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Innovation policy in the post-war period

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ABSTRACT

This paper provides a structured outline of innovation and industrial policies in a small and highly industrialised economy during the post-war period. Analysing the changing priorities of these policies in an open economy like Norway provides a contrasting perspective to the literature on the structure and evolution of industrial innovation policies with its bias towards US and other large country developments. The analysis lead us to introduce, inspired by Foucault's concept of mentalities, Kuhn's paradigms, as well as Gadamer's life worlds, policy mentalities as a concept to characterise main dimensions of industrial policies in various period. Policy mentalities are sets of implicit and explicit assumptions and views held by the policy system about the core task and objective of industrial policy. In a sense, these policy mentalities, reflecting current views or aspirations concerning the nature and dynamics of ongoing social change, can be seen as major determinants of policy objectives. As with Foucaultian mentalities, the policy mentalities tend to persist over time.

The paper briefly outlines some major trends in industrial and innovation policies in Norway, at the European level and in the US during the post-war period.

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This paper provides a structured outline of innovation and industrial policies in a small and highly industrialised economy during the post-war period. Analysing the changing priorities of these policies in an open economy like Norway provides a contrasting perspective to the literature on the structure and evolution of industrial innovation policies with its bias towards US and other large country developments. The analysis lead us to introduce, inspired by Foucault's concept of mentalities, Kuhn's paradigms, as well as Gadamer's life worlds, policy mentalities as a concept to characterise main dimensions of industrial policies in various period. Policy mentalities are sets of implicit and explicit assumptions and views held by the policy system about the core task and objective of industrial policy. In a sense, these policy mentalities, reflecting current views or aspirations concerning the nature and dynamics of ongoing social change, can be seen as major determinants of policy objectives. As with Foucaultian mentalities, the policy mentalities tend to persist over time.

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Innovation policies in the post-war period

Table of contents

Chapter 1. Introduction

The purpose of this paper is to outline some aspects of recent innovation policies in Norway and to point to some possible trends of these policies for the coming years. Our main concern is to elicit what the underlying presumptions about industrial production and 'value creation' is, what the ultimate aim of a 'modern', or competitive industry was. A core assumption in this paper is that industrial innovation policies in any period basically find their political aim in the perception of a gap between what at any time is regarded as the 'idealised modern' industry and characteristics of the present industries. This ideal may vary over time, and an identification of key ideal models in various phases would thus contribute to explaining shifts in policy makers perceptions of challenges to be met or problems to be solved by industrial policies, shifts in policy objectives and in the measures and instruments developed and used to attain these objectives.

Though there are various other mechanisms that may cause shifts in these policy mentalities, such as enhanced scientific understanding of f.i. economic growth and development, we venture that the contribution of these to explain wider mentality shifts of the policy communities will generally be minor. The guiding role of these inputs lies probably more in shaping and advising policy formulation at the detailed level, within the framework of any governing mentality.

Within the resources of the project funding this paper, it is not possible to substantiate these hypotheses. We will simply assume that they are true and work 'backwards' from this. By outlining trends and characteristics of industrial and innovation policies over the last decades we will attempt to identify some of the mentalities that seem to have been dominant in this period.

The importance that is generally given to industrial policy and its descendant innovation policy in any policy programme stems ultimately from the role of the industrial enterprise as a generator of welfare. The industrial enterprise, and the economic system, is a 'value creator' in these terminologies, generating national income both on the private and the public hand, the size of which determines the allowable levels of collective and individual consumption and hence of general welfare. Thus ultimately industrial policy is a central part of overall welfare policies. As well as pointing to why industrial policies have been given strong attention in the period we consider here form political parties and the policy system, it also throws light on why the indicated mentalities or ideals are important; they are ultimately ideals about the 'best' generation of social economic welfare.

As an introduction we will discuss some aspects of what innovation policy is – its content, structure and extension. The second section will briefly outline some main trends in industrial innovation policies in Europe and the US in the post-war period, and describe some attempts that have been made at distinguishing phases or stages in the core approaches and objectives used in these policies. As the attention that innovation policy presently is given in industrialised countries is a recent phenomenon, this outline is predominantly based on the precursor of present day innovation policies – mainly industrial R&D or science policies.

Integrated in this will be an outline of the more restricted innovation policies over the last 20 years, over the period when the term innovation policy has been acknowledged by policy makers as a valuable addition to the policy vocabulary. This outline will be more sketchy than the rest, a variant discussion of Norwegian innovation policies since 1945 is afforded in Ørstavik (1999).

These innovation policies have historically developed from a rather small base in Norway. While industrial R&D policies today of comparable size to other explicit industrial policies, as measured f.i. in the distribution of budget appropriations under the main industrial ministry in Norway, the Ministry of Industry and Trade, these policy areas were a minor activity in the Ministry during the 1950s and 1960s. An outline of the main trends of Norwegian innovation policies in the post-war period thus necessitates an outline of the wider industrial policies during this period. It is in these industrial policies the dominant mentalities will be most evident. This is the purpose of the third section.

Policy mentalities provide a general framework and mental models for policy makers allowing integration and reinterpretation of new policy developments, policy analysis and results of socio-economic research. These policy mentalities provide a long term stable framework to analyse and interpret policy development over time. It is our contention that any analysis of policy developments, and ultimately any analysis and research, intended directly or indirectly to serve policy needs or potentials, that do not adequately reflect core aspects of these mentalities will tend to be ignored in the policy system.

Our main concern is to elicit what the underlying presumptions about industrial production and 'value creation' is in industrial policies over the post-war period. With industrial policy generally seen as a process managing or guiding a 'modernising' process – the core aim is to modernise industrial and other production and market systems - the basic part of a mentality is the conceptualisation of the 'modern' industry. A core assumption in this paper is that industrial innovation policies in any period basically find their political aim in the perception of a gap between what at any time is regarded as the 'idealised modern' industry and characteristics of the present industries. The ideal may change over time, but at each time it provides the basic part of the contemporary policy mentality. By focussing mentalities we get directly a contextual stage description of policy development over an extended period, as well as an improved understanding of shifts in policy objectives and challenges.

Though enhanced theoretical and analytical understanding of economic growth, structural development and related welfare development may cause shifts in policy mentalities, we propose that the contribution of these to explain wider mentality shifts of the policy communities will generally be minor. By outlining trends and characteristics of industrial and innovation policies in Norway nad internationally over the last decades we will attempt to identify some of the mentalities that seem to have been dominant in this period.

The importance that is generally given to industrial policy and its descendant innovation policy in any policy programme stems ultimately from the role of the industrial enterprise as a generator of welfare. The industrial enterprise, and the economic system, is a 'value creator' in these terminologies, generating national income both on the private and the public hand, the size of which determines the allowable levels of

collective and individual consumption and hence of general welfare. Thus ultimately industrial policy is a central part of overall welfare policies. This throws light on why mentalities are important; they are ultimately ideals about the 'best' generation of social economic welfare.

The final section will outline some main trends in the development of industrial innovation policies and suggest some aspects of possible future developments of these policies.

Chapter 2. Innovation policy in context

2.1 The basis of innovation policies

As outlined below, *innovation policy* as term for a policy concern was introduced in the 1970s. In the Norwegian context it appeared for the first time in the Thulin Commission in 1981, as a somewhat belated impact of the process that had been ongoing for some years in international fora. It is however clear that innovation policies as functional areas of policy concern are not new. However, in contrast to many other policy concerns innovation policies have not been reflected in the same kind of institutionalisation. A Norwegian comparison may be made between the nearly contemporary emergence of a concern for environmental issues. This rapidly led to the establishment of a separate ministry for environment in 1972, though being the first of its kind, followed later by similar ministerial reorganisations in other countries.

The fragmented institutional structure of innovation policies is not a substantial problem as long as it remains within the territory of one single ministry, viz. a Ministry of Industry. Though not recognised as a policy concern in its own right, innovation policies are an integral part of wider industrial policies. However when innovation policy concerns are raised in other ministerial contexts, as in regional policies during the 1980s, this structure becomes accentuated. Combined with the shift of industrial policy to become a policy for enabling industrial restructuring and competitivity, the distinction between innovation policies and institutionalised policy areas becomes blurred. At the same time the enhanced priority of concerns for long term innovation capabilities accentuates the role of inter-ministerial coordination. The establishment of a Ministry if Environment facilitated this process in its area, the ministry being given the overall responsibility for inter-ministerial coordination and management. In the area of innovation policy there is no equivalent process.

It is far from evident, in an objective or analytical sense, what kinds of objectives the term of innovation policies should include. The interpretation of the term is clearly shaped by the historical evolution of these concerns and the institutional arrangements they spring out of. However, to delimit the concern of this note we will try to outline an approach to innovation policies.

A basic perspective of innovation policy as it is conceived is that it is focussed on firm level innovation, of individual firms' attempts to change and develop their long term business behaviour, enhancing competitivity and incomes. The importance of governmental involvement is based on the condition that the underlying processes are substantially affected by market failures, and that there is a consequent gap of private and social benefits from such activities (see f.i. Hauknes 1999). The core question for these policies is then how public authorities affect innovation capabilities in business firms, and how policies may be devised to enhance these capabilities.

We may identify five theses that together form a framework for devising innovation policies, based on the acceptance of the importance of policy intervention;

- innovation activities are localised in individual firms; the ultimate locus of innovation policies is on the firm,

- innovation capabilities and activities involve integration of a range of factors and activities in the firm, R&D activities, knowledge management, product development, market knowledge, design etc.,
- there is a substantial heterogeneity of firms' potential and capability for innovation, even within more or less functionally homogenous industrial sectors,
- innovation activities unfold in a dynamic interaction between the innovating firm abd its environment, such as customers, suppliers, R&D institutions, guidance and support institutions, funding schemes etc.,
- innovation activities are performed within a framework shaped and organised through public policies, of tangible and intangible infrastructures, legislation and other regulation, fiscal systems, education systems, etc.

The government may thus be characterised as the Master Builder in the national innovation system. The question then is what the tasks of this Master is and how the various roles are concerted to attain the overall objectives that are set for these policies. Public authorities have wide ranging roles that are relevant to innovation policy concerns. Some relevant examples are;

- they regulate decision making and behaviour in industry, through legislation,
- set prices and cost structures by fiscal arrangements,
- regulate short and long term access to financial capital through finance and monetary policies,
- organise education and training at all levels,
- public procurement makes the public sector a large market for goods.

2.2 What is innovation policy?

In spite of *innovation policy* being a fairly recent term, industrial policies have always included objectives that focus industrial growth and generation, whether by supporting acquired comparative advantages or by facilitating new ones. In this sense innovation policy goes at least back to the industrial revolution in the UK. Though frequently used, often in conjunction with the term *technology* policies, there has been few attempts to outline in any systematic fashion what policies the term constitutes. Furthermore, in contrast to areas such as education and health policies, it is rarely identified in ministerial organisation.

As is evident, it is easy to conclude that public innovation policy is more or less all of public policy, ultimately almost any policy initiative may be argued to have some impact on innovation performance. This is clearly a meaningless definition. There is a need for delimitation of innovation policies to make the concept operational. The few attempts that have been made to outline the characteristics of innovation policies usually reflect Paul Stoneman's definition (Stoneman (1987)) of technology policy[1]. Stoneman described as 'policies involving governmental intervention in the economy with the intent of affecting the process of technological innovation'. In David Mowery's formulation, these are 'policies that are intended to influence the decisions of firms to

[1] We prefer the concept innovation policy to technology policy to avoid the subsequent discussion to say that 'technology is much more than technology'.

develop, commercialise, or adopt new technologies' (Mowery (1992)). Both these definitions emphasise the intentional aspect of the policies included; these are policies that we may term *explicit or narrow* innovation policies. As such the relevant policy initiatives are mostly included among the areas of ministerial offices responsible for industrial policies, though they often also collaterally involve science or research ministries. Typically these policies involve grant schemes and other support for industrial innovation, supporting advisory systems, setting-up of funding agencies, etc.

However, the term innovation policies may also be used to cover what we may term *implicit* innovation policies, including policy areas beyond the explicit policies where impacts on innovation performance is a secondary political prerogative, but where the policy area nevertheless has a significant impact on innovation performance. Such policy areas include general industrial policies as well as fiscal and regulatory policies, other legislative measures, public procurement, trade policies, etc. In contrast to explicit innovation policies, will implicit innovation policies generally involve several ministerial authorities, also involving agencies and ministries that does not have a separate innovation agenda. It is clear that these wider, implicit innovation policies then often will create a framework and requisites of explicit innovation policies. What explicit innovation policies are tenable and possible, at times even acknowledged as allowable, will be contingent on the wider implicit innovation policies.From these considerations we may thus distinguish between *narrow* and *broad* innovation policies. Narrow innovation policies feature policies with primary objectives including improvements or shaping of innovation capabilities of individual firms or industries. Broad innovation policies include these narrow policies as well as the set of wider innovation policies.

Similar to this distinction we may make a distinction between general or specific innovation policies, depending on the character of the objectives of the policy area or measures in question[2]. While general innovation policies (primarily or secondarily) aim at enhancing innovation capabilities of business enterprises in general, or ultimately the innovation rate *per se* of firms, specific innovation policies in this respect aim at generating innovations of specific kinds or satisfying specific conditions. Examples of specific innovation policies could be policy initiatives to develop production technologies in a specific industrial context, satisfying specified emission rates of sulphuric acid, or incentives to develop products or technologies that meet specific present or future needs that are generated from f.i. demographic changes. Objective specific initiatives in this sense will generally be focussed on some perceived specific needs, they will typically have a character of being 'problem solving'. General policies and initiatives are non-specific in this sense, though they may, and often are, activity specific. A policy initiative to enhance the level of R&D in business enterprises based on an argument that such R&D is beneficial for the firm (f.i. in generating sustained competitivity) and for society at large, would be a general policy initiative in my sense.

