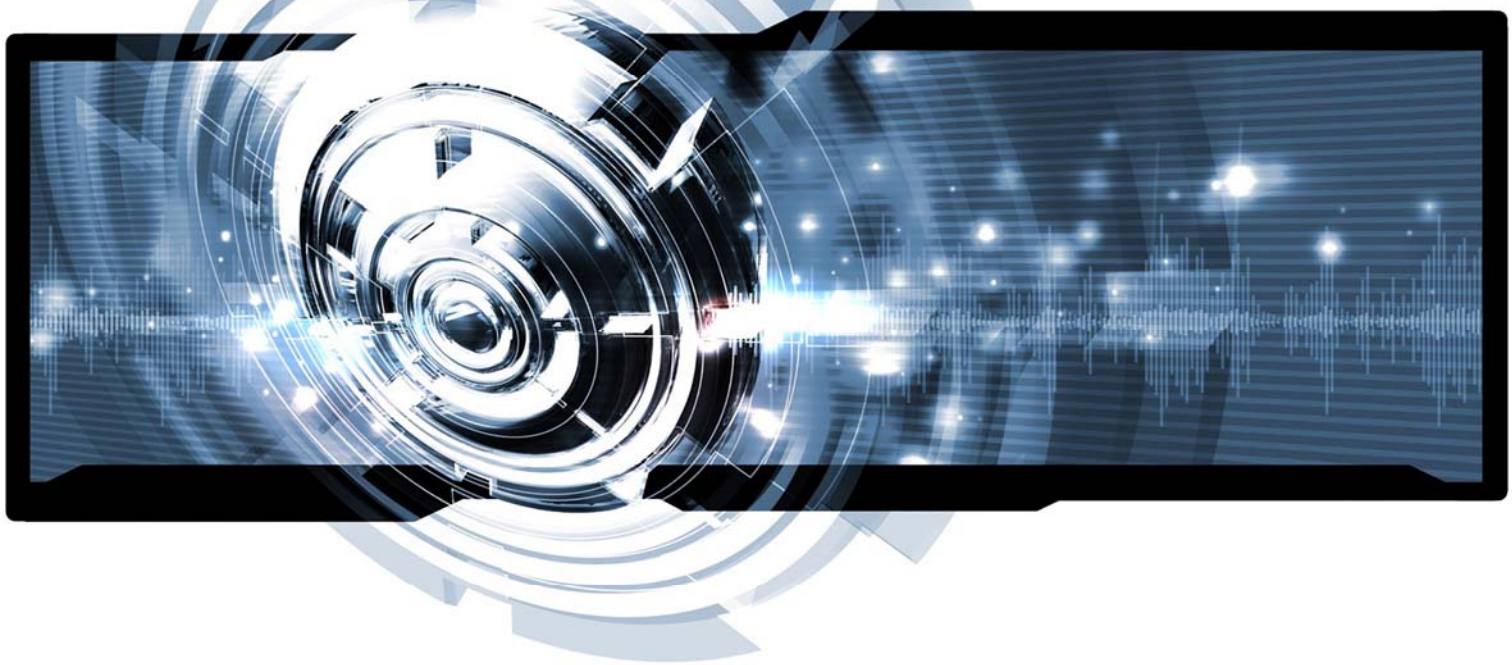
Towards a new growth and innovation policy in Norway



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Towards a New Growth and Innovation Policy in Norway

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PREFACE

The Norwegian Government has just released a Plan for a Comprehensive Innovation Policy. The plan is the Government's first step towards a comprehensive innovation policy. The work in the months and years to come will have to build on high quality foundations. It is our hope that this report will help us in doing so, and that it will provide us with some good and thought-provoking analyses and policy-recommendations in relevant fields for innovation policy.

During the writing of the plan many organisations, researchers and public institutions have contributed constructively, and we have learnt that a good innovation policy is not made or implemented overnight. Innovation – as a key driver to productivity growth – is influenced by a long list of policy areas which have to be consistently designed.

A comprehensive innovation policy is a necessary response to the challenges Norway is facing in the future. While more standardised production moves to and evolves in low cost-countries, high-skill and high-cost countries like Norway will mainly find business opportunities in innovative and knowledge intensive industries. At some point in time, the Norwegian petroleum sector will contribute less to industrial development and national income than today. At the same time expenditures on public health and welfare services are expected to rise.

These challenges are accentuated by observations of decreased competitiveness and relatively little innovation in the Norwegian economy. Clearly, there is a need for action. Through new insights and a comprehensive approach to innovation, we will create a better environment for long-term sustainable growth.

Ansgar Gabrielsen
Minster of Trade and Industry

TOWARDS A NEW GROWTH AND INNOVATION POLICY IN NORWAY

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Norway has recently taken decisive steps towards designing and implementing an ambitious reform agenda in support of innovation and long-term economic growth. Given ongoing fundamental changes in technologies and markets, in any country, innovative performance is now dependent on interactions and learning processes that involve multiple players within an economy as well as with the rest of the world. This report underlines the importance of adopting a systemic approach to innovation policy, which is able to span and combine reforms in a number of areas.

Adopting a comprehensive policy agenda for fostering innovation requires a strong mandate from the highest level of policy-making. At the same time, the task of building a more innovative society cannot be engineered from above. The key task is to cherish institutions, incentives and attitudes that are consistent in allowing societal actors and stakeholders to engage in innovative efforts. The present line-up in Norway of a process initiated by the Prime Minister, co-ordinated by the Minister of Trade and Industry, and encompassing a team of nine ministers appears to account for strong leadership. At the same time, the effort must transcend and effectively involve other key stakeholders, including the private sector, the unions and civil society. This will be crucial for ensuring relevance in proposed measures, as well as for putting in place a meaningful implementation process.

The Norwegian economy displays great strengths but also distinct weaknesses. The country belongs to the richest and most stable in the world. It is one of the most highly educated and equitable with strong social protection and high levels of transparency, and unemployment rates are among the lowest. Yet, there is a growing dependency on oil revenues and a risk of dangerous complacency. Under the pressure of high costs and, until recently, high interest rates, a far-going rapid tilt has taken place away from manufacturing towards public and private services. There are sizable investments in education but the highly educated mainly seek employment in the public sector, whereas the knowledge base in natural science and engineering is weak. Compared to the size of the economy, expenditures on R&D are relatively small. There are modest regional income differences but transport and logistics infrastructure is inferior and competencies for cultivating unique assets locally are insufficient. Norway is marked by modest flows of foreign direct investment, significant parts of the economy are sheltered from foreign competition, and there is limited international mobility of skilled workers. Norway appears less plugged into the rapidly expanding international knowledge flows than some comparable countries.

Further, the preparedness of individuals to experiment and take risks is hampered by the presence of a generous welfare state and ample career opportunities in the expanding public sector. Entrepreneurship accounts for relatively weak contributions to growth and employment and technology-based high-growth firms are rare. There is significant public

intervention in resource allocation and limitations in seed funding and venture capital markets, impeding driving forces for restructuring and renewal. Even though unemployment rates are low, a significant share of working-age population is on sick leave or prematurely retired which, coupled with the ageing population, will eventually put the pension system under pressure. As the oil-revenues will continue to contribute mightily to the economy for years to come, however, there is no immediate crisis. Yet, the ongoing structural shift and public sector expansion are unsustainable, whereas the oil-fund returns currently are used for propping up an increasing budget deficit rather than supporting investment in future capacity.

Since a number of years, Norway has had a policy-focus on raising R&D to a level that matches that of virtually any other country. While there has been limited success thus far the initiatives commenced in the last few years are viewed as promising and pointing in the right direction. At the same time, Norway should now review its target for reform. The public sector already spends relatively extensively on R&D whereas it is the private sector that displays scant expenditures in international comparison. Given the structure of the economy, Norway can hardly be viewed as under-investing in R&D compared to other countries. Still, the country crucially needs to strengthen its performance in innovation. Effective policy measures fostering a greater R&D-effort do constitute a vital element of a comprehensive approach by Norway to enhance long-term growth. Both direct and indirect support of R&D has an important role to play and should be actively pursued while ensuring an appropriate balance between the two kinds of measures. Above all, however, policies encouraging R&D must be complemented by reforms in a number of other areas that represent critical enabling conditions for innovation.

The report finally points to six challenges on which the Government is recommended to push for further improvements. Specific proposals for action are presented in the last chapter.

Challenge no. 1:
The government should formulate a target for a comprehensive innovation policy that is realistic and meaningful. The goal should be worked out in collaboration with the main stakeholders so as to make them engaged and committed to contributing to its fulfilment. There should be sensible sub-targets, and realisation of the objective should be possible to verify.

Challenge no. 2:
The government should address factors in the educational system limiting human capital accumulation in support of innovation.

Challenge no. 3:
In order to improve conditions for high-tech and fast-growing new firms, the government should strengthen mechanisms for the allocation of seed and venture capital.

Challenge no. 4:
The government should adopt an agenda for promoting participation and life-long learning in the work place.

Challenge no. 5:
The government should strengthen local competencies and processes conducive to innovation through selective decentralisation, while also promoting more internationally oriented innovation strategies.

Challenge no. 6:
A public-private partnership programme combining research, innovation and technology diffusion should be developed, drawing on established strengths in selected industries where resources and network capabilities account for critical mass. Oil, marine industries, and metals present important opportunities.

CHAPTER ONE
INTRODUCTION[1]

Norway today belongs to the richest and most stable economies in the world. While there are several reasons for this strong performance, it is to some extent driven by non-sustainable revenues generated by extensive natural resource-based production, especially in the petroleum sector. Apart from their benefits, however, these revenues also bring high cost levels and pressures on the economy as a whole. More subtle than that, they influence the mindset and attitudes of Norwegians, with tangible and long-lasting consequences for society.

It is greatly important for Norway to capitalise on its present strength by building a basis for sustainable long-term growth. An important part of the answer how to do so must entail the establishment of institutions and the implementation of policies that are conducive to *innovation*.

The Norwegian situation must be seen in an international context. Over the last decade, a number of structural and macroeconomic changes have become associated with the rise of a new era, popularly labelled the "new economy", or the "knowledge-based economy". The following trends form part of this picture:

- Continued internationalisation, or "globalisation", in the form of greater cross-border trade and, in particular, significant increases in foreign direct investment (especially through mergers and acquisitions) coupled with strategic alliances and other forms of networking (UNCTAD, 2002).

- A rapid structural shift from manufacturing to services, with high reliance on intangible assets, paralleled by a blurring of traditional sectoral barriers as goods and services are becoming integrated in high-value bundles of products.

- Enhanced investment in ICT (information and communications technology), especially in the United States but also in other countries during the latter part of the 1990s, and declining costs of diffusing and using information, notably over the Internet and through cellular exchange (ITU, 2002).

- Expanding generation and transmission of scientific and technological knowledge (World Bank, 1999/2000; Commission, 2003).

[1] Substantive input from Håkan Gergils, Ecofin, is gratefully acknowledged. The authors are thankful for comments by: Per Foss, Amersham Health AS; Truls Mølmann, Barlindhaug Consult AS; David White, European Commission; O. Henrik Akeleye Braastad, Innopol; Svein Fjellheim, LO Rogaland; Bjørn Haugstad, Ministry of Education and Research; Morten Berg, Helle Hammer, Kjerstin Spjøtvoll, Vincent Wego Fleischer, Ministry of Trade and Industry; Tove Normann and Sture Pettersen, Nasjonalt Senter for Telemidisin; Bjørn Stangeland, NHO Rogaland; Hans Skoie, Norwegian Institute for Studies in Research and Higher Education; Jarle Moen and Erik Vatne, Norwegian School of Economics and Business Administration; Olav Spilling, Norwegian School of Management; Erik Sandvold, Norsk Hydro Aluminium; Sigmund Waagø, NTNU; Stig Remoy, Olympic Shipping; Jan Lunde, Pan Fish; Kari Kveseth, Erik Skaug, Morten Staude and Jon Hekland, Research Council of Norway; Tor Clausen, Rogaland Research; Per Heum, Sammfunns- of Næringslivsforskning AS; Egil Ove Sundheim, Seafood Norway; Morten Loktu, Jann Langseth, Gunnar Sand, Håkon Finne, SINTEF; Per Stole, SIVA; Ådne Cappelen and Torbjørn Hægeland, Statistics Norway; Eric Iversen, Per Koch and Svend Otto Remøe, STEP Group; Magnus Henrekson, Stockholm School of Economics; Arnfinn Ingjerd, Ullstein Rolls Royce; Bjørn T. Asheim and Lars Oxelheim, University of Lund. Colleagues at IKED are thanked for input, and notably Jerry Johansson for data compilation.

- A rapid expansion of venture capital markets and patenting activity, especially in ICT and biotechnology (OECD, 2003*a*).

- Less convergence and more divergence in growth rates among countries, coupled with a tendency towards greater income differences within countries (Fagerberg and Verspagen, 1996; Arjona et al., 2001).

- A trend towards enhanced TFP-growth[2] in economies at already high levels of economic and technological sophistication (OECD, 2001*a*).

- Apparent changes in price dynamics, including strong growth without upward inflationary pressure late in the cycle at high levels of capacity utilisation and at unemployment levels below what had previously been viewed as compatible with price stability.[3]

The idea, cherished at the turn of the millennium, that a shift would have commenced towards countries attaining a permanently higher trajectory of economic growth, has faded. In reality, not even the peak of the "new economy" in the late 1990s saw any general trend across countries towards higher productivity growth compared to the previous decades. On the contrary, productivity growth has been on a downward trend over the last decades. In the last few years, the steep recession shattered any beliefs that the business cycle would have come to an end, and forced a consolidation especially of the technology sector around the world.

A complicating aspect, however, is the expansion of the service sector as well as that of the public sector, coupled with shortening product cycles and rapid quality improvements, which makes productivity measurement increasingly difficult. The fact remains that the last decades have seen a consistent tilt towards higher technology- and skill-content in international trade and production. In particular, ICT stands out as important for the changes in growth patterns that have taken place. Although it has taken time to reconcile seemingly contradictory observations at micro, sectoral and aggregate level, and opinions still vary on its relative importance, the evidence has continued to accumulate during the economic downturn on the significance of this factor.[4] Gradually, attention has shifted away from the production of ICT towards its use, and how ICT is embedded in the advance of other technologies and economic activities. The rate of success in the use of ICT is interrelated with the extent to which societies are prone to cherish new ideas, ventures, and ways of doing things. This has contributed to bringing innovation into the limelight.

[2] Total factor productivity (TFP) is the share of productivity that cannot be ascribed to individual production factors, such as labour or capital. TFP reflects the overall effectiveness with which these are used and is influenced by technical progress, organisational changes, and new ways of doing things. At the same time, TFP takes the form of a residual, i.e., it contains what cannot be explained by other factors. Correct consideration to, e.g., natural resources can be crucial for TFP-estimates in countries where they play an important role, such as in the case of oil extraction in Norway or fishing in Iceland. Another difficulty is the estimation of the capital stock. In the OECD growth project 1999-2001, alternative estimations of TFP were carried out for the purpose of enhancing comparability and clarifying sensitivity to key assumptions. Similar estimates have been produced based on IMF-data (OECD, 2001*a*; Haacker and Morsink, 2002). Nevertheless, international comparisons in this area must be treated with caution.

[3] This may be put as whether any permanent change has occurred in NAIRU (the Non-Accelerating Inflation Rate of Unemployment).

[4] See Jorgenson and Stiroh (2000), Council of Economic Advisors (2002), and OECD (2003*b*) for evidence on impacts. Gordon (2000) and Smith (2002) provide examples of a sceptical stance.

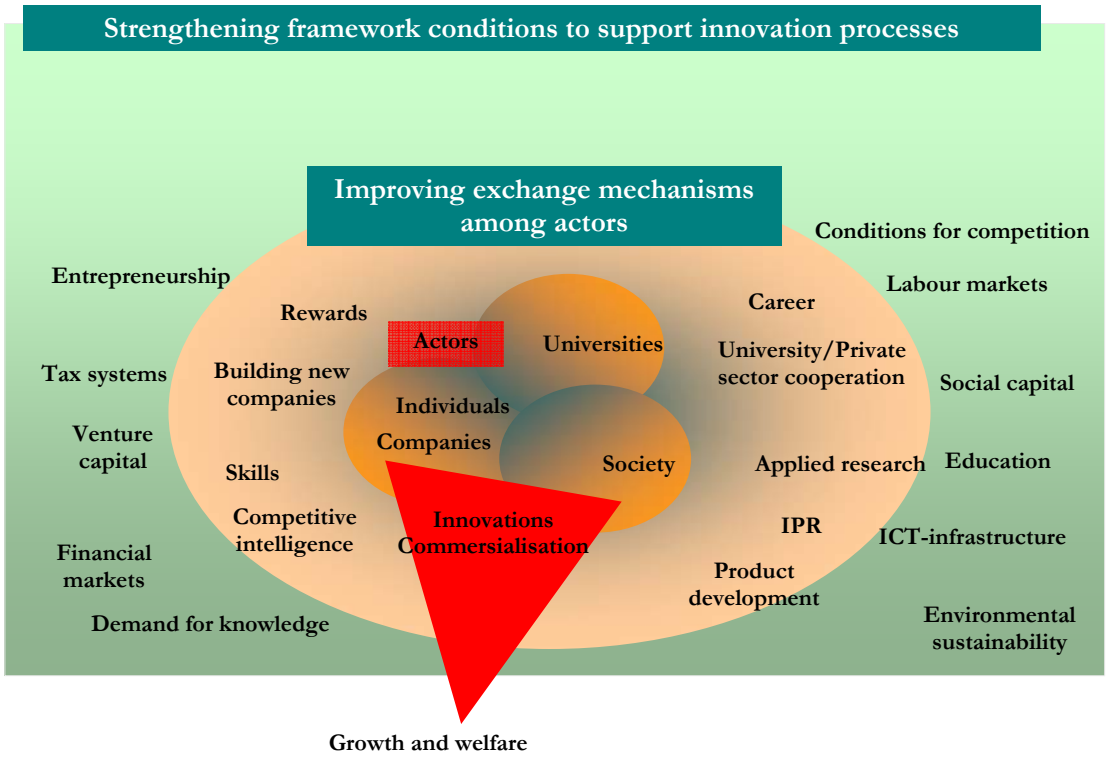
Innovation may be defined as the development of new, commercially relevant products or processes. Traditional perspectives have viewed innovation as closely related to science and technology. In practice, however, innovation can take many forms, including commercialisation of science and technology as well as the development and implementation of new ideas more generally, as in the form of organisational change or inventing new ways of doing things. This applies to services where innovation tends to draw less on science and research than is the case in manufacturing although, for instance, putting new communication tools to new use represents one important source. Innovation is thus the key not only to economic progress, but also to identifying new solutions to pressing social issues, such as an ageing population or environmental degradation. Innovations may be categorised in different ways, including product and process innovations, despite there being no clear-cut dividing line between the two.

It should be emphasised that innovation must not be conceptualised as a one-dimensional, linear process leading from certain input factors. Innovation is the result of efforts by multiple actors, and is enhanced by their constructive interactions. No single actor generally manages all the skills that are useful but complementary competencies are crucial, as is continuous exchange of impulses from both the supply and the demand side. For each of the actors involved, the efforts or investments required for innovation are risky or subject to genuine uncertainty, and outcomes will depend on so many factors beyond the control of the individual actor. Fostering conditions that are favourable to innovation in a particular society may require reforms in a number of areas.

Figure 1 provides an illustration of innovation as the result of efforts made by *actors* in the form of individuals, firms and organisations. Their behaviour and the innovations they pursue are influenced by exchanges among them, and, at the same time, by broader societal and economic factors placed in the outer circle of the figure. The term "innovation system" has emerged to capture the interrelated role of different actors, markets and institutions (Freeman, 1987; Lundvall, 1992; Edquist, 1997). The concept is relevant at national as well as local and international levels. Rather than depicting a static structure, it aims to capture the significance of interactions evolving over time. With the expansion of ICT and the associated marked decline in the costs of diffusing and accessing codified information, there is a greatly enhanced potential for intensive interactions in innovation systems, leaping in both directions between the "push" of new technologies from the supply side and the "pull" for new solutions from the demand side. However, traditional structures and rigidities continue to stifle many new opportunities.

As in the case of ICT, there is fairly strong evidence for causal impacts of innovation, and/or R&D, on economic performance at the level of firms and industries. Impacts are typically recorded in terms of productivity, sales or employment. At aggregate level, it has proven more difficult to nail down systematic evidence of impacts (Commission, 2001*a* and 2001*b*). There is no simple correlation between innovation and GDP, but significant effects have been demonstrated on the composition of growth. There is indeed ample evidence that R&D tends to generate social returns exceeding the returns accruing to the individual investors, resulting in "under-investment" by market forces alone. The overall impacts of R&D and innovation are, however, difficult to separate from those of other confounding variables, or *enabling* conditions which need to be in place if potential benefits are to be realised. For instance, the observed tendency in the late 1990s of a markedly stronger contributions of labour-productivity and TFP to overall

Figure 1: Framework conditions



Source: Andersson et al. (2002).

productivity growth in a limited number of the most developed countries has been related to R&D in combination with other factors (Bassanini et al., 2000; OECD, 2001*a*; Nicoletti and Scarpetta, 2003).

Several countries have taken decisive steps during the last decade to put in place a more consistent policy framework for innovation. Experience shows that, in most cases, a sense of crisis is decisive for building the political support required for the adoption of a comprehensive innovation policy agenda. Moreover, support from the highest level of policy-making appears to be a prerequisite for success. A clear signal from the "top" may be necessary for line-ministries and public authorities traditionally organised and administrated for the sake of fulfilling autocratic functions, to adopt a favourable position on letting loose initiative and creativity from "below". Among relevant experiences are the innovation- and ICT-related structural reforms given high priority in Korea, Thailand and other shaken "Asian Tigers" in the wake of the Asian financial crisis in the late 1990s. As part of the Lisbon process, the European Commission has launched an ambitious agenda for measuring the impacts and determinants of innovation in individual European countries.[5] Among the Nordic countries, Finland was most severely hit by the economic downturn of the early 1990s and subsequently the most effective in reforming a range

of policies so as to enhance flexibility and technology-led industrial renewal. More recently, in 2002, the Swedish government launched a critical review of a range of policy domains, led by IKED, unravelling systemic weaknesses and inconsistencies that help explain why the country that invests the most in R&D has underperformed in economic growth for the last three decades.[6]

Norway, by contrast, always had a less developed industrial sector, and its R&D efforts have been consistently lower than that of Sweden and most developed countries. Since the Second World War, the Norwegian government has actively promoted industrial development as well as R&D. The incumbent Prime Minister at that time, Einar Gerhardsen, strongly advocated a technology-driven policy for industrial renewal led by the state in close cooperation with academia and industry (Ørstavik, 1999). A report launched by the Lied Commission in 1979 concluded that it was not possible for the state to pick the "National Champions". The government acknowledged that industry needed to grow independently and that Norway could not rely solely on oil revenues in the future. For 30 years there has been an increasing determination in Norway that the industrial sector must be strengthened linked with a perception that a greater R&D-effort by enterprises is an important instrument to achieve success in this respect.

In 1999, the Norwegian government formulated, partly in response to the Lisbon strategy of the EU, an explicit policy objective to raise R&D intensity to the OECD average. This amounts to an increase from 1.6 % of GDP (in 2001) to 2.2 % by 2005, and a further increase to 3.0 % by 2010. There are questions, however, whether this is a meaningful objective, as well as whether it can be achieved. It is clear that higher R&D-intensity in itself is not enough to solve Norway's problems. On the initiative of the Prime Minister, Mr. Bondevik, the Norwegian government decreed on September 29, 2002 that an action plan for a comprehensive innovation policy in Norway would be developed. The resulting plan, presented by the government in November 2003, took stock of the factual situation and made recommendations in selected areas for the purpose of augmenting innovation in the business sector. Targets for policy-making were identified as well as a structure laid out for the purpose of enabling effective evaluation of the degree to which the targets will be met over the coming years (Ministry of Trade and Industry, 2003*a*). The government thereby reinforced its ambition to put in place a comprehensive innovation policy that can help spur growth in Norway as a whole.

The Minister of Trade and Industry was assigned the principal responsibility for preparing the plan – in close cooperation with the Minister of Education and Research, the Minister of Local Government and Regional Development, the Minister of Petroleum and Energy, and the Minister of Agriculture. The following specific areas were addressed in some detail:

- General framework conditions for business
- Knowledge and competence
- Research, development and commercialisation
- Entrepreneurship (including conditions affecting start-up rates and behaviour)
- Infrastructure (electronic and physical)

[5] See, e.g., Commission (2002*a* and 2002*b*).
[6] See Andersson et al. (2002).

Within each identified theme, groups entailing government officials from different ministries were set up. Each working group was assigned the task of presenting specific recommendations for its subject area. The preparations by IKED of the current report provided further background information and input to the process although, as should be stressed, the present report was prepared independently and its conclusions may not reflect the positions of the Norwegian government.

Hence, the government document "From Idea to Value: The Government's plan for a Comprehensive Innovation Policy" (Ministry of Trade and Industry, 2003*a*), and this report, follow to some extent a similar set-up. The report does not represent a traditional research paper, penetrating an individual issue in great detail or benchmarking the Norwegian position versus other countries on the basis of precise parameters. Rather, it forms an analytical and empirical review and synthesis of observations related to innovation across a range of areas where important questions regarding prevailing policy conditions arise. Based on this survey across a number of domains, using international comparisons where constructive, the report tries to distil *overriding priorities* for a Norwegian reform agenda in support of long-term economic and social well-being. No country can attempt to do everything. An effective reform agenda must focus on the most important issues and also be operational, meaning that it is designed in a way that allows it to be put into practice.

The project follows a period during which several important institutional and policy changes have already been made in Norway, including a reorganisation of the Research Council of Norway (RCN) and the regional councils, and the introduction of significant tax incentives for R&D. It is too early to evaluate the results of some of these changes, but they will be taken into account in the overall assessment of conditions for innovation. The next chapter reviews specific features of the Norwegian society and economy. Chapter 3 highlights outstanding issues across a number of relevant areas and Chapter 4 presents recommendations and conclusions.

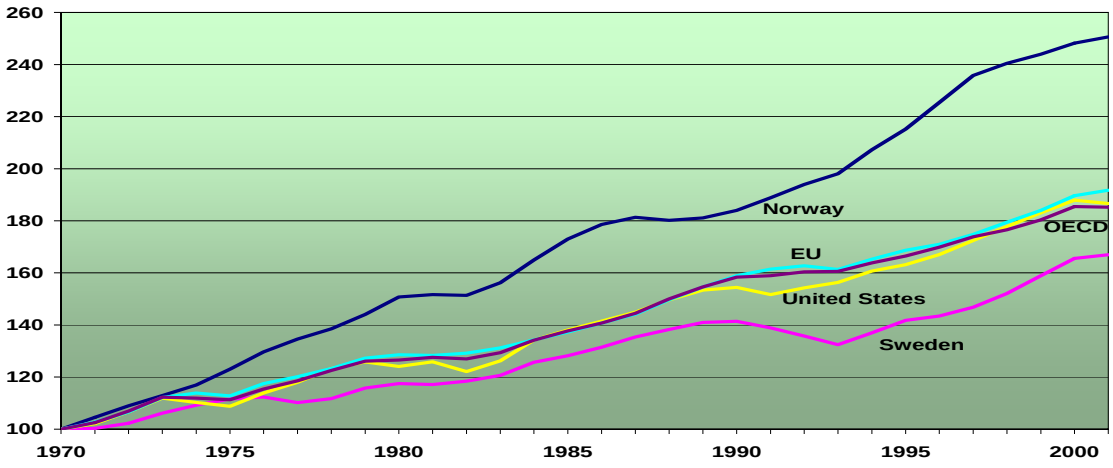
CHAPTER TWO

NORWAY'S SPECIFIC ECONOMIC AND SOCIETAL POSITION IN AN INTERNATIONAL CONTEXT

The discovery of oil and natural gas in the North Sea in the 1960s, and their subsequent production and export, have brought considerable prosperity to the Norwegian people. With a continental shelf that is four times larger than the mainland, Norway sits on half of the remaining petroleum reserves in Europe and now ranks as the world's third largest exporter of crude oil after Saudi Arabia and Russia. Petroleum activities play a substantial role in the economy. The industry today accounts for 20 % of the nation's income, 42 % of the value of total exports, 40 % of total investments and 12 % of overall value creation. More than 80 000 people – 3 % of the labour force – are directly employed in the industry and a further 220 000 – 7 % - are occupied in activities related to the industry. As for the coming years, the Oil Directorate aims to increase the average extraction rate from today's 44 % to 50 %.[7] In the best case scenario, oil will last 50 years and gas up to a century. In the so-called decline scenario, oil output will practically end in 2020. Measured in economic terms, up to year 2050, there is a difference between the two scenarios of 2000 billion Norwegian Krona in value created (NOK) (Ministry of Petroleum and Energy, 2002).

Apart from the contributions of oil and gas, a number of fundamental strengths mark the Norwegian society. It is one of the most highly educated and equitable in the world with strong social protection and high levels of transparency, and unemployment rates are among the lowest (NOU, 2001). Viewed over a longer period, Norway has displayed high growth in international comparison (Figure 2). In terms of GDP per capita and, especially, per hour worked, it is one of the richest countries in the world (Figure 3). Its citizens enjoy some of the highest social welfare rankings measured in terms of average life span, environmental quality, social cohesion, and low levels of criminality, among other things.

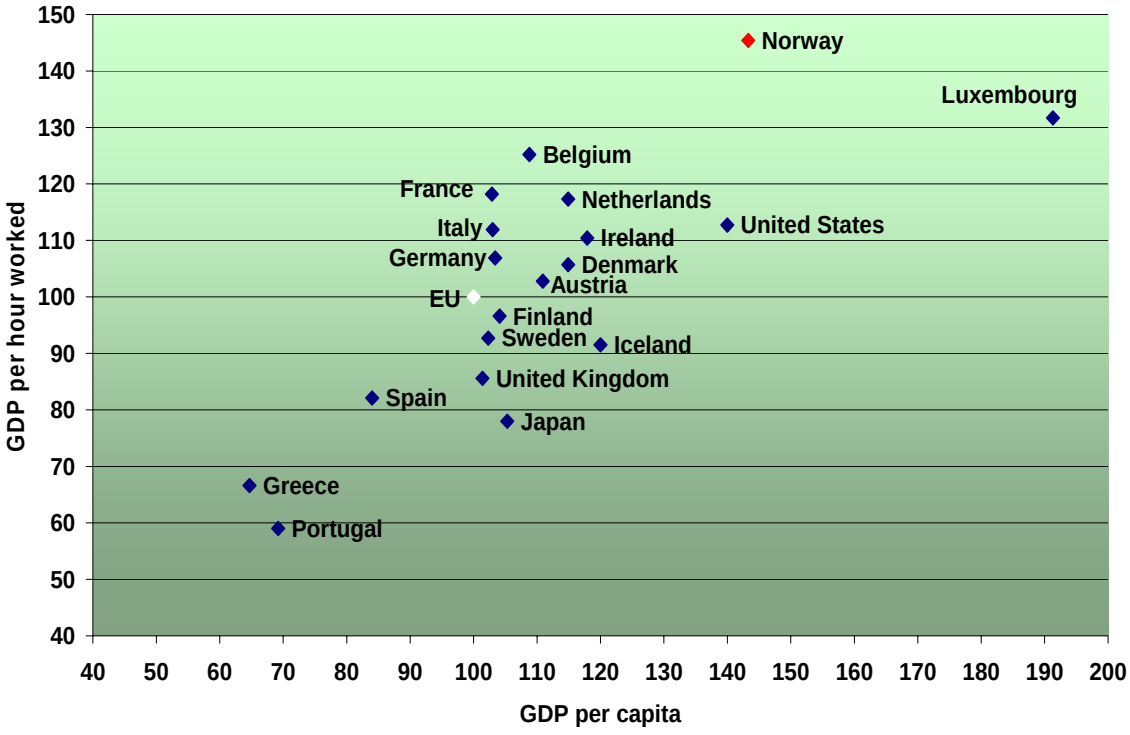
Figure 2: Long term growth*, 1970 - 2001 (1970=100)



*Based on GDP per capita (US$ 1995).
Source: OECD.

