japanese-Finnish scientific and technical co-operation with the aim of contributing to Japanese-Finnish research co-operation in innovation studies and technology policy. This publication documents the presentations given at the seminar.

Besides the seminar, there were two special reasons to celebrate 2002, which was the 60th Anniversary of VTT and the 10th Anniversary of VTT Technology Studies.

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