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[2] We might also make a distinction between generality and specificity as a characteristic of the targeted population of business enterprises, or in the functional or technological content of the implemented measures or their objectives. In these senses an innovation policy initiative for R&D or ICTs in the petro-chemical industry would be specific on these accounts. The distinction made in the text is not completely overlapping with these distinctions. However the independent parts of these distinctions are not relevant for our discussion here.

Thus explicit general innovation policies conforms with Teubal's (Teubal (1997)) outline of *horizontal innovation policies*. Horizontal innovation policies aim at promoting innovation and technical change in general rather than being specifically targeted at individual industrial or functional sectors. It is a functional promotion of what he terms 'socially desirable technological activities' (SDTAs). SDTAs; firm level R&D and innovation activities, transfer, diffusion and adoption of technological competencies, as well as technological infrastructures etc., are activities that (1) have strategic value to the economy and (2) are loci of market failures, and which therefore are 'socially desirable'. Specific and explicit policies could similarly be termed 'vertical' innovation policies.

Note that this simple taxonomy is based on the policies having some innovation related objectives. Thus f.i. fiscal policies would not fit easily into this framework; they certainly affect business behaviour and hence innovation activities, but mostly they cannot be said to include innovation related objectives. On the other hand we include here policies that are to a significant degree is motivated by its facilitating role towards business activities, and initiatives that explicitly aim at shaping business behaviour, as through implementation of regulation or incentive structures. The relation between environmental regulation and innovation is discussed extensively in Kemp, Smith and Becher (2000). It may often prove difficult in considering any individual innovation policy initiative to determine whether it is a general or specific, implicit or explicit initiative. In several instances individual initiatives that should be considered general and explicit (i.e. focussed on promotion of SDTAs) appears to be quite specific in objectives used, technologies focussed or firms targeted. A distinguishing feature would then not necessarily be the objectives or orientation of the individual initiative, but the policy or agency context in which it is introduced. The above outline may be summarised in a four-way table as shown below with some relevant examples.

		Specificity of innovation policy objectives	
		General	*Specific*
Innovation objectives in policy	*Explicit*	Enhancing R&D in business firms	Technology development for deep sea petroleum production of marginal oil fields
	Implicit	Vocational training schemes	Environmental regulation

Note that the examples in the table are chosen to illustrate one significant point. The distinction between general and specific, implicit and explicit innovation policies are not directly related to genericity or specificity of the impact of these policies. Few innovation policies have had a more substantial and wide-ranging impact in Norway than the innovation policies that were devised during the 1970s and 1980s related to the exploitation of offshore petroleum reserves in the North Sea.

The purpose of this outline is not to develop a complete system for cataloguing innovation policies, but to provide a rough guide to the overall topology of the landscape we may call industrial innovation policies. We cannot here discuss all the

variant specificities of these innovation policies and their evolution in the period we consider. Our main focus will be on general innovation policies. We will primarily have the set of policies located in the upper left corner of the table in mind in our discussion, explicit and general innovation policies. Furthermore we include the wider industrial policies as far as they concern initiatives and policies that are primarily motivated by their effect in shaping or supporting industrial development.

As will become clear the policies concerned with promotion of SDTAs have grown from being a marginal set of policies in the first post-war period into being a major policy concern in the 1980s and 1990s. This has been accompanied by an increasingly blurred line between these and the wider industrial policies we consider here in terms of policy level attention. This process is reflected in significant and long term reorientation of the industrial policies away from the planned economy approach that was particularly evident in the period 1945-1953 with a strong line of governmental involvement up to about 1980.

In parallel to these trends there has been an evolution in the orientation of regional policies. The focus of regional policies in the 1960s and 1970s on regional distribution and on de-population of rural areas as a consequence of altered mobility patterns and increased urbanisation in this period has shifted since the mid 1980s to a stronger emphasis of regional innovation policy[3] rather than regional distribution policy. This process had many aspects, one that is noteworthy being the explicit consideration of 'regional policies for metropolitan areas', with a White Paper launched in 1991. With 1993 and 1997 White Papers on regional policy these aspects were integrated into a perspective that highlighted the policy need of considering the 'broad' and the 'narrow' regional policy. The distinction, which is similar to our distinction between broad and narrow innovation policies, was used to argue that to make regional policy in the narrow sense efficient, an explicit assessment and regulation of the broad regional policy was necessary. This has recently led to reorganisations within the relevant ministry, with the responsibility for the assessment of broad regional policies being institutionalised within the ministry. The point to note here is that this involves a supervisory role from the perspective of regional innovation policies towards the regional implications of innovation policies as formulated in other ministries.

It is probably no coincidence that this process is accompanied with an increased emphasis of the need of coordination of governmental policies. The example of regional policies may amply illustrate the point. The developments we have sketched above, some of which will be expanded upon in the following sections, suggest an increasing overlap between policy concerns and objectives that have grown out of different institutional contexts. As there are few fundamental differences between a broad industrial innovation policy and broad regional policy (or in the words of the relevant ministries in the early 1990s; "en samordnet næringspolitikk" and "en helhetlig regionalpolitikk" – a co-ordinated industrial policy and a coherent regional policy), the

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[3] We have not been able to include regional policies in this survey. But we note here that the first signs of a shift of focus of regional policy had the same starting point as the concern for innovation policy, the 1981 Thulin Commission. The regional policy implications of the report from the Thulin Commission led to the initiative to establish regional techno-mercantile competence centres (teknisk-merkantilistiske kompetansesentre) and regional R&D foundations from the mid-1980s.

way the potential conflicts and needs for harmonising objectives are handled will probably be decisive for the future developments of these policy arenas.

Chapter 3. Phases in science and innovation policies

3.1 Periodisation of RTD and science policies

Several attempts have been made to develop periodisations of Science and Technology (S&T) policies in the post-war period. Though not necessarily the same as innovation policies, the emerging role of economic and industrial objectives in S&T policies, besides defence related objectives, in this period implies that trends in S&T policies will be a good proxy for trends in explicit and S&T related innovation policies. Present days innovation policies are the offsprings, if not directly then at least indirectly, of the science and R&D policies of the immediate post-war period ….

It is clear that any such classification run the risk of over-simplification of a process that is many-sided, where inspiration runs across different eras or periods, where national policies may be multi-layered with different layers reflecting concerns of different epochs and where national variations may be substantial. In this section we will briefly describe some attempts at periodising these policies before giving a short outline of main trends in such policies over the post-war period. In doing this we will focus broader than technology infrastructure policies, but we will note explicitly some aspects of TIP policies where it is relevant. The general trends we outline nevertheless have consequences for TIP policies in providing a more general framework within which TIP policies are shaped, whether implicitly or explicitly.

The famous OECD Brooks Report, published in 1971, is itself often cited by later observers as somewhat of a watershed in science policies in opening up for social and non-economic priorities in science policies. The report seems to have been the first to attempt some kind of periodisation of science policies in the post-war period. described the preceding period as falling in two phases, during the ‘naïve period’ up to the beginning of the 1960s science policies were dominated by a strong belief in ‘science led’ social development. From 1960 onwards the policy attitudes and objectives of science policies changed more explicitly towards national economic growth and other social objectives. Hence science priorities and resource allocation were given stronger emphasis.

Stuart Blume (Blume (1985)) distinguishes three phases in study of Dutch science policy after 1965, each characterised by its attitude towards science and research. The period 1965-1970 science is the 'engine of progress', followed with a period of science as 'problem solver' between 1970 and 1980. The last period is characterised with science as the 'source of strategic opportunities'.

Harvey Brooks (Brooks (1986)) emphasises World War II as a watershed, leading to the introduction of the new 'social contract' between science and society following the impact of Bush Report (Bush (1945)). With a US perspective he partitions the post-war period in three epochs:

- The Cold War period extends from 1945 to 1965;
- The period of social priorities runs from 1965-78 and is followed by

- The period of emphasis in innovation policy. (The rather specific boundary date between the latter two periods (1978) relates to President Carter's initiative that year to launch a policy review of industrial innovation.)

That Harvey Brooks seems to suggest that innovation policies are a direct outgrowth of science policies, must probably be understood within a US perspective, where industrial and technology policies, in contrast to science policies, have been kept outside the federal responsibilities.

Jean-Jacques Salomon, Salomon (1977) distinguished between the childhood of science policies up to 1955, followed by a period characterised with 'pragmatism' between 1955 and the second half of the 1960s. During the latter period emphasis shifted from energy, defence and space research to industrial R&D. The period up towards the end of the 1970s, was according to Salomon, an age of 'problematisation', while from 1977-79 onwards science policies are interlinked with policies for re-industrialisation to meet basic structural problems in national economies.

Aant Elzinga outlines a similar history of post-war science policies in Sweden. He argued at one time for a four phase periodisation[4] (Elzinga 1984), with

- a first phase up to ca. 1960, with a strong support for basic science, and an emphasis on developing an appropriate science infrastructure, adapted to an era of ‘big science’ that grew out of the war effort,

- a second phase during the 1960s were science is focused as a ‘productive factor’ in generating economic growth and higher levels of economic welfare. As a consequence of the restructuring of science objectives, a science policy system for coordination and setting of science policy priorities was established during this period,

- from the early 1970s basic science as a science policy priority receded into the background, with a stronger focus on social, often non-economic, priorities and on social use and application of science and technology rather than on technology development,

- a fourth phase emerged in the late 1970s with a reemphasis of basic science, now within a framework of strategic priority setting and development of the science and technology effort. During this period planning and control instruments as foresight exercises and evaluation proliferated and was integrated as an ordinary part of the science policy system.

Elzinga, together with Andrew Jamison, has given a later and more general outline of the ‘changing policy agendas in science and technology’, Elzinga and Jamison (1995). They point out that science (and technology) policies in the institutional sense was an invention of the immediate post-war period, but that there was significant precursors to the post-war developments of a public science policy back into the mid-war period. But they still characterise the period up to WW 2 as a period of corporate science policy. It

[4] These phases of Swedish science and technology policies are readily recognised also in a Norwegian context.

was only the newly founded Soviet state that had an active stance towards the social role of science. Towards the end of the mid-war period the inspiration from Soviet kindled developments that led to John Bernal publishing The Social Function of Science in 1939, so that in the late 1930s, science and technology was an explicit area of political debate.

Their first post-war period is denoted as 'from Pearl Harbor to Sputnik' and covers the 1940s and 1950s. The legacy of the war effort was to generate a 'victory for elitism' – the idea that science priorities should best be left to scientists gained ground and shaped science policy and policy institutions. They characterise the immediate post-war period as "a time of scientistic hegemony", where the S&T policy debate was dominated by the academic community, with emphasis of academic autonomy and the science community's need for freedom.

A more recent appraisal of science and technology policies in the post-war period is given by Gibbons et al (1994). They distinguish three phases in this period.

The period up to the second half of the 1960s science policies is characterised as being a period of *Policy for Science*. The main issue in this phase was the growth and maintenance of the science enterprise, science objectives was concerned with criteria for choice within science. This phase is characterised by an almost naïve belief in the scientific enterprise's ability to generate social benefits on its own if the enterprise is properly maintained and allow priorities to be set on the basis of scientific criteria.

The second phase up to the late 1970s was characterised by a shift from policy for science to *Science in Policy*. The rationale and objectives of science policies was the support the scientific enterprise could give to other policies. Rather than based on the presumption of direct social benefit of the former phase, the need of bringing in external criteria for choice is acknowledged in this phase. Science and technology is to serve needs and objectives of context outside itself and is expected to contribute to the attainment of various policy objectives. Gibbons and his collaborators cite the aforementioned OECD Brooks Report, together with the UK Rotschild Report as having the characteristics. In a Norwegian context, a similar approach is evident in the debate around Stortinget during the 1970s of the proposal to establish a directorate for social research and planning, and the first Science Policy White Paper, issued in 1975.

As Gibbons et al rightly points out the changing orientation of criteria for choice[5] was still based on the notion that science unquestionably had social beneficial effects. There was no independent role to play for transformation and utilisation of science; science was still in essence seen as a public good.

In the late 1970s and early 1980s this perspective came increasingly under scrutiny. Seriously reduced economic performance during the 1970s and growing concern for the sustainability of the science and technology base of economic growth and international competitivity led to increased questioning of the orientation of S&T policy objectives

[5] This term refers to the 'criteria for choice'- or Minerva-debate during the 1960s in the journal Minerva, with Michael Polanyi and Alvin Weinberg as the most well-known contributors. The main issue in this debate was the question of the autonomy of the science system and its priorities vis a vis the science policy system, in Weinberg's terminology the complementarity between internal and external criteria for setting science priorities.

and of the abilities of this base to generate the expected benefits. According to Gibbons et al, in this period S&T policies shifted to a *Policy for Technological Innovation.* The role of science in achieving national goals was oriented towards "the single question of how to hitch the scientific enterprise to industrial innovation and competitiveness". The policy shift involved a shift to technology and technological development, rather than the science base, as a more efficient base to support industrial development. The reorientation of focus led in the 1980s to the focus of the technology base, most notably in the focus of strategic and generic technologies. Here the many initiatives on information and communication technologies that emerged in this period are evident examples.

In the early 1980s the former presumption of a science base as the prime determinant of industrial performance was replaced with a view that the decisive factor was capabilities in a technology base, especially in core strategic technologies. This base was argued as necessary for the 'new industry', information and material technologies and biotechnology were to form the foundation for new industries and a revitalised growth performance.