[7] The Research Council believes in an extraction rate of 60 % within 5-10 years.

Figure 3: GDP per capita and GDP per hour worked, 2001 (EU=100)



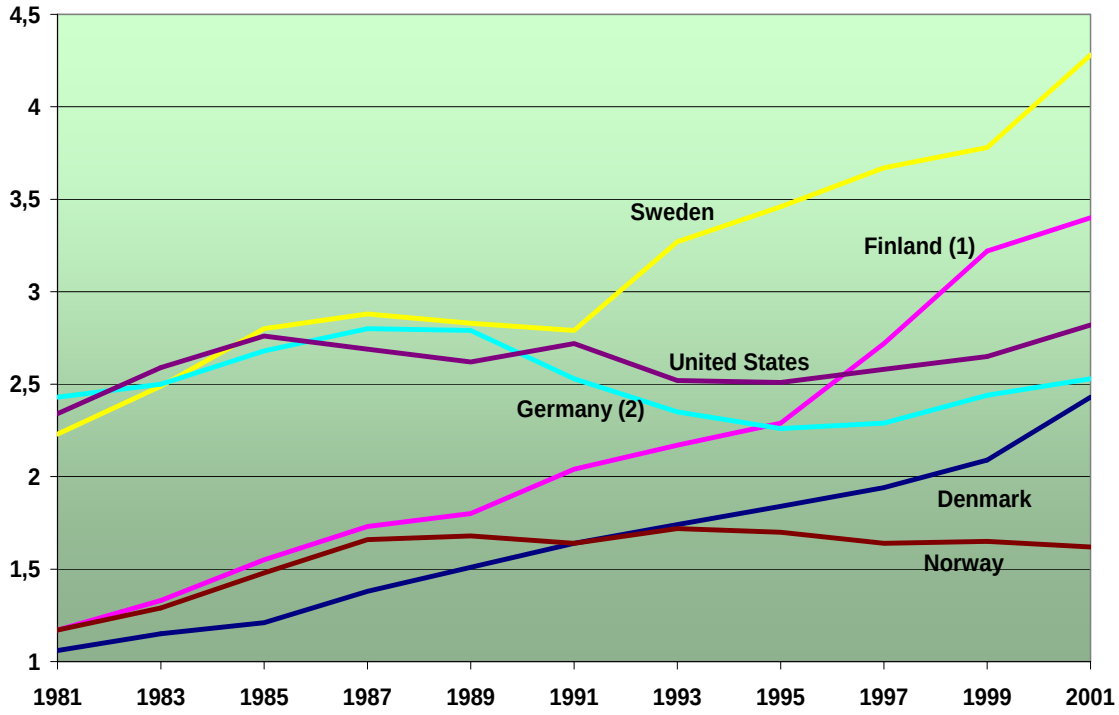
Source: Eurostat Structural Indicators.

Further, Norway is among the leading countries in terms of ICT-penetration: Cellular phones, PC and Internet users per capita (International Telecommunication Union, 2002). The ICT-service sector, driven especially by ICT consultancy services, is more important for the Norwegian economy than ICT-manufacturing (Statistics Norway, 2002*a*; Nordic Council of Ministers 2002). Compared to the other Nordic countries, Norway lags somewhat behind as regards importance of ICT for employment and turnover.

At the same time, several observations regarding Norway's knowledge-related assets, economic structure and growth trends give rise to concerns. In recent years, Norway experienced diminishing economic growth under conditions of high capacity utilisation and weak labour supply. In aggregate, R&D expenditures amount to 1.6 % of GDP, which is well below the OECD average. In fact, as seen from Figure 4, the R&D-intensity has been consistently low for a long time. Further, the science base displays weaknesses as do the patent record, at least compared to the other Nordic countries, although an improvement in the latter was recorded at the European Patent Office in 2001. Further, Norway is not as plugged in to the expanding networks of international knowledge exchange in terms of investment, technology diffusion and people as are most other countries at comparable income levels. Skills in science and

engineering are on the wane, and there are low levels of mobility of skilled labour from research to industry. Surveys tend to show a modest level of innovativeness in Norway's industrial sector (Statistics Norway, 2003*a*).

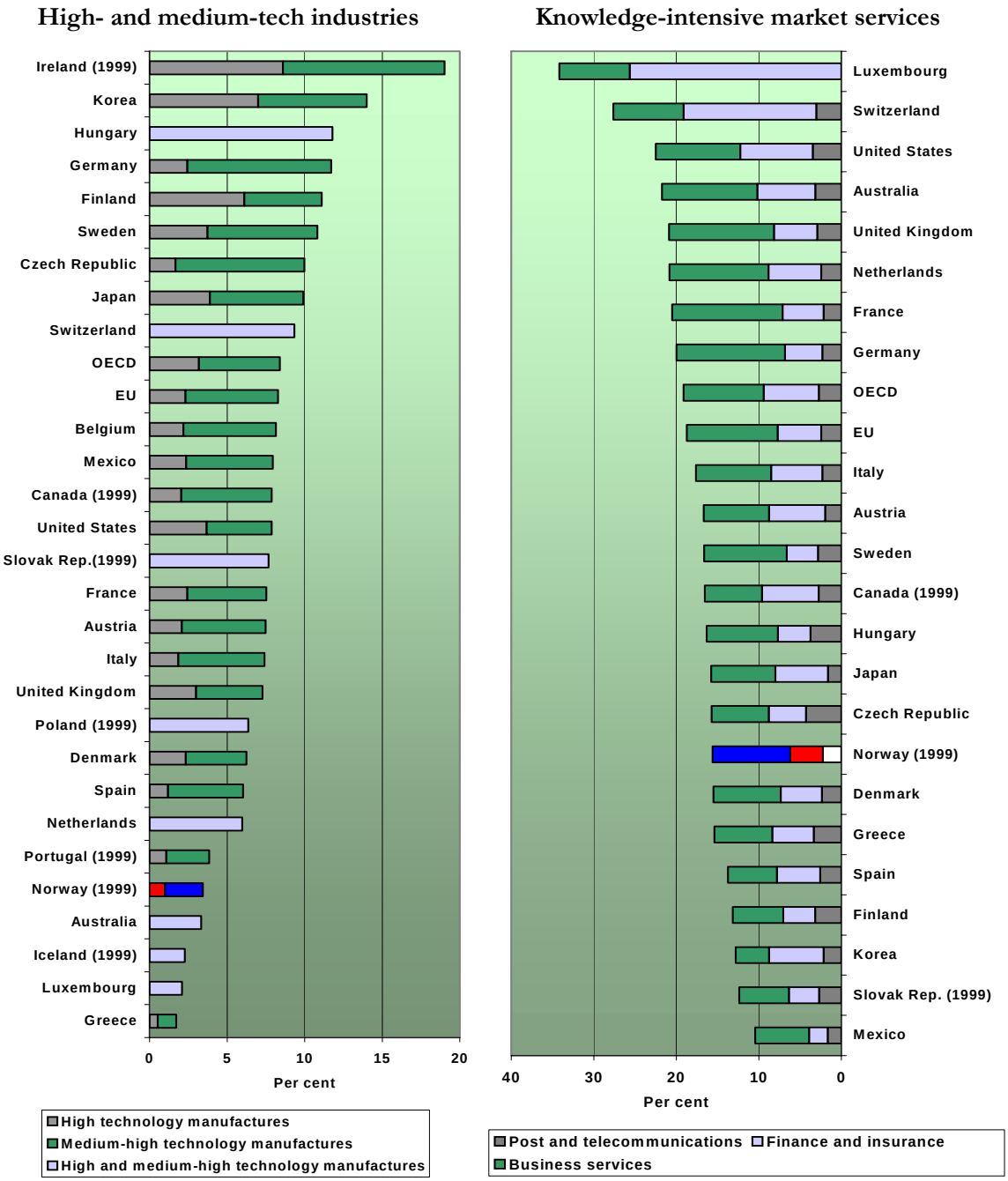
Figure 4: Semi-annual R&D expenditures in percent of GDP, 1981-2001*



1. Estimated value for Finland 2001.
2. West-Germany up to 1991.
Source: NIFU.

In fact, Norway is one of the few advanced countries that have not seen a tilt towards relatively knowledge-intensive industries over the last decade (cf. Figure 5). The high-tech sector is small in international comparison, and displays limited intensity of international exchanges in terms of trade, investment, and human capital (OECD, 2002*a*). Only in a few natural resource-based industries can Norway be characterised as a leading industrial power, notably in petroleum, aluminium and marine industries, including fish farming. Although typically characterised as capital-intensive rather than knowledge-intensive, advanced use of ICT, biotechnology, new materials, and other advanced technologies still play a key role in these natural-resource based industries.

Figure 5: The share of knowledge-intensive industries in GDP, 2000



Source: OECD (2003*a*).

The most obvious concern is that manufacturing as a whole appears to be losing competitiveness quickly. Although the weight of manufacturing is on the decline in all OECD countries, Norway is alone in experiencing an actual decline in total manufactured output. Only because output has fallen less than the number of hours worked, there has still been a certain productivity increase per hour worked in recent years. Meanwhile, mainland business investment has dropped significantly, despite heavy investment in the aluminium industry, reflecting weak demand and lower profit for Norwegian industry. These developments show up in international benchmarking indices, which have consistently reported declining competitiveness for mainland Norwegian industry since 1995. Domestic indicators reported a cumulative deterioration of 7 % between 1995 and 2001, the Commission 15 % (Commission, 2002*a*), and the OECD 24 % (OECD, 2002*a*).

Disaggregation of the manufacturing sector shows that publishing and printing, and food products and beverages have demonstrated particularly weak productivity growth. These two sectors are subjected to low levels of competition, for which trade barriers play a significant role. On the other hand, sectors that account for a considerable part of manufactured exports, e.g. chemicals, wood products and computer- and office-equipment, displayed high productivity growth. A problem is the low rate of restructuring within manufacturing from more productive to less productive segments, which seems to explain part of the productivity gap in Norwegian manufacturing relative to that of Sweden (Boug and Naug, 2001).

Conversely, a look at the private mainland sector in its entirety shows high growth during the 1990s in both labour productivity and TFP (Table 1). In this context, a different feature should be stressed, namely the weight of services in the mainland economy. Advantageous technological and organisational changes in, e.g., financial services, retail trade, and postal services, have contributed to the strong services performance (Ministry of Finance, 2003, Statistics Norway, 2003*b*). Whereas some of these segments, such as finance and postage contracted in terms of employment, private services as a whole combined high productivity growth with employment expansion. Manufacturing, by contrast, has contracted since the 1970s in both respects, and now account for 9 % of value added and 13 % of employment. These figures are very low in international comparison.

The mixed private non-oil sector performance has been paralleled by rapid expansion of the public sector. Since 1980, it grew by nearly 60 % in Norway compared with 20 % in Denmark and no increase in Sweden during the same period (Centre for Economic Analysis, 2002). The public sector now employs one third of the Norwegian work force, which is one of the highest shares in the world, and it continues to expand (Ministry of Finance, 2003; Ministry of Labour and Government Administration, 2002). This means that, for the greatest part, the onslaught of the service economy has taken place within the public sector. Some employment in the private sector has clearly been crowded out by this development. For years ahead, according to present estimates, the natural growth of the labour force will be 60 000 up to 2010, whereas the public sector is reported to require 100 000 more employees. The long-term budget scenario to 2050, outlined by the Ministry of Finance, predicts an increase in public employment by some 20 % whereas the private non-oil central government balance will be minus 6-7 % for most of the period (Ministry of Finance, 2001).

Table 1: Average labour productivity growth and contributions from growth in capital, intermediate inputs and TFP[1]

Sector	Period	Labour productivity	Contribution from capital	Contribution from inter-mediate inputs	Contribution from TFP
Mainland Norway[2]	1973-1981	3.6	0.6	2.8	0.2
	1982-1988	2.7	0.3	1.7	0.7
	1989-1996	3.8	0.0	2.3	1.4
	1997-2002[5]	3.4	0.2	2.1	1.1
	2001-2002[5]	2.5	0.4	1.1	1.0
Industry[3]	1973-1981	4.1	0.3	4.1	-0.3
	1982-1988	3.7	0.2	2.9	0.6
	1989-1996	3.3	0.0	2.8	0.4
	1997-2002[5]	2.9	0.2	2.5	0.2
	2001-2002[5]	1.7	0.3	1.1	0.3
Other manufacturing	1973-1981	4.6	0.8	3.0	0.8
	1982-1988	3.7	0.3	2.6	0.8
	1989-1996	4.1	0.4	1.5	2.2
	1997-2002[5]	2.5	0.2	1.6	0.7
	2001-2002[5]	3.7	0.5	1.7	1.5
Private service sector[4]	1973-1981	3.0	0.6	1.9	0.4
	1982-1988	2.2	0.3	1.2	0.7
	1989-1996	4.1	0.0	2.5	1.7
	1997-2002[5]	4.4	0.3	2.4	1.7
	2001-2002[5]	2.7	0.4	1.0	1.2

1. Labour productivity is measured as gross output per hour worked as are the other input measures. Gross output based productivity measures differ somewhat from value added based productivity measures, often used in international comparisons. However, gross output based measures are better to use when measuring sectoral technical change (OECD, 2001*c*).
2. Excluding housing, banking and insurance, and oil refinement.
3. Excluding oil refinement.
4. Excluding housing, and banking and insurance.
5. Data for 2001 and 2002 are preliminary.

Source: Statistics Norway (2003*b*).

These growth patterns are related to high costs and historically high interest rates. According to the Bureau of Labour Statistics (2003), on a national currency basis, Norway had among the highest average percentage wage increases of all OECD countries in the manufacturing sector in the late 1990s. As hourly compensation grew more than productivity, unit labour costs increased in national currency units. Real wages, adjusted for taxes, increased by 5 % in 2002 (Ministry of Labour and Government Administration, 2003), which is the greatest increase in real wages since the 1970s, and at the top of the range worldwide (European Industrial

Relations Observatory, 2003). During 1998 to 2002, the annual wage increase was about 1-2 % higher than in other OECD countries. Norway has nevertheless managed to keep inflation under control[8], helped until recently, by the appreciation of the NOK and declining import prices. (Ministry of Labour and Government Administration, 2003).

While Norway has a low unemployment rate, including very low long-term unemployment, the labour market participation rate of the working age population is less impressive due to high levels of absenteeism through sick leave and early retirement. In addition, relatively liberal disability benefits and eligibility requirements induce a large share of workers not to fully participate in the labour market. At the same time, Norway faces a demographic trend similar in scope to that of many other developed countries with 13 % old-age pensioners and 46 % of the population above 40 years old. The health sector is one of the areas that display the greatest growth potential but is almost exclusively subjected to public administration and slow in responding to changing needs and opportunities. Overall immigration of skilled labour remains limited, although substantial in specific areas such as nursing. There is a large presence of foreign students in Norwegian schools and universities, though most are from neighbouring Nordic countries.

Shifting the production function is crucial to Norway, given its high cost levels, requiring the introduction of more innovative ways of working. Again, however, innovation is not a given. Among concepts that matter in this context are those of "critical mass" and "path-dependency", that is, industrial trends may hinge on the presence of sufficient complementary resources, exceeding certain minimal limits, and other aspects of current structures. Underlying this is the role played by economies of scale and scope in processes of learning and innovation (see Box 1). On this basis, R&D resources in Norway might be effective only in limited areas of relevance to current industrial strongholds. On the other hand, discrete shifts in industrial specialisation must not to be ruled out. Although the specific nature of such limitations is difficult to grasp, it remains greatly important to understand how available strengths, or lack of strengths, influence future development opportunities.

A comparison between the Norwegian and the Swedish situation merits attention. In Sweden, which invests more than any other country in the world in R&D (4.3 % of GDP as of 2001), there is an apparent paradox between exceptional strength on the input side and modest economic performance in terms of output. The Norwegian economy, by contrast, performs well as a whole despite low R&D intensity. In Sweden, the manufacturing sector has high productivity growth overall, although it expands primarily abroad through outward investment. In Norway, the private service sector records both strong productivity growth and employment expansion. Again, the country is evolving towards reliance on a combination of natural resources on the one hand, and public and private services on the other.

[8] The consumer price index (CPI) rose by 1.3 % in 2002, compared to 3 % the year before, which represents the lowest rate since 1996. Prices are estimated to rise 3 % in 2003.

Box 1: On critical mass

The concept of "critical mass" can be used with reference to various assets subjected to economies of scale and scope. There are many examples of cases in which "bundles" of resources or production factors can be seen to matter greatly. For instance, personal contacts and networks of researchers are known to be important for research-industry linkages (Siegel et al., 2002). One aspect is the decisive role played by a minimal concentration of workers, managers, experts, financiers, entrepreneurs, etc., that possess complementary skills. Another is the presence of "path dependency", suggesting that future industrial strongholds depend on what assets and skills are available today.

The features of "clusters" of co-located interrelated economic activities, displaying structural complementarities, have attracted attention in industrial organisation literature for more than a decade (Porter, 1990). Some of the interactions can occur over any distance and need not be confined to a particular country or territory. Others hinge on proximity, because markets and institutional conditions are geographically segmented to some extent, and because effective human interface is sometimes dependent on "tacit" knowledge and people sharing day-to-day experiences (Dei Ottai, 1994). A sufficient pool at local level of individuals with complementary skills may also be necessary for attracting new members to a team. For such reasons, a geographical concentration of activities may be crucial for "critical mass". R&D-intensive industries, for instance, tend to agglomerate geographically (Saxenian, 1994; Almedia and Kogut, 1997). There is also empirical evidence that such groupings tend to grow faster than the economy in general.

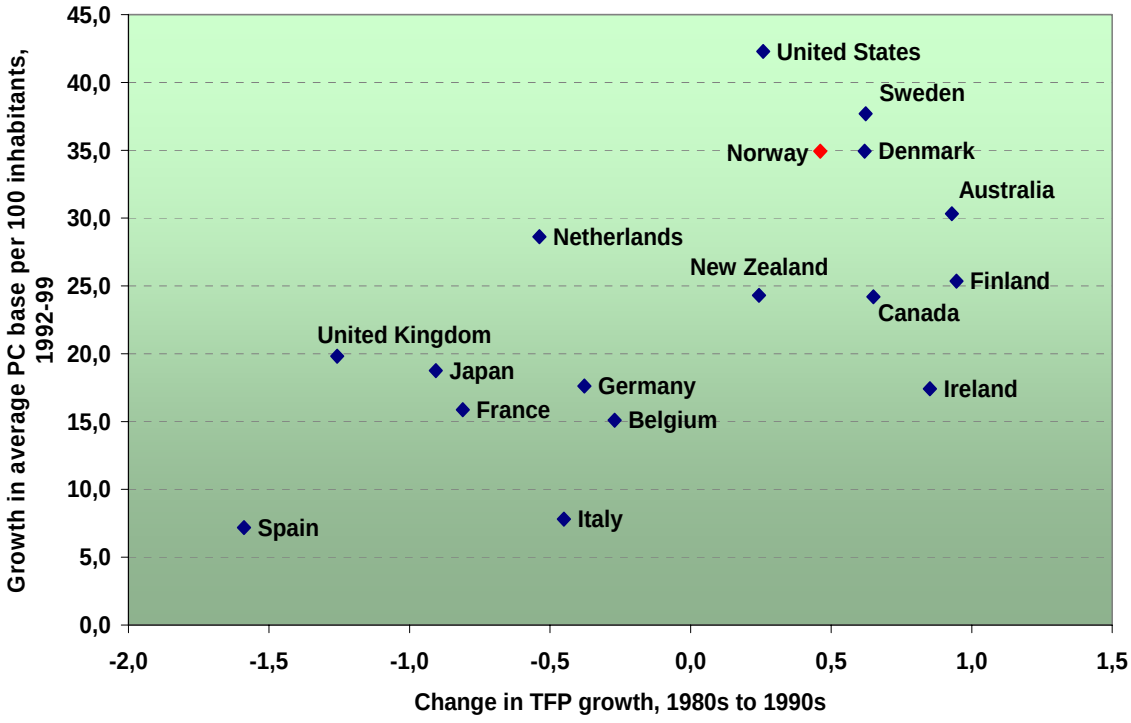
The concept of "critical mass" may matter greatly for the economic specialisation of countries or regions. Krugman (1991) suggested that international trade and regional integration may favour a geographical concentration of knowledge-intensive activities in relatively large countries, whereas smaller and peripheral ones would move towards specialisation in constant-returns-to-scale standardised production. According to Casella (1996), on the other hand, liberalisation and technical progress, by improving access to foreign markets, reduce the comparative disadvantages that small countries experience in the attraction of knowledge-intensive activities.

Meanwhile, there are many observations of ICT and also regulatory changes reducing advantages to scale in knowledge management. While this development is likely to open up new opportunities for small economies and for Small and Medium sized Enterprises (SMEs), the size of an economy still brings constraints with respect to the number of fields it can sustain. A "thinner" local basis may also make a country or a region more vulnerable to the loss of resources and skills that form essential building blocks in cluster development. However, further work is warranted on specific local processes of skill accumulation and path-dependency, and in which ways policy interference may be motivated (Asheim and Herstad, 2003; Andersson et al., 2004).

[9] In "The Cluster Initiative Greenbook" produced for the World Competitiveness Conference in Gothenburg, 17-19 September 2003, Sölvell et al. (2003) presented a "Green Book" on "cluster initiatives" undertaken by different countries. Mandated by the Competitiveness Institute, IKED is currently preparing the subsequent "Whitebook" on such policies (Andersson et al., 2004).

As discussed in the previous section, the Norwegian economy performs impressively across a range of macroeconomic indicators, and must presently be regarded as one of the most stable economies in the world. Norway benefits strongly from oil production, while the government is also acting to prevent the accumulation of oil revenue from havocking macroeconomic stability. ICT may not serve as much as an engine of growth as in the other Nordic countries, but there is nevertheless evidence of increasing contributions to growth from that end. Figure 6, for instance, indicates a rather good position for Norway as regards aggregate ICT and TFP-growth, although it does not provide evidence on any causal linkage.[10] Effective application of ICT is viewed as one reason for the combination of high productivity growth and economic expansion in the private service sector. At the same time, the declining competitiveness of industry, the expansion of the public sector, the onset of the ageing society coupled with high absentee rates in working age population and low mobility, are examples of developments that, when combined, give rise to major concerns for the long-term vitality of the Norwegian economy. The oil sector will continue to generate substantive revenue for years to come, but it will be essential to diminish the dependency on oil revenue.

Figure 6: Growth in ICT use and total factor productivity (TFP)



Source: OECD (2001*a*).

[10] See Andersson and Kind (2002) for a discussion on evidence of impacts of ICT on productivity including TFP, in Norway and the other Nordic countries.

Given high capital costs, upward pressure on wages and limited scope for enhanced future labour supply, Norway must put factors of production to very good use. The key concept in this respect is innovation. Again, this is not equivalent to research, and we will only gradually approach the question whether Norway needs and should support more R&D and, if so, in which way. Before that, we address a number of areas where challenges relating to innovation have been identified. Systemic linkages matter and are pointed out where relevant.

The importance of adopting a systemic perspective should be underlined clearly. This is founded in the fundamental case argued increasingly convincingly over the last decade in a growing academic literature, i.e. that the innovative performance of a society cannot be understood by looking at individual actors or factors in isolation. Again, the conditions for innovation are crucially dependent on complementarities and interactions between different players. The procedures through which various institutions and markets foster capabilities and incentives underlying innovation are interrelated, so that reforms and improvements in individual areas may be largely ineffective unless supplemented by measures in other areas. This has fundamental implications for policymaking which could become more effective if able to identify and address bottlenecks in the innovation system, repair or establish inadequate parts of infrastructure in order to surpass certain enabling thresholds, or implement packages of mutually complementary reforms. Having said this, it should be recognised that much of the academic literature professing the concept of innovation systems has failed to derive concrete or operational recommendations. Success will hinge on an approach that combines concrete issues with a strive for pragmatic considerations how real improvements can be achieved.

This review does not attempt to cover all relevant areas. The growing public sector, for instance, largely falls outside the scope of the present report, although it represents one important area where new technologies and organisational changes need to be put in place. There could be great returns from explicit and consistent reforms targeting the public sector for the purpose of supporting innovation in response to real customer demand. Neither will there be any detailed conclusions on reforms of universities or research institutes - issues that have already been addressed in a number of recent examinations. Considerable ground is nevertheless covered in the report, and no complete precision is possible in each individual area addressed. The ambition has been to examine major strengths and weaknesses, of relevance to the overarching challenge confronting Norway in the area of innovation and long-term growth, and identify key areas for reform. Again, the work has been undertaken in parallel with the government's own effort to develop a plan for a comprehensive innovation policy in Norway. Our reflections on that work, and its continuation, are returned to in the last chapter.

i) Framework conditions for innovation

Enabling framework conditions are of utmost importance for innovation. The scope of what is viewed as framework conditions may be defined in different ways. In a broad sense, they may include well-functioning *product markets* (goods and services) as well as *factor markets* (labour market, the financial markets including venture capital), *education and science system*, and physical, institutional and juridical *infrastructure*, including a *governance* system that is able to sustain effective and consistent playing rules for innovation. Hard-defined aspects such as *social capital*

and *attitudes* that underpin trust in transactions, entrepreneurship, risk-taking, etc., are also of great importance.

The influence of framework conditions on innovation varies markedly between countries. For instance, the policy frameworks of North America, Western Europe, the transition economies in Central and Eastern Europe, and East Asia display varying profiles. Weaknesses prevail in all for historical reasons, and because of the inherent difficulties in designing a policy that is horizontally consistent with respect to the institutions and incentives affecting innovative behaviour (OECD, 1998).

In recent decades, liberalisation, globalisation and technical progress led to changes in the fundamental conditions for economic growth. A number of previously strongly regulated markets were deregulated in most countries including Norway, where in the 1980s the steel industry and the market for housing were privatised. This was followed by deregulations in electricity and telecommunication during the 1990s. Telenor was partly privatised in 2000 and Statoil the following year. On the other hand, state ownership still accounts for roughly 27 % of the Norwegian economy, which represents a higher figure than in most other OECD countries. There is strong public interference in the financial sector, as seen clearly for instance in the various facets of seed- and venture funding. A special white paper from the government has declared an intention to privatise parts of the state owned business sector, but the development has been slow (Ministry of Trade and Industry, 2002).

Historically, Norway used to have large subsidies compared to EU-countries (NOU, 2001). However, following the European Economic Area (EEA) agreement in 1994, the government eased the provision of subsidies along with regulatory adjustments. The main exception is agriculture, as farmers obtain the bulk of their revenues in the form of subsidies and retail prices are about twice as high as in the world market. This stands in sharp contrast to the fishing industry, which acts on a highly competitive international market, exporting 95 % of its output and producing up to ten times as much fish as the agricultural sector produces meat. Further, the National Competition Authority was recently strengthened, thus putting in place an actor capable of intervening in response to market dominance. At the same time, several studies have pointed to remaining heavy product market regulations in Norway (Nicoletti et al., 1999; Kaufman et al., 1999; Pryor, 2002). To this should be added that corporate governance practices are underdeveloped (NHO, 2002), which is likely to be socially costly especially in the presence of weaknesses in product market competition. Overall, Norway continues to display high prices compared to other European countries (Table 2).

A related factor is Norway's position as not fully part of the European integration process, although through the EEA it has to adjust to Single Market regulations. Norway is thus heavily affected by EU-decisions while mostly lacking the capacity to itself engineer policy initiatives at the European level. EU-decisions can be seen to be greatly relevant for innovative capacity in Norway. This no doubt influences the strategies of Norwegians at home and abroad. Finally, as a non-member of the European Monetary Union (EMU) with a noteworthy current account surplus, Norway's national currency has for years been relatively strong under conditions of high real interest rates. During the last year, however, interest rates have declined considerably and Norges bank's sight deposit rate is now down at 2.25 %.

Table 2: Price-levels[1] for different goods and services, 1999 (EU=100)

	Food and household	Alcoholfree beverages	Apparel	Housing	Construction	Energy	Medicine and hospital equipment	Transport
Norway	151	**209**	114	106	**131**	68	98	151
Denmark	127	143	99	107	128	**158**	119	121
Finland	113	123	103	**133**	79	90	**126**	121
Iceland	**153**	182	**130**	103	103	91	122	130
Sweden	118	126	107	125	126	86	119	**163**
France	109	88	98	111	127	102	94	99
Italy	97	92	95	65	80	103	88	67
Germany	101	105	106	132	108	106	126	125

1. Highest levels in bold for Nordic countries.
Notes: Price level index is calculated as the ratio between the purchasing power parity and the nominal exchange rate.
Source: Eurostat.

These conditions are interwoven with other subtle albeit pervasive aspects of Norwegian society. Norway has a relatively homogeneous population. Investments in education are high, social welfare nets are strong, crime rates are low, and there is a generally high level of trust in transactions, as well as in processes of organisational change. At the same time, there is limited scope for risk-taking, experimentation, and for pecuniary rewards. There are great local variations in industrial structure and working life, yet there are limited income differences outside Oslo, the capital, and there are limitations in mobility.

Summing up on framework conditions, Norway presents a picture of generally high costs and price levels. Education levels are favourable overall although, as we will see, there are issues with respect to skill distribution, mobility and flexibility. Extensive protection provided by the welfare state hampers pressures for restructuring. Great openness in some areas is coupled with cumbersome limitations to competition in others. A combination of extensive government interference, including an expanding public sector, high taxes, and weaknesses in governance mechanisms, hampers the role of market forces in resource allocation. This is a long list of seemingly detrimental framework conditions. It must not be forgotten that they prevail in a society with great accumulated wealth and highly developed human and social fabric, with exceptional levels of trust in human relations and transactions. These traits support high-quality interactions and learning processes. On the other hand, there are barriers to accepting and making use of skills that are "different", reluctance to take on risk and unfamiliarity how to handle failure. There is also a lack of tradition of examining and learning from the experience of other countries. The overall influence of the broader framework conditions in Norway appears to form a veil, blurring the driving forces for individuals to engage in the efforts needed for entrepreneurship and risk-taking.

The following sections transcend from the general level to look more closely at selected areas, such as education, human capital, and entrepreneurship. Throughout, the influence of framework conditions will be treated in the same context as that of more direct determinants of innovative behaviour, since the different levels are intrinsically linked. It should be noted, however, that broader framework conditions for innovation generally must be taken as given, at least in the short term, for individuals, firms and the various institutions that serve as the main actors in innovation. From a policy perspective, on the other hand, they must not be taken for granted, i.e. be viewed as exogenously given, or cast in stone.

For any society that wishes to fundamentally improve its conditions for innovation, it is essential to succeed in broadening the perspective, and the mandate, for what matters in the light of innovation. At the same time, it remains vital for governments and public policy makers to seek out clear-cut objectives and *rationale* for policy action. It is important for Norway to take a broad view, not in a way that blurs the picture but in order to sharpen the focus on what crucially should be addressed, irrespective of traditional barriers between policy domains.

ii) Human capital

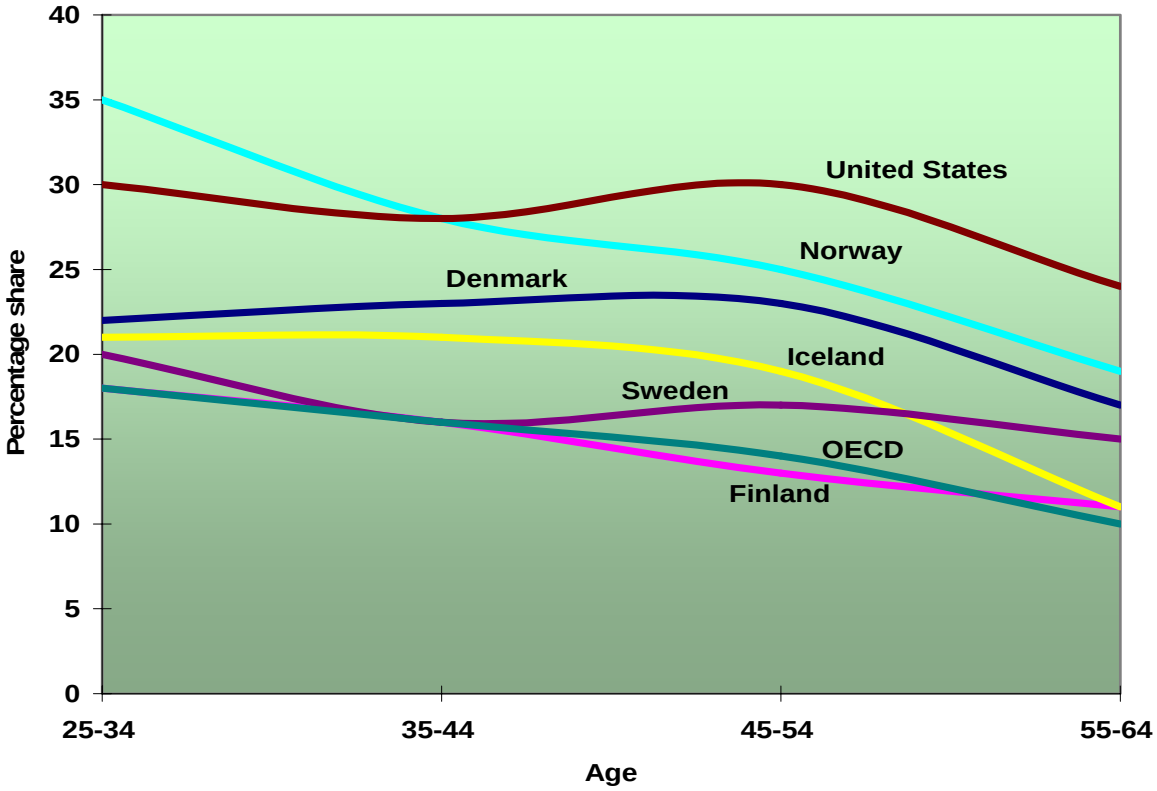
Human capital presents policymakers in many countries with issues that are highly relevant to innovation, but also complex and often difficult to address. Basic educational institutions, usually publicly funded, remain the key vehicle for human capital development. Empirical evidence shows that people with better basic education are more apt to learning later in life (Mincer, 1984; Heckman, 1998). Other factors also play an important role, including the behaviour of employers, the means and incentives for training, and attitudes towards new ideas and experiences.

Because of imperfections in individuals' ability to invest in education as well as positive spill-over effects from individuals who do attain knowledge, society has a basic interest in promoting upskilling. In recent decades, most countries expanded their education systems markedly. Paradoxically, previously well-established relationships between education and economic performance have seemingly vanished (Psacharoulos, 1994). Several studies cast doubt on the significance of education as a determinant of cross-country variation in recent growth rates (Barro and Lee, 1996; Nehru et al., 1995). There are several possible explanations. Quantity now means less in the case of education; the key is in *quality*, which is hard to measure. The impact of skills on growth seems intertwined with organisational and technical factors (Gudmundur et al., 2001; de la Fuente and Dmenech, 2000). Not only do basic education and the supply of skills matter, but also the demand for and application of skills broadly in society.

Norway belongs to those countries that have undertaken impressive educational reforms. Norwegians are today well educated. Between 1970 and 1999, the share of the population with only compulsory education (6-16 years) fell from 69 to 32 % (Barth and Torp, 2001). As indicated by Figure 7, Norway displays a higher share of the population with tertiary education than almost all other OECD countries, although comparisons are complicated by country-differences in definitions. Likewise, comparisons of educational attainment in the work force rank Norway ahead of any other country in services, and also among the highest in goods-producing industries (OECD, 2003*c*). As seen from Table 3, however, compared with

other countries, the results recorded in various dimensions do not appear fully on par with the high level of investment in human capital. In particular, the composition and the use of skills give rise to various concerns. Mathematics and science literacy among 14-year old students are reckoned as "average" in Norway, whereas the number of tertiary graduates in science and technology is "below average". Such observations matter for innovation, not least since problem -solving skills tend to demonstrate connections with math and science intuition.[11]

Figure 7: Share of population with tertiary education*, Nordic countries, US and OECD average, across age groups, 2001



* Tertiary-type A and advanced research programmes.
Source: OECD (2003d).

[11] In 1994-1995, in their final year at high school, Norwegian students received above average scores for their general knowledge in science and mathematics relative to students in other OECD countries (Mullis 1998). Today, Norwegian students display clear-cut weaknesses in science and mathematics, and rank below students in other Nordic countries (OECD, 2002*e*).

Table 3: Human capital indicators in Norway.

Position	Indicator	Ranking (number of OECD countries)
Above average	Public expenditure on education as a percentage of GDP (2001)	2(17)
	Total employment rate in percentage 15-64 years (2001)	3(21)
	Total population ages 25-64 that has attained at least a tertiary Education (2001)	9(30)
	Researchers per thousand Employees (1999)	4(25)
Average	Mathematics and science literacy among 15-year old students (2000)	16(27)
Below average	Total tertiary graduates in science and technology per 1000 population (2000)	11(20)
	Percentage of 15-year old students using a computer at school at least a few times a week (2000)	11(16)

Source: Based on Eurostat and OECD.

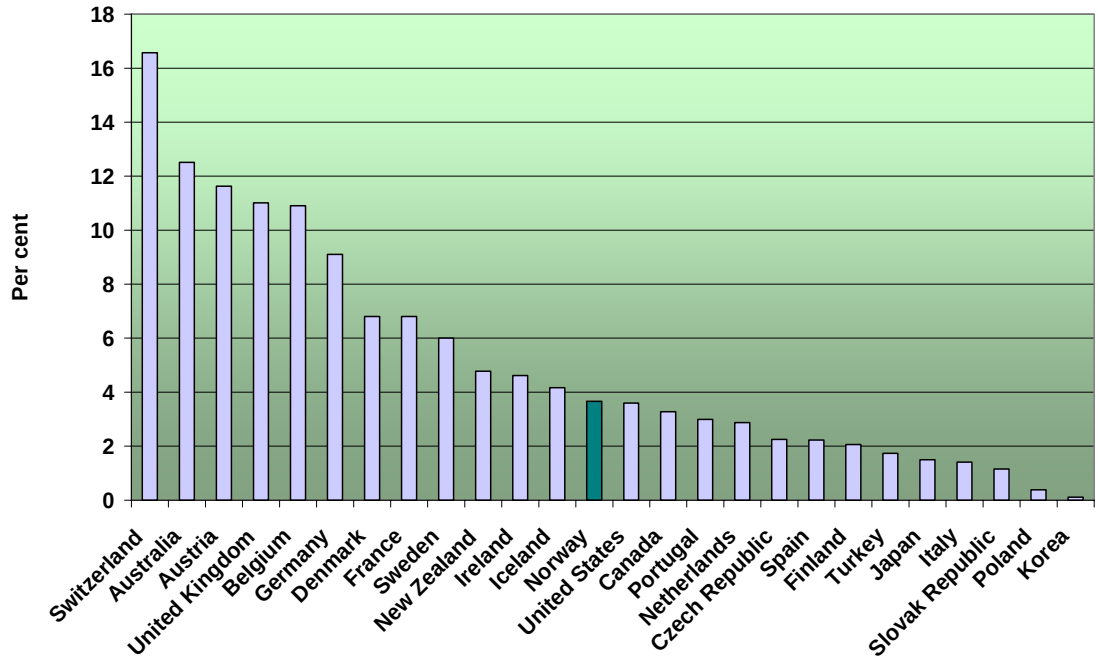
Norway's education system prepares a large number of graduates for work in the country's public sector, which employs up to 60 % of the academically trained workforce (Bjornstad, 2000). Areas such as nursing, social work and, more recently, education absorb a large share of graduates whereas science and engineering receive shrinking numbers. Among 24 year-olds, only 4 % received undergraduate degrees in natural science and engineering in 1998 compared with 9 % in Finland (National Science Board, 1998). As seen from Table 4, as of 1999 Norway had few doctorate degrees in science and engineering compared to other countries, and especially in math and computer sciences. As for international mobility of students, Norway demonstrates fairly high average numbers. The ratio of foreign students is about equivalent to that of the United States, higher than that of Finland but lower than, e.g., Denmark or Sweden (see Figure 8). However, less than one-quarter of foreign students enrol in science and engineering. The leading source countries are Sweden and Denmark (OECD, *2002i*).

Table 4: International comparison of earned doctorate Science & Engineering degrees, 1999

Country	All S&E doctoral degrees	Natural Sciences	Math and computer sciences	Agriculture	Social and behavioural sciences	Engi-neering
Norway	416	151	28	28	88	121
Sweden	1 755	502	222	118	282	631
Finland	918	254	77	40	235	312
Denmark	559	181	27	66	104	181
Germany	11 984	6 271	980	522	1 982	2 229
United Kingdom	7 386	3 668	680	326	907	1 805

Source: National Science Board (2002).

Figure 8: Percentage of foreign students in tertiary education (2000)



Source: OECD (*2002c*).

Which factors may discourage skill formation in areas that appear pivotal for boosting innovation capacity? The question calls for consideration to a broad set of issues. These include, for instance, the relatively low return to education due to the generally depressed wage structure (Moen and Semmingsen, 1996). Likewise, taxes may affect not only individuals' educational level but also choices of educational type. In a recent paper, taking both monetary and non-monetary returns into account, Alstadsater (2003) argues that the progressive tax system coupled with compressed wage differences distorts individuals' educational choices. Students seem to forego limited future wage returns and instead opt for types of education that are associated with less effort and higher levels of "consumption".

At the same time, it is inherent to more or less all educational systems that students contemplating their choice of study do not have perfect information on returns – monetary, societal or personal – in various fields. Basic attitudes matter crucially. There are observations that skill formation and performance in technology-related subjects are adversely affected at early stages. Principals at Norwegian secondary schools suggest that poor instructional materials, insufficient number of computers per students and inadequate science laboratory equipment and use hinder learning (Table 5). Instructions in science and the use of laboratories may be instructive for developing task management and problem-solving skills as well as for stimulating students' interest in invention at early age.

Table 5: Comparison of quality of school resources for 15-year olds with Norway's major trading partners (2000)

Countries	Percentage of students enrolled in schools where principals report that learning is hindered to some extent or a lot by:			Percentage of students who report that they use the science laboratory at least several times a month	Percentage of computers available to:	
	lack of instruction material in library	lack of computers	inadequate science laboratory equipment		15-year olds	Teachers
Norway	59	61	49	62	51	18
Sweden	27	51	16	83	55	14
Finland	43	43	43	9	77	11
Denmark	14	28	21	77	63	8
Germany	35	50	32	37	68	10
United Kingdom	38	56	42	67	78	10

Source: OECD (2002*c*).

Following gradual expansion, Norwegian university students now spend relatively many years in education. While a shift has occurred towards practically oriented courses, where there appears to be excess demand in the market, more time is devoted to theoretically focused studies in those fields (NOU, 2001). At the same time, it is frequently argued that too few Norwegian students graduate with qualities that are relevant to innovative methods within companies.

Whereas it is impossible *a priori* to conclude on any optimal length of study or appropriate mix of theoretical and practical knowledge, a supply-driven shift towards longer study programmes respectively stronger theoretical content in practical courses may be costly, especially if unrelated to social needs and in the absence of countervailing checks and balances.

Table 6: Teachers' salaries in selected OECD countries, 1999

	Starting salary USD PPP	Ratio of starting salary to average production worker wage	Ratio of salary after 15 years to average production worker wage	Wage premium for experience
	(1)	(2)	(3)	(4) = (3)/(2)
	Primary			
Norway[1]	**22 194**	**0.80**	**0.93**	**1.16**
Denmark	28 140	0.88	1.02	1.16
England	19 999	0.73	1.23	1.68
Finland	18 110	0.76	1.04	1.37
Germany	29 697	0.98	1.19	1.21
Ireland	21 940	0.98	1.58	1.62
Sweden	18 581	0.83	1.09	1.31
United States	25 707	0.86	1.16	1.35
	Lower secondary			
Norway[1]	22 194	0.80	0.93	1.16
Denmark	28 140	0.88	1.02	1.16
England	19 999	0.73	1.23	1.68
Finland	20 394	0.86	1.18	1.38
Germany	33 196	1.10	1.27	1.16
Ireland	23 033	1.02	1.60	1.56
Sweden	18 704	0.83	1.09	1.31
United States	25 155	0.84	1.11	1.33
	Upper secondary general education			
Norway[1]	22 194	0.80	0.93	1.16
Denmark	28 986	0.94	1.25	1.33
England	19 999	0.73	1.23	1.68
Finland	21 047	0.88	1.24	1.40
Germany	35 546	1.17	1.38	1.17
Ireland	23 033	1.02	1.60	1.56
Sweden	20 549	0.92	1.09	1.28
United States	25 405	0.85	1.21	1.43

1. Teachers' pay has increased more than average wage over the period 2000-2002
Source: OECD (2002*d*).

Teachers are vital to the development of problem-solving and decision-making skills of the future generations of workers. Observations of the development of Norway's education system at both the primary and secondary levels indicate that the corrosion of teachers' salaries over the last three decades represents another factor affecting skill formation. Since the mid-1970s, teachers' average income fell dramatically relative to those of industrial workers. By the late 1990s, Norwegian teachers were among the lowest paid in the OECD (Jourmard and Suyker, 2002). A striking feature is also the modest wage premium for experience, which is considerably smaller than even in the other Nordic countries. (Table 6). Low remuneration levels and decline in status have rendered the profession unattractive to new and younger recruits, particularly in the subject areas of natural sciences and mathematics. According to Statistics Norway, 40 % of all teachers in secondary school were over 50 years in 2001.

The government has recently attempted to raise the number of qualified teachers by raising salaries.[12] However, because wages are increasing from a very low level, they are likely to remain below the OECD-average for some time (OECD, *2002c*). Furthermore, an important feature of the labour market for teachers in Norway is that it is based on a system where teachers' salaries are exclusively determined on the basis of the level of higher education and experiences, excluding considerations to regional variations in the cost of living (Falch and Strom 2002). Because real salaries are low, shortages of qualified teachers are more likely in regions with high living costs. Part of the reason for Norway's sizable expenditures on education is the decentralised education system, especially at primary level. Any attempt to improve the quantity as well as quality of teaching does wisely to consider the regional structure along with variations in subject areas as well as living costs.

Taken together, features of Norway's education system are likely to contribute to disengaging students from innovation-related studies as well as from problem-solving projects with small private companies. This is not to denounce the significance of social science and the achievements that the Norwegian education system do deliver, e.g. Norwegians are respected worldwide for skills in language and conflict settling. General competence levels following primary education are also, as in the other Nordic countries, at the top of the range (OECD, 2003*d*). Norway provides examples of innovative initiatives in childcare pedagogy, pioneering, e.g., cultural awareness and creativity in animal care and eco-services. Indeed, a society supportive of innovation requires an education and training system that allows for multiple forms of responsiveness to social needs, at all levels and stages of life. Fulfilling the government's objective to increase R&D expenditure by 2.2 % by 2005 is, however, hardly conceivable without addressing those features which currently counteract the supply of future workers equipped to conduct research and development activities.

Meanwhile, the extent to which Norwegian companies demand skilled workers, invest in creating knowledge, and absorb it from other sectors and institutions for innovation purposes, fundamentally influences the incentives for young people to invest in industrially relevant skills. Clearly, there are limitations to the preparedness of industry, both large and small firms, to absorb and make use of skills. Thus, knowledge diffusion broadly in the economy and across various sectors is uneven and partial. The oil industry is the most important recruiter of

[12] In 2002 the estimated growth of salaries for teachers in primary and lower- and upper-secondary education was 8 %.

engineering graduates. Many of the brightest tend to both begin and end their careers in this industry, thereby impeding potential positive transfers of knowledge and spill-overs to other areas. In 1999, more than 16 % of Norwegian scientists and engineers worked in the oil industry, which continues to absorb large numbers from other disciplines (Trondsen, 2002).

The introduction of SkatteFUNN,[13] intended to induce innovation and R&D in enterprises, may result in an increased demand for skilled R&D personnel broadly in industry. There are also programmes such as FORNY which aim to boost commercialisation of research and stimulate mobility between research institutes or universities and industry. Beyond the introduction of such schemes, however, further measures are warranted to facilitate flows of graduates from universities to companies. Incentives may be introduced to encourage universities to offer a new basis for business relations, e.g., by connecting business courses to scientific curricula, or encouraging faculty to support small business as advisors or board members. For science and engineering faculties to increase the number of applicants, they must be able to communicate the availability of multiple career paths for those who conclude their programmes. The virtues of "free science" are important for the attraction of future lead scientists, as well as for accessing prime international research networks. At the same time, providing the means for a broader selection of private companies to establish relations and on-site recruitment activities, in the likeness of the extensive collaboration between Norwegian University of Science and Technology (NTNU) and the country's major energy companies, could help inform a wider pool of students about career opportunities beyond the country's public and natural resource based industries.

It appears that a comprehensive strategy which can strengthen the supply and the demand of skills in tandem could add value. Experiences in other countries demonstrate the potential usefulness of various approaches, which can be more effective than one-sided strategies in influencing attitudes (Box 2). One method is to put in place incentives for universities as well as for prospective employers to become engaged in increasing the number of graduate students studying science and engineering.

Lifelong learning beyond formal education is greatly important for innovation. Rapid technical and organisational change makes it less conceivable than ever that training received early in life will be sufficient to serve an individual during the course of a career.[14] Following reforms, many Norwegians now participate in courses and various other programmes with training for grown-ups, and there is a multi-faceted vibrant industry offering such services. On the other hand, it appears that relatively little effort goes into training related to the work place. Compared with many other OECD countries, Norway provides weak monetary incentives for lifelong learning, at least for highly qualified workers. The private return to education is low in Norway – according to one estimate, between 3.5 and 7 % compared with 5-10 % in OECD countries (Haegeland and Klette, 1997). Since people work relatively few hours and retire early, there is also a shorter period to recuperate investments in education.

[13] SkatteFUNN provides Norwegian enterprises with tax incentives for R&D. Enterprises with over 250 employees are eligible for an 18 % tax deduction for R&D expenses. Smaller enterprises with fewer than 250 employees and an annual turnover not exceeding €40 million are eligible for a 20 % deduction.

[14] See, for instance, Lazonick and O'Sullivan (1998) for a discussion on processes of "cumulative learning" and how they allow what has already been learned to provide a foundation for future learning.

Box 2: Combined incentive schemes for increasing enrolment

Several countries have embarked on schemes of public-private partnership for the purpose of putting in place processes that can mutually strengthen a compatible upgrading in both the supply and the demand of skills. One example is the design of incentives that can make both private companies and universities more committed to co-operate in the evolution of university programmes. This may involve arrangements that spur industry to share costs in offering or upgrading university activities as well as introducing innovative elements or side-activities that can raise the relevance of programmes and being able to identify potentially interesting recruits.

In Ontario, Canada, a programme was initiated in 1998 by the state government with a budget of $150 million over a three-year period, for the purpose of doubling the enrolment of students in high-demand computer science and engineering programmes at universities and colleges. The expansion of enrolment in these programs, however, was made dependent on the private sector matching start-up costs (e.g. labs and equipment) identified by universities applying for the new funds. A private-sector reference group was further established to engage prospective employers to provide summer and co-op placements and permanent employment for graduates. An estimated 8,000 new entry-level spaces were created by September 2000. Undergraduate enrolment at the 17 eligible universities increased by 145 % in engineering and by 180 % in computer science over the ensuing three years (Ontario Confederation of University Faculty Associations, 2003).

There are also useful examples of similar strategies serving to deepen relations between key sectors and the educational system introduced within the context of "cluster policies" that aim to strengthen mutually beneficial sets of linkages at regional level. These include various kinds of university-industry collaboration in the United Kingdom (Department of Trade and Industry, 2002) and a sizable programme in Japan which supports the promotion of such links through utilisation of coordinators as well as government funds (Japanese Ministry of Economy, Trade and Industry, 2003).

The government is now focusing on vocational training for job seekers to support adjustment of skills to labour market needs. The scope of these programs contributes to labour participation rates. The Competence Development Programme is a development programme that serves to contribute to innovation in the market for lifelong learning. The Ministry of Education and Research allocated NOK 50 million to the programme in 2000 and 100 million in 2001. Companies, municipalities, knowledge institutions, labour organisations and others may initiate projects under this programme. Over 1200 applications were submitted between 2000 and 2001. As part of a broader strategy, this kind of programme may be greatly important. At the same time, the overriding influence of more fundamental incentives must not be forgotten. An effective human resource policy should operate on the demand as well as the supply side.

iii) Entrepreneurship

Conditions for the establishment and growth of new businesses are important for innovation. The presence and efforts of entrepreneurs, with innovative ideas and the possibility to carry them to fruition, represent an important part of any well-functioning innovation system. While entrepreneurship can take various forms, as originally envisaged by Schumpeter (1934), the concept is used here primarily with a view to the start-up of new business.[15] Several studies have pointed to the growing importance of entrepreneurship and the performance of SMEs for the economy, due to the impetus on competition, the commercialisation of technologies, and

innovation (Henderson and Clarke, 1990; Jovanovic and Nyarko, 1996; Baldwin and Johnson, 1999; Audretsch and Thurik, 2001). The entry of new plants, and exit of old ones has, for instance, been found to contribute to TFP-growth (Ueda, 2002). Structural change is likely to proceed more quickly in the presence of an active entrepreneurial sector. Although there is no clear causality, a mapping of country performances during the 1990s demonstrates a positive correlation between entrepreneurship and GDP growth, which contrasts with the situation in previous decades (OECD, 2001*b*).

Measuring entrepreneurship is difficult, partly because some is informal and does not lead to fully registered companies. Based on new firm registration statistics, Norway appears to have a fairly high level of entrepreneurial activity. Between 20,000 and 30,000 new companies are started each year, though few can be characterized as high-technology firms. Most are established in traditional sectors such as agriculture, construction or retailing (Spilling 2001). Still, there are limitations to using new firm registration statistics as a proxy to entrepreneurial activities because of complexities involving definition and comparability across countries.

Since 1999, the Global Entrepreneurship Monitor (GEM) project has attempted to measure rates of entrepreneurial activities systematically based on population surveys. The most recent report concludes that compared with Americans, Europeans are less likely to become entrepreneurs notwithstanding the lesser availability of jobs in Europe (Reynolds et al., 2002). The report makes the following three observations about Norway:

- Norway belongs to the group of countries with fairly high levels of entrepreneurial activities (Figure 9);

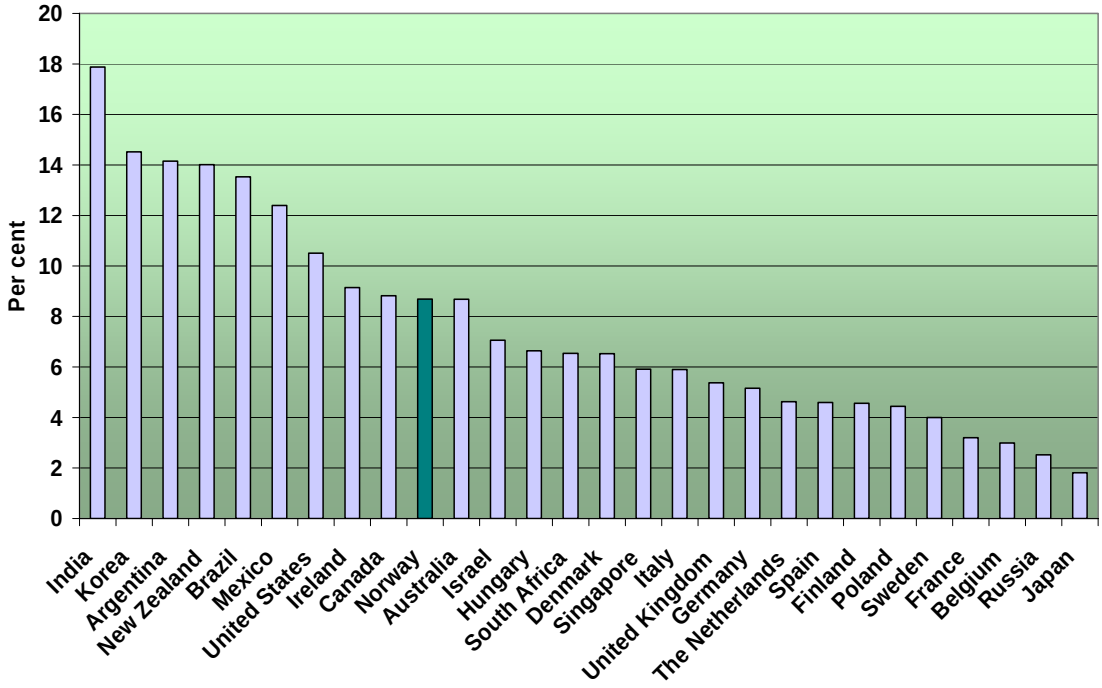
- Entrepreneurship in Norway is almost entirely opportunity-driven;[16] and

- Levels of female participation in entrepreneurial activities are relatively low in Norway.

[15] There are several definitions of entrepreneurship. Wennekers and Thurik (1999) define entrepreneurship as the extent to which individuals recognise opportunities and possess the capacity, motivation and skills to exploit them while confronting uncertainty and risk.

[16] Opportunity-based entrepreneurship reflects the voluntary nature of an individual's preference to start a company while enjoying numerous viable alternatives.

Figure 9: Entrepreneurial activity among citizens, 2002



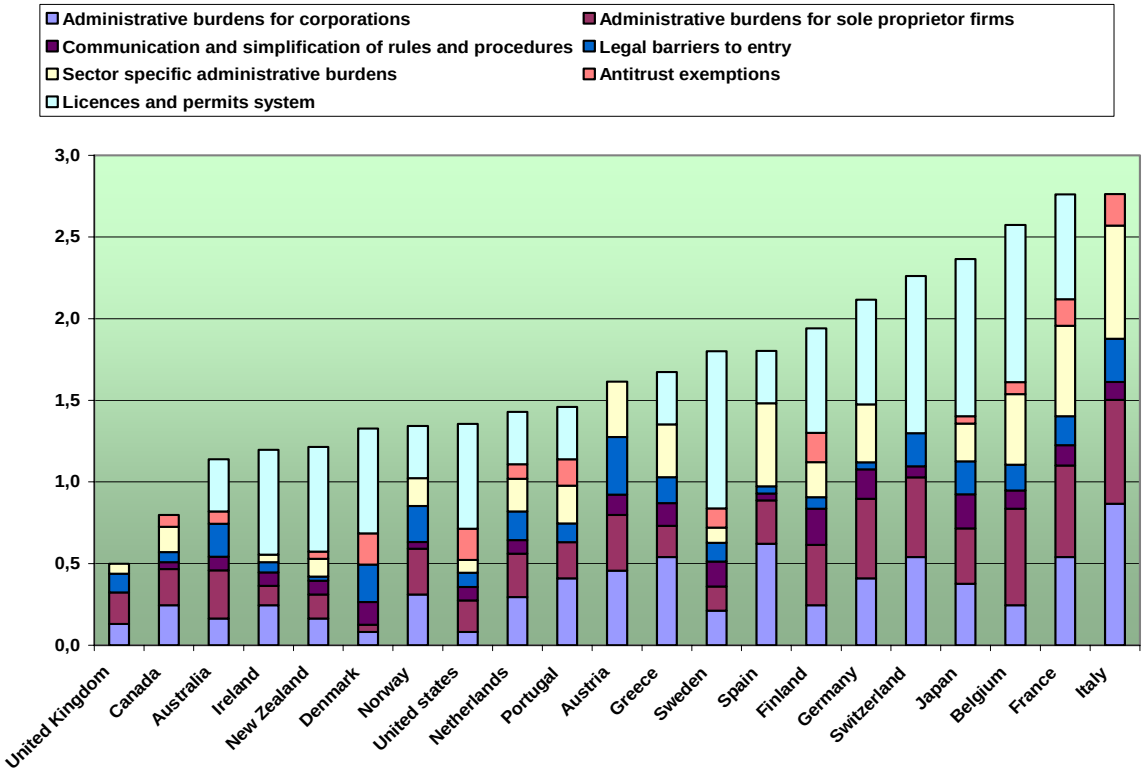
Note: Percentage of population between 18-64 who are engaged in starting a new company or in charge of a company less than 42 months old.
Source: Reynolds et al. (2002).

Whereas GEM depicts a relatively vibrant entrepreneurial culture in Norway, a look at non-agriculture entrepreneurial levels suggests a less sanguine picture. Compared with its major trading partners, levels of entrepreneurial activities outside the agricultural sector are, on average, fairly low. More fundamentally, although a respectable number of companies are started overall, most are found in sectors that can be characterised as low-tech, and few are growing fast. Further, only one-third of firms across the country were recently characterised as innovative.[17] Between 1995 and 1997, around 54 % of Norwegian firms in manufacturing were reported to have introduced new or technologically improved products, compared with 61 % in Sweden and 71 % in Denmark (OECD, 2002*b*).