In the 1990s these policies have lost the primacy as innovation or technology policy priorities. Gibbons et al suggest that the inability to revitalise productivity growth following the emphasis of strategic technologies led to a reduced impetus of these policies. If this was decisive for the shift in policy during the early 1990s, in assessing the impact of ICTs it was termed the productivity paradox, recent resurgence of productivity development during the business cycle since the recession in 1990-92 might lead to a resurrection of similar ideas.

All of these point to a transition period located somewhere between 1965 and 1970, where S&T policy objectives change away from an often naïve link between scientific and welfare progress to focusing social objectives. In innovation policies this is also reflected in a transition from 'technology push' to 'market pull' strategies. In addition they also point to a shift somewhere towards the end of the 1970s and early 1980s, to strategic opportunities (Blume), industrial innovation (Brooks) or re-industrialisation (Salomon). As none of these but the last cover the most recent period, ca. 1985 – 2000, their characterisation of their own present epoch may be influenced by myopia. However, these characterisations seem to catch some main aspects of the innovation and S&T policies that were dominant during the 1980s. The shift to strategic industrial objectives of S&T policies is accompanied by a reappraisal of market based mechanisms of technical change, a process that is concomitant with a shift in wider economic policies away from the broadly Keynesian policies of the post-war period.

3.2 Periodisation of innovation policies

The evolution of technology policy on the European scene is discussed by Rothwell and Dodgson (1992). The following outline is a brief summary of their periodisation.

1950s and 1960s – separated science and industrial policies

During the 1950s and 1960s there were two main tracks of technology policies; resp. science and industrial policies with little coordination or active collaboration between policy makers from the two tracks. In some countries state intervention in industrial development was substantial. These policies were predicated on a 'science discovers,

technology pushes' model of the innovation process, with a relatively clear-cut division of labour between the science system and the industrial support system. Emphasis was on large firms and industrial agglomeration.

1970s – innovation policies

Rothwell and Dodgson date the emergence of innovation policy to the early 1970s with a more direct involvement of collective research institutes in product development of individual companies. Support schemes are broadened to cover wider innovation activities that before, with increasing support in new forms to SME-based innovation.

1980s – technology policies

During the early 1980s technology policies emerges, replacing the innovation policies of the 1970s. National programmes on generic technologies, primarily IT and to a lesser extent biotechnology, and involved inter-institutional linkages focussed on collaborative pre-competitive research on the basis of increased inter-departmental collaboration. University-industry linkages were focussed, as well as strategic research in universities. Emphasis was put on NTBFs, while the availability of venture capital expanded.

We take two additional points for the last period from Rothwell and Dodgson. This period saw growing pressure for accountability, for the research system to account for its resource use in terms of its societal impact, accompanied by increased evaluation of RTD policy initiatives and RTD institutions. After 1980 regional policies shifted from largely exogenous, formulated by national authorities. They characterise the regional policies of the 1980s as strongly endogenous, focussing mobilisation of regional industrial and technology resources. The creation and enhancement of regional technology/transfer infrastructures, involving innovation centres, technopoles etc., is perhaps the most marked trend,

Rothwell (1992) has outlined a generational taxonomy of (policy) approaches to innovation. Though it is not directly linked to a periodisation, the use of a generational model suggests a reflection of historical shifts of emphasis. He identifies five generations, of which the last is an idealised model of future development of integrated approaches to innovation:

- First generation - R&D-based technology push, in a sequential process (1950s and early 1960s).
- Second generation - need-pull with R&D as reactive to market trends and needs, in a sequential process (1970s).
- Third generation - coupling mode of integration of R&D and marketing, in a sequential process with feedback (1980s).
- Fourth generation - integrated mode, with parallel and integrated development, based on strong user-producer links, non-sequential processes (late 1980s and 1990s).
- Fifth generation - systems integration and networking model (1995-2000 - ?).

We have supplemented these generations with suggestions of which periods each was dominant. This generational model thus represents itself a sequential process of sophistication of innovation models, leading from simple production line, or so-called 'linear', models to developed 'innovation systems' approaches to innovation and innovation policies.

3.3 A sketch of innovation policies in the post-war period

In giving a brief sketch of post-war developments we will not directly use these periodisations. But the outline will reflect several of the concerns reflected in the schemes. For our purposes here, we focus explicit innovation policies. Since our main focus is technological infrastructures this focus of explicit innovation policies is probably sufficient as a basis for the further refinement of this sketch into a historical analysis of policy learning in the area of TIP policies.

Basic science as pacemaker 1945-1960

During the post-war period these policies in Europe grew out of the political concern of reconstruction and the building of a new European industry after the war. A distinctive event at the beginning of this period was the publication of the Bush Report, Bush (1945), which laid the ground for the development of US science policies and led to the establishment of the National Science Foundation in 1950. From a European perspective it is probably an exaggeration to claim that the Bush Report was a *decisive* event. It is however noteworthy for two reasons. Firstly it was to a large extent based on the experiences of the allied countries efforts into science-based development of defence technologies. Here the report summed up several ideas and experiences that shaped science and innovation policy making in several countries. Secondly the re-interpretation of the Bush Report, and in particular on the issue of the tasks of the National Science Organization/Foundation. that followed its publication provided arguments that were widely used also in European countries. This re-interpretation is best captured by the argument of a 'social contract' between the science system and society, a science system left to follow its own logic would in the long run return gains to society satisfying any reasonable claims of social accountability.

Broadly the noted concern took two forms, firstly the emergence of new S&T policies with the establishment of new or reorganised S&T agencies and institutions, and secondly an emphasis of state-owned, -managed or -organised industrial enterprises. The first led to institutions as NSF in the US, while Clement Atlee's nationalisation of UK core industries in 1948 may illustrate the second.

Science and technology, as well as wider industrial policies in Norway were completely revamped after WWII.

Economic growth - Science and technology 1960-1970

Though the so-called 'Sputnik shock' was interpreted in its time as a signal of the failure of Western industrial policies to generate unparalleled industrial growth and technological leadership, the period 1950-1970 has since been characterised as the 'golden era' with a substantially higher income and production growth in the OECD area than anytime before or after. Nevertheless the Sputnik shock lead to an intense development of S&T policies, first in the US, later through the organisation created on

the basis of the Marshall Aid and OEEC, the OECD. An indicative event here is the development of the first versions of what became known as the Frascati-manual, as well as the background report OECD (1963).

This period, which Salomon notes is a period of pragmatism, is a period where evidently some of the naïvetes of the previous belief in the welfare generating potential of the science effort were questioned. It is in this period the Arrow-Nelson rationale for public science policies was developed, but it is also the period in which the growth accounting residual (Abramowitz (1956), Solow (1957)) was noted widely for the first time with its claim that technical change is an almost totally dominant source of economic growth. What was later denoted the *Minerva*-debate, after the journal in which most contributions were published (later published in Shils (1968)), shows substantial questioning of contemporary S&T objectives. In this period the establishment of an institutional infrastructure aiding national industries was prominent in national S&T policies, many of the institutional characteristics of the national systems of S&T institutions, as R&D institutions, structures of HEIs, technological service institutions etc., reflect policy developments in this period.

Productivity slowdown – the need for targeting 1970-1980

For economic development after 1970, it is common to point to the OPEC crises of 1973-4 and 1978-9 as events that had dominant effects on future growth. Also important for the orientation of S&T and innovation policies was the shift in focus to social priorities and market needs, as noted above. In 1971 the Rotschild report, establishing the customer-contractor principle, was published as a UK Green Paper. When Richard Nixon was elected in 1968 he was elected on a programme that featured social priorities prominently (Averch (1985)), one of his first S&T policy initiatives was the launching of the War on Cancer in 1969. A symptomatic landmark of the onset of this period is the OECD Brooks Report, published in 1971 (OECD (1971)). Environmental concerns, as well as issues of social reform, were factors that shaped the profiles of S&T policies, as well as the portfolios of policy instruments. Program-organised, targeted research becomes a strong mode of organising research priorities.

It is in this period that the international policy debate starts using the term 'innovation policies', by 1980 the term is used as a well-known term in OECD fora, see eg OECD (1982). In the Norwegian context the term was used for the first time in the report of the Thulin Commission, published in 1981 (NOU 1981: 30). Innovation policy as a concept emerged together with an increased focus of SMEs in industrial policies in several countries, f.i. Germany and France, as well as in Norway. In Norway the concomitance of the Thulin Commission and the SME White Paper published in 1978 is probably not coincidental. Innovation policy emerged as a policy concern in this period as a consequence of this increased SME focus.

An equally striking aspect of innovation policies in this period is that they grow out of the former R&D industrial based S&T policies. In Norway this is particularly evident. The Thulin Commission was set up by the Labour Government in 1980. The terms of reference the Commission was given was to consider the volume, organisation and efficiency of public support to industrial R&D in Norway, with a considerable bias towards assessing the role of public R&D institutions, the structure of public funds and agencies supporting industrial R&D and the role of higher education institutions (HEIs). The weight given to industry-academy links is clearly reflected in the composition of

the five member Commission; beside representation of LO, the major trade union organisation in industry, and Norges Industriforbund (the Norwegian Association of Industries), the other two ordinary members were representatives for the major relevant universities (Universitetet i Trondheim and Universitetet i Oslo). During its work the Commission strayed considerably from this starting point.

What is happening in this period is a specialisation of S&T policies, with emerging policy focus of the need to direct attention to other issues than the former S&T dominated policies, relying heavily on scientific research as the main vehicle. At the end of the decade international focus is widely attended to giving priority to 'strategic research', to (technological) research areas that are potentially widely applicable, later often claimed to be generic in applicability, but which require substantial scientific research and development to reach a stage where it is commercially applicable. The first document that identifies strategic research priorities is the UK Dainton Report, published together with the Rotschild report in HMSO (1971), but in full disconcord with its conclusions. Reflected in the concerns behind the 'innovation policy movement' of the 1970s, the following period also saw a much stronger emphasis of SME perspectives, in particular as to the development of an appropriate system of guidance and mediation towards enhancing SMEs capabilities to innovate. These concerns, the 'strategic basis' for future industrial development and the intermediation of innovation practices and technological requisites of innovation have formed the core of the development of these industrial innovation policies in the period since 1980. The emerging specialisation of S&T policies is reflected in changes in the institutional structure of these policies. In Norway the former Office of industrial R&D (Industridepartmentets forskningskontor) is reorganised as a Department of industrial R&D (IDs forskningsavdeling).

Strategic focus – the new industrial challenge and its technology base 1980-1990

In the period after 1980 the area of innovation policy debate involves an increased focus on regional competition of technological hegemony. Contributing to this, and probably a strong impetus to it, was the increased awareness of the productivity slowdown after 1973 and the idea of a 'new economic and social context' that science and technology policies had to meet, as argued in the OECD Delapalme Report, OECD (1980). The increased perception of a 'Japanese challenge' in Europe and the US was accompanied by the idea of Fortress Europe in US. International debate was increasingly formulated in terms of the Triad; the perceived triangular technology competition between Europe, US and Japan. When Japan launched its fifth generation programme for development of information technologies towards 2000 in the footsteps of the highly successful VLSI project, it was quickly followed by IT and other technology initiatives in US and the European countries (Rothwell and Dodgson (1992)). Based on the notion of generic technology, mainly meaning information and materials technology and microbiology based biotechnology, a dominant trend in many countries was the implementation of large scale policy initiatives to build up the national and regional capabilities that were perceived as necessary to compete and survive in sunrise industries of tomorrow.

Our claim here is that the transition in the orientation of industrial and innovation policies that evolved in the period 1973-1980 was a substantial and basic shift in the mentality governing industrial policies in the post-war period. This transition was wide ranging and with it what came to be known as innovation policies were promoted from being a rather marginal aspect of European industrial policies to become an integrated

and central concern of these policies. Thus we see the specialisation and expansion of the S&T policies of the period c. 1950 – 1970 into innovation policies and subservient S&T policies as closely related to the general shift in emphasis of economic policies in this period. During the 1970s the economic policies that generally are called Keynesian was increasingly coming under pressure and was replaced in variant forms of economic policies with stronger market based approach.

Not surprisingly, there were many responses of this shift in the area of information and communication technologies. ICTs were generally seen as the major strategic technology of the era, a technology that would be decisive in shaping future industrial structure and international competitivity. It was especially in this area the Japanese challenge was seen as serious. The contemporary assessment of the link between the productivity slowdown since 1973 and the 'productivity paradox' of ICTs substantiated this move further. On the European scene this was further exacerbated by the perceived inability of European industries to reap the potential benefits of the science base and the related threat of 'de-industrialisation'. A substantial pro-active initiative was needed.

The French Nora-Minc report, Nora and Minc (1980), published in French in 1978, set the pace for a subsequent focus of *informatique* and *telematique*. The well known French initiative of the *Minitel* is part of a longstanding tradition in French state administration, but it also illustrates the extent of the public involvement and leadership that was considered necessary to guide and concert the phase shift of industrial production and organisation that was needed. During the mid-1980s the initiatives to establish national programmes in the area of ICT proliferated. In the UK the Alvey programme was initiated in 1985, in Sweden the IT4 programme was launched in 1986-87. The Norwegian IT 'target area' was set up in 1986, growing out of conclusions drawn by the Thulin Commission in 1981 and clearly inspired by the discussion in international fora like the OECD. On the European scene this period was accompanied by the establishment of ESPRIT, the EU large scale IT RTD programme, in 1982 and later the first Framework Programme in 1984, as well as President Mitterand's initiative with the establishment of EUREKA in 1985.