This situation cannot be explained by traditional barriers to entrepreneurship. Although no comprehensive, fully updated international estimates of such barriers are available, the best mapping available suggests a modest combined influence of administrative barriers and burdens on entrepreneurs in start-up phases. As shown in Figure 10, Norway displayed more favourable conditions in this respect, in 1998, than most EU countries.

[17] To be categorised as innovative in this examination, an enterprise had introduced new or considerably changed products or processes during the period 1999 to 2001.

Figure 10: Entrepreneurship barriers, 1998

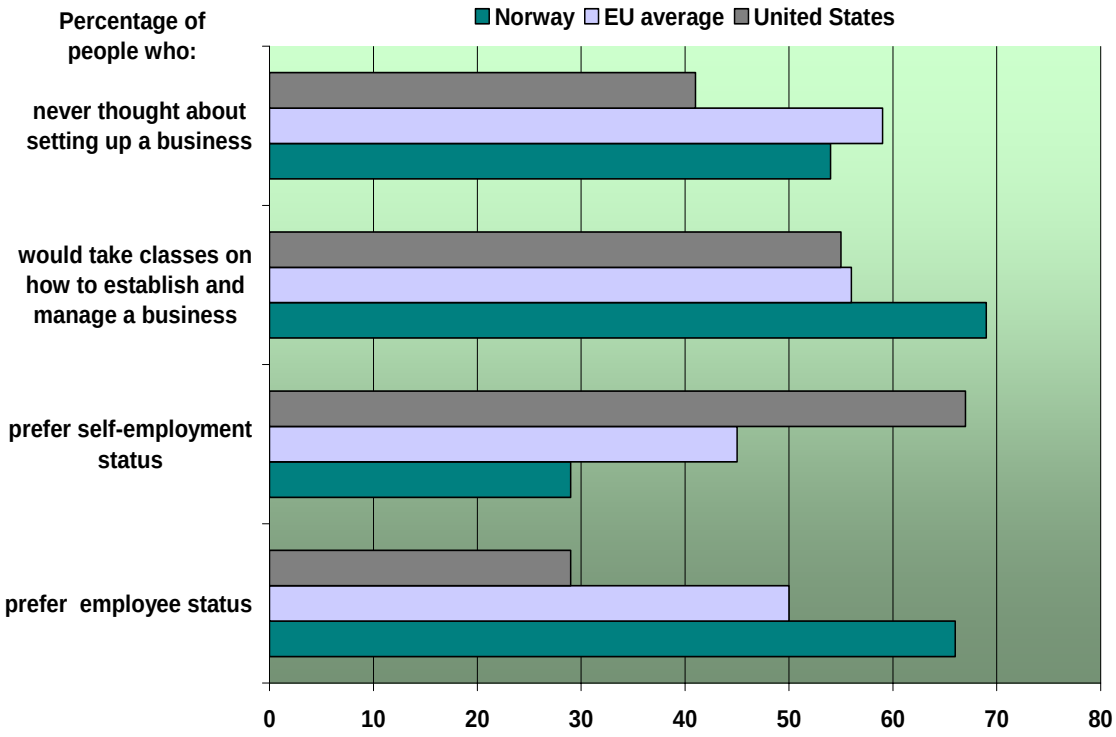


Indicators vary between 0 (no barriers) and 6 (highest number of barriers).
Source: OECD, International Regulation Database.

Norway's performance in entrepreneurship and SME-development may be associated with attitudes. A recent survey carried out by the European Commission found that although 66 % of Norwegians prefer the security that comes with being an employee, even more desire to learn more about entrepreneurship (Figure 11). This may indicate a change in the traditional culture of mistrust and resentment in regard to personal achievement. Industry leaders in Norway's Sunnemore region concur that attitudes toward entrepreneurs in Norway, especially successful entrepreneurs, have become more favourable in recent years. For many respondents, however, the risk that a business might fail is enough of a deterrent to enter a new venture. Social stigma attached to failure most certainly plays a role, indicating the continued significance of attitudes. The risks most feared were income insecurity, bankruptcy, and devoting too much energy and time.

Attitudes are not given once and for all, and attention should be paid to fundamental influences such as those caused by opportunity costs, taxation, corporate governance, and bankruptcy legislation. Another factor, to be addressed below, concerns the way in which seed- and venture capital markets influence the incentive to start a company and above all, take on risk.

Figure 11: Attitudes towards entrepreneurship

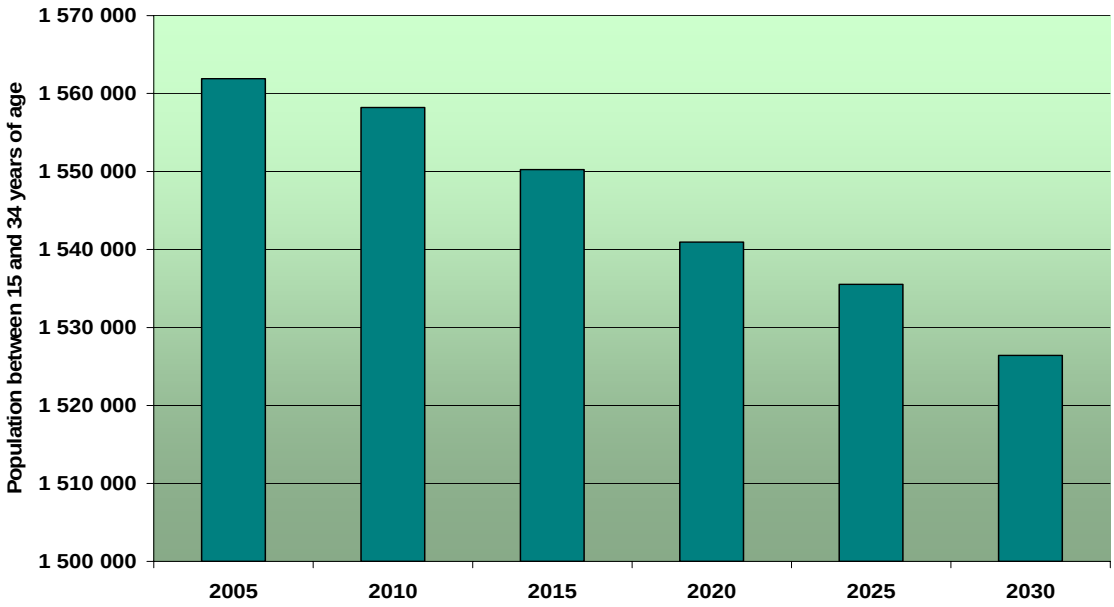


Source: EOS Gallop Europe (2002).

Given the labour shortage in Norway, entrepreneurs tend to be faced with attractive alternatives in terms of a well-established system of high social benefits as well as other generous benefits that come with being a employee, not least in the public sector. The National Insurance Scheme provides support for those who are employees whereas those who are self-employed carry their own risks.

Most relevant in the present context are the choices facing those between 15 and 35 years old, which for sociological reasons are most prepared to start new companies and accept high risk. The pool of potential young recruits is, of course, known to diminish consistently in years to come (Figure 12). Meanwhile, the prospect that the government will further strengthen its role as the country's foremost employer, offering a reliable and ever expanding pool of career opportunities, most likely exerts a tangible discouraging influence on any individuals in the new generations who may be contemplating to embark on the less-travelled paths of entrepreneurship.

Figure 12: Estimated medium national growth* of Norwegian population between 15 and 35 years of age

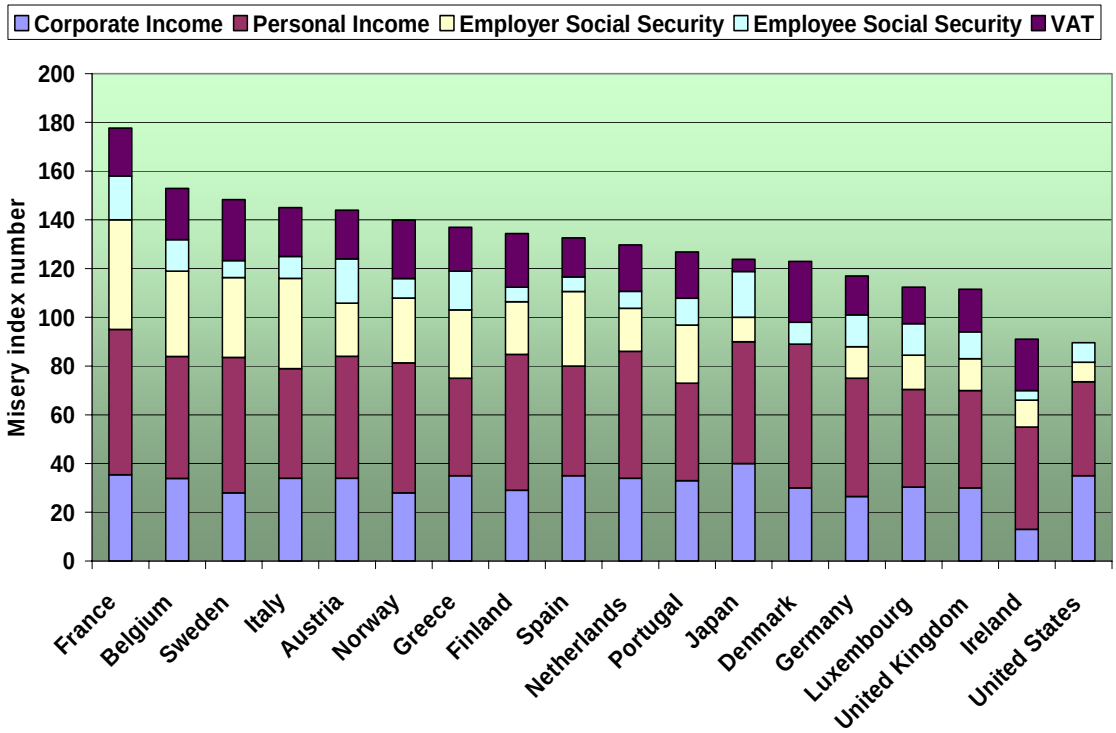


*According to the medium national growth scenario calculated by Statistics Norway.
Source: Statistics Norway.

Several studies have demonstrated an influence of *tax rates* on entrepreneurial activity and the creation of new enterprises (Carroll et al., 2000). An attempted comparative scorecard is the so-called Misery Index, developed by Forbes Magazine, illustrated in Figure 13. The index takes account of the top marginal rates on personal and corporate income, value-added taxes and social welfare taxes. The higher the index, the greater the misery to entrepreneurs, who look closely at top marginal and effective tax-rates when making business and employment decisions (Forbes, 2002). France, Belgium, and Sweden record the highest figures, with Norway among those found at a slightly lower level.

Estimating the influence of taxes on entrepreneurship requires, however, more careful scrutiny of specific taxes, as well as of related regulatory and institutional conditions. Broadly speaking, Norway has fairly high indirect taxes and a substantial labour tax. Taxes on capital income and corporate income are fairly low, as are the tax revenues obtained through ownership and wealth taxes. Yet, looking in further detail, the wealth tax, for instance, cuts in already at a very low level in international comparison, and may put in place various incentive effects despite its insignificance from a fiscal perspective (see further below).

Figure 13: Combined tax weight felt by entrepreneurs



Note: The misery index measures the combined tax weight felt by entrepreneurs and it is based on the top marginal rate in the different categories of taxation.
Source: Forbes (2002).

The availability of external funding is central to the prospect of entrepreneurship, and especially relevant for innovative entrepreneurs who inevitably encounter high risks and thus difficulties in obtaining traditional forms of finance. The dynamism of innovative entrepreneurs must to a large extent be sustained by appropriate mechanisms for the provision of seed funding and private equity.[18] Part of this takes the form of venture capital which specialises in overcoming agency and information problems among entrepreneurs, innovators and financiers. This is typically done by investors taking a stake in ownership and actively participating in management (Admati and Pfleiderer, 1994; Carpenter and Petersen, 2002).

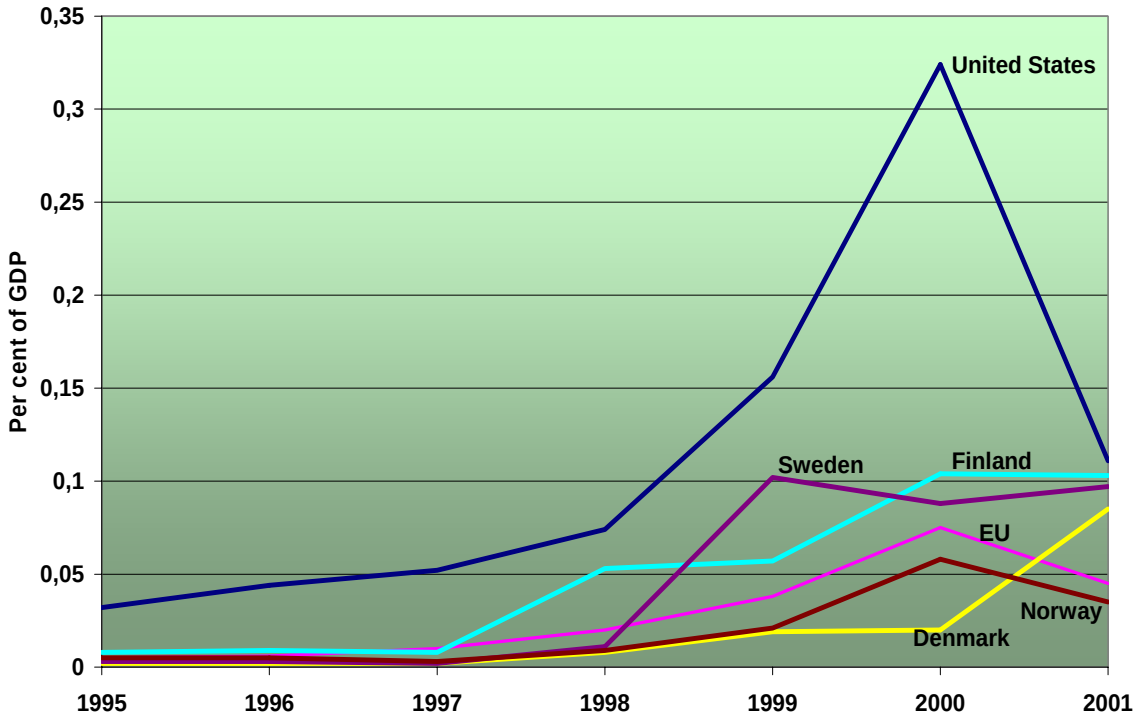
Venture capital is particularly important in demanding early stages of firm expansion associated with risky steps initiating the commercialisation of innovations. In those situations, potential investors face severe difficulties in assessing the strength of ideas, which tend to rely heavily on specific intangible assets (e.g. brand names, patents, the brain or the stamina of the entrepreneur) or investments (R&D, software or organisational change), and the ability of the venture to acquire a lasting first-mover advantage relative other competing actors and products.

[18] Private equity is the term used to describe investments made in unlisted companies. The market for private equity is made up of venture capital and buyout funds.

Business success at that stage may only be feasible with the engagement of *active* and patient investors, who bring not only financial support but also non-financial assets like relevant experience, business related skills, complementary networks, and monitoring capacity. A well functioning venture capital market is dependent on a pool of potential investors with surplus funds to invest in new ideas as well as relevant competencies. Institutional investors such as pension funds, banks, and insurance companies, may operate through various intermediaries.

Most developed countries saw a rapid expansion of their private equity markets in the late 1990s (IKED, 2004). Available data suggests, however, that Norway has a poorly developed market for venture capital financing and considerably lags behind most other OECD countries in terms of volume and diversity of source of financing (Centre for Economic Analysis 2003). For instance, Figures 14a and 14b illustrate that Norway has low allocation of venture capital financing to seed and start-up compared with other Nordic countries and equally low supply of financing to projects in the expansion phase. The Milken Institute's annual Capital Access Index (CAI) ranks Norway number 30 in comparison with 36 countries regarding the ability of entrepreneurs to gain access to financial capital.[19] Norway has consistently been behind its

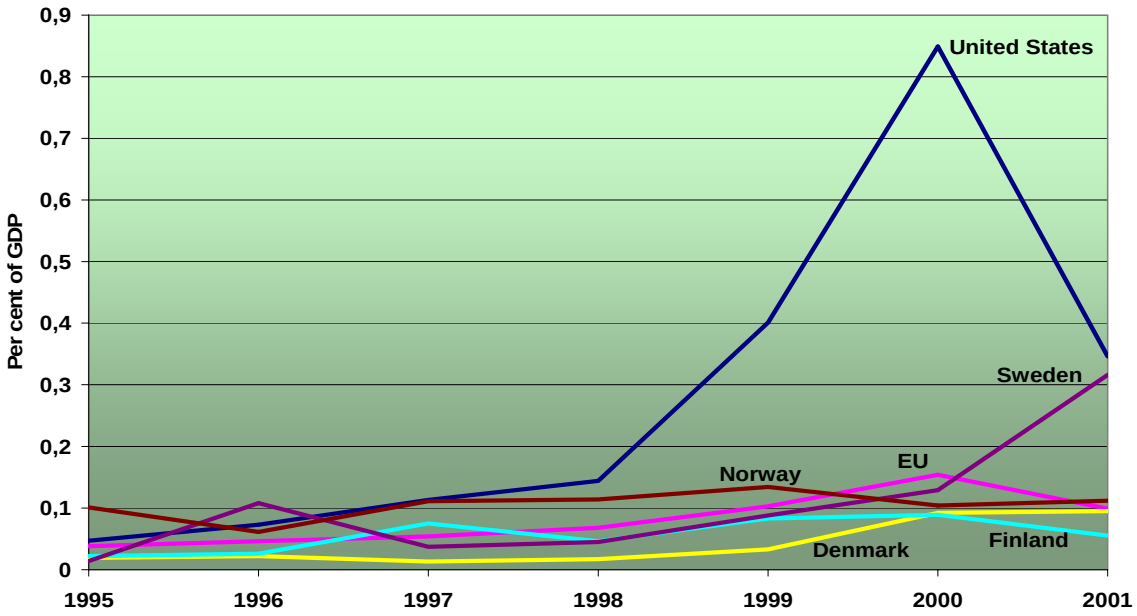
Figure 14a: Venture capital early stage (seed and start-up) in percent of GDP, 1995-2001



Source: Eurostat Structural Indicators.

[19] See also Barth el al. (2003)

Figure 14b: Venture capital expansion and replacement in percent of GDP, 1995-2001



Source: Eurostat Structural Indicators.

Nordic neighbours and other EU countries in this respect (Table 7). This is greatly relevant for, e.g., what success can be expected from SkatteFUNN in boosting Norway's innovation capacity at the seed and start-up phases (see further below). Measures to improve the situation have been suggested in the state budget for 2004 which outlines the establishment of a nationwide fund of seed capital to the amount of NOK 800 million. Private interests are proposed to contribute 50 % of the capital, and the government the remaining 50 %.

Although financing levels are improving in Norway, a strong and diverse mix of sources of venture capital funding is still lacking (Table 8). Private individuals, government agencies and corporate investors are the main sources of financing. The share of private individuals, however, fell from nearly 40 % of total financing in 2000 to 18 % in 2002, while government agencies significantly increased their share of contributions to the market from a low of 0.3 % of total financing in 2000 to 38 % in 2002 (Centre for Economic Analysis, 2003). The Norwegian venture capital industry is strongly dependent on government funding which is directed mainly at projects in a relatively mature expansion phase. Since 2002, the dynamics are stronger in seed stages, reflecting the new orientation of the government agencies toward financing start-up activity. Whereas this, in principle, is good news, public funding will be most effective if it is able to stimulate private investment in early stages as well.

Table 7: 2003 Capital access index

Country	2003		2002		Change in	
	Score	Rank	Score	Rank	Score	Rank*
Hong Kong	5.74	1	5.65	1	0.09	0
United Kingdom	5.63	2	5.59	2	0.04	0
United States	5.55	3	5.50	3	0.05	0
Singapore	5.50	4	5.43	4	0.07	0
Netherlands	5.48	5	5.53	6	0.13	1
Switzerland	5.40	6	5.38	5	0.02	-1
Canada	5.25	7	5.22	7	0.03	0
Luxembourg	5.20	8	5.16	8	0.04	0
New Zealand	5.19	9	5.16	8	0.03	-1
Denmark	5.12	10	4.94	15	0.18	5
Ireland	5.12	10	4.98	13	0.14	3
Australia	5.12	10	5.00	10	0.12	0
Germany	5.02	13	4.96	14	0.06	1
Finland	5.02	13	5.00	10	0.02	-3
Spain	4.94	15	4.78	18	0.16	3
Sweden	4.92	16	4.84	17	0.08	1
Taiwan	4.88	17	5.00	10	-0.12	-7
South Korea	4.83	18	4.78	18	0.05	0
Japan	4.78	19	4.88	16	-0.10	-3
Israel	4.77	20	4.71	21	0.06	1
France	4.72	21	4.66	24	0.06	3
Austria	4.69	22	4.65	25	0.06	3
Belgium	4.69	22	4.76	20	-0.07	-2
Iceland	4.67	24	4.71	21	-0.04	-3
Kuwait	4.67	24	n/a	n/a	n/a	n/a
Bahrain	4.66	26	n/a	n/a	n/a	n/a
Portugal	4.62	27	4.70	23	-0.08	-4
Malaysia	4.60	28	4.56	28	0.04	0
Chile	4.58	29	4.53	29	0.05	0
Norway	**4.56**	**30**	**4.57**	**27**	**-0.01**	**-3**
South Africa	4.50	31	4.62	26	-0.12	-5
Italy	4.35	32	4.45	30	-0.10	-2
Hungary	4.35	32	4.21	33	0.14	1
Barbados	4.30	34	n/a	n/a	n/a	n/a
Greece	4.28	35	n/a	n/a	n/a	n/a
Thailand	4.26	36	4.37	31	-0.11	-5

*Because 14 countries were dropped and five were added to the total list of countries this year, changes in rank may reflect some movement that occurred solely due to these modifications. The Milken Institute Capital Access Index ranks countries by the ability of its entrepreneurs to gain access to capital. The five components of the index are general economic environment, bank lending, capital market development, international environment and sovereign ratings.
Source: Barth et al. (2003).

Attention should be paid to ways in which the government could further develop the market by, for instance, lowering restrictions on engagement by pension funds in unlisted companies, enabling financing via public/private syndications, and by strengthening exit routes for investors. The national investment fund "VækstFonden" in Denmark offers one recent example of successful strategies. By setting up "funds-of–funds", VækstFonden is co-investing with a large part of the private capital market. In fact, VækstFonden is active in approximately 50 % of the total number of seed investments in Denmark, either directly or indirectly through the funds, which have been set up encompassing private involvement (VækstFonden, 2003). Still, like Norway, Denmark appears to have a shortage of domestic exit routes, meaning that successful ventures are likely to be sold to foreign investors and lead to business expansion primarily overseas (see section on globalisation below). Sweden, in contrast, has a more mature venture capital market and a more sizable industrial sector which bring a greater potential for establishing domestic production, but still suffers from weaknesses in mechanisms for risk-taking and resource allocation in early stages.

Again, venture capital financing is more than investment; it brings partnership between the investor and the entrepreneur. At the same time, professional institutional venture capitalists search for profit aggressively. Normally, they do not enter very early phases of business development. It is important for the innovation system as a whole that entrepreneurs encounter alternative finance and development routes (IKED, 2004). Similar to institutional venture capitalists, business angels are active and engaged investors.[20] In addition, they may provide informal risk capital at early stages, while also bringing access to infrastructure of professional services, assisting innovative entrepreneurs in the development of business plans and helping to prepare products for commercialisation.

In the absence of formal registration requirements, the true number of business angels is difficult to assess. As in many other countries, however, they are known to make up an important source of financing for entrepreneurs in Norway (Centre for Economic Analysis 2003). Their diversity and the lack of organised channels for their activities weaken their accessibility to potentially innovative entrepreneurs, however, suggesting that benefits could derive from the development of more diverse and transparent Business Angels Networks (Gullander and Napier, 2003). There is still a case for public support in early stages, for instance because business angle networks may not be sustainable without some public support, and because they are unlikely to provide sufficient support for early stages and high-technology investment (Harrison and Mason, 1996).

The factors impeding the access to funding for entrepreneurs and commercialisation of innovation in early stages combine with the already discussed factors in discouraging entrepreneurship and risk-taking. In this context it is worth reflecting again on the role of the wealth tax, which is progressive but reaches a maximum rate of 1.2 % already at levels of wealth that are exceptionally low in international comparison, and it operates in a society where the dispersion of incomes is already compressed. Few other countries have a similar tax and only

[20] Private individuals are often referred to as "business angel" investors. They are typically wealthy and seasoned individuals, who themselves have a history as successful entrepreneurs. They tend to have strong experience in a specific industry or sector they invest in, and a good understanding of the challenges facing a start-up. They frequently sit on the board of young start-up companies and are active in providing advice.

Table 8: Sources of funds raised for private equity / venture capital in Europe, average 1995-99 (% of total)

	Banks	Pension funds	Insurance companies	Corporate investors	Realised capital gains	Private individuals	Government agencies	Academic institutions	Others
Austria	**57.5**	0.6	4.3	17.2	0.3	6.6	13.4	0.0	0.0
Portugal	**55.8**	0.0	0.2	0.3	12.9	0.0	21.1	0.0	9.6
Germany	**48.7**	10.8	11.7	9.1	0.1	8.5	8.8	0.0	2.3
Nether-lands	**47.4**	7.5	14.7	1.9	17.2	3.0	0.7	0.1	7.5
Spain	**43.2**	8.0	3.9	9.0	6.6	6.0	8.6	0.0	14.6
Italy	**39.6**	6.9	4.9	8.8	12.0	16.6	1.6	0.0	9.7
Denmark	**37.7**	6.5	0.0	7.1	13.8	18.1	4.7	0.0	11.9
Greece	**31.2**	0.0	5.5	16.4	**27.6**	10.1	0.0	0.0	9.2
France	**27.8**	10.1	11.5	8.4	**29.3**	4.0	2.1	0.3	6.4
European Union	**27.8**	**23.0**	12.6	9.1	8.9	5.8	3.9	0.6	8.5
Switzer-land	**26.7**	11.4	7.3	12.6	8.5	12.1	3.6	0.0	17.7
Belgium	22.1	1.9	2.9	9.7	**39.7**	8.4	4.5	1.7	9.1
United Kingdom	20.1	**35.7**	14.4	9.5	2.6	4.4	3.1	0.9	9.4
Ireland	19.0	**19.5**	6.8	2.9	4.1	**21.3**	8.6	0.0	17.7
Finland	15.5	**28.9**	**24.7**	5.6	2.8	1.8	13.3	0.3	7.2
Norway	**7.7**	**6.7**	**14.0**	**21.7**	**23.1**	**23.2**	**0.6**	**0.0**	**3.0**
Sweden	6.4	**27.7**	16.5	18.0	5.0	5.1	3.3	1.3	16.7
Iceland	2.6	**29.3**	0.3	1.8	**48.6**	2.4	4.2	0.0	10.7

Source: European Private Equity and Venture Capital Association (EVCA). Various Yearbooks.

Sweden can be said to face a similar situation. The lack of transparency in international transactions makes it easy to avoid it by investing abroad and, while hard data is unavailable, the overwhelming evidence points to a resulting significant capital outflow in the Swedish case. In both countries, a range of investment decisions are affected by considerations to the wealth tax. While the public revenue raised by the tax is small, the crucial question concerns what impact it exerts on attitudes.[21]

The main issue with respect to entrepreneurship is the willingness of potential entrepreneurs to take on risks. Policy packages mitigating the high opportunity cost confronting entrepreneurs in the form of heavy welfare support in secure government bodies or established businesses meet with political resistance. Other ways must be sought to improve the perceived feasibility of venturing into new business. Role modelling may be one way forward, that is, involving existing companies and experienced entrepreneurs in education and promoting more problem-based learning in education. Under all circumstances, there is a case for improving conditions for the provision of seed- and venture capital. The sole answer in this area must not be more public money. A way forward that looks to the real nature of the problem should include an element of tax reform and, politically controversial, abolition or adjustment of the wealth tax. Mistakenly, addressing the wealth tax is often viewed as a matter of ideology rather than economic efficiency. While this may have been true in the past, the situation is different today. For the already wealthy who can easily, within a matter of minutes, transfer virtually any funds across national borders, paying wealth tax is in principle a voluntary decision. The real impact is that the prospect of such taxes serves as deterrent for those who are young and without any capital in the first place, favouring secure skills and professions at the expense of trying more difficult and risky waters where success is uncertain and not really socially acceptable. Communicating this state of affairs should form part of a comprehensive innovation policy.

iv) Labour Market and Social Welfare Issues

Labour market policies matter for innovation in multiple ways. In the presence of substantive unemployment benefits, jobless workers will be less inclined to start a venture of their own and run the associated risk of failure. Apart from influencing conditions for entrepreneurship, or self-employment, relative to traditional employment, the labour market exerts an impact on the behaviour of both employers and employees as regards, e.g., business expansion, hiring, flexibility, mobility and, more broadly, the development and use of knowledge in the work place. For example, the principles for wage-setting and conflict resolution influence work effort, training expenditures, sharing of information, team-building and delegation of responsibility. With regard to entrepreneurship, employees may be less inclined to start a venture of their own if labour market regulations prescribe generous benefits for wage-paying jobs.

[21] The Norwegian government recently took steps towards reforming taxes, including the wealth tax which it proposed to phase out in the long run. In Sweden, the government has similarly responded to criticism by announcing that the wealth tax is to be abolished. In public debates, the Swedish Prime Minister Mr. Göran Persson has referred to it as "perverse".

Globalisation and technological change have forced governments and firms alike to revise their strategies and seek more innovative ways to increase efficiency, including by adjusting employment conditions and wage systems. Compensation schemes are greatly important for shaping an innovative culture. A significant positive relationship has been demonstrated between performance-related pay and increased levels of productivity and innovation in firms (Snellman, 2003). On the other hand, there may be various ways forward, as innovative outcomes can be promoted through the use of performance-related pay schemes as well as through non-monetary forms of remuneration. Outcomes often depend on the extent to which changes in compensation are accompanied by organisational adjustments that are able to facilitate a combination of enhanced work force flexibility, training and learning processes.

In Norway, the wage-setting mechanisms carry significant elements of a centralised rather than a decentralised approach. In fact, international ranking places Norway on the top of the list in terms of coordinated wage-setting, although some subsequent adjustment of salaries does take place within individual enterprises (NOU, 2001). As already discussed, experience and long education, do not result in strong monetary rewards, and there is limited wage dispersion overall. Given the differences in productivity performance between sectors, this has contributed to the decline of manufacturing which has had the greatest problems with productivity growth. In recent years, wages have grown on average 2 % above the wage growth of Norway's trading partners. Across the economy, overall wages increased by 5.5 % (European Industrial Relations Observatory, 2003). Wages for public sector employees grew approximately by 6 % in 2002. That some groups within this sector, e.g. teachers, have previously been lagging behind explains only a minor part of the surge in public sector wages.

With current changes in the workplace, professional life is becoming less stable. There are mounting pressures on people to demonstrate preparedness for flexibility and mobility. Ongoing internal restructuring in firms involves shifts towards a greater emphasis on temporary, project-based employment (OECD, 2003*c*). There is also a clear-cut trend in most countries towards enhanced flexibility of various sorts. These include numerical flexibility, which allows for adjustment in the number of hours worked, functional flexibility allowing for changes in work assignments, organisational flexibility, and wage flexibility. While enhancing the capacity of firms to adjust to changing market and customer needs, the trend towards temporary employment raises issues with respect to firms' preparedness to invest in upgrading the skills of staff. In principle, problems of that kind may be mitigated by counterbalancing arrangements with respect to remuneration, for example, lower wages in return for training (Becker, 1993) or structures of remuneration that postpone high returns until late stages of employment (Koike, 1988).

In Norway, the labour market is fairly tightly regulated overall. Despite some reforms in recent years, employers still have a strongly delimited room for governing workers, including as regards lay-offs. It is possible for employers to request changes in the allocation of working hours over time, but this is also known to be costly (NOU, 2001). Meanwhile, mobility between professions, between regions, and between the public and private sector, is low. Wage-setting mechanisms further limit the room for adaptation and for spurring adjustments in work organisation.

Preparedness of people to try unexpected things is greatly important for innovation. Consumers that are open to new ideas are a big asset for innovators. On the other hand, developing new ideas may mean relinquishing established but outdated methods. In order to occur within an organisation, innovation requires tolerance and openness by management, and yet it often involves painful processes. Creativity and innovation may require the stamina of "rebels", and the ability of surroundings to let them have their way in some respects.

In addition to entrepreneurship, discussed in the previous section, "intrapreneurship" is a common instrument for pursuing innovation within a large company.[22] Historically, well-established companies have been – and still are - the cradle of most successful innovations. An important development in this context is the rise of "high-performance workplaces", observable in many countries, which excel in implementing organisational changes conducive to effective exchange of information, multi-skilling, decentralisation of responsibility, strong sense of customer demand, higher motivation among staff, etc. Whereas such companies have been conspicuous in several countries, as noted in Box 3, they have been found less well represented in Norway (NOU, 2001). Still, many firms use, explicitly or implicitly, intrapreneurship programmes to increase innovation and develop new products as well as breed an entrepreneurial culture from within the organisation. Integrating openness to innovation in corporate culture; that is, encouraging conditions that are supportive of radical ideas, is commonplace in companies in the Sunnmore region, and is widely practiced by successful entrepreneurs at Olympic Shipping in Fosnavåg, for instance. Labour market conditions in conjunction with other factors influence the scope for more widely spread, and more effective strategies, of this kind.

The overall labour force participation rate in Norway, which stands at about 75 %, belongs to the highest in the world.[23] There is nevertheless cause for concern in this area. The high participation rate belies the large number of people, around half a million Norwegians, or one-sixth of the labour force, on various transfer schemes (Ministry of Finance, 2003). Disability pensioners make up more than one-half of the number of recipients and 63% of those receiving disability pensions are between 30 and 59 years old. In addition, exit routes from the labour market in the form of early retirement schemes provide fiscal incentives for many Norwegians to prematurely leave the country's tight labour market while severe labour shortages prevail in several sectors. Over one quarter of those aged 55 to 59 have now left the labour market (OECD, *2002d*).

This situation not only evokes substantive social costs, but also means that great numbers of Norwegians are left idle, rather than encouraged to participate in the work place. The case for mismanagement is strengthened by the fact that the pension system fails to reflect an actuarial principle, by which benefits would be directly linked to how much one has earned and for how long one is likely to live. The adoption of such principles would be one way to raise workers'

[22] Intrapreneurship is entrepreneurship practiced by employees within established organisations, normally a large organisation. According to The American Heritage: Dictionary of the English language: "An intraprenuer is a person within a large organisation who takes direct responsibility for turning an idea into a profitable finished product through assertive risk-taking and innovation".
[23] Norway's labour force is defined here as persons between the ages of 16 and 74 years. The labour force participation rate for persons 16-66 years amounted to 76 % in 2002.

Box 3: Relinquishing stewardship

Strengthening conditions for flexibility and innovation has become a key imperative for societies and companies alike. Firm-level studies undertaken in the mid-1990s in a number of countries estimated that one fourth of all companies have undertaken extensive organisational changes in order to upgrade innovative capacity (NUTEK, 1998). Various studies have demonstrated the presence of a strong link between the extent to which firms engage in organisational change and upgrade human resources and learning processes, and their ability to reap the gains of new technologies (Nyholm, 1995; Greenen and Guellec, 1998; Caroli and van Reenen, 1999; Bresnahan et al., 1999; Black and Lynch, 2000; Bertschek and Kaiser, 2001).

With firms under pressure to focus harder on core business, the scope for individuals to innovate within existing firms in ways that do not appear to lead in the predominant direction may be met with resistance. Opportunities for diverse innovations may then require reduced barriers to spin-offs. At the same time, it remains imperative to allow for and encourage those innovations that are potentially critical for raising firms' own performance. Appropriate incentives for staff within firms to innovate, or serve as "intrapreneurs" (Pinchot, 1986), represent a delicate but important agenda for organisational renewal.

Examples of firms embarking on significant innovation-related organisational change can be found in all industries. The characteristics and mechanisms differ depending on sectors, firm-specific factors, cultural context, etc. In Nordic countries, examples of such firms have been highlighted in Denmark, Finland and Sweden. In these countries, employers and well-organised labour unions tend to be constructive partners in raising functional and organisational flexibility. There are some indications that Norwegian firms lag behind their Nordic neighbours in this area (NOU, 2001).

The Royal Dutch/Shell group provides an example of how an energy company is seeking to foster innovation from within. Through the company's "GameChanger process", developed in 1998, the Royal Dutch/Shell's Exploration and Production division is now the leading innovation zone within the group. GameChanger is a process used to fast-track the company's best ideas to market quickly. It is made up of teams that are taught how to identify and challenge industry conventions, anticipate and exploit discontinuities of all kinds, and leverage competencies and assets in novel ways.

Intrapreneurship is further encouraged through seminars and brainstorming exercises. After reviewing viable ideas submitted by employees, planning and development sessions are held and employees are inspired to create viable business plans and 100-day action plans to test their ideas. Strong pecuniary rewards form part of the set-up. The GameChanger team reviews plans submitted and allocate between $100 000 and $600 000 in seed money to projects gaining approval. Funded projects are reviewed after several months to determine "proof-of-concept" for a second round of funding. Projects awarded a second round of funding are integrated into existing business units. Altogether, teams allocate a total of $20 million annually to viable "game-changing" ideas submitted by employees.

Since its inception, the GameChanger has reportedly received over 350 venture ideas and have resulted in breakthroughs in key areas – cheaper exploration, intelligent wells, non-conventional energy, energy conversion and environmental improvement. The overall purpose is to create markets for ideas, partly by giving employees an opportunity for *personal wealth creation*. Such approaches may be controversial in other cultural settings. While successful emulation in other countries requires adjustments, the fundamental importance of putting in place effective incentives in one way or the other applies universally.

incentive to remain in the labour force.[24] Steps to defer retirement age could generate substantive benefits while, at the same time, giving rise to new challenges, e.g. as regards investment in senior education. This would at the same time stimulate innovation in life-long learning, e-learning, and methods for organisational adjustment designed to capture the skills of experienced workers. Employers and work places currently do no not appear fully capable of adjusting to, and making full use of, the special characteristics of older workers.

Like most developed countries, Norway is going through a rapid shift towards a service economy. Employment in manufacturing has fallen since 1970 and the service sector now accounts for 74 % of total man hours worked in mainland Norway. As in many other developed countries, business services represent one of the fastest growing elements of the economy. To some extent this is a reflection of outsourcing of non-core business from manufacturing firms, but there is also organic growth. Strong business services are increasingly the key to adapting and adding-value to various kinds of traditional products. Available evidence indicates that computer-related services and business organisation services are relatively dynamic in Norway, whereas technical and marketing services appear less developed (OECD, 1999). On average, the service sector in Norway has a very well educated work force and displays high R&D-intensity and innovativeness in international comparison (OECD, 2001*d*).

Another important sector, although often not associated with innovation, is that of household services. The number of hours devoted to household services is huge in any society, in total perhaps as high as in the market economy, but in Norway as in the other Nordic countries only a minor part is subjected to professional work. The option to "do-it-yourself" is strongly promoted by the prevailing wedges in labour and indirect taxes, and other work or activities are thereby discriminated and substituted for. Benefits of specialisation are foregone and the driving forces for innovation weakened compared to a situation of more intensive entrepreneurial activities. This serves as a drag on other industries, including high-tech business, where it is essential that staff is motivated and able to continuously train and improve so as to keep abreast of competition in other countries. Such effort is counteracted if individuals have limited opportunities to purchase services which can free up their time for skills development at work. The absence of differentiated services thus risks weakening knowledge-intensive activities throughout.

For the greatest part the onslaught of the service economy takes place within the public sector which, since 1980, grew by nearly 60 % compared with 20 % in Denmark and no increase in Sweden during the same period (Centre for Economic Analysis, 2002). The central government in Norway is smaller than in Sweden and Denmark, local government, conversely, employs three-quarter of the public sector workers, is larger and continues to grow. The expansion in public services contributes to the omnipresence of the public sector in the labour market, where more than 60 % of workers with a tertiary education now work . (Bjornstad 2000).

[24] In a speech at the NHO annual conference in January 2004, for instance, Prime Minister Bondevik stressed that the pension system has to be reformed in order to create incentives for individuals to stay in the labour force.

This situation, together with the availability of favourable social transfers, account for incentives for workers to remain in the security of wage-earning employment. An employee who has fallen ill is entitled to 100 % coverage for a maximum period of 260 days.[25] Employers pay for the first 16 days and the National Insurance Scheme covers the remaining days (Ministry of Social Affairs, 2003). The substitution rate for unemployment is high whereas, for entrepreneurs, benefits are less encouraging. Entrepreneurs are entitled to 65 % of their income from the 17th day of illness for a maximum period of 248 days. In the event of redundancy in a struggling company, the employer has to cover wages for the first three days after which it becomes the responsibility of the government. Recently, the government proposed increasing the period covered by the employer to 20 days.

In the presence of such incentives, much of the population scattered across small distant towns, poor transport infrastructure and services, and most of the academically trained workforce occupied in local governments, the mobility of workers is limited. Norway has, for instance, the lowest mobility rate of educated workers among the Nordic countries (OECD, 2002*b*). While this also applies to R&D personnel in a general sense, researchers who do move tend to leave research institutions and join the public sector (NOU, 2001). Reportedly, the highest rates of mobility are in aquaculture and health/social services (European Commission 2002*a*). Few persons move from industry to research institutions, which constitute an important conduit for technology transfer. Because innovations increasingly arise from a recombination of existing ideas, a certain level of mobility of skilled workers, including among scientists and engineers, is likely to boost the innovative capacity of companies. Through such circulation of knowledge, they are particularly sharpening their ability to exploit opportunities for absorbing existing technologies and ideas from a range of industries and recombining them in novel ways. Hence, R&D-objectives and labour market policies, e.g., in support of mobility, may be crucially complementary in enabling favourable impacts on innovation.

While direct programmes to increase the level of mobility remain widely used throughout Europe, several countries have recently developed schemes which seek to induce such effects through indirect impacts. These include, again, various cluster-initiatives containing packages of measures that aim to pave the way for, or remove barriers to, productive local linkages between related activities. One element is the establishment of joint ventures between companies and research organisations, e.g., 'competence centres' which are aimed to be interactive, flexible and implemented in a decentralised fashion. Austria, Denmark, Finland, Germany, and Sweden are examples of countries where such centres have been seen to generate positive effects. These include the development of new technology-based firms and also favourable employment effects, not least due to improved matching of supply and demand of specific skills. Intensified interactions and increased mobility of individuals, between institutions, professions, and also geographically, are at the core of the processes set in motion.

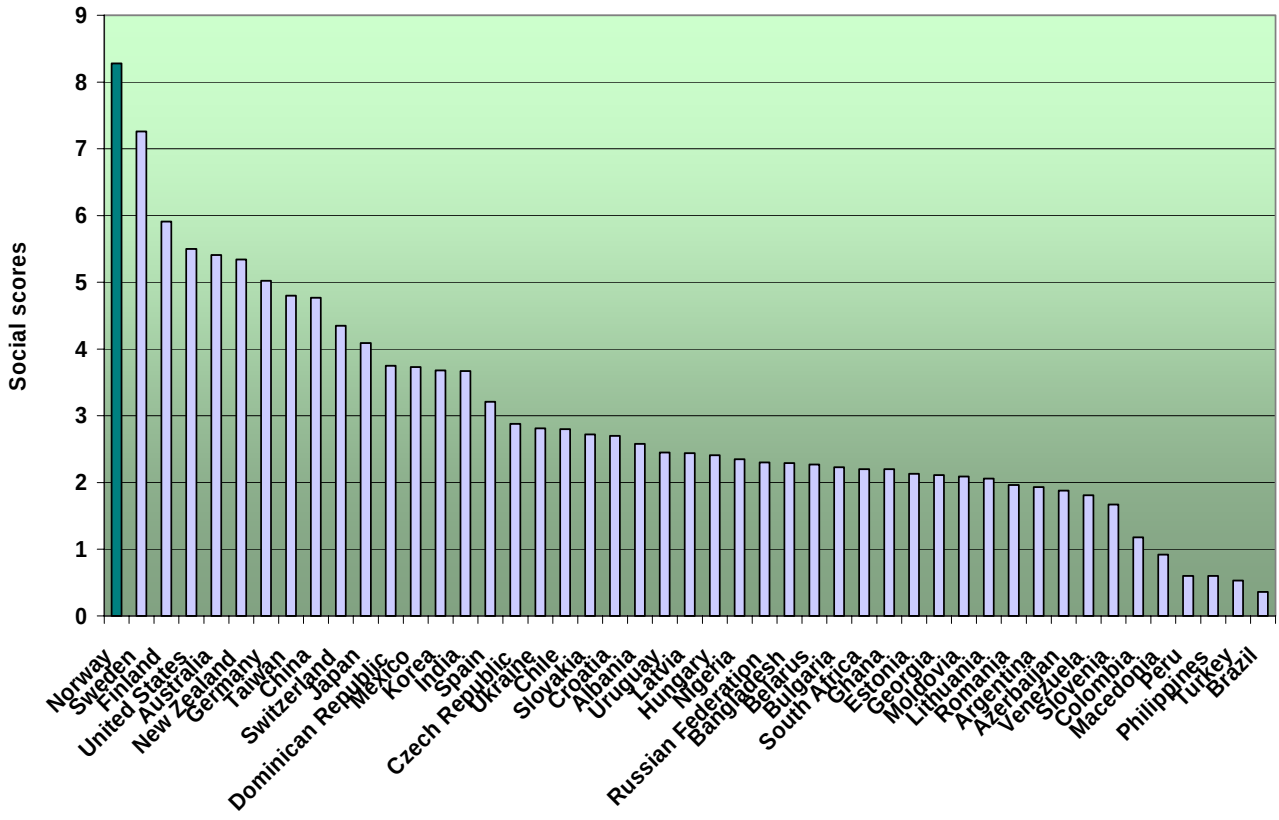
Social welfare systems that provide citizens and workers with strong security may support *trust* in interactions and transactions. This facilitates long-term planning, is beneficial for investment decisions and can support risk-taking. Further, people's contributions to innovation emanate

[25] Although by making extra contributions they can obtain 100 % from the first day, the system is widely viewed as relatively unfavourable for self-employed.

both from their personal achievements and from their contributions to *networks*. The latter are often person-specific, i.e., tacit or sticky in that they carry features of personal bonds between individuals, and may also be embedded in particular local or inter-regional patterns of communication (Asheim and Isaksen, 2002). Adding new and different staff members in an organisation may at the same time be crucial for renewal (Watts and Strogtaz, 1998). The degree to which people are open to a wider range of experiences, move across sectoral or national borders, matters greatly for communication and for the establishment of trust.

In "low-trust societies", confidence is hard to establish outside narrowly defined "family-like" relations, whereas "high-trust societies" allow for relatively easy establishment of confidence in multiple forms of associations (Fukuyama, 1995). Norway is estimated to have the world's highest level of societal trust and communal solidarity (Figure 15). This supports knowledge exchange as well as organisational change within the relatively homogeneous population. At the same time, taken together, current conditions may also serve as a barrier to accepting and trying out complementary experience.

Figure 15: Social trust ranking



Source: Norris (2001).

Value systems that account for high levels of security may conversely serve as breeding ground for complacency. Both monetary and non-pecuniary incentives, such as drive for social approval, may strongly influence the driving forces of risk-taking, which can be deterred both by lack of social acceptance for failure and lack of rewards in the case (uncertain) success would materialise. Again, preparedness for experimentation is affected when people suffer obvious disadvantages from giving up more secure alternatives. Issues arise, for instance, when security systems are *asymmetric*, e.g. between employed vs. self-employed, and between risk-prone and risk-averse entrepreneurship. Generous but partial welfare systems hamper or distort work efforts, entrepreneurship, and innovation. Such effects may be intertwined and it is important to identify main, destructive effects, and strive for politically feasible adjustment.

v) Research and Innovation Linkages

As discussed, Norway's relatively low R&D-intensity has attracted considerable attention over the years. Although Norwegian governments on several occasions declared their intention to raise it, even to the highest levels found in developed countries, little progress has been achieved. Recently, the government made what seems to be a strong commitment to lift it to the OECD average, i.e. 2.2 % of GDP by 2005, and a further increase to 3.0 % by 2010. Achieving these numbers is viewed if not a panacea, at least a critical component in the country's strategy to build a stronger basis for sustainable long-term growth. Indeed, the government has instituted radical changes in public support of R&D, notably introducing a significant tax incentive, coupled with reforms in intellectual property rights aimed at strengthening the incentives for universities and research institutes to support innovation. There have also been reductions in direct subsidies for R&D and organisational changes in the institute sector as well as in the major public agency distributing such support, the RCN.

While public support of science and technology is often motivated by the economic significance of innovation, research is not synonymous with innovation. It is greatly important for Norway to take a critical look at its policy vis-à-vis R&D[26], and to reflect on its role relative other measures that matter for innovative performance. For instance, it is conceivable that the government's emphasis on increased public support for R&D distracts attention from other more – or at least equally – important reform areas. On the other hand, it might serve as a signal, providing a momentum inducing complementary reforms conducive to innovation. Which perspective may be viewed as "correct", or serve as the most constructive building block for policy in Norway at the current time?

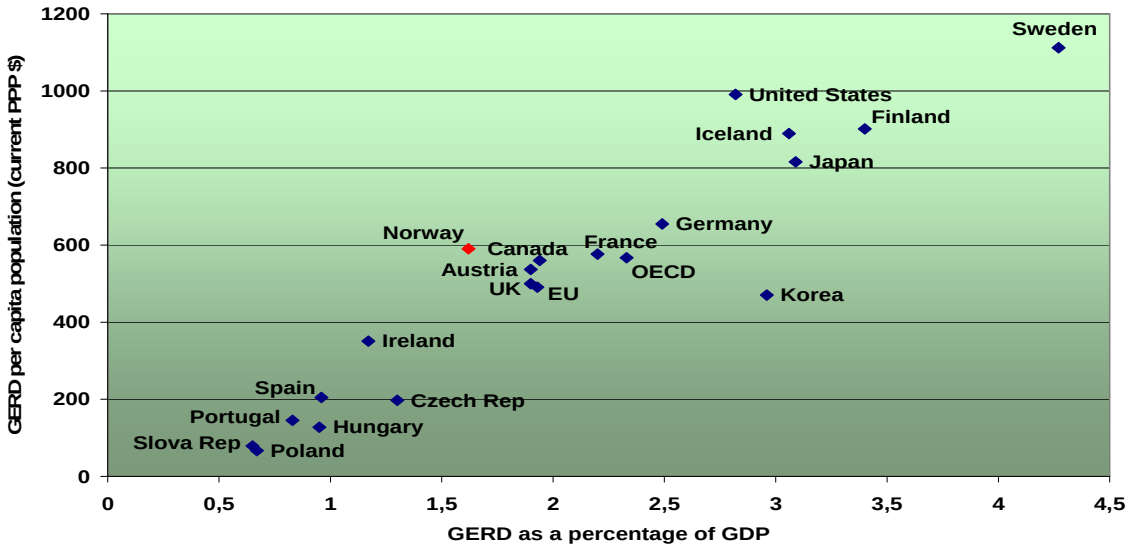
Before addressing that question, let us take a closer look at Norway's position with respect to science and technology. At first glance, Norway's science and research community appears reasonably large compared to other countries, with a relatively high number of researchers per employee (Table 3). Only Finland, Sweden and Japan are markedly ahead among the developed countries. In terms of scientific publications, Norway is performing less well than suggested by the number of scientists (Arnold et al., 2001). The same applies to patent data, although that may be as expected given that the Norwegian scientific as well as industrial

[26] Recommendations for possible actions increasing R&D-activities in the private sector are provided in NOU (2000).

structures are less oriented towards ICT and biotechnology than in some other developed countries, and those areas are today strongly dominating in overall patent statistics.[27]

Roughly speaking, the level of scientific citations and patents are on par with Norway's R&D-intensity (RCN, 2001), which is at a lower level relative to other countries than the ratio of scientists to the population.[28] As the low level of R&D relative to GDP has been identified as a key issue and major policy target, it is useful to reflect on how low the level actually is in Norway. Whereas Figure 4 verifies that a number of countries score considerably higher in this respect, Figure 16 shows that already a comparison between research and population (rather than GDP) presents the Norwegian performance in a somewhat more favourable light. Figure 17 further illustrates that Norway is reasonably well positioned relative other countries as regards the level of *government-funded* R&D relative to GDP (a comparison with population thus positions it even better in this respect). On the other hand, it also displays a relatively low level of *industry-financed* R&D. Indeed, in R&D-intensive economies, the private sector consistently accounts for the lion share of total R&D. While the share of the private sector in Norway increased over the last decades and grew further from 47 % in 1999 to 52 % in 2001,[29] however, it is still low compared to countries with high R&D-intensity overall.

Figure 16: GERD per capita population vs. GERD as a percentage of GDP, 2001



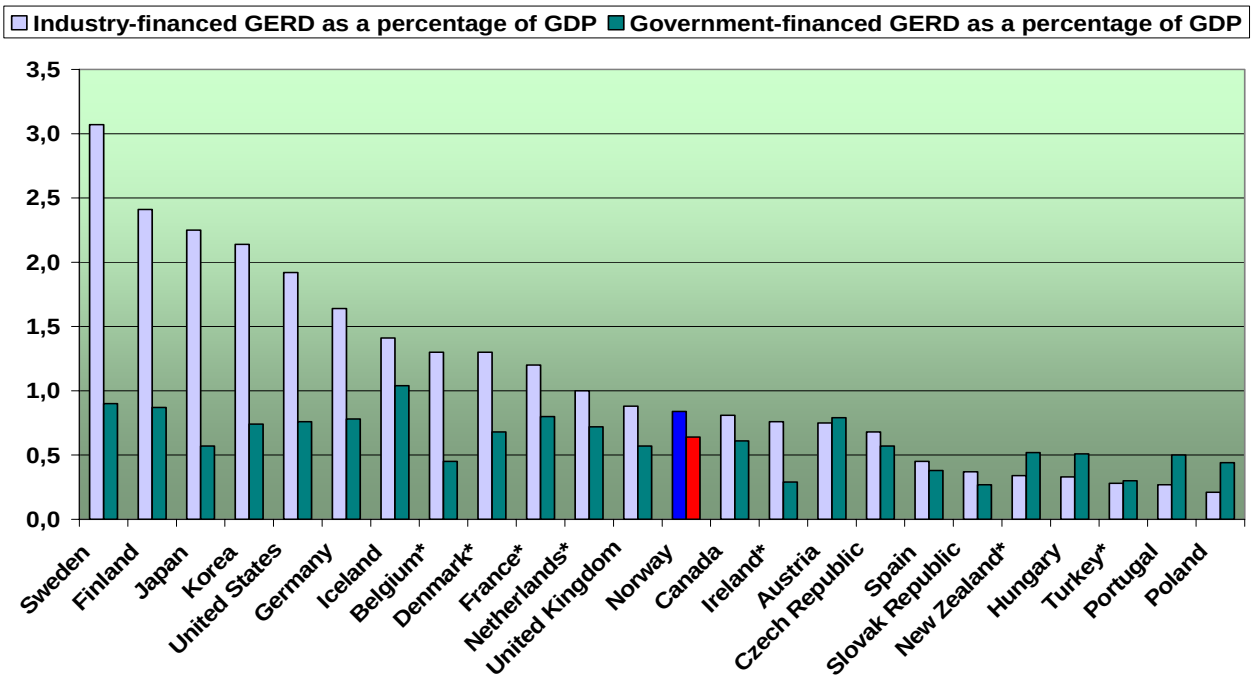
Source: OECD (2003*e*).

[27] It should be noted that the number of Norwegian patents registered at the European Patent Office increased markedly from 136 to 289 per million inhabitants between 2000 and 2001, but one year is not sufficient for signalling a shift in the trend. The number of Norwegian patents granted at the United States Patent and Trademark Office remained on a low of 68 patents per million inhabitants, which is clearly below the EU average of 80 (Eurostat Structural indicators database).

[28] For more detail on Norway's scientific and innovative profile, see OECD (2003*d*) or Gergils (2004).

[29] The Norwegian definition of the private sector is different from OECD's business enterprise sector that is often used in international comparisons. Using the OECD definition, the share rises to 60 %, which is still low in international comparison.

Figure 17: Industry- and government-financed GERD as a percentage of GDP



* Numbers on government-financed GERD as a percentage of GDP from 1999.
Source: OECD (2003*e*).

To put the Norwegian R&D-issue in perspective, additional considerations are warranted:

i) Industries traditionally classified as "low-tech" based on average R&D-intensity, dominate in Norway. Studies controlling for this factor find that Norway has relatively high R&D-intensity in several areas, especially a few typical high-tech industries. Taking industrial structure into account, the Norwegian R&D-intensity looks somewhat more favourable, but still lower than the OECD average (RCN, 2001; Statistics Norway, 2003*a*).

ii) R&D-intensity tends to be systematically lower in SMEs, as they tend to have less capacity to handle the fixed costs and risks involved. The Norwegian industrial structure is geared towards SMEs, with large firms accounting for a small share of overall employment (Table 9);

iii) Within small OECD-countries, R&D tends to be highly concentrated in a limited number of headquarters for highly internationalised multinational firms, which Norway has few of.[30] The reason is that R&D facilities so far remain more concentrated in the home base than in the production facilities of affiliates abroad.

[30] Of the smaller OECD-countries, Finland, the Netherlands, Sweden and Switzerland display the highest R&D-intensity, all of them with the bulk provided by their unusually large home operations for multinational corporations (Andersson, 1998).

Table 9: Percentage distribution of employment in manufacturing firms according to size class, 2001

	1-9	10-49	50-99	100-499	500+
Norway	9.1	21.1	11.5	28.4	29.9
Finland	10.3[1]	14.1	8.0	25.0	42.7
Sweden	7.9	15.5	8.4	21.9	46.3
Denmark	7.8	19.2	10.1	28.6	34.2

[1]0-9 employees
Source: OECD (2002*f*).

No attempts have been made to date to control for the second and third of these considerations, i.e., the size structure and the virtual absence of highly internationalised firms that originate in Norway. Although it is difficult to make a comprehensive assessment in these respects, it appears likely that those considerations explain most of Norway's apparent "under-performance" as regards R&D.

The importance of R&D for innovation is the highest in manufacturing, and in large businesses. SMEs typically lack the capabilities and scope of activities that are needed to both carry out and capitalise on investment in R&D before others do, but rather tend to access and apply the results of R&D already undertaken by others. In fact, despite low R&D-intensity, many SMEs are innovative due to flexibility and ability to innovate through incremental improvement. The difficulties for SMEs to invest in R&D are compounded by the framework for intellectual property rights, which displays severe weaknesses at global and European level. Individuals and small firms are badly equipped to gauge and manage the risks of costly legal disputes in the current uncertain landscape. Such considerations underline the problems of a policy of R&D-support targeting SMEs.

Likewise, the *service sector* has low R&D-intensity worldwide, and Norway is no exception. Nevertheless, the service sector accounts for around one third of total business expenditures on R&D in Norway, which is high in international comparison (Statistics Norway 2003*a*; OECD, 2001*d*). As noted, 30 % of enterprises in the service sector reportedly introduced a new or considerably changed product or process between 1999 and 2001, compared to 36 % in manufacturing. The highest share of innovative enterprises is in telecommunication- and computer services. A relevant observation is that the use of expenditures on R&D as a measure of innovativeness is misleading because important means for innovation in the service sector, such as organisational change and customer feedback, tend not to hinge on such costs.

Related to this, the value of *intellectual capital* – intangible assets that are crucial for innovation - is difficult to measure and communicate. Efforts are now under way to remedy the situation. This is notably occurring through vigorous experimentation pursued by individual firms to develop their specific reporting schemes, for the purpose of improving understanding among internal as well as external resource providers which investments matter crucially. Some

governments and public agencies seek to catalyse such efforts, e.g., through public campaigns or in the context of public procurement. This is usually done to stimulate innovation, skills upgrading and higher value-added as well as to spur more socially responsible behaviour by firms. The Danish and British authorities, and private firms in the United States, Denmark, Finland and Sweden, belong to the most advanced. International initiatives launched to stimulate internalisation by firms of previously external effects on the environment and on social values, are pushing similar results.[32] The benefits from collecting and diffusing more sophisticated information on firm-specific assets, and their social ramifications, are on the increase.

All in all, Norway may not have a low R&D-level once industrial and firm structure, etc., has been taken into account, and R&D represents only a subset of what matters for innovation. Norway does display a low level of private sector R&D, and raising R&D in that sector appears a prerequisite for reaching the overall levels aimed at by Norway. However, the critical test for public support of R&D is whether the social returns exceed the private returns to investors. To the extent that is the case, and given that public support can compensate for the discrepancy, the policy is motivated as a response to a clear-cut market imperfection. It pays for society as long as the benefits generated exceed the costs of the measure. A number of studies in different countries have concluded that the social rate of return to R&D normally does exceed the private return (OECD, 2001*b*). All developed countries do provide significant public support for R&D since several decades, all of them through direct subsidies and some of them through indirect fiscal support, normally tax deductions. It is also commonplace that some schemes involve an element of targeting, i.e. provide a greater level of support to prioritised industries or to some special category of firms, in several cases SMEs. On the other hand, there are often incentive problems to public support schemes, for example showing up in poor *additionality*, i.e. not much of a real increase in the level of R&D due to the public support provided (OECD, 1998). Due to the noted difficulties of achieving results, not least in regard to SMEs, some countries have cut back on support vs. these firms and instead attempted other approaches, such as the recent emphasis by Japan on cluster-initiatives, noted in Box 2.