In this period funding agencies and R&D institutions that had been a central part of S&T policies in the post-war period increasingly came under scrutiny. The main aspect of the criticisms that were raised were addressed to agencies lacking ability to address the long term issues of building up national capabilities in these generic technologies, processes that eventually led to reorganisation of funding agencies in many countries. In Norway the Grøholt Commission was initiated in 1990 (NOU 1991:24) and its conclusions led to the disbanding of the former five research councils and the establishment of an intended single body research council, Norges forskningsråd, in 1993. Norges forskningsråd was given a strengthened and formalised agenda that went beyond the role as a classical research council *cum* funding agency. Besides being a research council in the established sense, the new body was also given the explicit task of being a central policy formulating and advising body for national R&D and innovation policies. The formalisation of this independent policy making role and the expectations linked to it is probably the main aspect that explains the establishment of the new research council; it grows directly out of the criticism of the former research council structure handling of national coordination and organisation of the strategic S&T priorities during the 1980s, viz. in the organisation of the target areas (hovedinnsatsområdene).

Networks and systems – searching for a new model 1990-2000+

Towards the end of this decade and into the 1990s it was frequently argued that fundamental changes in research and science-based innovation policies were emerging, there were "many signs that we may be looking at the end of an era, with the possibility of a much greater discontinuity on science policy than … transitions in the mid-60s and late 70s … it is possible that we face … a 'sea-change' in the role of science and technology comparable to what took place after World War II" (Brooks (1990), p 19). The S&T system in the new era must fulfil stronger demands of societal steering (Yoxen (1988)), accountability and collectively organised research, with 'science in a steady state' of public funding (Ziman (1987). During the 1980s the use of assessments and evaluations exploded. In parallel the literature on research and policy evaluation, on evaluation methodologies, practice and indicators boomed. To what extent this was paralleled by a systematic use of evaluation efforts for building a policy oriented knowledge base was widely discussed at the time and is still unclear.

A signpost for the developments of innovation policies in the 1990s was the publication of the OECD Sundqvist Report in 1988 (OECD (1988)). The main message was the need of a 'socio-economic strategy' for technological change, the report argued that traditional approaches to the relevant policies had been to narrow in neglecting the interdependence of technical, economic and social change. The policy objectives of technology policies should feature 'the effectiveness of social systems which generate and diffuse technical innovations' prominently. With the first indications of an emerging system approach to technological innovation the report reflected ongoing changes of emphasis in member countries. Policy attention was increasingly directed at the powers to mediate and diffuse innovation capabilities in national systems.

The Sundqvist Report was a direct precursor for establishment of the OECD Technology and Economy Programme, a substantial effort to synthesise recent research into innovation processes and formation of innovation capabilities, OECD (1991) and OECD (1992). The period after 1990 has substantiated these systems and network approaches to innovation further, together with a significant increase in the use of innovation analysis and research as input to policy making processes. With the third and fourth framework programmes the profile of EU S&T policies has shifted to include specific socio-economic objectives and related research. This process has further been developed in the new structure that was introduced into the fifth framework programme.

These most recent developments in innovation policies highlights changes in the roles of the traditional organisations being parts of national S&T systems. The use by several national authorities of 'innovation agents', such as in the UK Link, the EU MINT and the Norwegian BUNT programmes, involve attempts to build markets for innovation services that have been within the realm of S&T institutions. It would seem, though this needs substantiating further, that in parallel to the policy developments there is a shift in policy emphasis from S&T institutional infrastructures to provision of infrastructural function or services.

Chapter 4. Instruments for regulation of industrial development

4.1 Introduction

This section discusses public policy instruments to promote and regulate industrialisation in the last part of the 20th century. The attempt to regulate industrialisation is not a new phenomenon for this period. On the contrary, industrial societies have undertaken measures to regulate aspects of industrial development since the Industrial Revolution. Regulation has partly been directed towards socio-economic aspects of production (working conditions, child work, minimum salary) and partly towards promoting economic growth through attempts to increase the speed of industrialisation. The measures undertaken to promote economic growth have partly been directed towards the improvement of the general economic framework and infrastructure (financial markets, education, trade agreements etc.) and partly to improve the specific conditions for manufacturing industry. It is the latter aspect of industrial policy which this paper focuses upon.

The analytical approach chosen in this section is to define certain industrial strategies chosen by European countries, and to present the instruments introduced in order to implement the strategy. The definition of strategies is based on empirical and theoretical understanding of industrialisation and main industrial policies of the period. They describe what politicians have argued was necessary to do (with the economy) in order to succeed industrially. In the following I will point out three main strategies, and at the end of the paper I will point at an emerging fourth strategy. The paper presents measures undertaken to regulate industrial development as 'instruments' used to shape the economy. It should be stressed that in the 'real world' politics have never been this rational. Political measures are often introduced *ad hoc* and not as part of wider strategies - and strategies are often not coherent. However, the linking of 'instruments' to existing and changing 'strategies' is a useful analytical approach to organise knowledge on industrial policies.

4.2 Industrial strategies for industrialisation

The institutional history of industrial policy is young. In Norway the Ministry of Industry (MoI) was established in 1947.[6] The main objective of the ministry has been to promote economic growth through industrialisation. However, also other ministries have been important for shaping industrial development. In the Norwegian context in particular the Ministry for regional affairs has played a significant role for the implementation of industrial policies.

During the first decades following the establishment of the MoI the idea of an existing 'productivity gap' (1950s) or 'technology gap' (1960s) between America and Europe significantly influenced industrial policy. The productivity gap across the Atlantic peaked in the late 1940s (Maddison (1982), and 'America' remained a hegemonic model for European industrialisation until the late 1970s. The perception of Europe as

[6] During WW1 the Norwegian government established a Ministry of Industry, but it was closed down during the recession following the boom 1919-20.

backward relative to the leading industrial nation, the USA, lead to the introduction of policies for catching up or closing the gap. The seminal theory of Alexander Gershenkron on backwardness in economic theory is a useful point of departure for analysing the policies undertaken by governments, Gershenkron (1962).[7] Gershenkron's theory reflects as much the conditions of Europe in the post WW2 period and the strategies chosen by European governments to catch up with the USA, as much as it reflects 19th century history. His theory in short, argues that a successful catching up is dependent on the establishment of specific institutions and the degree of backwardness. The more backward the economy is (bigger gap to leading nation), the stronger is the demand for new institutions to become industrial successful.

The industrial strategy of the catching up period was to imitate aspects of American industrialisation which were regarded as crucial for its success. The dominant strategy was to use state measures to promote the construction of big industry: large producing units, large organisational units directed towards large scale production. (strategy 1) The importance of the great corporations in the success of American economy was argued in influential books by John Kenneth Galbraith and other leading economists of the 1960s and indicated the role of planning and the role of the 'visible hand' in successful economic development, Galbraith (1967).[8] The attempt to create large corporations became an important element of European industrial policy of the 1960s, and also in Norway.

From the late 1970s and even more during the 1980s the gap was not any longer as wide as in the post war period and 'America' lost its appeal as a model for economic development and prosperity. The theoretical basis for a new policy was based on the assumption that Western economy was going through a transition period characterised as an industrial revolution or change of technological paradigm. The theory introduced by Chris. Freeman who used history to illustrate how radical new technologies, was the foremost academic argument for a policy arguing that new technologies would create new growth industries which in the long run could become the driving force for wealth and welfare, Freeman, Clark and Soete (1982). The theory was became one of the theoretical bases for a strategy for *re-industrialisation* in a period characterised by stagnation in manufacturing industry. The new strategy was based on the idea that future industrial expansion was dependent on success within a few core high-tech technologies: IT, biotechnology and new materials.[9] Growth could not be achieved by improving old products and industries, but could only be achieved by developing new products or completely new industries (strategy 2). In Norway the main model became the computer company, Norsk Data, which grew rapidly until the late 1980s and became a symbol for the advent of a new phase of capitalist industrialisation. The computer industry and other 'high tech' productions was the main model for industrialisation.

Both strategy 1 and 2 is based on the assumption that there was a need for a radical restructuring of the economy to succeed in creating long term growth. The role of industrial policy/strategy is to promote the necessary change. There is often an implicit element of scepticism that the market alone will produce the radical changes, and that

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7 The main politics of the book is to deal with development of non-industrial countries.

8 The visible hand relates to the seminal book on the historical development of American corporations, Chandler (1977)

9 In Norway this policy was introduced 1986 in the State Budget for the financial year 1987.

the state/public sector has to intervene. There has always been an opposition to these strategies which argue that policies should not be directed towards specific (and radical) structural changes, but to promote improved productivity and diffusion of new technologies throughout all parts of the economy. This ideology was rather strong in the interwar period in the 20.th century and also strongly represented in the productivity policy of the 1950s, relatively weaker during the 1960s to 1980s. This ideology regained position from the late 1980s when policy documents, for the first time since WW2, stopped arguing for the importance for growth in manufacturing industry: the 1990s was the decade when we entered into a 'post-industrial policy' era in the sense that manufacturing industry was not any longer given political priority relative to other sectors of the economy. Therefore instruments promoting industrialisation should - in theory - not give priority to any specific type of production and industry (industrially neutral). The general conditions and infrastructure for industry became core elements of industrial policy. Actually the new strategy of the late 1980s to a large extent was in line with the ideas promoted by 'the small-is-beautiful' supporters. They argued for less direct state intervention and for improvement of the general conditions for SMEs. In addition they supported the instruments which during the inter war period supported a rapid de-centralisation of industry. The most important of these were instruments for diffusion of technology and of best practices in the company. The *diffusion of technology strategy* (strategy 3) gained political support from the late 1980s and early 1990s, and a number of new instruments for promoting diffusion of best practices and technology were introduced.

In economic theory the book 'The Second Industrial Divide' by Michael Piore and Charles Sabel reflects this ideological turn towards the importance of small companies in industrial development, Piore and Sabel (1984). The book argued against the idea that large scale production systems necessarily were the most efficient and argued that there was a potential alternative for economic welfare in production systems with collaboration and competition between small and medium sized companies. In Europe studies of 'The Third italy' indicated that some industrial regions could be seen as alternatives to the 'American' model based on large corporations. The diffusion of technology strategy may be regarded as an element of the ideology underlying this economic literature.

Towards the turn of the century many politicians (and others) argue that the economy is going through a radical transformation. Concepts like 'knowledge economy' and 'globalisation' are used to indicate different aspects of the transformation. To what extent the transformation is as radical as many have argued is only partially relevant for the political discussion. The important point is that the perception of main political agents that the economy is changing and that there is a demand for a new policy. The globalisation of the economy and politics also influences which measures each nation is permitted to use in order to promote industrialisation. We will use the strategies discussed in the article as analytical tools for identifying the character of the emerging strategy (comparisons).

In the following we will present the three main strategies introduced above. It is worth noting that all strategies experienced specific periods of political significance. Strategy 1 (big industry) c. 1945-75; strategy 2 (new industries) during the 1980s and strategy 3 (technology diffusion) in the 1930s and 1990s. However, politics is never about absolutes but about degrees. All strategies have lived side by side throughout the second

half of the 20th century. Periodisation of industrial policy is therefore based on degree of importance of the strategies, not on the existence of the strategies.

4.3 Strategy 1: The American ideal - constructing big industry

The emphasis on big companies and the need for restructuring the existing industry in the post WW2 context was a political reaction towards what had happened in the economy during the 1930s and 1940s. A large number of small manufacturing companies were established, partly as a response to market conditions and partly as a consequence of diffusion of new small scale production technology. Most important was the economic and social crises in the early 1930s, the closing off of international markets in the 1940s and the introduction of low cost small electro motors. The economic crises of the 1930s strengthened industrial entrepreneurship in local communities in parts of the country (Western Norway), Sejersted (1982). During WW2 and the first post-war years there was a gap between existing domestic demand and industrial supply. The market conditions favoured the establishment of a large number of small work shops directed toward the local market. These companies became known as 'ashtray companies' indicating that they produced simple consumer products, using simple production technology, and having low productivity, Hjeltnes (1984).

Table 1 Number of industrial companies and employees in Norway 1922-1948[10]

Year	*No companies*	*1000 man-hours*	*1000 man-hours/company*
1925	10 512	306 246	29,1
1930	11 175	309 470	27,7
1935	13 093	325 819	25,0
1940	14 565	364 431	25,0
1945	17 002	350 323	20,6
1948	18 845	514 164	27,3

Source: Historisk statistikk 1978, table 130

The Labour governments of the first post war period regarded the industrial structure which existed in the late 1940s at the major obstacle for creating a modern industrial economy. A large part of the Norwegian political establishment lived in exile in the UK and the USA during the war, and the personal experience of living in a 'modern industrial society' became an important source of inspiration for ideas of how to design a new economy and society at home[11].

Both the Labour party and the unions believed that the small companies, mostly owned by individuals or families, were not able to modernise the economy by introducing efficient production technology, management skills or organisational changes. It was therefore necessary to establish policies which would promote the transformation of the existing small scale industry towards a more 'rational' large scale production system. Labour introduced different types of instruments to increase the size of companies. The first sub-strategy was to directly control and regulation the existing structure (sub-strategy 1). Laws introduced by the German occupation regime during WW2 were

10 Ulykkestrygdede bedrifter (under compulsory accident insurance)

11 R.P. Amdam, Industrirådene i New York og London

prolonged into the post-war period. The *rationalisation laws* gave state bureaucracies power to force individual private companies to close down, reduce capacity or to expand. The laws became the main battlefield between the Labour government and the non-socialist opposition until Labour decided not to prolong the laws in 1953.[12] The laws were never used, but reflect that the government regarded it of crucial importance to find instruments which could create a more 'modern' industrial structure.