In most developed countries, there is currently a strong development of new measurement techniques to try and improve *evaluation* of innovation policies, including R&D-support. On the other hand, there are remaining deficiencies in evaluation, including notably:

i) overemphasis on efficiency of resources used rather than economic outcomes,
ii) focus on limited, marginal schemes rather than systemic considerations, e.g., including whether problems are addressed most effectively, and also
iii) weaknesses in the institutional set-up for evaluation, which prevent the results from being fed back into the design and implementation of new policies.

For such reasons, and also because of the difficulties in applying as encompassing time horizons as ideally needed in the context of technical progress and innovation, there are clear limitations to what is measured, and remaining uncertainty in many cases whether R&D-support is socially profitable.

[32] These include the UN-led Global Compact and Global Reporting Initiative (GRI), and the OECD's guidelines for Multinational Enterprises. The EU is under way to implement extensive accounting-related requirements leading in the same direction.

Then again, does it make sense for Norway to reach such levels of R&D intensity as have been postulated, and if so through what means? Quantitative measures of progress, such as R&D-intensity, are generally desirable because they are easy to communicate, but scoring high to look good in international comparisons should not be a goal in itself. Chasing quantitative targets carries the risk of ending up with a statistical artefact. Qualitative estimates and applying judgement must therefore complement numbers in evaluation. In fact, the ratio of R&D-expenditures to GDP is a shaky and partly unpractical policy target. The denominator is GDP - a measure of welfare, which in itself is a policy objective, whereas R&D-expenditures serve as numerator. Thus, in case R&D-expenditures grow at the same rate as GDP, R&D-intensity will remain unchanged. Given that R&D helps increasing GDP, a further increase in expenditures is required to sustain the ratio. Moreover, in case R&D can be made more effective, a reduced R&D-intensity might actually be desirable, if driven by a greater contribution to GDP generated per NOK spent on R&D.

Related to this, the social benefits of R&D are not a given. Econometric examinations of R&D and economic performance across countries over time have documented that significant impacts are dependent both on the kinds of R&D undertaken and how they are combined (Guellec and van Pottelsberghe, 2001). Although the distinction is far from straightforward, many countries have recorded a tilt in recent years away from basic towards applied R&D which, compared to basic R&D, is likely to generate relatively greater private rather than social returns. This has given rise to concerns about negative implications for long-term growth while also raising questionmarks for some general R&D-support, since the lower incidence of spill-over effects provide less of a rationale for policy interference in the case of applied R&D.

As for the sectoral distribution of R&D, Norway's natural resource based industries account for close to 10 % of total R&D expenditures (Table 10). At the same time, they attract a large number of the most lucrative proffessionals in science, engineering, and commerce. The metal industry is more R&D-intensive in Norway than in any other European country. In marine industries, rapid diffusion of new technologies and products has been observed within dynamic and highly diversified clusters (Wiig Aslesen et al., 2002). Oil and other natural resource-based industries must in fact not be seen in isolation, but represent a big source of knowledge-generation and skills upgrading that probably could play a greater role than is currently the case in revitalising the economy more broadly (Box 4).

The social value depends not only on the kind of R&D, but on the presence of complementary enabling factors and processes. Again, apart from generating certain direct outcomes, R&D matters for cherishing various competences. R&D is important for developing the skills required for attracting and using technologies broadly. Firms' ability to source new technology internationally has, for instance, been shown to be strongly related to in-house R&D (Andersson, 1998). The ongoing shift away from natural sciences and technologically-oriented activities in Norway appears mutually linked to the absence of focus on R&D. It is further connected with the evolution in attitudes towards shunning risk while embracing secure jobs that directly or indirectly are supported by public sector expansion. Given the limited size of the industrial sector, and available researchers and workers with relevant skills, a considerable number of new jobs would also have to be filled. According to some estimates, 13 000 jobs are needed in order to achieve the prescribed policy goal (RCN, 2001).

Table 10: R&D expenditure by industry, 2001 (NOK million)

Industry (SN 94)	1999	2001
Fishing, operations of fish hatcheries and fish farms (5)	169.4	288.9
Extraction of crude petroleum and natural gas (11)	782.4	736.3
Total industry and mining (13-37)	4 740.8	6 660.1
Of which: Chemicals and chemical products (23-24)	942.7	1 039.0
Machinery and equipment (29)	569.2	870.6
Electrical and optical equipment (30-33)	1 853.0	2 691.3
Transport equipment, furniture and other (34-37)	370.2	796.6
Other industry and mining	1 005.7	1 262.6
Electricity, gas and water supply (40-41)	80.3	84.4
Construction (45)	51.8	260.8
Total services (50-99)	3 715.3	4 583.2
Of which: Transport and telecommunication (60-64.2)	747.9	795.7
Financial intermediation (65-67)	196.0	449.8
Computer and related activities (72)	1 560.1	1 941.6
Other business activities and consultant services (74)	874.9	768.5
Other services	336.4	627.6
Total	**9 540.0**	**12 613.7**

Source: NIFU

Box 4: Turning oil and gas into a broader knowledge resource

In several countries, the defence sector and related institutions have been central to innovation. Commercial exploitation of some key technologies would not have been possible without government development and support. Many observers believe that part of the explanation behind the United States dominance in high technology markets lies in the country's cross-subsidisation of civilian' technology by investments in military R&D (Reppy, 2000). Many management and accounting innovations, especially techniques for administrating large-scale, complex programmes, can indeed be traced back to the US defence sector. For instance, through the two programmes Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) the Department of Defence fund over $1 billion each year in early-stage R&D projects at small technology companies. These aim to serve the US defence industry needs and to generate successful commercial applications. Companies retain the intellectual property rights to technologies they develop under these programmes.

Does the petroleum industry in Norway have a greater potential than realised today for serving as source, customer or financier of new processes and products more broadly, that would be similar to what the defence industry has done for many years in some other countries? This is both a matter of the nature of technical advances and learning processes in oil and gas on the one hand and how that relates to other sectors on the other hand.

Judging from political rhetoric, the objectives of the government's policy regarding oil and gas are strongly influenced by concerns for long-term resource management. According to Report No. 38 to Stortinget (2001-2002) (Ministry of Petroleum and Energy, 2002), the government:

- will ensure that the petroleum sector remains a significant contributor to financing the welfare state and to nationwide industrial development,
- will lay the basis for continued development of the petroleum sector by ensuring that the Norwegian continental shelf remains an attractive area for investment, value creation and industrial development,
- will pursue ambitious environmental and resource management policies,
- aims for the petroleum sector to be a leading-edge industry with a strong focus on health, safety and the environment at all levels with a view to continuous improvement, and
- aims to contribute to the internationalisation of the Norwegian oil and gas industry.

In practice, R&D-intensity measured as, e.g., the share of innovation costs in turnover, is low in oil and natural gas extraction. While the sector is still a significant spender in absolute terms, it appears to underperform in R&D. According to the Norwegian Petroleum Directorate (NPD), the oil companies do too little to achieve long term goals such as improving oil recovery or increasing the effectiveness of exploration activities, but are excessively focused on short term goals of expanding production (NPD, 2002 and 2003). Meanwhile, the complexity of the issues encountered in marine oil and gas exploration must not be understated. Under-investment in R&D can result in, e.g., slow introduction of new methods to raise the exploration rates of oil drills.

The current R&D-policy in Norway as regards oil and gas is, in fact, primarily based on political and, notably, general macroeconomic considerations. It fails to reflect financial or socio-economic considerations of the returns to R&D in the sector or the economy as a whole. The situation must be viewed as an example of economic mismanagement on a grand scale, where potential benefits of more effective exploration are foregone and the long-term returns to Norway diminished relative to potential. This kind of situation may be acceptable in countries facing a severe trade-off between short-term development needs and long-term resource management, but makes little sense in Norway. As regards mechanisms for exerting favourable impacts on other sectors, the low mobility of researchers and experts to other sectors, weak conditions for outsourcing and spin-offs of new technology-based firms, the undeveloped state of venture capital markets, and the shortage of dynamic entrepreneurship, further underline the impression that the potential of the oil sector to serve as a major engine for broader technological and industrial development is far from fully tapped.

Table 11: Government budget appropriations or outlays for R&D[1] in Norway by socio-economic objectives, 2002-2003 (NOK million)

Socio-economic objectives	2002	2003
Agriculture, forestry and fishery	1 253	1 093
Of which: fishery	*837*	*653*
Industrial development	992	1 041
Production and distribution of energy	244	223
Transport and telecommunications	224	249
Living conditions and physical planning	19	18
Environment	301	299
Health	839	920
Social conditions	140	168
Culture, mass media and leisure	127	138
Education	82	81
Working conditions	99	82
Economic planning and public administration	353	397
Exploration and exploitation of the earth and atmosphere	223	243
General advancement of knowledge	5 628	6 349
Space research	247	240
Defence	495	501
EU contingent	558	310
Total	**11 824**	**12 352**

1. Includes resources for R&D performed in Norway and abroad, final budget.
Source: NIFU (2003).

An important consideration concerns who *performs* and who *funds* R&D. A major expansion of R&D must no doubt occur in the private sector, which is where Norway is really under-performing. Such an increase could only occur given public support. Present support structures in Norway require consideration. Table 11 for instance, which shows a sectoral distribution of R&D-support according to socio-economic activities, the agricultural sector receives a considerable share. Here, efficiency is clearly hampered because the sector is subjected to excessive public protection, reducing driving forces for structural change associated with innovation. This is merely one example that priorities influencing the direction of public R&D-support may require consideration.

So far, direct support in Norway has mainly been operated through RCN, the Norwegian Industrial and Regional Development Fund (SND) and the established industrial research institutes. Besides direct grants from government ministries, where the Ministry of Trade and

Industry and the Ministry of Education and Research are the largest, the RCN is the biggest institutional source for R&D-funding. The council's share of public funding is about 25 %, and it accounts for approximately 10 % of total R&D. The RCN represents the government's advisory body based on a broad policy perspective of R&D. It coordinates all research fields including the institute sector and international research cooperation, and works for further integration between basic and applied research.

There has been extensive debate on RCN's achievements and organisational structure (Arnold et al., 2001). In the autumn of 2003, the council assumed a new administrative shape. The major change consisted in the move from six discipline areas to three task orientated departments - for basic research, innovation and applied research - and strategic programmes respectively. The aim of the new structure is to improve internal coordination. On the one hand, it appears likely that the revised structure, given its clear mandate, will facilitate well-coordinated outcomes. Staff has been moved between traditionally separated spheres, and old reporting lines have been adjusted, which provide new impetus. On the other hand, there are some worrying signs. First, clear strategies seem to be lacking in some areas, e.g., in regard to objectives of programmes as regards social vs. private benefits. Second, in large scale programs, it similarly appears unclear what criteria are to be applied for measuring success. Another observation is that the division for basic research has obtained the coordinating responsibility for the institutes. This may prove not uncomplicated given the sector's obvious connection to innovation. As it appears that the department for innovation will be the one engaged most closely with the industrial institutes in day-to-day work, frictions may be anticipated. It is too early to tell, however, whether such issues will appear and to what extent the new setup will prove beneficial. During 2004 the Ministry for Education and Science will outline a revised grand design for Norwegian institute policy, presented in a White Paper to the Parliament.

The *institutes* support especially technology diffusion, absorption and use, by serving as translators of academic knowledge towards the public and private sector. The institute sector is a relatively large player in Norway, almost as large in terms of R&D as the universities, and considerably larger in relative terms than in most other developed countries. One explanation for this may be that the statistics also cover institutes that conduct research among other tasks, such as museums, which boost the size of the sector especially when counting numbers of institutes (Skoie, 2003). Many institutes face challenges with respect to sense of relevance, and must increase their adaptability to new trends. According to the RCN (2001), the institutes are struggling with an identity problem caused by an overload of contradictory requirements. Institutes are called upon to be both market-oriented and policy-relevant in their research, while at the same time developing fundamental long-term technology, contributing to training of researchers.

Considering the number and size of projects the sector appears to play a smaller role in private research than what would be suggested by the financial flows involved, although a thorough evaluation is lacking (Broch et al., 2002). Most of its research is financed by the public sector, with one-quarter of funding coming from the private sector. However, critique has been presented that the level of basic funding would be too low, hampering research initiatives of the institutes and forcing them to look for projects outside their turf in order to secure funds (Skoie, 2003). Competition for funding is intense among institutes and, in addition, there is no clear

demarcation line between them and private consultancy firms, neither with respect to private nor public projects (Ekeland and Bugge, 2002).

The *universities* naturally differ from the institutes through their primary role in education, and their embeddedness in, and reliance on, academic credentials. Scope for "free research" serves as a life-line for universities in order to ensure critical integrity, attractiveness in recruitment of new researchers, and in order to lay the basis for truly path-breaking research. Compared to the institutes, universities are less involved in private sector cooperation. This is changing, however, most notably through intensifying links between the Norwegian University for Science and Technology (NTNU) and the oil industry (Trondsen, 2002). In contrast to the institutes', with their longer experience of such interlinkages, universities are only in the early stage of building the

Box 5: The structure of research in institutes and universities

Compared to other countries, Norway has a sizable public institute sector for R&D-efforts. In 2001, it accounted for NOK 5.6 billion, or 23 %, of total R&D-expenditures. This is almost as much as the higher education sector, with NOK 6.3 billion, or 26 %. Applied research accounts for more than 61 % of total R&D expenditures in the institute sector, while 13 % goes to basic research. The final 26 % is devoted to development work. The corresponding figures for the sector for higher education reflect a different picture where the share of applied research is 36 %, basic research 49 % and development work 15 % of total R&D-expenditures.

The institutes are mandated to serve both public and private interests, especially SMEs that would not otherwise engage in R&D. They are divided into "research institutes", with research as their main activity, and "other institutions that conduct R&D". The former account for above 80 % of the institute sector's R&D-expenditures, half of which consists of technology and natural science with an industry focus. A quarter is so-called prime research, which is targeting farming and fishing. Research related to the environment and culture has obtained 10 % each of the total funding. All in all, there are 125 institutes in Norway, with some 9 000 employees. Roughly 60 % of income is public money, of which one third represents basic funding in support of developing the institutes, increasing competence and underpinning strategic long-term research. The remaining public funds are tied to projects or commercial tenders.

The sector for higher education has about 21 000 employees. Here, research mainly covers mathematics and natural sciences, medicine, and social sciences, accounting for 20-30 % each of total R&D-expenditures in the sector. With Norway following international trends, the universities overtook the institutes as the biggest research entity by 1998. The single largest and most important technology- and science-based university is NTNU in Trondheim, which co-operates closely with Norway's prime industrial institute, SINTEF. Oslo University has the largest student population, 30 000, and an R&D-budget roughly equivalent to that of Trondheim, approximately NOK 1 billion. Oslo is strong in social science, medicine and natural science. The third biggest university is in Bergen, with a research focus similar to that of Oslo. The fourth university, in Tromsø, serves as centre for the development of marine industry.

competencies needed for effective partnership with the private sector. It is important they are free to do so based on their specific credentials, and in a way that is in line with their natural role in the innovation system. The fundamental values of free research must not be jeopardized by institutional reforms or the introduction of competition-based research funding. The task is rather to provide room for alternative career and development paths, so that researchers do encounter effective options to go down the road of generating innovations and supporting their commercialisation (Box 5 makes observations on the institute sector and universities in R&D).

A development anticipated to improve the role that universities play in the commercialisation of research is the new law on *intellectual property rights* passed in November 2002. The law strengthens the stake of the institution versus the individual researcher in regard to the property right of an invention, as well as the revenue it generates.[33] In this move, Norway has followed an international trend which aims to reconcile the incentives of universities and research institutions, on the one hand, and individual researchers on the other, in the development and commercialisation of scientific results (OECD, 2002*a*; Commission, 2003). Whereas potentially beneficial, however, such division of property rights is typically not sufficient for raising the incentive of universities to support commercialisation in situations where they are subjected to strict central rules. For universities to really respond, and benefits to accrue, public policies typically should allow or even actively encourage competition between universities at several levels (Goldfarb and Henrekson, 2003). Although conditions in Norway are ambiguous in this respect, and the discussion is ongoing what level and sort of autonomy is desirable, tangible evidence of effects is reportedly becoming visible, at least in some universities. The precise governance structures, including principles for funding and achieving a fine balance between basic science and openness to industry cooperation, still raise issues that require additional analysis, as well as tracking of continued developments and impacts in years to come, of reforms already undertaken.

In technologically leading countries, about 90 % of all patents and new commercialisation spring out of research activities carried out within large firms, with the rest flowing from universities and research institutes. Moreover, research and patents leading to commercialisation stemming from large firms tend to generate higher returns and, to the extent they are developed by spin-offs in the form of new enterprises, display a higher probability of survival and fast growth than do new entrants in general. On the other hand, of the patents belonging to large firms, a rather small ratio is never commercialised. In part, this may be due to strategic behaviour as some patents are "defensive" and not meant to be commercialised. Beyond this, however, commercialisation of patents is also diminished by the presence of barriers to outsourcing risky projects, including mechanisms for starting new firms.

Over the last 8 to 10 years, Norway has developed several new, both direct and indirect, instruments to induce R&D and innovation in SMEs. This is a challenging task and many countries have had limited success in public programmes supporting R&D in SMEs. Japan belongs to those that changed tactics a few years ago, and switched to activities that strive to underpin competitiveness through network- and cluster-promoting measures. In Norway, direct support programmes include notably Mobilisation for R&D-related Innovation Programme

[33] See Odelstingsbeslutning nr. 10 (2002-03) for more information.

(MOBI) and FORNY. MOBI mobilises R&D-related innovation and incorporates sub-programmes such as Technology Transfer from Research Institutes to SMEs (TEFT), which support technology diffusion to manufacturing corporations with 10-100 employees. FORNY aims to support commercialisation of R&D by enhancing the linkage between innovation and start-ups.[34]

As for indirect support, many countries have likewise offered significant tax incentives without recording notably higher levels of R&D in SMEs. In Norway, a granting system for SMEs investing in innovation, with a limit of one million NOK per enterprise, was recently reorganised into the tax credit system for R&D-expenses, SkatteFUNN. The scheme has quickly managed to reach a much greater population of SMEs than previous programmes in support of R&D. Of the applications for tax reduction, 96 % have been from new "customers" at RCN, and over 50 % from the ICT-sector. The total budget for these projects in 2002 was about NOK 4.5 billion, whereas the estimated tax reductions for 2002 were approximately NOK 760 million. According to the observations so far, SkatteFUNN is poised to increase the R&D-intensity of Norwegian industry, not least due to its wide reach as it attracts attention by SMEs throughout the economy. It is also in the process of bolstering a higher level of general *awareness* in enterprises of R&D and associated costs and benefits, including the various programmes for R&D-support available in Norway and abroad. On the other hand, it is too early to judge the programme's impact on the performance of individual companies or the enterprise sector as a whole.

With the introduction of SkatteFUNN, indirect support of R&D has taken on a greater role in Norway. Direct support to R&D, technology diffusion and commercialisation processes, on the other hand, has been subjected to certain cuts.[35] This forms part of a broader strategy favouring indirect public support measures while diminishing direct support. Whether substitution of that sort will prove beneficial in part depends on the extent to which the indirect measures prove to generate additionality, whereas the reductions focus on the least effective direct support measures. Gauging whether these conditions are in place will require careful scrutiny. Another aspect is that the combination of measures should be designed so as to radiate a message that the government aims for a more effective overall strategy to boost socially beneficial R&D.

Again, public support of R&D is motivated by the *discrepancy* between private and social rates of return. On the other hand, there are problems with additionally, as public support may simply just replace private funding that would have taken place anyway, without igniting an increase in R&D efforts. Related to this, all R&D is not the same and is not characterised by the same level of return, or the same relation between financial and social returns. Ideally, public support generates higher returns to the extent that it manages to boost research in areas characterised by the greatest discrepancy in returns while also invoking the greatest additionally, meaning that it manages to target those areas where there are real problems and where real results can be achieved.

[34] See Iversen (2003) for a survey of SME and innovation programs.
[35] SkatteFUNN surpassed the budget for other more direct measures that the Industry and Energy department had at its disposal in 2002 by approximately NOK 130 million. The budget of this department was cut quite in 2002, affecting applied research (Research Council of Norway, 2003).

In principle, tax incentives and indirect R&D-support are generally more neutral in respect to funding of R&D in different operations which, among other things, enables reaching out widely among different kinds of actors and firms. Measures providing direct support of R&D, on the other hand, may more effectively be targeted to those areas where the gap between financial and social returns is the largest and where it can be bridged by policy. They may also have greater flexibility to encourage various kinds of innovative effort, rather than merely boosting the monetary value of investment in R&D. By offering complementary value-enhancing mechanisms, direct support may also help generating higher additionally. A strong prevalence of SMEs and services, in which innovation is less dependent on R&D than in manufacturing, further speaks in favour of direct support measures. On the other hand, as already discussed, no complete information is available on returns to R&D or on the effectiveness of public support, suggesting that the discretion that tends to be practiced in direct support programmes can also result in costly mistakes. For such reasons, an effective R&D policy should strive for an appropriate balance between direct and indirect support.

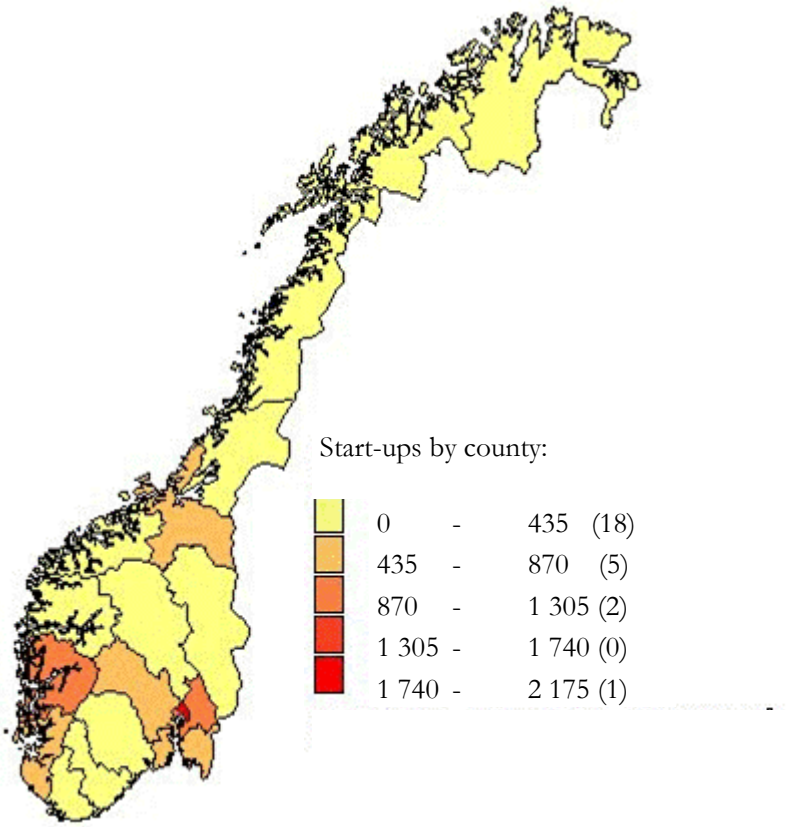
Whether the ongoing changes in indirect and direct support of R&D will help close the gap between social and private returns in innovation, and strengthen the effectiveness of the Norwegian innovation system as a whole, remains to be seen. It is too early for any general assessment of results, given the recent date of changes in the IPR-law and SkatteFUNN as well as the cuts in direct support programmes. Tough questions nevertheless remain whether a real increase in R&D will be achieved, and also whether an increase in R&D to the levels aimed for through the mix of strategies and instruments currently pursued is optimal. In the last chapter we will return to the issue what use of indicators and quantitative targets may be desirable.

As stressed, what outcomes are achieved as well as their consequences for society and for the economy will strongly depend on the way in which the policy in regard to R&D is effectively integrated within a broader comprehensive approach. Public support of R&D must not be pursued in a vacuum. In Norway, it is now pivotal that the policy of upgraded and redirected R&D-support is appropriately accompanied by measures strengthening complementary competencies, more competitive markets and other conditions enabling higher returns to R&D and greater innovative efforts in a general sense. While some of this work must be done at national level, local competencies and strategies are also greatly important.

vi) Logistics and Regional Development

While national policies and conditions matter greatly for innovation, so do factors that are *local* in nature. This can be seen in the case of entrepreneurship/start-up rates, which vary considerably between regions within individual countries, including Norway (Figure 18). The level of entrepreneurship locally tends to be negatively correlated with the relative size of the public sector and positively related to education levels. Meanwhile, the extent to which regional clusters with advantageous links evolve, is not a given. Studies from different countries point to

Figure 18: Start-ups by county, Norway



Source: Statistics Norway.

the significance of competencies in public authorities and which strategies they pursue (Freeman, 2002; Andersson et al., 2004). What innovation policy is actually implemented is much dependent on what is done at local level. At the same time, local strategies must not be inward-minded but be able to connect to, and make use of, the opportunities brought by the internationalisation of product and factor markets (Mytelka, 2000).

Norway is a highly diversified country, rich in rugged natural beauty stretching across mountains and encircling the sea as it breaks into the land through *fjords*. It is diverse in local culture split up in towns and villages far apart in the sparsely populated countryside. People all over the country keep a close connection to their origins and many give priority to excursions in the weekends to meet their relatives and be close to nature. Most of the regional variation in incomes emanate from the gap between Oslo and rural, peripheral areas. While the latter display varying industrial and economic structures, however, heavily subsidised infrastructure and services still sustain relatively similar income levels as well as standard of public services.

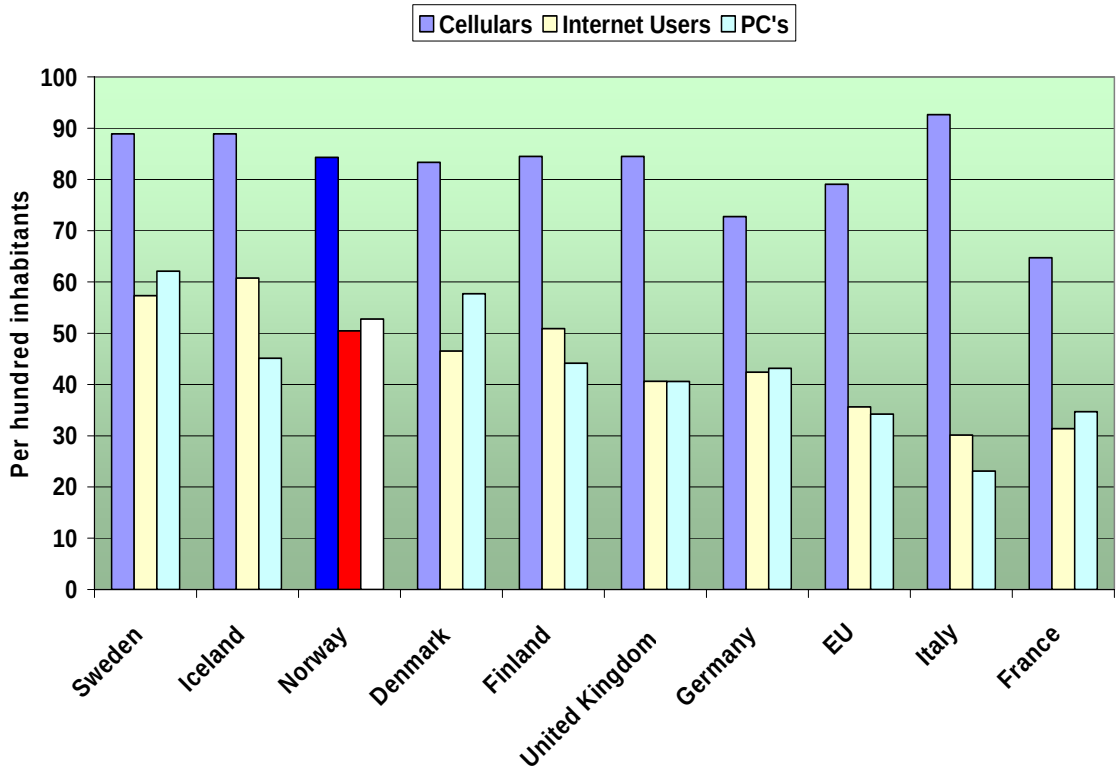
As for R&D, most capacity is concentrated in Oslo, Sør-Trøndelag, Akershus and Hordaland, measured both by absolute expenditures and expenditures per capita (RCN, 2001). The share of private sector expenditures is particularly high in Buskerud, Aust-Agder and Rogaland. In Oslo, Akershus, Hordaland, and Aust-Agder, R&D expenditures by the private sector are concentrated in ICT, while in Rogaland and Sør-Trøndelag they are concentrated in Offshore-technology (Gundersen, 2002). Rogaland, together with Oslo, has the highest concentration of private sector patent applications, while in Sør-Trøndelag it is the sector for higher education that dominates.

A common perception is that distant and sparsely populated regions would tend to suffer an irrevocable handicap in attractiveness and skill accumulation. Bit by bit they would be losing out due to emigration and the delocalisation of increasingly mobile industries, and be left with dependency on natural resources and a few idealists. Such trends are today commonplace in many parts of the world. In Norway, peripheral areas in the north typically has low unemployment levels, reflecting a particularly active labour market policy in those parts of the country (NOU, 2001). At the same time, those regions display high dependency on public sector services and subsidies, and attitudes are often unappreciative of entrepreneurship. Marginal improvements in process technologies are generally embraced, but innovations that hinge on more radical experimentation and outsourcing tend to meet with difficulties. On the other hand, such regions are not universally subjected to stagnation, as exemplified by Iceland, Australia, New Zeeland, and also some individual municipalities in the Nordic countries.

Skills and innovations that emanate from the special features of peripheral regions can provide the basis for various high-value added products and services, as in the case of cold-proof automobile equipment in Iceland, the blue lagoon of Reykjavík, the ice hotel of Jukkasjärvi in Sweden, or offshore oil drilling in cold seas developed by Norway. Rather than based on R&D, this kind of innovations spring from new ways of responding to a growing demand for space and untouched scenery, by packing services in the form of attractions that become exotic and unique. If rightly handled, technical progress (see Box 1), internationalisation and the new communication tools offer ways of designing, managing and diffusing information on new services in distant regions. This is highly relevant for Norway, which is leading in the diffusion of cellular technology.

ICT-infrastructure beyond doubt harbours great potential for rural areas. In an international comparison, Norway is doing well regarding the use of cellular phones, Internet and PC's (Figure 19). However, broadband access so far remains underdeveloped in rural areas, where levels of entrepreneurship are low and few new technology-based firms created. Today it is mainly businesses and private persons in heavily populated counties that can enjoy the advantages of high-speed access (Statistics Norway, 2002*b*), although projections hold that in the year 2005 as much as 85-90 % of the population will have access to broadband (Ministry of Trade and Industry, 2003*b*). Meanwhile, other issues, related to trust and control of misuse of the Internet, also need to be tackled (see further below).

Figure 19: ICT infrastructure per hundred inhabitants, 2002



Source: International Telecommunication Union (ITU).