The second strategy was to collaborate and communicate with selected industrial companies and make large companies responsible for developing a more efficient structure of each industry. (sub-strategy 2). This was the object of the corporative structure where bransjeråd (industrial councils) became the main instrument for achieving structural change, Bergh (1973). The industrial councils became a meeting place for the state representatives and representatives of each industry to discuss the future development of the industry. Bransjerådene, however, never came to play a role in promoting structural change.

The third strategy was to regulate industrial development by controlling investments and inputs into production. (sub-strategy 3) An administrative system was established to regulate imports (and exports) in order to steer inputs towards selected industries and companies. In addition, investments were closely monitored and companies had to get state permission to expand production. It is doubtful that this strategy was more successful for changing the structure of the industry than the two others mentioned above, Myklebust (1981). Established norms in public administration and unclear instructions turned the regulation system into a tool which actually preserved the old structure.

The fourth and most successful sub-strategy of the first post WW2 years was to construct new large and modern companies outside the old industrial system. (sub-strategy 4) Though some private investors were invited to establish new industries, the state became the main actor in building up the new modern big industry. The largest construction works going on for most of the 1950s was the national iron mill in Mo in Northern Norway. The state also invested in aluminium mills in Årdal and Sunndalsøra; the former established by the Germans during WW2 and the latter financed by the American government in order to cover the military demand in the early Cold War. In addition, state capital established a number of fish processing factories along the coast of Finnmark and Troms counties. (Fi-No-Tro).[13]

From the early 1950 until c. 1960 there was no new decisions made by the Stortinget to establish new state industries. Also the sub-strategy to directly control private companies was abolished. In addition direct control of investment was gradually de-regulated. The main instrument in industrial policy was the regulation of the credit system (state banks, agreements with private banks (could be included in sub-strategy 3). The government decided to keep interest rate low (2,5%) and to regulate the credit market towards the politically prioritised areas. This created a system for supporting specific elements of industrialisation, in particular to promote large scale production units in process industry (electro chemical and metalurgical industry).

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12 There are many studies of the planning of the laws in the early 1950s. Among these are Sejersted (1984), Bergh (1987) and Slagstad (1993).

13 On state industry, see Grønlie (1989)

In addition, the governments gradually succeeded in developing closer collaboration with some selected companies which shared the government's ideas on industrial modernisation. Large industrial companies became political entities and instruments in pursuing specific political objectives. A close relationship between core people in the Labour movement/ government and industrials managers emerged. As instruments to promote this *indicative planning* policy, a number of state funds were established during the 1960s to attract companies to become policy instruments, Sogner (1994)[14]. The more important funds were directed towards regional distribution of industri (Distriktenes Utviklingsfond), development of new activites (Utviklingsfondet) and directly towards changing the structure of the industries (Strukturfondet, Strukturfinans, Småindustrifondet). As part of the broader strategy, a number of political initiatives were taken in the 1960s and 1970s to promote a 'rational structure' of each industry ('strukturrasjonalisering'). In the 1960s emphasis was put on the old industries in the industrial region around Oslo, focusing on ship bulding, paper industri and textile industry, Industridepartementet (1968).

A good example of this sub-strategy is shipbuilding where the Aker company played a crucial role in transforming the industry from a traditional to a modern production system, Andersen (1986). The ship yard became the symbol of social democratic success of collaboration between the unions and management, and the company became the leading ship building company with production units in many small towns in south Norway. Much less successful was the attempt to restructure paper/cellulose industry. No company in this industry was able or willing to play a political role, and even the strong involvement of Norway's largest commercial bank was not sufficient to induce a restructuring of the industry, Lange and Sejersted (1984). Industries which consisted of a large number of small companies could hardly be restructured using this strategy, and market mechanisms was far more important than political strategies for the restructuring of industries like clothing and furniture. In the late 1970s a leading Labour politician throughout thepost second world war period, Jens Chr. Hauge, made an attempt to restructure the emerging electronics industry, defining 3-4 national champions which should become the centre of a national growth industry, Sogner (1994). Hauge's attempt failed and was the last political intervention to establish a 'modern' industrial structure of big companies in a bigger scale i manufacturing industry.

4.4 Strategy 2: New technology - new production structure

The idea that a successful industry consisted of large and financially strong corporations became much less influential in industrial policy from the late 1970s. However, the idea that there exists a 'best' industrial structure survived. Now the focus was not so much on company structure, but on the structure of the production and product. While it had been common to think that growth would be secured by the most efficient bussiness structure, politicians now focused on industries or products which had the largest growth potentials. In most countries new technologies like IT, biotechnology and new materials, became the basis for policies directed toward industrial development. In

[14] Examples of the funds: Tiltaksfondet, Industribanken, Industridepartementets omstillingsfond, Det nye fond for vekst og omstilling, Småindustrifondet (Håndverks- og småindustrifondet), Distriktenes Utbyggingsfond (1960-992; inn i SND), Strukturfondet, A/S Strukturfinans, Industrifondet, Eksportfinans

Norway, also oil and gas and fish farming were regarded as important sectors for future economic growth.

The idea that existing production structure could not sustain long term economic growth was not a new one in 1980.[15] In Norway the need for a radical structural change of the manufacturing industry to sustain long term growth was first argued in a report from the Industrial Research Council (NTNF) in 1964. The argument was that Norwegian industry was too dependent on domestic natural resources and that limited supply of resources would lead to reduced growth in the long term perspective. In order to compensate for the gradually diminishing growth potentials in industries like fish processing, wood processing and industries based on cheap supply of energy, the report argued that future growth was dependent on the success in productions were knowledge, not natural resources, was the more important input factor, (NTNFs forskningsutredning 1964)

Part of the background for the new strategy was the relatively slow growth of Norwegian economy and industry in the 1950s. International statistics indicated that traditional industries experienced slower growth rates compared to new industries. Norway's slow industrial growth could be linked to the dependence on industries based on natural resources. Some of the new sectors which were expected to grow quickly were parts of engineering industry, electronics (including telecommunication, automation/regulation) and new materials.

The strategy directed towards developing a new industrial production structure can also be seen as part of a catching up strategy. The USA was the main developer, producer and user of the new technologies and the in the 1960s the success of the American economy was linked to the success in the new sectors.. The OECD policy of 'technology gap' in the last part of the 1960s indicate the perception of Europe as backwards compared to the USA, and that the objective of the strategy was to close the gap across the Atlantic.

The strategy did not gain a strong political foothold in the Ministry of Industry and in governmental policy until the early 1980s. While Labour supported such a strategy in the mid 1960, the party lost it political strength and a non-socialist coalition governed Norway between 1965 and 1971. In the short Labour government 1971-72 there was a renewed interest for implementing this strategy, but the 'no' of the EC referendum 1972 and the economic slump of the second half of the 1970s did not establish a political support/context for this strategy. Politically, emphasis was put on saving old industries rather than supporting the development of new sectors with growth potentials.

In spite of the rather weak support of this strategy, instruments were established to implement the development of new industries. The main instruments was the Development Fund (established 1965), public R&D contracts (introduced 1967) and regulations for public procurement. The Development Fund supported different industries, but focused in particularly on new technologies (electronics) and new products for engineering industries. The R&D contracts became an important tool for promoting electronic industry as only defence and the telecommunication agency used

[15] We here consider only the post WW2 period. Also during WW1 there were political initiatives to develop new industries (new for the Norwegian industry) based on large scale R&D projects, see Collett (1983)

this instrument widely. The same goes for procurement policies were also Televerket and defence were the active users of the regulations.

However, the strategy to develop new industries based on new technologies - telecommunication, electronics, computers, regulation/automation systems - were also shaped by institutions established to promote the technologies. Crucial were NTNF, the Norwegian Defence Research Establishment (FFI), Televerkets Forskningsinstitutt (the former national Telecom R&D Institute), SINTEF's electronics lab; the old state munitions company Kongsberg Våpenfabrik and gradually other public institutions. The network between a few companies defined as national champions, public research institutes, public procurement agencies, etc created a strong structure for the establishment of a high tech industrial sector - but a rather limited one.

At the end of the 1970s the 'new industry' strategy got a much broader political basis. In parallel, there was an ideological shift away from using direct state intervention towards using market mechanisms to promote new industries. The first part of the 1980s was the period when the 'new industry/technology' strategy reached its peak in political popularity. The rapid growth of the IT sector until the stock exchange crises of 1987, created a strong belief that this sector would become a main economic activity and remain a vital factor for economic growth. In Norway, Norsk Data, became a symbol of the new phase in industrialisation. With an average growth of 40 per cent a year from its establishment in 1967. for about twenty years, the company became one of the winners on the international stock exchanges. In a period with increasing general de-industrialisation, Norsk Data became the main argument for a re-industrialisation strategy. Simplified, the re-industrialisation policy became a policy to establish and develop more companies like Norsk Data.

Table 2 Manufacturing industry 1975-1992

Year	*No. companies*	*Employment*
1975	13 741	380 800
1980	13 273	368 713
1985	13 023	329 096
1990	11 513	284 135
1992	10 502	270 868

It was generally accepted that the development of new industries was the outcome of scientific and technological processes. The new industries were defined as 'science based industries'. R&D became the core element in this industrial strategy, and the main supporters of the strategy were people closely connected to the R&D system. Therefore the R&D system became the main instrument for the re-industrialisation policy of the 1980s. The policy had two main objectives: to expand the R&D sector (public and private), and to improve the industry-research/science relationship so that more science-based industries could be established.

In order to increase industrial R&D the Labour government in 1978 introduced 'Goodwill agreements'. The policy informed the international oil companies that they had to procure R&D services in Norway in order to be regarded as a serious competitor for getting concessions to produce oil from oil fields in the North Sea. The Goodwill agreements rapidly increased the size of the research sector of Norway, in particular the institute sector. The main winner was SINTEF in Trondheim which became the largest

research institute in Northern Europe. The Labour government which entered into office in 1986 decided to increase public real funding with 5 per cent per year. The outcome of the various policies (including Hovedinnsatsområdene) was that industrial R&D grew rapidly through the 1980s.

Table 3 Industrial R&D private/ public (by funding) 1974-1991 (mill kr)

Year	*Public*	*Industry*	*Oil*	*Others*
1974	995	552	-	35
1979	1927	1200	-	73
1983	2924	1824	684	160
1987	4830	3654	1329	299
1991	6883	4478	902	331

The numbers indicate the importance of public funding for industrial R&D in Norway, and that the institute sector was a very important producer of R&D. Criticism of the institutes for neglecting their industrial role, led to a market oriented policy for the institute sector. The institutes gradually received less direct basic funding from the research council (NTNF) and were forced to make more income from contracts from industry. Over time the institutes were turned into service institutions for industry more than the politically strategic technology institutions as they were from the establishment.

The main new instrument established to improve the 'technology market' to increase re-industrialisation of high tech industries, was the policy of strategic technology areas (hovedinnsatsområder 1987-90). There was a broad national consensus behind the idea to increase funding for a few selected technologies (IT, oil/gas, new materials, biotechnology, fish farming) and to improve the co-ordination between public and private actors (companies, universities, R&D institutes, public agencies etc) within each technology area. The strategic areas policy were successful in the sense public funding for the selected areas increased, but there is less evidence that the system succeeded in improving co-ordination.

Each technology area had different histories and institutional setting, and there were different policy measures used for each area. The most complex policy was in the IT sector where a number of initiatives were taken to improve both education, research, production and use of the technology. As an industrial policy, R&D and direct support for companies became a main tool for improving growth and development.[16] In the oil and gas sector also R&D became an important instrument for the development of a strong national industry directed toward the market for investment goods in the North Sea. The most important instrument was the introduction of a more national 'procurement' policy. In the years to come Norwegian companies became the majority supplier to the expanding North Sea market. Again we see the emergence of 'national champions' and in particular Kværner and Aker expanded rapidly during the 1980s. A third policy was used toward the rapidly expanding fish farming industry, where also

[16] However, market forces made it impossible to produce the 50 000 new jobs in the sector which promotors of a national IT plan promised in the mid-1980s.

R&D played an important role. This industry was dependent on a rapidly expanding international food market, and the important aspect was to ensure quality of the product and a low price to the consumer. Public R&D played a crucial role in developing the core technologies for the new sector of the industry. However, the overall size of the R&D effort was very limited.

The 'new industry' strategy did not radically challenge the existing structure of institutions established in the post WW2 period to promote industrialisation. With the exception of the institutional devolution of the industrial RTD institutes out of the public sphere ('fristilling', to enhance 'market orientation' of these research institutes), the system survived. The research council did not radically change organisation or policy. The policy of the late 1980s did however reveal that NTNF was not able to function as a strategic agency for the new and or complex technology policies. Also the ministry in charge of the oil sector seemed critical of the research council and de facto established its own research council. The combination of the research council's lack of strategic capacity and the breakdown of key institutions for the 'new industry' strategy like Kongsberg and Norsk Data towards the end of the 1980s, led to a period of restructuring of industrial policy and establishment of new institutions to pursue industrialisation.

4.5 Strategy 3: Diffusion of technology

The last strategy to be discussed here is that of *diffusion of technology and best practices.* Historically this is both the latest strategy to get a politically strong position and a strategy with long traditions. In contrast to the two other strategies discussed, the diffusion strategy is not directed towards achieving a specific and well defined industrial structure. But also this strategy is linked to situations of technological gaps: the idea is to spread/diffuse knowledge and technology which has been proved successful in more advanced parts of the economy to more 'backward' companies. This strategy is directed towards a large number of companies rather than a small number of selected favourites, and there is a demand for a very different institutional setting for implementation of this strategy compared to the others. It is not sufficient to develop close relationship between relative few selected companies/technologies and public agencies, but to establish mechanisms which make both SMEs and larger companies active in searching for new technologies, implementing new production techniques and developing their product range.

The diffusion strategy is well documented for the inter-war period which saw the establishment of a large number of new companies, in particular in rural areas and in coastal regions of South Norway. A significant redistribution of industrial production took place, moving industrial production from the old industrial centre of Oslo to rural areas in Western Norway. Labour intensive industries were most affected, both clothing, furniture, wood, and mechanical industries experienced radical changes both geographically and structurally. The new companies were small with low capital costs as well as low labour costs. The relatively low cost was the outcome of broader technological processes and local social capabilities. Cheap mass-produced electrical motors and a surplus of electricity in large parts of Norway created the technical foundation for diffusion of cheap and simple machinery for a number of new industries. This opportunity was exploited by a large number of people in small villages and towns, as well as in larger cities. The diffusion process was pushed by public institutions

established to spread information and technological knowledge, and to support small companies in the process of introducing new technologies.

In the writing of the history of this transformation process, two institutions are often mentioned. STI (Statens Teknologiske Institutt) was established prior to WW1 in order to support introduction of new production technology in SMEs. During the inter war period the institute both set up training programs for managers and skilled workers in SMEs as well as consultancy work for individual entrepreneurs and companies. A large number of people were involved in STI's training system, and local schools also designed courses for training people to work in industry. The other institution frequently mentioned in the literature on the growth of SME's in the 1930s, is Småindustrikontorene (Small industry offices - SIK) . They were established on a regional basis and received very little financial support from the government. However, there are numerous examples of how these offices played a crucial role in assisting companies in defining both products, production technology and markets. Both STI and SIK were rather small institutions, but there is good historical evidence that they both were influential in the diffusion of production technology as well as know-how on organisation, markets and finances.

During the post WWII period and until the 1980s, the diffusion strategy received limited attention. There is one big exception. The USA's Marshall aid program of the 1950s was directed towards transferring American technology, management ideology and organisation systems to the European economy. The Norwegian Productivity Institute established in 1953 was the main new institution for the technology transfer policy. However, in national policy there were no major initiative to secure diffusion of the American technologies and ideas to the large number of SMEs. The case of Aker illustrates that the new American methods were directed towards large companies.

The diffusion strategy did not have much support in the (Labour) governments, however, the strategy still had its proponents in the Stortinget. Political parties with a strong basis in Western Norway and rural regions (Venstre, KrF and SP) were traditionally in support of this strategy and so did the Left Socialist party (SF – Sosialistisk Folkeparti (established 1960), later reorganised as part as SV – Sosialistisk Venstreparti). These political parties were however not sufficiently strong to impose the strategy on a national level, not even during the non-socialist government 1965-71.

The strategy gradually became more influential with the break down of the idea that large corporations was the only best way to organise industrial production (late 1970s). The strong idea that growth was dependent on the performance of many small companies enforced the idea for diffusion policies as a general industrial policy. The two Willoch governments (1981-86) were strongly in favour of SMEs, but the main policy was to support the establishment of new high tech companies. It was during the Brundtland governments (Labour, between 1986 and 1996; and the short period of Syse's government 1989-90) that the diffusion strategy became central of policy documents. We will return to the economic and political background for the new policy of the late 1980s, and here draw the attention to some of the instruments established to pursue the new strategy.

The restructuring of the policy instruments directed towards diffusion of technologies was part of a broader international trend with a number of policy measures undertaken in particularly in the USA. The old state owned diffusion institution, STI, was

transformed into a private foundation with the objective to promote knowledge on technology and management for SMEs (and changed name to Teknologisk Institutt TI in 1988). A new Service Office for industry for Northern Norway (Veiledningstjenesten for Nord-Norge, VINN) had parallell functions to TI but only focused on the special needs of the northern parts of the country. Similar services were offered by Bedriftenes Rådgivingstjeneste (BRT established 1991) consisting of 18 advisory companies offering consultancy services to SMEs. Information on new technologies were also provided by Norges Industriattacher which is a part of the TI system, and on design by Norsk Designråd.

From the 1960s and even more in the decades to follow the public research system was criticised for supplying only a small percentage of the funding for SMEs. From the 1980s new arrangements were introduced to ensure that SMEs received a larger part of the resources. Research programmes like TEFT (Teknologiformidling fra forskningsinstitutter til SMB) and RUSH (Regional Utvikling SMB Høyskoler) are examples of the attempts by governments to promote technological development and diffusion in SMEs, and other programmes were established directed towards diffusion of technologies for all companies (FORNY - Forskningsbasert Nyskaping; BU 2000 - Bedriftsutvikling 2000). SND also introduced measures to improve productivity in SMEs (nettverksprogrammet and FRAM - Forstått, Realistisk, Akseptert, Målbart). A highly successful organisation for diffusion of technology was the NT-programme (Prram for nyskaping og teknologispredning) for Northern Norway (1987). The development of regional resource and technology centres also became important organisations for diffusion of new technologies. KAD introduced specific programmes for linking the regional research institutes to local industry (Næringsrettet forskningsprogram ved regionale forskningsinstitutter). There was also a programme for widening the use of economists and engineers in industries in Northern Norway.

The examples of new instruments for diffusion of new technologies and best practices indicates that the diffusion strategy gained political significance from the late 1980s and early 1990s.

4.6 Towards a new strategy?

The three strategies defined above, can be used as analytical tools to analyse contemporary policies. Which of the mentioned strategies have strong political support today and which instruments are used to support them? In addition to looking at old strategies I will shortly search for indications of new strategies and briefly discuss some institutional aspects of introducing a new strategy into a political-administrative system built up to implement old and familiar strategies.

The socio-economic background for a new industrial policy of the 1990s was the problems which started by the fall in the oil prices 1986, followed by stock market collapse in 1987, bankruptcy of the high tech national champions Norsk Data and KV 1987-89, rapid de-industrialisation, increased flow of people from the periphery to the centre, collapse of fishing resources (cod) and the fish farming industry, collapse of the national financial system, the highest unemployment figures since WW2 and social problems for large groups (debt/interest rates). In total these problems constituted a period defined by politicians as ‘crises’. (1986-93)The consequences for politics was as

significant as that of the crises of the early 1930s. Old ideas and institutions were being abolished, new ones were being introduced.

During the crises of the early 1930s, Labour introduced the idea that manufacturing industry had to form the basis for future industrial growth, and that big industry was the best way to establish a strong economy. The crises of the late 1980s ended this ideology. Policy documents from the early 1990s argued that manufacturing industry was not to be given any political priority to other sectors of the economy, and it was explicitly stated that the governments did not want to push for a specific business structure.

The crisis also influenced political practices. Labour governments between 1986 and 1996 abolished core institutions of industrial policy of the post WW2 period. Some of the symbols of the modern social democratic society and of state planned industrial modernisation were completely transformed. The state construction of an iron works at Mo was coupled with an idea by Labour to produce an ideal modern industrial urban society. At the end of the 1980s Labour reduced the activity of the iron works to a minimum and privatised the remaining activities. The government introduced political measures to transform the Mo society from a community dependent on one large industrial company, towards a community with a much more diversified social and economic structure. In Kongsberg the state owned high tech munitions company was partly privatised and divided up in a number of smaller independent units. The governments also attempted to transform some other communities which were dependent on one large mining or manufacturing industry company; Sulitjelma, Sør-Varanger, Horten, (Askim) into more diversified communities.

The Brundtland government defined a new industrial strategy consisting of the following elements:

- focus on 'healthy' general economic conditions: inflation, cost level, interest rates, infrastructure (including a more efficient public sector)[17]
- no longer only priority to manufacturing industry
- less direct support to any industry
- de-centralising instruments for industrial policy; local communities and regional authorities responsible for development

The government also argued that the number of instruments available for industrial policies were rather limited. International agreements like WTO and European Space Agreement (EU) to a large extent defined the instruments which could - formally - be used to shape industrial development. The government defined the main areas for governmental intervention as[18]:

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17 Næringsdepartementet (1989) is the first White Paper presenting the new policy of the Labour government.

18 'Virkemidler' (narrow policy) defined as: R&D, education, development of infrastructure and initiatives to stimulate *establishment* of new industrial activity.(Næringspolitikken; redegjørelse

- R&D, technology and competence development
- capital supply (venture capital)
- infrastructure (transport and communication)

Based on the analysis of general documents describing the formal industrial strategy, the impression is that the 'diffusion strategy' is *ideologically* stronger compared to the 'big industry' and 'new industries' strategies. The emphasise was on developing structures to support a large number of companies with venture capital and technological services. In addition, the public sector should in particular develop efficient infrastructures for communication and transports.

However, it is not a given that a change in the ideology will change political practices in the short term. This is similar to the policy pursued by the Labour government 1935-40 which was rather in contrast to the official big industry strategy of the Labour party. Nygaardsvold's government continued the traditional policies which supported a decentralised industrialisation based on small local firms, and the new institutions established to promote big manufacturing industry had rather limited influence on socio-economic processes. In order to improve our understanding of actual policies of the 1990s we have to study more carefully how strategies were detailed and implemented by the various governments during this decade. Firstly, were also the 'big industry' and 'new industries' strategies implemented?

New production sectors - 'high tech industries'

The basic underlying philosophy of the new policy of the late 1980s was to develop a new basis for future welfare by a 'modernisation' of the total economy. The Brundtland government argued that Norwegian economy had to become less dependent on oil revenues and exports of non-processed products. Norway was too dependent on exports based on natural resources, and in the long term welfare would depend on a successful transformation towards less resource based productions. The government's LTP from the late 1980s therefore argued for the need to transform the national economy and ensure a radical structural change. The main difference from the policies of the earlier 1980s was that the government refused to indicate how the structure of the future economy ought to be.

Looking at the initiatives taken by the governments and Stortinget during the 1990s, there is little doubt that IT/ ICT *de facto* remained a core technology of industrial policies. There are strong indications that many politicians - and other groups and individuals - still followed the 'new industries' strategy from the 1980s and argued that future welfare was dependent on the development of a strong ICT sector in the economy. During the 1990s - and in particular from 1996 a number of initiatives was taken in the Stortinget and by the governments to support the development of IT and promote increased ICT production. The establishment by the Jagland government to establish an IT department and the proposal for a broad national ICT plan indicates the

for Stortinget ved næringsministeren Stortingstidende 3124 (1990-91), 29. April 1991). The three point list is from the White Paper on Industrial Policy, Næringsdepartementet (1998)

wide belief that this technology represented modernity and 'the future' for large part of the political establishment.

The most important political conflict on ICT in the late 1990s was the plan to establish of an ICT centre at the old airport area Fornebu close to the Oslo centre. IT Fornebu was an initiative by a group of investors (Norsk Investorforum and Telenor) and a plan to develop a centre for production of and education in IT. The idea was supported by the Jagland government (Labour), while the Bondevik government (centre) opposed the idea and the plan. The theoretical foundation of the plan was that the economy and the society is currently undergoing a transition characterised as a paradigm shift from an 'industrial' to a 'knowledge' economy. The future growth sector of the economy was according to some dependent on success in the ICT sector, including the ICT industry. ICT is regarded as the main driving force behind the socio-economic transformation which demands a radical change of existing institutions. The policy underlying the plan is therefore radical - it implies radical institutional change on a number of societal areas.

The discussions around the IT Fornebu plan show a broad support for the idea that ICTs are the core element in the future economic development arguing that future welfare would depend on success in the ICT sector and in ICT production. There was however also a rather significant political opposition to the IT Fornebu plan, and a few academics argued that ICT production was not necessarily the decisive sector for future economic growth. The main arguments of the political opposition was that ICT production was concentrated in the central parts of the country and would not could the basis for a de-centralised economy. IT Fornebu would accelerate a process to concentrate resources and growth in the Oslo area. Many of the sceptics of the plan wanted to use ICT for de-centralised economic activities rather than develop ICT companies.

Towards the end of the 20th century the ICT sector was the main technology behind the growth strategy of 'new industries'. But there were also a couple of competitors which were based on natural comparative advantages. As the oil sector was declining, natural gas became an alternative industrial growth sector. Also the combination of fish farming and biotechnology was regarded by its proponents as a sector which would become an important part of Norwegian economy and industry, and was defined as a priority area by the Research Council.

Corporate structure - 'globalisation'

During the 1980s large corporations lost their importance as focus of economic policies. The 'new sectors' strategy emphasised the importance of establishment of new companies, entrepreneurship and growth of companies in new sectors. The large corporations were regarded as less innovative than small ones and belonging to the 'Fordist' production paradigm. In a post-Fordist area other types of companies would be the successful ones.

In the latter half of the 1990s the importance of financial strength of large companies once more became a political matter. Globalisation - the increased importance of multinational corporations in the global economy - raised the question of how Norwegian companies could compete with large global multinationals in increasingly more open international capital and goods markets. The sale of the most successful Norwegian company of the early 1990s, Nycomed, and the national symbol company Freia (chocolates) to foreign competitors, as well as Kværner's decision to move its

headquarter to London, triggered a discussion on how to keep national control of the more important companies as well as being an attractive economy for multinational corporations, MNCs. The argument for national control being the need for keeping knowledge production and R&D in the country.