The administrative set-up in Norway carries marked features of both centralised and decentralised structures. The local administration is split in more than 400 municipalities, half of which have less than 5 000 inhabitants. On the regional level, there are 19 county councils. Neither the municipalities nor the county councils have the right to levy taxes, but rely heavily on obtaining funding from central authorities. The Norwegian Parliament decides how to allocate resources, and decides the framework for the welfare and educational activities conducted at local or regional level.

On January 1st 2002, the central government charged responsibility for the hospital sector, taking it over from the regional counties. The hospitals are now organised as enterprises with the central government as owner. Local authorities carry the responsibility for childcare, basic schooling and care for the elderly. The regional counties have responsibility for further education, except universities, and for local transportation. In total, the municipalities and county councils account for 60 % of public service production in Norway.

Even the so-called regional or district policy is conducted by the central government, although implemented locally in each county by special authorities. These are SND and The Industrial Development Corporation of Norway (SIVA), a seed funding institution. In January 2004, the SND was merged with the Norwegian Trade Council, the Norwegian Tourist Board and the Government Consultative Office for Inventors, into what is called Innovation Norway. The new organisation will, as its overriding target, promote an internationally competitive Norwegian business sector. Through this reorganisation the regions are set to gain somewhat greater influence over public means and become more important players in fostering business development. It appears clear, however, that these entities have a thin fabric in terms of activities that are experienced and traditionally confronted with issues of research and innovation. This suggest a lack of competence on research-based innovation in the new system for support of regional innovation processes which is worrisome and, unless compensated for, is likely to cause problems in the future.

The government has proposed several changes in municipalities' framework conditions in support of enhanced efficiency (Ministry of Local Government and Regional development, 2003). It is also acting to improve administration and regional co-operation, e.g., through inter-municipal cooperation and mergers in order to help generate more effective nodes for local development and underpin critical mass in administrative units.

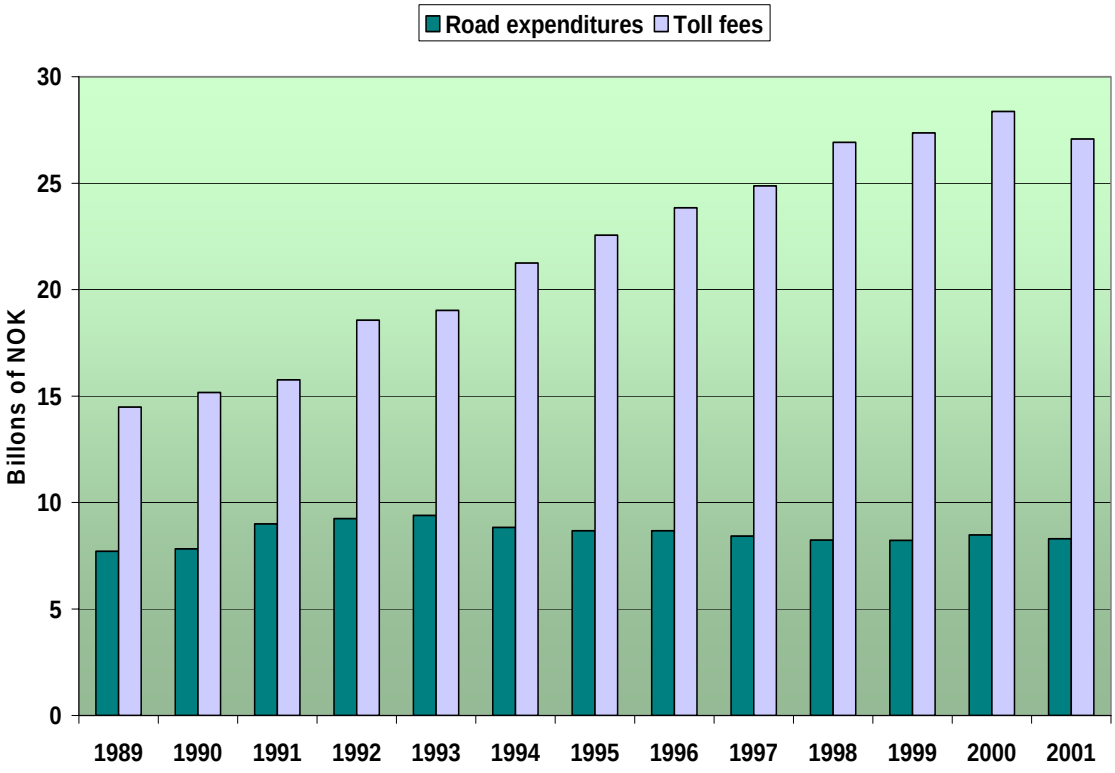
Whereas the cultural and industrial diversity of Norway represents potential economic assets, the traditional emphasis of regional policy has been on providing mechanisms for redistribution to compensate for differences in results. Recent developments represent a shift in emphasis. There is now a marked effort to foster initiatives that can build a stronger basis for sustainable growth, in which the encouragement of local learning and innovation processes represents a key component. The Norwegian government (Ministry of Local Government and Regional Development, 2002) is currently working to identify how competencies in the development of special assets can best be promoted at local and regional level. Success is likely to require an appropriate combination of:

i) public support of better coordinated logistics infrastructure and services, and;

ii) enhanced room to manoeuvre at the local level, and an associated upgrading of relevant local competencies.

On the first point, logistical solutions are counteracted by unsatisfactory national coordination. In road construction and maintenance, for instance, there is clear-cut underinvestment in public infrastructure. Even though Norwegians in international comparison spend above average on inland transport infrastructure (Bjørnland, 2003), the quality of available services is among the lowest in the developed world, with results going beyond what can be explained by inhospitable natural conditions. That more should be done is illustrated by the fact that government revenues from taxes and toll fees derived from the auto-industry by a wide and increasing margin exceed government outlays on road expansions (Figure 20). The issue is broader than road transport, however.

Figure 20: Government expenditures on roads and income from toll fees (Billions of NOK at 1989 years prices)



Source: NHO

High quality logistics solutions are today critical for industrial and economic progress, not least as they have a major bearing on the ability to ship products to customers in ways that are reliable, fast, and flexible, and thereby able to respond effectively to customer demands that may be varying over time and also increasingly require taylor-made solutions. Adequate access to markets hinge on complex linking between different transport modes, associated with significant coordination costs. Whereas there may be difficulties in defining private benefits that can be appropriated, it may be impossible to calculate the social returns, and serious attempts to do so are far in between. For distant and sparsely populated regions, tangible economic pay-offs tend to reside in the dark, or in a distant future. This does not mean that no investments should be made, nor must it mean that driving forces for efficiency and working out better solutions can be allowed to be absent. Transparency is required, and criteria must be applied that can help weigh traditional economic considerations with social and environmental considerations. Failure to combine high ambitions to allow for local development in all parts of the country with effective logistics solutions, sooner or later results in economic activities with low and uneven productivity coupled with high social transfers. Further, efficiency in investment decisions must be viewed in the same context as the management of transport systems, including regulatory conditions and the degree of competition in different transport

modes. This includes air transport where weak competition until recently accounted for high costs, worsening the geographical lock-in effect caused by the poor quality of road transport.

A fundamental objective is to create better integrated infrastructure and governance decisions with a view to what represent first best solutions and dynamic improvements in logistics systems as a whole. Improvements are needed. A recent study by the Federation of Norwegian Transport Users (2003) shows that Norwegian companies consider transport costs to be as serious a problem as high costs connected to taxes and other fees in their competition with foreign firms. As much as 55 % of the companies participating in the study viewed the costs for transportation to be an important factor when they choose where to locate production, 20 % consider them irrelevant, and 24 % were neutral.

Finally, not only traditional logistics but also modern communications technology requires a sharpening in certain national strategies for providing common infrastructure. Broadband is one such area where national expansion of supply capacity should go hand-in-hand with local initiative that helps mobilise the demand side. Korea is a prime example of a country that is able to successfully combine the two, whereas most others have run into various coordination failures and problems in performance. National and international strategies are further warranted to help improve security and privacy, countering the threat of cyber crime and enabling trust in electronic commerce. This is especially important for allowing SMEs to exploit the Internet for commercial transactions.[36] The area is evolving rapidly, no simple solutions are available today and the results of approaches tried so far have largely been disappointing (Gartner, 2001). A more proactive stance may thus be required if governments are not to be overrun by mounting risks of misuse. The experience available from different countries points to the importance of regulatory conditions that facilitate flexible countermeasures and market solutions, e.g., Public Key Infrastructure (PKI) and the development of appropriate digital certificates. With Norway outside the day-to-day cooperation of the EU, whose institutions are active in seeking out pragmatic solutions, the Norwegian government needs to make sure it takes a sufficiently active stance in pushing for user-friendly solutions, thereby guarding effective future application of the new electronic tools particularly by SMEs which otherwise run the greatest risk of long-term damage.

On the second point, decentralisation of responsibilities invokes costs. There are risks of mismanagement due to lacking competencies when local bureaucracies gather influence on, e.g., the allocation of seed funding. If greater innovativeness is to be mobilised in society, however, regional and local actors must be confronted with incentives to take the lead in carving out niches for successful specialisation. Success requires instruments for a widened scope for local initiatives, including stronger mechanisms for raising and allocating resources at local level. Without such means, local actors remain crucially dependent on the national government, which inevitably affects incentives and reduces dynamism. This points to the importance of managing a subtle but crucial balancing act.

[36] According to the RAND Institute, 70 to 80 % of today's Internet users are restrained in their use of Internet by security concerns, see further Cremonini and Valeri (2003).
[37] The Ministry of Local Government and Regional development provides financial support to valuations of consequences from mergers between municipalities.

Co-ordination across broader administrative units should take pre-eminence where that is appropriate and effective, but innovativeness and local development will crucially hinge on what room is available for local stewardness and ownership of initiatives.[37]

One important aspect concerns what effort is made to engage the business sector in various programmes. Such engagement is often pivotal for innovative use of new technologies, e.g., in education, health, agriculture, or the maritime sector. Effective means for coordination are sometimes national and sometimes local. Ideally, both the public and the private sector should be able to develop effective strategies of coordination spanning the different levels. Problems to do so are visible in various countries. In Sweden, IKED in cooperation with the Confederation of Swedish industry recently produced a strategy report for how the private sector may improve its way of working so as to account for more constructive impacts on innovation systems nationally and locally (Andersson and Möller, 2004). Better coordination should also be put in place between local authorities in Norway and various public national programs, such as those marketing Norway as a country for tourism or location for investments. Here the newly created merged public authority responsible for innovation locally should be of great significance.

Regional policy should push for, and cherish, local *specialisation* particularly in those areas where efforts are otherwise most wasted, e.g. because they are spread to thin. A middle-sized town cannot compete with a world class capital in every domain, but it can do so in some sectors. An individual county cannot develop internationally competitive research and tertiary education across-the-board, but can do so in some disciplines. Norway, like many other countries, has put in place means and incentives, e.g., through regional transfer mechanisms, that lure local authorities into establishing a battery of more or less complete services. One is the strive in each location to obtain full-fledged universities, replicating the whole range of imaginable skills and functions believed to be part of an institution for comprehensive high-level education and research. Such ambitions inevitably run into conflict with prerequisites for critical mass in skills accumulation, thereby diminishing the capacity to achieve crucial thresholds required for establishing genuine academic and technical strongholds at local level.

While authorities should avoid "picking the winners" in terms of which specific firms and industries are to succeed in a region, as in a country, they do need to invest in infrastructure and other assets of public-goods nature thought to be key for underpinning available opportunities. In distant regions with "thin" industrial structures, the list of available choices inevitably becomes shorter. With innovation coming into focus, however, the emphasis is on providing the basis for new initiatives and possible development paths, whether within existing firms or in the form of new enterprises, rather than investing for the sake of "propping up" faltering specific existing ventures. There is ample experience of local development in different countries showing that "letting go" of sunset industries tends to be pivotal for revitalising those regions where they have been dominating for a long time. Only that way can positive energy and creativity be brought back, and human resources be "freed up" to develop new ventures.

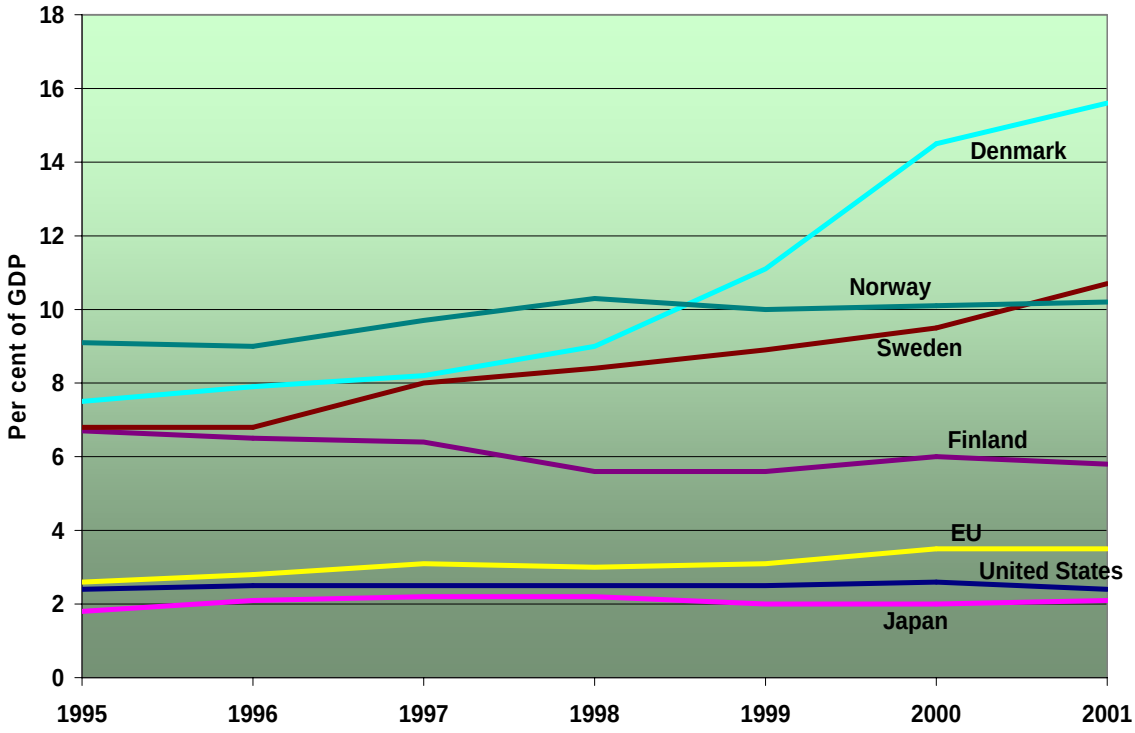
Depending on circumstances, areas where critical initiatives are needed may include removing barriers to, or activating, the development of attractive living or office facilities, educational opportunities, meeting places, social activities, etc. Specific networks of human relations are

essential (Asheim and Isaksen, 2002). These may be partly local and partly national, international or global. However, what can be done in a specific region to develop its nodes as well as how to hook them up to the outside world, is *best known locally*.

vii) Globalisation and Related Governance Issues

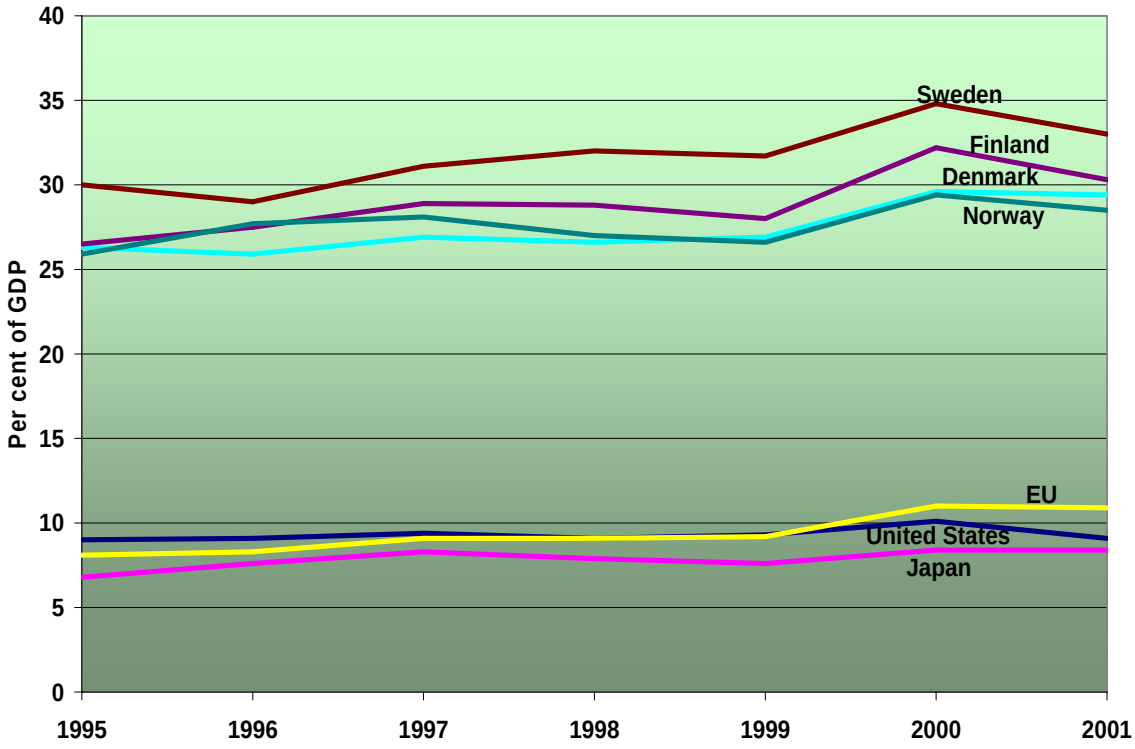
All the Nordic countries are marked by relatively open economies, as measured by international trade flows. As can be seen from Figures 21a and 21b, the weight of international transactions is the highest in Denmark as regards services, and in Sweden in the case of goods. The Nordic countries, including Norway, are way ahead of the EU-average, the United States and Japan in both respects. This is only in part a reflection of the smaller size of the Nordic countries, as they are in fact also more open than most countries of comparable size.

Figure 21a: Average value of imports and exports of services as a percentage of GDP



Source: Eurostat Structural Indicators.

Figure 21b: Average value of imports and exports of goods as a percentage of GDP



Source: Eurostat Structural Indicators.

At sectoral level, however, there is considerable variation. Connections with performance are obvious as industries that are relatively open display more favourable use of new technologies and greater innovativeness. In some areas, trade barriers limit the scope for upgrading value-added, e.g., in the case of import barriers to processed marine products in the EU (see Box 6). While Norway has attained a strong position in fish-farming, the barriers to export of processed products to the EU now put a cap on innovation and weaken the development potential of the entire industry. The restrictions further account for limitations in returns and access to funding, creating a vicious circle. Not only economic efficiency is hurt but the result is a also a drag on the development of more environmentally friendly production techniques. A well anchored process for commercialisation in the bigger European and American markets is in this case crucial for any major upgrading of innovation strategies in Norway to be successful.

Alongside trade in goods, the main source of international transfers of skills and technologies is *foreign direct investment* (FDI), which is long-term investment undertaken by so-called multinational firms. Both outward and inward flows of FDI are today recognised as an important source of such transfers. In contrast to portfolio investment, which involves much greater financial transfers, FDI is marked by the control exercised by the investor in

return for accepting the risks of engagement in an alien environment. In recent years, the localisation decisions of multinational firms have tended to become strongly interlinked with processes of deepened local specialisation and learning within knowledge-intensive industrial clusters (Dunning, 2000). However, the degree to which technologies are diffused from multinational firms to host countries, and inward FDI thereby is conducive to local innovation, cannot be taken for granted. That will depend on domestic capabilities and policies as well as the strategies pursued by the investing firms, and how the two interact (Mudambi, 2002).

Box 6: The marine sector in Norway

Norway is at the forefront when it comes to a range of marine activities. The maritime sector, usually divided into ocean transport and shipbuilding, is one of the most important for the national economy. According to calculations by Hervik and Jakobsen (2001) the value created in the sector amounts to NOK 45 billion, or 9 % of the total for the entire Norwegian business sector.[38] Further, the sector grew twice as fast during the late 1990's as Norwegian manufacturing in general. Its success can to some extent be attributed to the presence of strong domestic as well as international competition, which keeps actors in the sector on their toes. Many of the world's leading shipping companies have chosen to locate here due to the special maritime services offered. A division of the sector into a manufacturing and a service component shows that the former still tends to operate through traditional value chains while the latter is now orientated towards networking (Benito et al., 2000).

Fish-farming is a relatively new sub-industry which started in Norway in the 1970s when the country attained an early advantage. In the 1990s, the production of especially salmon rocketed. As of 2001, the total value creation of fish-farming amounted to NOK 12.1 billion, (Fraas et al., 2002). Today, however, producers in countries such as Chile and Scotland are making great strides in fish farming, cutting into the European markets and putting pressure on prices. The new competitors not only display cost advantages but are also developing new products and qualities.

Whereas Norway's position outside the EU allowed it to partially protect the fishing stocks at seas, thereby supporting the industry and the environment for the future, it had to pay a high price in regard to market access. The fish-farming industry is plagued by tolls on value added which gives Norwegians little scope for raising value added. Hence, 78 % of the export recently consisted of fresh or frozen salmon. A strongly debated issue is the so-called "Salmon-treaty" between the EU and Norway. A trade conflict began in 1989 when the United States accused Norwegian salmon exporters of dumping prices and receiving illegal subsidies. Later, Scottish and Irish fish-farmers filed a complaint with the European Commission about Norwegians' dumping the price of salmon. In 1997, a five-year treaty was signed introducing, among other things, a minimum price for salmon. The treaty is now abolished, but has been criticised for shifting the industry's driving force from a functioning market structure to a heavy regulated sector (Fredriksen, 2003).

Despite its recent expansion, raising innovative performance in fishing is critical. There is a need for the sector to renew itself if it is to stay ahead of its competitors, but trade-related rules severely impede the incentives for upgrading and innovation.

[38] Value creation is the sum of salaries and operating surplus.

It is well-known that outward FDI can take various forms. Some are motivated by enhancing a firm's access to foreign markets, others are made to reduce production costs, and yet others may be undertaken for the purpose of sourcing foreign technologies. Throughout, however, outward FDI tends to make more resources available for the investing firms. In this way, outward FDI generally strengthens the basis for R&D and other knowledge-generating activities connected with headquarters. At the same time, when R&D-activities at home partly support production facilitates in other countries, there is a higher probability that innovations result in new or upgraded production not in the home country but abroad. Again, however, far from all new options for innovation are effectively exploited within the organisation of a big firm, which brings us back to the importance of outsourcing and conditions for entrepreneurship.

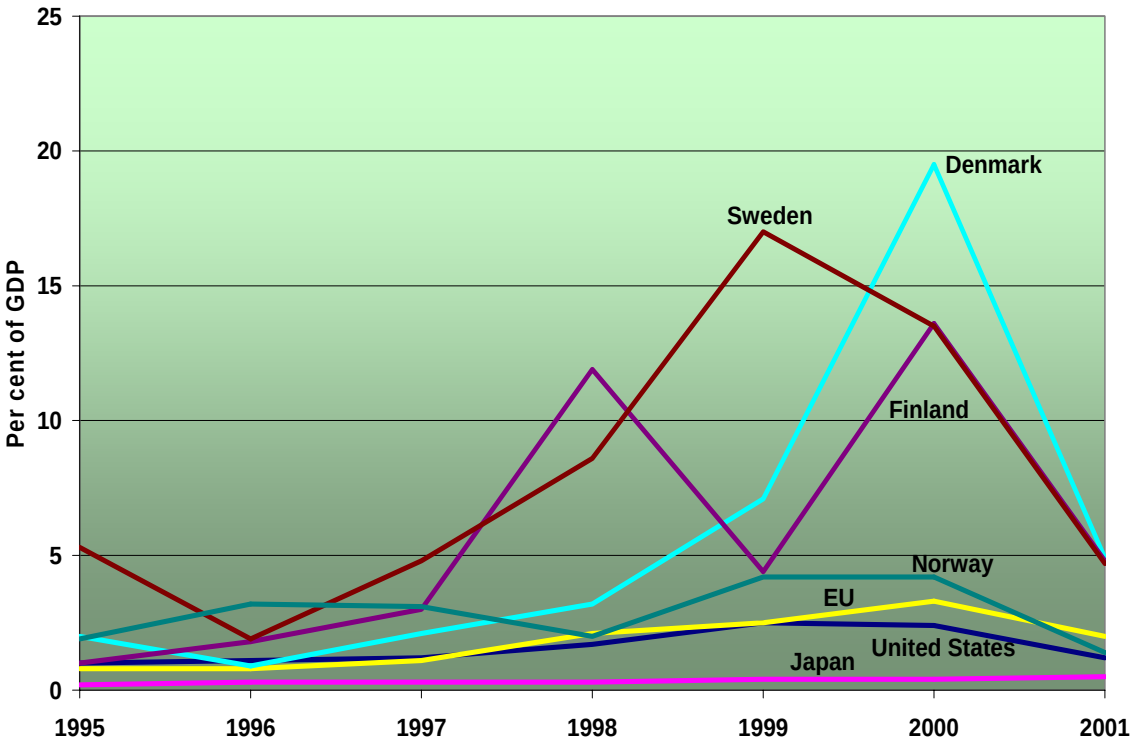
Today, R&D is becoming increasingly internationalised. This is driven both by opportunities for further market penetration, as local R&D can serve to adapt exports or local production to the specific needs of customers in host countries, and to the benefits to the process of knowledge creation itself. Like other activities, R&D can be strengthened through international specialisation, and a greater capacity for update of new ideas in different countries. Conversely, the establishment of local R&D increases the potential for sourcing of technology by the multinational firm in a foreign market. So far, the evidence leans toward complementarity rather than substitution between the internationalisation of R&D and a strengthening of home country R&D (Åkerblom, 1994; Andersson, 1998). For the host country, local R&D involves opportunities for enhanced diffusion of technology and skills in its direction, but it also opens the door to increased sourcing of technology by foreign firms. In a world of intensified economic interactions it is often neither possible nor desirable for a country to try and separate one from the other. On the other hand, a country can suffer systematic losses to the extent that conditions for the international specialisation of operations do not operate in its favour. Foreign investors may lean towards sourcing local skills and technologies for application in their organisations worldwide, rather than promote diffusion of technologies from abroad to the local environment. Such strategies are particularly plausible in countries where local knowledge assets are strong but conditions for industrial development weak (Mudambi, 2002). It cannot be taken for granted that inward FDI "will help"; it will serve to speed the processes of adjustment and restructuring that are triggered by fundamental conditions.

Norwegian industry started to grow abroad many years ago. By 2000, the 30 largest domestically owned firms had established larger operations – and engaged a greater number of employees – in foreign affiliates than in Norway itself (Heum, 2002). The revival of the Baltic Sea region over the last decade has triggered some additional much publicised cases of delocalisation, which effectively transferred production and jobs from Norway to units in those countries. This kind of restructuring, and specialisation, by Norwegian firms should not be bemoaned, however. On the contrary, it is necessary for the efficiency and very survival of what is left of Norwegian industry. The challenge is to manage upgrading productivity in Norwegian operations to levels where competitiveness is sustained despite the prevailing costs and where there are prospects for continued development.

As seen from Figure 22, however, Norway for years had consistently smaller flows of combined inward and outward FDI relative to GDP than comparable countries. Among the Nordic

countries, there is a particularly stark contrast with Sweden and Finland, but also Denmark in recent years. While there tends to be a connection to the presence of large firms, the causality goes both ways – the expansion of firms and the scope of outward FDI generally reinforce each other. In Norway, relatively few firms have grown as well as expanded abroad. With only a handful significant headquarter functions of multinational enterprises (MNEs), there is now a limited basis both for outflows of FDI and for the attraction of large-size FDI through mergers and acquisitions (M&A). In fact, Norway displays unusually small flows even in comparison with some other countries that are also characterised by a dominance of SMEs. Denmark is a case in point.

Figure 22: Average value of inward and outward foreign direct investment as a percentage of GDP

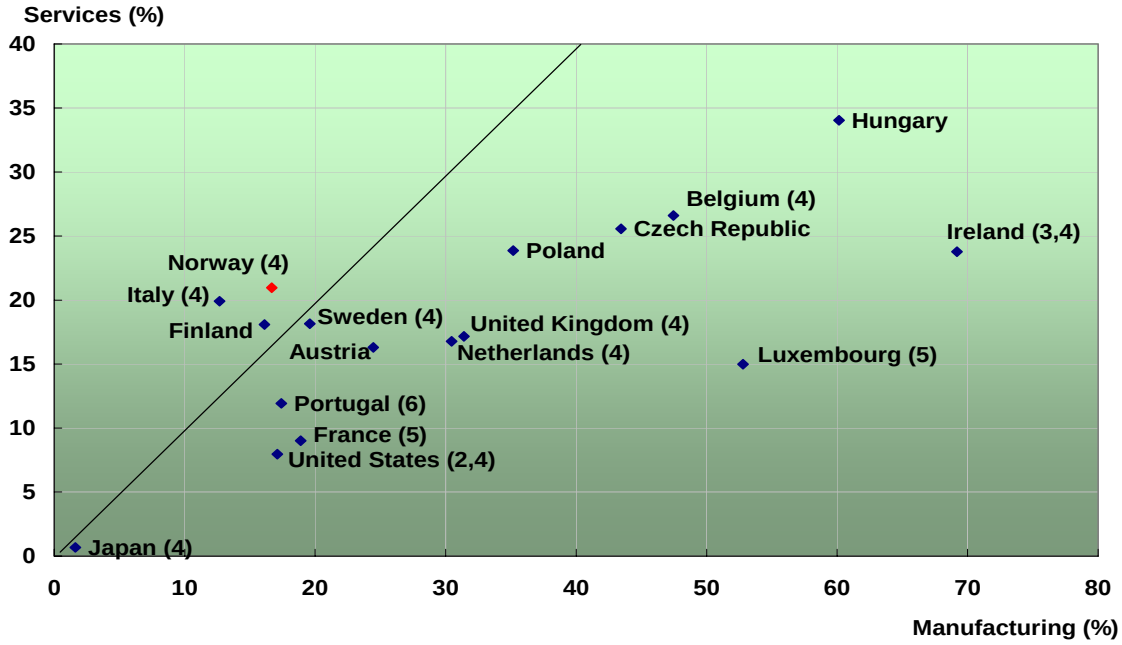


Source: Eurostat Structural Indicators.

There is likewise limited leverage in terms of complementary expansion of FDI and strengthening of R&D. Given Norway's limited volume of R&D in private companies, low levels of outward FDI, and high costs for local manufacturing, there is little scope for virtuous circles due to substantial technology transfers into Norway through FDI. One out of three companies with more than 200 employees is nevertheless now foreign-owned in Norway.

Within that size-category, foreign-owned firms accounted for 30 % of employment and 44 % of value added in 1999. The share is smaller in manufacturing where foreign-owned firms were responsible for 18 % of total value added, which is rather low in international comparison. Figure 23, on the other hand, shows that foreign affiliates have achieved an unusually high penetration in services in Norway. In fact, the Norwegian position stands out as quite special among developed countries. Norway is, together with Italy and Finland, the only country in which foreign affiliates have achieved a higher level of penetration in services than in manufacturing.