The political problem on the agenda in the middle of the 1990s was therefore partly to develop financially strong national companies and ownership. The state had become a major owner in Norwegian industry, controlling both big manufacturing industry (Statoil, Norsk Hydro), the bank sector (the largest commercial banks) and high tech institutions (Telenor). State ownership could be used to make sure that important industrial companies remained Norwegian. In addition the government returned to the old policy of selecting some 'national champions' which could be a collaborator in developing strong national ownership. The politically most interesting case was K.I. Røkke's role in developing a integrated company in fishing and fish processing industry in collaboration with SND from 1993. Røkke also became an important player in shipbuilding and investments products for the oil sector as he became a majority owner of the Aker company in 1996. Also in this sector he became a political player, negotiating for a new deal for which companies that would get access to the oil resources in the North Sea. Another example of new 'national champions' is IT Fornebu/ Norsk Investorforum were Fred Olsen, the former owner of Aker, followed a long tradition of his old company to enter into agreements with the government to support the government's strategy. However, we may argue that there were not many industrial owners in the late 1990s who were willing to play the role as a 'national champions'.

The discussions in the Stortinget in January 1999[19] indicated that the old conflicts in industrial policies still prevails at the dawn of the 21st century. Labour's representative (Kjell Opseth MP) argued that it must be a political objective to develop strong and large economic units, and accused the centre government on focusing too much on ownership in SMEs and the problems of family owned companies. It seems likely that the increasing role of MNCs in the economy will make the 'big company' strategy an important part of future industrial policy.

The end of big strategic planning?

During the period from the late 1940s to about 1990 industrial policy was characterised by an attempt to construct a specific industrial structure. The development of this specific structure was regarded as necessary to achieve long term economic growth and to be able to compete in an international market. Until the late 1970s the emphasise was on establishing a best corporate structure with large and financially strong companies, and from the 1980s on the development of new technology based industrial sectors. The strong emphasis on the existence of a 'best' industrial structure has lost ground in policy documents after the end of the Cold War. In stead political documents argue for broad innovation activities in various parts of the economy, and to some extent *innovation theory* has been influential in shaping political thinking on industrial development.

In Norway, the ideas of an innovation policy was first presented in a White Paper on research policy in 1993 and the following White Paper on research policy of 1999 were

[19] Governmental White Paper on ownership in Norwegian industry

completely structured around innovation theory. The Research Council (founded 1993) became the institutional stronghold for the theory and was supported by the Research Department at KUF and partly by the research department of the Ministry of Industry and Trade (NHD). In addition there were individuals in ministries and in other agencies working on industrial policy for developing a new strategy based on innovation theory. I 1999 the Research Council succeeded in creating an alliance with the National State Fund for industrial and regional development (SND) and the Norwegian Export Council to promote the idea that Norway needed a new industrial strategy and that this strategy should be based on innovation theory.

There is, however, no strong evidence that innovation theory has much influence in the actual shaping of a national industrial policy. Firstly, it is problematic to argue that there is a coherent national industrial policy at all. Policy decisions influencing industrial development are made in many ministries and public agencies and there is no systematic co-ordination or attempt to analyse the consequences the various policy decisions have for industrialisation. Secondly, the traditional split in the Ministry of Industry between the Research Department and the Industrial Department seems to prevail. The Research Department is interested in innovation theory but has not been able to develop the ideas of the theory into a coherent policy. It is doubtful that the existing structure of the department makes it possible to become an ‘innovation department’.

There is no agreement in among economist working on innovation theory development on to what extent there exist a 'best' industrial structure for economic growth and welfare. In the literature dealing with 'new technologies' (primarily ICT) there is a strong group which argues that the way to economic success is closely linked to success in ICT, see f.i. Fagerberg et al (1999). This perspective is closely linked to the ideas which were dominating in the 1980s, but is today challenged by others who argues that even if ICT is important for economic development, the way new technology influences economic development is complex and diverse. The argument is that there are many ways of using new technologies to achieve economic success. The latter approach is in line with trends in economic history in the 1990s based on for example studies of the industrial revolution. This literature downplays the role of core technologies (textile machinery, steam engines, factory as organisational principle) for economic development in Britain and also for other parts of Europe compared to what was common in the literature in the 1960s and 1970s. Alternatively, the process of change during industrialisation is regarded as broad and complex social processes involving both new and old technologies, and where there were many more new technologies than those which traditionally have been described as core technologies, see Berg (1994) and Hudson (1992). Also, the historical literature on European industrialisation stresses the marked differences between various regions, and indicate that economic success has been achieved through many different combinations of technologies, organisational forms, and use of many kinds of knowledge.

The historical literature may reflect the political situation in the post Cold War period, characterised by much more pluralism in social as well as economic thinking. This does not imply that the conflict dimensions between groups who want to promote specific economic structures is gone, rather that it is more difficult to get political acceptance for the idea that there exist one - and only one - best way towards establishing the good society, including that of producing welfare and economic growth.

Chapter 5. Trends and patterns

How can the evolution of industrial innovation policies in the post-war period be characterised? In the preceding sections we have surveyed national and international developments respectively in science and technology policies and in the economic industrial policies. Our conclusion on the basis of these is that there seem to emerge some definite trends in these developments. Furthermore as argued in both sections we may identify characteristic phases in these developments, phases that suggest the existence of phase shifts in *zeitgeists*, or basic policy attitudes or *mentalities*. The mentalities are based on gross assumptions about the 'ideal' state of industrial production, and by identifying the major deficiencies of the contemporary industrial system, points the major challenges for policy initiatives in each period.

Table Main phases of industrial policies

	Background	Main challenges	Policy response
Strategy 1: The American ideal 1945-1980	'America' a hegemonic model for European industrialisation Technology gap	1: Productivity and technology gap between 'America' and Europe 2: Economies of scale and scope as major determinant	Dominant strategy: Promote the construction of big industrial corporations, corporative 'strukturrasjonalisering' and indicative planning
Strategy 2: New technology - new production structure 1977-1990	'America' losing appeal as model New technology and re-industrialisation	1: Productivity slowdown 2: The threat of de-industrialisation 3: Stagnation of traditional manufacturing industries	Core idea: Growth can only be achieved by developing new products or completely new industries, not by improving old products and industries. From aggregate demand to supply side New strategy for re-industrialisation, industrial expansion based on core generic technologies Re-industrialisation as ideological shift; technological development became the core aspect of economic change and growth: Computer industry the dominant model of new industrialisation. Supplementary strategy: The revival of SMEs as important for employment and growth. Combined focus: The importance of having NTBFs (New Technology Based Firm)

Strategy 3: Diffusion of technology towards all industries 1985-2000	Crises and breakdown of established policy approaches Collapse in petroleum revenues (1986), National champions topple (Kongsberg Våpenfabrikk, Norsk Data 1987-89), Staple marine resources (cod) near extinction (1988-90), Major recession, accelerating structural unemployment (Largest unemployment rates since 1945, 1989-92), Commercial banks near failure (1991-2)	1: Increasing resignation towards the growth promise of the new re-industrialisation. Increased uncertainty of the ideal industrial structure 2: Need of wide-ranging productivity growth in all sectors 3: The welfare state in trouble	1: Manufacturing industries, at least in rhetorics, lost political hegemony. Emerging focus of the role of service sectors 2: Strong reliance of market system as dominant mode of generating productivity growth and competitivity 3: Market-emulating transformation of public services to transform public institutions 4: Industrial neutrality of policies promoting industrialisation – the disappearance of the ideal. Focus general conditions and frameworks 5: From diffusion of technology to diffusion of best practice
Strategy 4: Need of a new strategy? 1995-?	The learning-based knowledge economy	1: Globalisation 2: Specialisation 3: 'The network economy' 4: Structural policy and neutrality – a contradiction in terms 5: Post-petroleum Norway = ?	1: ICT as de facto structural policy 2: National ownership/State ownership 3: Autonomous funds as dual funding (Start- og såkornfondene/Norges forskningsfond/…) 4: Revival of the Large corporation model?

Table Main phases of S&T and innovation policies

Period	*Characteristics*
Basic science as pacemaker 1945-1960	The social contract established Science-led development Institution building for a science based industrial future
Economic growth - Science and technology 1960-1970	Scientific effort tied to economic growth, OEEC/OECD Rationalising science policies, rationales and criteria for choice
Productivity slowdown – the need for targeting 1970-1980	Social priorities and "market pull" Targeted program-organised S&T policies Emerging SME focus and innovation policy The emerging Triad
Strategic focus – the new industrial challenge and its technology base 1980-1990	The era of Triad technological competition Autonomous technology as the industrial base Re-industrialisation on generic technologies Redefinition of the S&T infrastructure
Networks and systems – searching for a new model 1990-2000+	Innovation systems and networks as emerging model

In this sense these mentalities 'explain' gross features and priorities of the contemporary industrial policies, and more directly contributes to an identification of drivers of the shifts in these policies. But this is just a first step towards a full explanation of these shifts. We have just transferred the need for explanation of phases from the policy priorities proper to the underlying *zeitgeists*. A richer understanding of this intriguing interaction must wait for more extensive research.

5.1 Strategies of industrial strategies 1945-2000

The preceding sections outlined three major phases in the orientation of Norwegian industrial policies in this period. The outlined is summarised in the first of the preceding tables. The second column characterises some background variables of each phase, while the third column outlines what were considered some main challenges for industrial policies in each period. The last column attempts to characterise the main policy responses to these challenges. The second of these tables summarise the overview over S&T policies and their innovation policy offspring. Here we will briefly identify major trends in these developments.

SME vs. LEN

The first decades showed a substantial orientation towards large enterprises (LENs). LENs were seen as the dominant model in industrial policies. This was a parallel of international developments, as illustrated by the dominant ideas of the 'new industrial state' and the role of the new forms of management or 'technostructures' in the 1960s. During the first phases of the post-war period the perceived Soviet success during the 1930s with its NEP style economic policies also favoured large scale production. Nevertheless the orientation was given a distinct Norwegian (or Scandinavian?) flavour, as in the initiatives for strukturrasjonalisering in the 1960s.

But as noted, though the strong SME orientation of the 1930s had receded into the background, an 'SME strategy' re-emerged during the late 1970s and became a strong strand, but not necessarily dominating, in industrial and innovation policies of the 1990s.

From state directed to market based

During the immediate post-war period, there was a substantial distrust in the market system to deliver its welfare benefits, see Søilen (1998). The distrust, together with a strong belief in the 'real-økonomi' as the decisive part of the economic system, set its distinct mark on the economic policies during the first decade after 1945. Even though the reliance on markets improved somewhat when the detailed planning system of 1946-1952 was abolished, the basic stability of the market system was seriously questioned until the late 1970s. These aspects of Norwegian economic policies gave its 'Keynesian' profile a specific touch that Søilen ascribes to the 'Oslo school', to Ragnar Frisch and the environment around him.

In the area of industrial policy this view was clearly evident in the strong role the Labour governments in the 1950s and 1960s had in industrial development, also with a substantial and actively used public ownership. In S&T policies this was accompanied by a considerable institution building and organisation; that the government had to play the leading role in organisation even of R&D institutions that were intended as centralised R&D labs for private companies was unquestionable. Even the centre-right government in the last half of the 1960s did not change this.

The final breakdown of these policies came with the breakdown of the counter-cyclical policies of 1976-78. In fact the new phase is opened by one of the most ardent organisers of public involvement in industrial development, Finn Lied. The Lied Commission of 1979 was a signal of the need of a new approach, a transition that was brought to fruition with the second Brundtland government.

The process had by then gone from one extreme to the other. While it was the market system that was regarded as fundamentally unstable and that the only viable approach was a centrally planned economy around 1950, it was the market system that increasingly became the measuring rod and stable anchor, compared to which publicly organised provision was deficient.

From science-driven to technology-created

The immediate post-war period has been characterised as the period of 'science as the motor' of social and economic development. The view that science, and especially in its pure variety of basic science, was fundamental to produce the welfare benefits that should be reaped in the future was a stronghold for science policies in many countries. The de facto compromise that was struck between the science enterprise and public authorities has later been characterised as the 'social contract' of science policies. A general model of funding academic science that was increasingly used implied that prioritisation of funds was essentially left to the scientific community. This model, that lay behind and was reinforced by the establishment of various science or research councils, where prioritisation was by what Alvin Weinberg termed internal criteria in the Minerva debate, contributed to an institutionalisation of the necessity of academic autonomy also in setting science priorities and funding.

The constitutive role of the social contract, the related science view of social development and the use of internal criteria for choice has lead many to argue that this era was dominated by a 'linear model of innovation'. The claim is that S&T policies in this period was based on some notion of a dynamic model of innovation where there was a direct causality from basic science to business and market development. It is often pointed to the Bush Report as the founder of this view, with reference to his remark of 'basic science as the pacemaker of economic progress'. This 'linear vice' was according to legend further promulgated by the establishment of the National Science Foundation and spread to European countries.[20]

Whether this is correct or not, the dominant view of this period involved a definite view of advanced technology. New and advanced technology was essentially regarded as 'applied science', all important technological questions that was or potentially could be met would be solved sooner or later by a sufficient regard for the development of the science base of these technologies. This view was strong, in fact so strong that even the impact of the 'Sputnik chock' in a US that was solidly convinced of its primacy in science was weathered. Though the early 1960s came out with a stronger focussing of the scientific effort on economic growth, the hold of science on technology remained (see f.i. Hauknes (1998)).

It was first with the 1970s that arguments of the differences between science and technology became dominating. One factor that we might hypothesis contributed to this was the increasing emphasis of social priorities and the emergence of a considerable public opposition to the established views of economic growth. With the increased focus of the ill impacts of a technological race and capitalist development, it was fortunate for the science enterprise not be treated as synonymous as the technological enterprise.

But when the market based approaches of the 1980s emerged this was in a sense a revival with a vengeance. Now the former focus of the science base was shifted to a view of the criticality of the technology base. There were still links between science and

[20] This view may be questioned, at least when it comes to the source of the model. Bush, himself being an MIT engineering professor before the war, did not subscribe to this view, but it may be argued that the 'linear view' was developed as part of US academia's arguments in the debate before the scaled down NSF was established in 1950.

technology, but the acknowledgement of essential differences between the two, implied an autonomous technology. This contributed to give the policies of the 1980s a very different character from former S&T policies. The period since then has further marginalised science as to its role for economic development and growth, with the consequence that the pendulum has swung too far to the other end (Hauknes 1998).

The paradox of this process was that the shift from science led to technology led development reawakened a 'linear view'. Now the technology push characteristic of the policies was quite dominant. The considerable focus of generic technologies as the base for a re-industrialisation in this period does not necessarily imply a dominant technology push view. But in the specification of this focus that came with the 'hovedinnsatsområdene' and the related plans, such as the national planning document for Information Technology (the so-called Kuvås-plan) as late as 1989, this became evident. More explicitly expressed a belief in technology push dynamics was dominant in technology diffusion initiatives of the mid 1980s, as in the area of CAD/CAM and flexible manufacturing.

This technology push approach was quickly countered by arguments of the criticality of client capabilities, but evidently it did not generate a 'market pull' alternative strategy.[21] Rather the subsequent development quickly proceeded to approaches were network interactions were argued to be important. The disillusionment with the hovedinnsatsområdene and the research councils' organisation and coordination of these led to them quickly losing favour. By 1990 the policy of large scale mobilisation of national effort to targeted technological development was in reality over.

The recent popularity of network arguments and innovation system arguments may point towards new agendas, but it still very unclear what the impact of these developments will be in future innovation policies. However, we believe that the focus of technology rather than science will continue, perhaps with a more substantial reappraisal of the structural change element an through that of the role of especially knowledge intensive services in a generalised 'technological' development (see f.i. Hauknes (1998b))

5.2 Emerging issues

Below are briefly suggested some topics or emerging issues, arising from the preceding survey, and a few more speculative suggestions

Industrial policy without ideals – a contradiction in terms

As noted above, it is difficult to identify new mentalities substituting for those that have dominated the post-war period. The popular approaches to rationalising innovation policies in terms of networks and systemic innovation do not have the same mobilising power as f.i. the focus of LENs in the 1960s. It is doubtful that even the simplified ideas or illustrations of the analytical repertoire of modern innovation theory, such as those of innovation systems could be grafted as a basis for idealistic policy thinking outside the professionalised ministerial system.

[21] It may be argued, however, that the so-called Skår-doctrine of NTNF post 1990 was a market pull strategy for NTNF 'institute policy'.

There are then two options for future developments, either we will see several idealistic models being operated in the political system by different actors, or some new model will appear. If we look to recent management 'fads' for potential models, the idea of the knowledge company, illustrated both by the idea of '*the virtual company*'; the 'lean and mean company', based on the notion of core competencies or core services, could be role model. The speculation of what new industrial innovation policies would be conceived on the basis of this mental model of 'successful business' should then start from the premise that the challenge to these policies was that 'firms are too real'. This business management idea of the virtual company is a concept that have grown out of analysis of the growing sub-contracting, Just-InTime producing networks in the 1980s, other network production modes and the core competencies argument. Thus the idea is not without analytical credentials.

Such a model would probably have a strong high tech flavour, not necessarily in the sense of what the firm produces, but at least in terms of the 'sophistication' of the firm's organisation and production(-coordination). This model would clearly be an advantage to the high tech firm model that to some extent have dominated the 1980s and 1990s. But that does not mean it would be a wise choice.

Another possibility for capturing some elements of the modern innovation analysis could be the shifting of focus from single firm models to multiple firm models. A possibility that have been around for some time and which now seems to be emerging again, is the concept of *clusters* (see f.i. OECD (1999)). This concept which has been used intermittently for several decades, has recently been revived as a variant conceptualisation of innovation systems. The concept is equally flexible and may thus be given many variant meanings, according to the context in which it is used. At the same time it is a denotion that clearly has much stronger mobilising power than 'network production' or 'systemic innovation'. Furthermore it can allow an escape from the dilemma that increasingly is riding industrial innovation policies, the inability to strike a balance between the overriding requirements of economic neutrality and a selectivity which is a necessary ingredient in any functional innovation policies (see below).

Broad consistency – new coordination models

As already described the last decade has seen an increasing pressure on the functional distribution of policy responsibilities and the institutional organisation it has given rise to. The need to consider the *broad* dimensions of f.i. innovation and regional policies reflects that the direct policy areas and their objectives are strongly intertwined with their broad relations. This raises the issue of how these objectives should be accounted for beyond the institutional basis of the narrow policies. These trends may evidently have both functional implications for the orientation and contents of innovation policies, and organisational implications for the ministerial organisation, the Sentralforvaltningen.

The need of selectivity

As noted above the pressure on the requisites of economic non-distortion or neutrality, in economic policy instrument will probably increase. We have seen how the principle of economic neutrality was introduced as part of the reorientation of industrial policies in the 1980s. It was largely a reaction to the explicitly selective policies of the preceding

decades. This suggests that these requisites are not sacrosanct, and a closer study of the principle would probably show that the interpretation of this principle has evolved over time. The policy making institutions of narrow innovation policies have for a long time been aware of the strongly selective pressure of these policies. These selective tendencies of these policies also contributes to explaining discords in the institutional framework around these policies.

The possible evolution of the dilemma between neutrality and selectivity hinges closely on the evolution of informal and formal rationales for industrial innovation policies, and the inherent view of divergences between the social benefits 'optimised' by policy makers and the private benefits 'optimised' by firms. A possible balance may be struck by designing policies on the basis of some concept that suggest a kind of functional selectivity that is consistent with a principle of redefined economic neutrality. We have already suggested that cluster based innovation policies may afford such a balance.

Globalisation and specialisation

During the last few years of this century Norwegian policy makers have been exposed to some of the consequences of internationalisation trends, both in specific industries such as financial services, aquaculture and telecom and in the development of international regulation and cooperation.

Increasing internationalisation over the last two decades has slowly entered a phase where there is clear signs of increasing factor mobility and hence prospects of 'globalisation', or perhaps 'regionalisation', in a wider sense. Globalisation will raise many issues for the formulation of industrial innovation policies in its own right, but it will necessarily also be accompanied by related challenge. Intensified globalisation will give a pressure towards increasing specialisation, and hence raise a central issue for future industrial the innovation policy effort. The challenge is how policy makers in the coming two to three decades shall find a stance towards these processes that retains the basic objectives of industrial innovation policies at all times, securing a sustainable industrial, whether in manufacturing or services, base for future 'value creation'.

A related issue, 'floating in the air', is how national innovation funding and support, being primarily regarded as support for the development of national economic activities, shall relate to 'globalised and footloose' companies. This issue is not new, but may get increased focus as a consequence of increased mobility of firms, corporate ownership and essential factors.

Big is great or small is beautiful

It is clearly to be expected that with increased impacts of globalisation, new questions will be raised to innovation policies. A mode of approach will certainly be issues about of expected firm sizes. Two lines may be identified that may be strengthened in the future. First the globalisation of markets for corporate ownership will focus also in other industries the advantages of large firms or corporations. As already noted telecom and financial services are contemporary examples. On the hand, internationalised markets and reduced trade barriers (ex. WTO and agrofood) will even more than today lead to a focus of international competitivity of SMEs also in mature industries. Here what appears to be a failure of the recent massive investment in restructuring of the agrofood

industries may lead to hesitance by public authorities to attempt similar approaches again.

International regulation

A factor that may have decisive effects on the future development of innovation policies is regional and global regulation. The Single Act process that led to the establishment of EU RTD policies in 1982 has continued since then. It has clearly been in the interests of the Commission to create a system where the EU system increasingly take an even more dominant role in European innovation policies.

A substantial role of innovation related funding and objectives in the EU system may prove decisive for the possibilities of formulating an independent innovation policy in Norway, irrespective of our relation to EU. A further possible development of a new European system is EU/EEA regulation of allowable funding instruments and policy measures. With a reduced role of the traditional public good/market failure argument for supply of innovation related services, these forms of support will increasingly be seen as subsidies and hence as distorting. The distorting effects are towards business firms as recipients of funds and support, but may also affect institutional arrangements like the Norwegian institute sector. This sector may increasingly appear as a commercial consultancy industry in its own right, without any rationale for treating this industry differently from similar industries. A striking trend today is the increased 'KIBSification' of formerly public or semi-public RTOs (many of which are organised in EARTO, the European Association for RTOs) in many European countries. A reactive process to such developments would be to retract 'semi-public' contract RTD institutes from the market again or to marketise them fully, implying that they lose the institutional monopoly they have today for supplying publicly funded innovation related services.

A related development having similar effects is a further expansion of the WTO/GATS system to also include innovation services. There are, however, no signals as yet that this will be a topic for the coming 'Seattle' Round. But, in fact this issue has already been raised, Norwegian authorities met claims from the US around 1990 that support for the incipient marine farming industry in the 1980s was a trade-distorting subsidy as an argument for imposing tariffs on Norwegian salmon for the US market.

Evolutions as these could also open for requirements of national innovation policy measures being offered on equal terms to foreign companies. This could create a disincentive for developing national innovation policies, by opening up for 'policy free-riding' on innovation support measures elsewhere. Or it could open up for a 'war of innovation policies' if such regulations allow locational requirements, where generous measures, as well as the quality of innovation services provided are primarily intended to attract companies to locate in Norway, and not as support for domestic firms.

On the other hand systems like WTA/WTO should not be taken for granted. The recent Seattle ministerial may have suggested some of the problems the WTA/WTO system may face in the future. Economic history has already given us examples of large free-trade systems collapsing and the industrialised world reverting to protectionism. But with present levels of international trade and national patterns of industrial specialisation the economic consequences would be substantially more severe.

Corporate governance and regulation

Increasingly innovation policies are focussing related to corporate governance. It is to be expected that this focus will be a prominent one over the next decade. The relation between systems of corporate governance and innovation are complex (see f.i. Lazonick and O'Sullivan (1998)) and it is difficult to see what the effects of this increased focus will be on innovation policy priorities.

Three issues here are

- the role and regulation of financial vs. industrial corporate investments, national vs. foreign ownership and capital markets for corporate investments
- altered regulation of corporate ownership
- economic and other regulation and innovation, including the practices used in competition policy vis a vis its impact on innovation

New knowledge infrastructures?

The knowledge economy argument that is now frequently used has one important consequence. Part and parcel with the ongoing structural changes with increased use of knowledge intensive inputs from private market suppliers (consultants, equipment suppliers, etc.) is a process of fundamental changes in the appropriability of productive knowledge and consequently the emergence of new categories of private 'knowledge' markets (see f.i. Hauknes (1998b) and Hauknes (1999)).

This has substantial consequences for the role and impact of the innovation infrastructure policies. These policies have in the post-war period been strongly based on a 'knowledge as public good' approach. New private systems for generation , diffusion and use of productive knowledge will be a challenge to these policies and to the infrastructures.

In some instances policy initiatives have been devised that in fact reflect these trends, such as the BUNT programme and its various derivatives. Today it is not unusual for public agencies like SND to direct applying firms to f.i. private consultancies. These explicit 'market building' efforts of innovation policies may be particularly important as SME oriented initiatives, see Teubal (1996).

Prolonging the trend since the 1980s of increased reliance on market based supply also of social services, a consequence could be a privatised innovation policy; an innovation policy where policy initiatives were limited to 'neutral' funding and the infrastructure was fully privatised. As long as firms are able to express their demand for innovation services it is not the function of public instruments to supply these when 'productive knowledge' is a private good.

These trends raises the issue of information asymmetries on these markets, particularly prominent on markets with a large share of SME customers. The implied need of public regulation through signalling measures, such as certification, has already been pointed out, Hauknes (1998b).

Post-petroleum Norway

Related to this is of course the central issue of how industrial innovation policies can proactively prepare for the situation when the industrial activities in the offshore sector enters a declining phase, and ultimately when the production of petroleum resources will have reduced economic importance, either because of physical depletion of resources or through economic depletion through reduced or vanishing demand for petroleum based energy resources.

As far as we can see there are still no signals of any policy reorientation in these areas to approach these issues. Related to this is the issue of the management of the Petroleum Fund. The fund is still treated mainly as a financial asset, and there has been little consideration for how the financial assets may be transformed into industrial assets. The dilemma with use of the fund is as is always pointed out by the Finansdepartementet, its effect on aggregate demand.

A large scale fire-killing policy effort is probably not likely. This is partly based on the disillusionment from the experiences of the hovedinnsatsområdene and initiatives such as the crash restructuring programme for the agrofood sector in 1994-95. Even though the agrofood initiative suggest the political willingness to tactical redefinitions of the neutrality principle, large scale restructuring initiatives will at least be faced with considerable challenges to circumvent this principle.

After ICT?

As we have seen an ICT focus have been strong and long lasting in the innovation policies of the period since 1980. Ten years from now this may prove to be a very passè innovation policy. The productivity and organisational impact of introduction and use of ICT have been fully reaped, and ICT being a mature technology by then, it proved to be a level effect in productivity growth, rather than an effect on growth rates. Thus after the extended transition period, productivity growth will revert to its underlying ‘normal’ rate.

The relative success of this focus of ICTs would then inspire to look for new foci to replace ICT as drivers for transitions to new regimes. Is it time now for biotechnology?

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STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.