Figure 23: Penetration of foreign affiliates in services and manufacturing with regard to turnover



1. Financial intermediation (ISIC 65 to 67) is excluded from turnover for all countries except France, Hungary, Norway and Poland. Insurance (ISIC 66) is also included for Austria, Luxembourg and the United States. Community, social and personal services (ISIC 75 to 99) are excluded for Austria, Belgium, Ireland, Italy, Japan, Netherlands (except ISIC 90 and 93) and the United Kingdom.
2. The data used here for affiliates under foreign control are broken down by industry of sales to be compatible with national total data.
3. Production instead of turnover for manufacturing.
4. 1997 instead of 2001.
5. 1998 instead of 2001.
6. 2000 instead of 2001.

Source: OECD (2003*a*).

Again, innovation is likely to be less driven by R&D in services compared to manufacturing. Innovation in services may still draw strongly on new technologies, but is likely to depend more on how technology is absorbed and put to use through organisational change and incremental improvement. It is plausible that the inroads of foreign investment have made positive contributions to services by putting imported skills and technology contributions to use, possibly in conjunction with knowledge transfers from abroad, and through increased competitive pressure. While the potential for gains is there, however, again the benefits cannot be taken for granted.

Large multinational firms are naturally skilled in exploiting opportunities for market dominance in economies plagued by barriers to competition. The financial sector, which is greatly important for mobilising savings and for allocating investment, was until recently marked by old structures borne out of extensive public ownership and other public interference, as state-owned banks dominated not long ago under conditions marked by heavy regulations. The financial sector is now primarily managed by private actors - only one out of three major financial groups is dominated by the state – and has demonstrated impressive progress in recent years. For inward FDI to contribute effectively to enhanced dynamism there is nevertheless a need for further reform. Depending on circumstances, regulatory reform or privatisation may serve to strengthen competition, responsiveness to customer needs, and openness. So far, the public sector remains dominating in overall resource allocation, and new financial instruments evolve only slowly, as in the areas of private equity and venture capital.

All in all, FDI represents an important source of restructuring in Norway but to a lesser extent than in comparable countries. On its own, it does not represent the key to enhanced knowledge and R&D-performance. Given a strengthening of local capacities and competition, however, its significance will grow. A noteworthy aspect in this context concerns mechanisms for *governance,* a subject which attracted attention worldwide in recent years. Differences in corporate governance systems have been shown to influence the relative performance of sectors across countries (Carlin and Mayer, 2002). The gradual advancement of institutional ownership and growth of equity markets worldwide has been accompanied by weakened monitoring of management by company owners, as portfolio investment expanded and ownership became much more dispersed than previously. This development, which started in the United States and the United Kingdom, gradually spread across the European financial markets over the last decade. The result has been enhanced flexibility and improved mechanisms for making resources available for industrial expansion, as manifested in a surge in restructuring across European borders (further fuelled by the Single Market integration in the European Union and then by the prospects and launch of the European Monetary Union). At the same time, agency and information problems in corporate governance have worsened, leading to excesses in M&A, as well as levels of remuneration for corporate managers marked by disproportionate influence of self-interest (Bebchuk et al. 2002; Maher and Andersson, 2002).

Norway, given the extensive government role of its financial sector, its industrial structure and limited FDI-flows, has only partially been affected by these international developments. The country thus escaped major financial excesses and bubble effects on its home-soil. At the same time, the swift expansion of new business-activity and commercialisation of new technologies that recently marked the international economic landscape – no matter how disappointing and

costly to those who lost severely in the downturn - has provided lessons from experimentation and diverging experiences. The restructuring that has taken place, closely associated with intensified venture capital activity and entrepreneurship, will continue to evolve. In the process, there will be further renewal of the mechanisms supporting innovation and risk-taking in new technologies and business development, and there will be new forms of competition as well as co-operation.[39] It will be important for Norway not to be left out in these processes.

Initiative and innovation tend to go together. Norway's limited role in headquarter functions of larger firms as well as in R&D, creates risks of falling behind in strategic capabilities. An expansion of public funding of science and R&D will not provide an answer to this problem. There is also the question of what Norway's position without EU-membership means in terms of shaping capabilities for decision-making and, through that, capacity-building and innovative potential. There are both advantages and costs. Being outside the EU, Norway can speak with its own voice. In areas such as multilateral negotiations on environmental issues or in geopolitical conflicts requiring trusted forms of arbitration, this can enable Norway to act on its own and make a difference in ways that are not possible for nations that need to work through the tedious decision-making processes of the European Union. In areas where the latter are constructive and a small country can tip the balance of power, on the other hand, there may be a loss from not being able to participate in forming the strategy of the group. Many regulatory and economic decisions are now of a cross-border nature and Norway must accept what the EU decides while having limited ability to exert an influence. To those actors for which it is important to be represented in EU-decisions, and who can choose where to locate, Norway offers a strategic disadvantage relative to a location within a country that is a member of the EU. Today, there is a certain sense of despair in parts of the Norwegian administration and also in parts of the population, due to lack of influence on the rules of the European scene. Whether this translates into erosion of strategic capacity or not, we do not know, but it is certainly an issue that deserves to be followed closely.

Science and research represent a big area for intensified international exchange, as scientists are free to link up to work with colleagues anywhere. All evidence indeed shows that scientists belong to those that exploit the new communication tools most effectively for much intensified international exchange. Norway is no exception, and the number of countries that Norway cooperated with in international co-authorship doubled from 41 in 1986 to 80 in 1999 (National Science Board, 2002), which still is somewhat lower than in its Nordic neighbours. Co-authorship was in 1999 most common with the other Nordic countries, the United Kingdom and Germany. Noteworthy success of Norwegian scientists in the European framework programmes provide part of the explanation for the rapid advances that have taken place. For innovation and commercialisation, however, this should be supplemented by more exchanges in other areas.

[39] This includes measuring intellectual capital, intangible assets, and impacts of corporate behaviour on social and environmental assets. Both private and public governance are confronted with issues how to handle discrepancies between private and social costs pertaining to different kinds of economic behaviour. This raises transboundary issues that cannot be effectively addressed by individual societies alone, but requires effective exchange of experience and cooperation internationally

Immigration of skilled experts and mobility of human capital represent an increasingly important mechanism for international knowledge flows. The Norwegian government has taken steps to encourage immigration of certain kinds of skilled workers. Through the Public Employment Service (Aetat), the government assists employers recruiting doctors, dentists, nurses and engineers from the Nordic countries, Germany, France and Austria (SOPEMI, 2002). Four percent of students enrolled in tertiary education are now foreigners, which is a higher figure than the average for the U.S. and compared to industrialised countries of Norway's size (Figure 8). Norwegian universities have also demonstrated great capabilities in the establishment of operations and the formation of strategic links with foreign education and research institutions. This applies both to distant regions, as in the case of China, and closer to home as in the case of the Baltic countries. These activities bring new human interface resulting in potential social and economic impacts. Their ultimate economic significance remains to be seen but is likely to depend much on the evolution of science-industry linkages, including the record of high-tech entrepreneurship and the openness to making use of new skills in the private sector.

Box 7: Ireland's global and national effort

Being a small, peripheral member country of the EU, Ireland set out in the 1970s to compete vigorously for FDI by offering lower taxes than other European countries, as well as a range of other investment incentives. The Irish government also pursued domestic reforms that gradually succeeded in supporting a vigorous interplay with local industry. Even FDI in high-tech sectors, where an industrial base had previously been lacking, was attracted on a big scale. Ireland is today marked by higher R&D-intensity in foreign-owned affiliates than in its domestically owned firms.

Among the other key measures that helped stage a remarkable process of economic recovery were early reforms in education and human resource management. Among these enticing emi-grated Irishmen with valuable skills to return from abroad formed part of Ireland's strategy to acquire the skills needed for the country's development effort. Gradually, the Irish authorities started to pay attention to the benefits of attracting expertise from overseas more generally. A few years ago, the government embarked on a two-stage programme to attain an international edge in key niches. The first involved developing basic research competencies in the form of internationally leading scientists in Irish higher education institutions. Then the Programme for Research in Third-Level Institutions (PRTLI) was launched in 1998, involving the establishment of a range of basic research programmes, from human genomics to computational physics. The government now aims to set up 10 "world class research teams" in the country and, since 2000, the Technology Foresight Fund has been established. Administered by the Science Foundation of Ireland, international calls for proposals are announced and all eligible proposals submitted are assessed by peer review. Some £500 million over the course of seven years has been earmarked to enable leading scientists and engineers to carry out research projects of their choice in Ireland for a period of 3 to 12 months.

A significant share of immigrants is enrolled in science and engineering programmes. According to the recent labour force survey, fewer students with immigrant background choose studies within education and teacher training compared with the total population, and more of these students choose studies within natural sciences, trade and industrial programmes. These trends apply for both men and women with immigrant background (Statistics Norway, 2001). The sizable presence of foreign students and experts in areas where Norway appears to suffer from a potentially serious deficit in skills indicates important but yet unfulfilled opportunities. Norway may do well to examine in detail strategies pursued by other countries, including some small peripheral ones such as Ireland (Box 7), in attracting and engaging valuable skills from abroad.

CHAPTER FOUR
POLICY CONCLUSIONS AND RECOMMENDATIONS

i) The problem of success

The Norwegian economy displays great strengths but also distinct weaknesses. Its inhabitants share some of the highest per capita incomes in the world and, at the same time, some of the highest production and wage costs. There is heavy dependence on the oil sector and a rapid tilt away from manufacturing paralleled by expansion of public and private services. Whereas Norway makes large investments in education, there is declining interest in science and research and the highly educated go first and foremost to the public sector. The macroeconomic situation is stable but account for a high-cost society with historically high interest rates. Parts of the economy remain sheltered, FDI flows are fairly limited, there is considerable public intervention in resource allocation and venture capital markets are poorly developed, restraining driving forces for restructuring and renewal

The stable revenue flow generated by the oil sector, the presence of a generous welfare state, and the perceptions of opportunities for a secure life in an expanding public sector, impact on the choices made by the Norwegians. Levels of entrepreneurship are fairly high in comparison with some other European countries, but the contributions to growth and employment are limited and technology-based high-growth firms are rare. Unemployment rates are low, but a significant share of working-age population is on sick leave or prematurely retired, and the share of elderly is steadily rising. A surplus of NOK 100-200 billion a year in the oil sector is equivalent to at least 10 % of GDP. This means that the Norwegian society, and Norwegian policy makers, do not face, and will not face, any urgent crisis for years to come. Yet, trends are worrying. The current rate of public sector expansion is unsustainable and returns from the oil-fund are today exploited for propping up an increasing budget deficit. As for long-term prospects, not even a continued build-up of the oil fund at present rates could compensate for the anticipated financing requirements of future pensions for the ageing population, and would soon dwindle in significance in the face of a long-term decline in motivation and innovative spirit among *people*. The present sense of security, if unchecked, may evolve into dangerous complacency.

In this situation, raising Norway's R&D intensity to levels that are more on par with the leading economies has been identified by the government as a key policy vehicle for invoking a changed course of direction. The complications of achieving and reaping the benefits from such an increase in R&D have been discussed in the previous chapter. Norway's R&D-intensity most probably cannot be characterised as "low" in international comparison, once the industrial structure, the dominance of SMEs, and the limited extent to which Norway serves as a base for multinational enterprises, are controlled for. R&D-intensity is itself a shaky indicator and a "moving target". The level of government support for R&D is not particularly low, but it is the level of private sector R&D that falls behind that of other developed countries. A major increase in R&D can only occur given further public support which, if it is to contribute to growth, must be performed in an effective manner and generate positive social returns, since the costs of the policy will otherwise exceed the benefits.

Norway's R&D-capacity does stand out as small in absolute terms, and there are specific examples of areas in which the R&D-effort clearly appears beneath what would be socially or, for that matter, financially optimal. The oil sector itself represents one such example. The Norwegian economy does need revival, and mechanisms for renewal. For this, a stronger performance with respect to innovation is greatly important. At the same time, R&D is not equivalent to innovation. The extent to which the results of R&D will be transformed into innovations and successful commercialisation crucially hinges on enabling conditions, some of which are not in place in Norway today. There is also a need to master kinds of innovation that are not directly related to R&D.

ii) The renewed ambition – towards a comprehensive innovation policy

We have seen several attempts by Norwegian governments over the years to promote industrial development and R&D. Now, the government has yet again adopted an approach entailing an increased R&D-intensity as an important intermediary target and stepping stone (Ministry of Trade and Industry, 2003*a*). This time, however, a plan in search of a comprehensive innovation policy has been launched, constituting an ambitious agenda that engages a number of ministries and puts up several new goals for policy. Let us point out some main elements:

- General framework conditions for innovation and value creation are to be improved through new efforts to secure well-functioning markets and to make public procurement more effective. There is a stated ambition to revise the tax system so as to ensure an efficient use of society's resources, establish user-friendly public services and to make regulatory frameworks more efficient so that business can devote fewer resources to regulatory matters.

- Aiming to support a more research-based private sector, the government promises to reinforce measures to make Norway achieve the average R&D-intensity of OECD-countries before 2005, work for higher quality and internationalisation of Norwegian research, promote commercialisation of research results, and stimulate cooperation between knowledge institutions and the private sector.

- Renewed efforts are to be made to ensure that educational institutions produce and mediate relevant knowledge at high international levels, and strengthen competence and recruitment in science. Further, to boost lifelong learning and the ability among companies to be innovative, knowledge flows will be promoted regionally, nationally and internationally.

- Entrepreneurship tutoring is to be promoted in the educational system, as well as direct support measures be developed to target entrepreneurs, young companies and SMEs with the ability to grow, and to facilitate risk-management and access to funding in early stages.

- The government plans to enhance electronic and physical infrastructure to encourage interaction among companies, markets, and centres of knowledge-creation and use. The national transportation net will be further developed, as will easy access to electronic signatures and high-quality electronic payment solutions.

Since work on this plan has paralleled the development of the current report, there naturally is a resemblance in the structure of domains. With the described set-up, the government has upgraded its ambitions for innovation policy in a broad sense. Further, for the year to come, it has strengthened the ministerial setup involved, widening the group of ministries engaged in the process from five to nine. It appears that the Norwegian government has finally committed itself to address the main issues, irrespective of whether they are found within the narrow realms of traditional research and innovation policy. The fundamental challenge may still be how to evoke sufficient political support to actually pull off any real, long-lasting reform effort.

iii) Recommendations for further reform

The policy targets set up by the Norwegian government can only be achieved given that the private sector moves decisively towards greater expenditures on R&D. Given the industrial structure, that can only happen in the presence of generous public support of R&D. If support measures are inefficient, the programme will be costly. On this basis, the government must be careful to ensure high quality in its policy design. First, it must be *consistent in its support of* R&D. *Credibility* is the key to long-term adjustment in expectations and actual investment in R&D by the private sector. So far, diverse and partly contradictory steps have been taken. Second, there is need for an appropriate *balance* between direct and indirect support measures, each measure having its own distinct advantages as well as disadvantages. An excessive reliance on one kind of support at the expense of the other risks giving rise to high costs. Third, there must be sufficient efforts to *evaluate* and adjust programmes, and to phase out inefficient channels of support. During the last 15 years, Norway has made a growing and substantial effort to establish ex-post evaluation of programmes, financial measures and institutions. Nevertheless, it remains for the main ministerial bodies and institutions to conclude and follow up on this work. This becomes even more important to the extent that the overall R&D effort increases and competition intensifies for needed scarce human resources

Public support programmes, such as MOBI and FORNY, that incorporate strong involvement by the institute sector, have been subjected to favourable evaluations. Norway's institutional set-up for direct R&D-support appears fairly strong in comparison with many other countries. There are also old programmes, such as BUNT, which were widely viewed as filling an important mission in their days. Those countries and regions that excel in capturing significant social benefits from R&D-activity generally also belong to those that are most successful in the development of micro-programs and specific institutions for intensive local innovation, diffusion and learning processes. The examples include Finland and the Netherlands in Western Europe, the Unites States, and Singapore, mainland China and Chinese Taipei in East Asia. The policy regime in Norway, on the other hand, has so far appeared ambivalent. There is resistance to engaging adequate resources, e.g., for catalysing effective public-private partnership. In the prevailing climate, the oil-fund is extensively exploited for supporting public consumption and,

hence, underpinning unsustainable policies, whereas it is not appropriately put to use for investment in infrastructure that is required as a basis for future growth. There is thus a need for rethinking, and for upgrading attention to micro-programmes and approaches. This should still be based on a demanding approach that includes critical evaluations approach so as to ensure their continued improvement (Box 8).

At the same time, it needs to be recognised that the Norwegian innovation system is fundamentally weakened by excessive involvement by the government and the public sector in too many aspects of resource allocation, including with respect to R&D and innovation. Fragmentation in approaches related to innovation contributes to the problem, as interaction between ministries and public agencies, and organisations representing business and industry is weak. For cooperation to improve in the future it is important that the private sector and business organisations can be more strongly engaged, while also enhancing their own resources, competences and capacity for initiating new forms of public-private partnership.

The expansion of the public sector has to be curbed, and privatisation as well as regulatory reform allowing for the introduction of private alternatives and enhanced competition may bring considerable benefits. At the same time, the availability of new communication tools provides the potential for much enhanced efficiency and effectiveness within the public sector. Again, the full realisation of such opportunities would require organisational changes and pressures for adjustment led by a drive to satisfy real social and customer needs.

Further, there must be room for private services to evolve in response to needs in technology diffusion. Sharpened demarcation lines are desirable between measures that compensate for prevailing market or policy imperfections on the one hand, and "pick the winner" policies on the other hand. For instance, in the provision of information and services to the private sector, public agencies should strive to consistently fulfil "public goods" functions, e.g., with respect to building awareness of new technical opportunities, catalysing socially favourable network effects which do no occur spontaneously, or enabling funding of a portfolio of risky, pioneering new technologies. Meanwhile, private consultancy firms should be left free to exploit niches of well-defined demand, e.g., through the introduction of specific business services in response to tasks of marketing or funding the expansion of already established high-tech ventures. Unless such separation of functions takes place, Norway will eventually face difficulties in its promising sector for business services.

Box 8: Diffusion of knowledge and inspiring the young

Given the importance of exploiting available "critical mass" in Norway, a critical question is whether the government could and should do more to exploit sectors that currently represent "hidden" generators of innovative technology, for wider diffusion in the economy? The prime candidates would be diffusion of knowledge of technology deeply embedded in the country's mature industries, such as the oil and gas exploration, fish farming and food processing. These medium- to low-tech industries (based on intensity of R&D input) cultivate specific skills and use state of the art technology. For example, fish farming uses high-technology input (based on advanced materials and incorporating complex new materials and design knowledge). The food industry more generally covers a broad knowledge area, including food-related chemistry, biology, physics, instrumentation, and engineering (Smith, 2000).

The BUNT programme once excelled in assisting firms with organizational change, which remains a crucial perquisite to adopting new technology. A comprehensive diffusion services approach, that could cover different types of technologies, firms and sectors, seems to have been lacking so far, however. Insights and inspiration could be obtained from studying diffusion-targeted programmes in selected other countries, such as Finland's Technology Development Centre (TEKES)[40] technology clinics and diffusion services programmes or the Manufacturing Extension Partnership (MEP) in the United States.[41] A diffusion programme combining public and private initiatives may help widen awareness of innovation and exert a positive impact on mobility. A work culture that is more responsive to new experiences and ways of doing things could form part of the results.[42]

Oil companies in Norway are today characterised by an ageing workforce and frequently complain that there are too few students in science and engineering at Norwegian universities. Recent setbacks and talks of an end to oil exploration have led students to entertain the conjecture of a "sunset industry" (Trondsen, 2002). To ensure a steady supply of young scientists and engineers, the industry may have to alter its image and offer students from multiple disciplines a vision of access to cutting-edge technology. New recruits would then expect to gain valuable training in managing successfully within a technology-sophisticated sphere and to learn how to bridge to the marketplace. Graduates would expect to be inspired and spurred to innovate and to later in life encounter opportunities to build on what they have learned by establishing firms in other non-energy sectors. Creating and then meeting such expectations may be far from straightforward for the industry itself. Since the task coincides with a prime social need, however, there is a case for public-private co-operation to transmit new messages to the young.

[40] The technology diffusion programmes of Finland's Technology Development Centre (TEKES) are centered on technology clinics, which have had wide-ranging impetus on product and process development, technology adoption, technology strategy, recruitment and outsourcing of expertise.

[41] The Manufacturing Extension Partnership (MEP) is a network of regional centers in the United States focused on helping small firms access the knowledge and expertise of specialists from high-tech industries. Evaluations concluded that participating companies experienced between 3.4 % and 16 % higher growth in labour productivity over a five-year period than similar non-participating firms. The programme is decentralised and funded by federal and state funds as well as universities and industry. The success of MEP in diffusing technological know-how and expertise led the federal government to request an additional provision of $12.6 million for the programme in 2004 (more information on the MEP-programme is available at the homepage of the National Institute of Standards and Technology, http://www.mep.nist.gov/about-mep/overview.html).

[42] A 1994 survey of the MEP programme found companies that participated in diffusion programmes to become six times more likely to independently plan technical improvements than non-participating firms (OECD 1998). It was also found to produce results in terms of the skills and competences of workers.

Any policy of R&D-support must be firmly integrated in a comprehensive package to establish key enabling conditions for innovation. The policy should be prepared, communicated and implemented in a way that helps focus attention on, and facilitate the implementation of, crucial complementary reforms, and where there may not otherwise be sufficiently strong driving forces to overcome resistance to reform. For instance, the government's strategy of combining the R&D-policy with changes in rules for intellectual property rights already succeeded in highlighting the linkage between different policy domains in influencing the opportunities for knowledge creation and use. Further progress in this respect can be facilitated through the provision of information and incentive schemes that *help raise public awareness of the importance of innovative activity*. For this to be taken seriously, however, we propose that, the government should reconsider the goal of a higher R&D intensity in Norway's strive to become one of the most innovative countries in the world. Achieving the average for all or for selected OECD-countries on R&D intensity represents a simple message, but it is not a truly meaningful or inspiring objective. We believe that the Norwegian government, and its societal partners, can do better. As a minimum, measures catching national innovation efficiency and effectiveness should be added to the R&D-intensity measures. This could be a task for the Cabinet innovation council in collaboration with key societal stakeholders.

There is the issue of what determines the ability of governments to design and implement a comprehensive innovation policy. A number of studies, e.g., OECD (1998), Georghiou (2002) and Boekholt et al. (2002), point to the presence of various institutional impediments to the implementation of effective approaches in this area. The available evidence indicates that success requires a strong mandate from the highest level of policy-making. Again, the task is not to engineer from above, but to send consistent signals throughout the institutional fabric that innovation is wanted. The present line-up in Norway of a process initiated by the Prime Minister and encompassing a team of nine ministers appears to account for strong leadership. At the same time, the effort must transcend and effectively involve other key stakeholders, including the private sector, the unions and civil society. This will be crucial for ensuring relevance in the proposed measures, as well as for putting in place an effective implementation process.

In the following, we point to six *challenges* that deserve high priority in Norway, besides the discussed R&D-support. The first one is that of formulating a new, lead target for the overriding reform effort. Again, the government must communicate the significance of a comprehensive agenda, and that the associated challenges are addressed not one-by-one but in an integrated fashion. Without a considerable degree of commitment across ministries and major stakeholders, as well as sufficient appreciation among the general public that these things hinge together, the political momentum required for addressing each one of them is likely to be lacking. Under each heading, recommended instruments are indicated.

Challenge no. 1:
The government should formulate a target for a comprehensive innovation policy that is realistic and meaningful. The goal should be worked out in collaboration with the main stakeholders so as to make them engaged and committed to contributing to its fulfilment. There should be sensible sub-targets, and realisation of the objective should be possible to verify. It is further recommended that:

- The measure should broaden the measurement of innovation beyond R&D to include other aspects of innovation, reflecting the importance of complementary critical factors such as technical skill, organisational change, entrepreneurship, seed and venture funding, and governance. The indicator should correspond to the overriding objective of Norway to become the most innovative country in the world;
- The overall objective should be coupled with concrete and verifiable intermediary targets;
- The time period chosen for the intermediary and final objectives should be short enough to create high ambitions but long enough to allow for sensible planning and for generating real, long-lasting effects, and;
- Launching of the new target should be accompanied by the introduction of improved methods and practices for systematic evaluation of innovation policy, with emphasis on economic outcomes and systemic considerations.

Challenge no. 2:
The government should address factors in the educational system limiting human capital accumulation in support of innovation. Recommended measures include:

- Promote problem-solving skills in the educational system;
- Fostering public-private partnership combining support of both supply and demand of high-quality education at universities in science and engineering;
- Introducing incentives for science education, ranging from "hard carrots" such as scholarships or knocking off part of students' loans when graduating in science, to creating role models by establishing promotional awards for young scientists, and other marketing measures;
- Make better use of international student exchange programmes for promoting openness (see example below), and;
- Adopting more progressive remuneration packages for teachers, coupled with other measures to restore the weakened status of the profession.

Challenge no. 3:
In order to improve conditions for high-tech and fast-growing new firms, the government should strengthen mechanisms for the allocation of seed and venture capital. Recommended measures include:

- Supporting the accumulation of sufficient depth and competencies in seed- and venture capital financing, ensuring a richer market of financial services which entails various and complementary public and private venture capitalists supporting innovative entrepreneurs in both early and later stages;

- Improving exit conditions for investors partly through facilitating a larger investor pool on the market and partly by strengthening the secondary stock market;
- Reducing transaction costs in locating either investment opportunities or relevant investors, and encouraging active coaching of growth companies, through supporting and financing the development of transparent and effective business angel networks, and;
- Strengthening attitudes in favour of entrepreneurship and seed funding by, e.g. abolishing or reducing the wealth tax and taking supplementary steps to make success more socially acceptable.

Challenge no. 4:
The government should adopt an agenda for promoting participation and life-long learning in the work place. Recommended measures include:

- Allowing employment conditions to be adjusted more effectively to individual circumstances, with more flexible collective agreement;
- Making eligibility requirements to disability pension benefits less liberal, possibly by shifting a share of the cost to employers;
- Designing compensation systems and organisational change that reward accumulation of experience and promote "high-performance" work places with strong sense of customer demand, applying also to the public sector, and;
- Measures to increase R&D, such as SkatteFUNN, should be matched by network- and mobility-enhancing initiatives that facilitate knowledge flows, notably of skilled graduates from universities to companies and from institutions to industry;

Challenge no. 5:
The government should strengthen local competencies and processes conducive to innovation through selective decentralisation, while also promoting more internationally oriented growth strategies. Recommended measures include:

- Raising the awareness of local and regional authorities to issues affecting innovation systems, such as critical mass and networking, and their roles as catalysers of private initiatives;
- Seeking ways to induce upgrading of competencies in regions and municipalities on how to further strengthen learning processes around unique skills and assets, for example, promote specialisation in universities and counter pressures to include all disciplines at each location;
- Fostering better-integrated and more competitive logistics solutions;
- Making the funding of regional development more responsive to local initiatives in innovation while also more predicable and conducive to long-term planning, and;
- Increasing investments in infrastructure facilitating/supporting the creation and the development of regional networks and clusters, as well as exploring other avenues for strengthening their dynamics and international linkages.

Challenge no. 6:
A public-private partnership programme combining research, innovation and technology diffusion should be developed, drawing on established strengths in selected industries where resources and network capabilities account for critical mass. Oil, marine industries, and metals present important opportunities. The following represent examples of possible measures:

- Norway could enhance its role as the world's leading R&D-country in oil and gas, with knowledge production underpinning new emerging goods and services in adjacent industries. The means would include upgrading domestic knowledge assets as well as attracting foreign investments and expertise;
- Norway could develop a special researchers' program attracting, e.g., a significant number of senior researchers and post graduate students from the rest of the world through "oil and gas scholarships". These would not only strengthen the research base of Norway but generate new international networks and impulses;
- Such programs could be financed by allocating a small part of the oil revenue for this purpose. By investing in R&D programs, laboratories and equipment, and building new capacity partly through "imports" of researchers in support of the establishment of internationally unique "Centres of Excellence", wage demands fuelling inflation could be minimised, and;
- A government initiative engaging from the outset relevant private sector representatives, could serve to foster interaction that initiates learning processes. The institute sector should be inspired to mobilise its resources and competencies so as to strengthen its interface with the private sector, including large established enterprises, while enabling SMEs to participate actively and upgrade their technology capacity and enticing foreign enterprises to plug into domestic networks devoted to innovation.

Naturally, this is not a complete list. There are also other compelling issues, some of which were touched upon earlier in this report. Further it is not a question just of what is to be done but, most importantly, how measures are implemented. Some steps may be pursued in innovative ways that can address several issues at once. One example could be the establishment of a high-quality Norwegian scholarship programme, in the likeness of Fulbright, designed tosupport masters and doctoral studies in priority areas. In addition to generating student mobility and promoting the exchange of ideas, that could be arranged with a view to offering thrilling networks and insight into Norwegian society for future creative leaders and researchers in all fields from around the world. If designed and marketed appropriately, such as scheme could help improve the quality and quantity of the domestic supply of graduates with leadership capabilities and problem-solving skills, as well as extend and strengthen relations between Norway and non-Nordic countries.

Summing up, Norway should adopt a policy which goes against complacency and builds stronger support in society for a comprehensive growth and innovation policy. Success is contingent on constructive horizontal cooperation and coordination between traditional policy spheres. Success will hinge on the realisation, in all major parts of government as well as in society more broadly, that Norway needs to invest for the future.

iv) Recommendations for further analysis

This report, produced during the course of the last year and paralleled by the gradually intensified work by the Norwegian government to launch a broad-based plan for a comprehensive innovation policy, has spanned considerable territory and reflected on a broad range of issues. It has tried not to shun for problems that are politically controversial, but to identify and point to what has been concluded as important issues to resolve. On the other hand, some issues already examined extensively in earlier work, such as Technopolis' evaluation of RCN (Arnold et al., 2001), were not penetrated in detail. There are also areas which should be subjected to additional, in-depth work to explore the merits of further policy initiatives. Examples include:

- Suitable intermediary and final targets for a comprehensive innovation policy that are realistic and meaningful, and which go beyond R&D-intensity to include other elements of innovation;
- The significance of strengths in manufacturing for the competitiveness of services, how manufacturing and services relate to each other in the Norwegian context, and how they may evolve in the future under different circumstances;
- Effective strategies for selective decentralisation of innovation policy in ways that are conducive to competence-building and successful niche strategies locally;
- Key factors influencing attitudes towards, and preparedness to engage in, entrepreneurship and potential high-growth ventures;
- Appropriate methods for enhancing innovation in public sector administrated growth areas (e.g. the health sector);
- The fishing industry is under pressure in part because of trade-related barriers to innovation. A review of development trends and how competitiveness is affected by incentives related to the combination of trade and innovation would be instrumental for the development of appropriate policy responses, and;
- Identification of sectors and actors that form suitable candidates for launching effective public-private partnership processes in support of innovation and industrial renewal.

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