

Global Pressure – Nordic Solutions?

Nordic Globalization Barometer 2010



Global Pressure

Nordic Solutions?

Global Pressure – Nordic Solutions? The Nordic Globalization Barometer 2010 *By Christian Ketels*

ANP 2010:714 © Nordic Council of Ministers, Copenhagen 2010 ISBN 978-92-893-2059-7 Print: Scanprint as Layout: Scanad Copies: 600 Printed on environmentally friendly paper This publication can be ordered on www.norden.org/order. Other Nordic publications are available at www.norden.org/publications

Printed in Denmark



Nordic Council of Ministers Store Strandstræde 18 DK-1255 Copenhagen K Phone (+45) 3396 0200 Fax (+45) 3396 0202 Nordic Council Store Strandstræde 18 DK-1255 Copenhagen K Phone (+45) 3396 0400 Fax (+45) 3311 1870

www.norden.org

Nordic co-operation

Nordic cooperation is one of the world's most extensive forms of regional collabora-tion, involving Denmark, Finland, Iceland, Norway, Sweden, and three autonomous areas: the Faroe Islands, Greenland, and Åland.

Nordic cooperation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.

Nordic cooperation seeks to safeguard Nordic and regional interests and principles in the global community. Common Nordic values help the region solidify its position as one of the world's most innovative and competitive.

Foreword

The global challenges related to climate, the environment, energy, welfare and the financial markets are huge and urgent. None of these challenges can be solved by one country or region alone. They require a co-ordinated approach. For the Nordic countries it is quite natural to look for joint solutions. The Nordic region has a common history, strengths, values and knowledge that support joint efforts to answer these challenges.

The Nordic Prime Ministers therefore took joint action to strengthen Nordic cooperation as a tool to better meet the challenges of globalization. In Punkaharju, Finland in 2007 they stated a shared and positive attitude towards opportunities and challenges of globalisation. According to the Prime Ministers Nordic co-operation should be more focused on globalization and the opportunities stemming from it. They therefore called upon joint Nordic activities related to innovation, climate and energy, research and education, welfare and health issues – areas where the Nordic region can be successful.

One of the initiatives initiated from the Nordic Prime Ministers' joint Nordic globalisation policy is a Nordic Globalization Forum. The objective of the forum is to seek joint solutions to the challenges of globalisation. The Nordic premiers together with representatives of industry and commerce, research, politics and non-governmental organisations are taking part. The first Nordic Globalization Forum was held in Sweden in April 2008 and the second in Iceland in February 2009. On both occasions the Nordic Prime Ministers confirmed the Nordic globalization process that was started in 2007

At the 20 of May 2010, the third Nordic Globalization Forum will take place in Denmark. This year the focus will be on green growth. Previous years the Nordic Globalization Barometer have contributed with valuable input to the debate that took place at the Globalization Forum and the Nordic Prime Ministers wished to se an updated version in 2010. I am therefore proud to present the 2010 Globalization Barometer.

The Nordic Globalization Barometer identifies issues related to the dynamics of globalization. Many things have changed, both globally and in the Nordic region. Over the last few months, the focus has gradually started to shift from emergency crisis measures towards longer-term growth and global competitiveness. While last year's Barometer discussed the role of globalization in the emergence of the crisis, this year's Barometer thus returns to the central role of global competitiveness in overcoming its consequences. In this context, the Barometer continues to track the global competitiveness of the Nordic region. As a special topic for this year, it looks at the status and trends of private sector innovation in the Region, contrasting the situation in the Nordics with the developments in China.

Finally, I would like to give my warmest thanks to the author Christian Ketels (Harvard Business School / Stockholm School of Economics) and to Sylvia Schwaag-Serger (VINNOVA and Research Policy Institute, University of Lund) and Nannan Lundin (TEKFORS AB) that have contributed with valuable input to the report. The analysis and conclusions in the Nordic Globalization Barometer are those of the author and do not necessarily reflect the views of the Nordic Council of Ministers. However, I am convinced that the report will be a useful instrument in our future work implementing the globalization initiatives that started with the Prime Ministers summer meeting in Punkaharju.

Copenhagen, 29 April 2010

ldór Ásgrímsson

Secretary General Nordic Council of Ministers

- Nordic Solutions?

Contents

Foreword	3
Executive Summary	5
Chapter 1 Introduction	11
Chapter 2.Global Competitiveness of the Nordic countries2.1 Economic Climate2.2 Economic Performance2.3 Competitiveness2.4 Globalization Readiness2.5 Overall assessment	13 14 19 22 36 40
Chapter 3. The robustness of Nordic innovative capacity 3.1 Current status of Nordic Business R&D 3.2 Drivers and outlook for Nordic business R&D 3.3 Nordic innovation – a Chinese perspective 3.4 Overall assessment	43 44 52 59 87
Chapter 4. Conclusions 4.1 Key findings 4.2 Key policy implications	89 91
References and further reading	94

Executive Summary

The 2010 Nordic Globalization Barometer is the third in its series, again designed to serve as input to the Nordic Globalization Forum. Less than three years after these fora were launched, the longer-term challenges of globalization have in the public debate been pushed aside by the short-term consequences of the global crisis. Over the last few months, the focus has gradually started to shift from emergency crisis measures towards longer-term growth and the agenda that has been the focus of the Nordic Globalization Barometer from the start: global competitiveness. While last year's Barometer discussed the role of globalization in the emergence of the crisis, this year's Barometer thus returns to the role of global competitiveness in overcoming its consequences.

The Global Competitiveness of the Nordic countries

There is an increasing realization that growth policies need to be countryspecific, addressing the unique challenges countries face based on an in-depth review of strengths and weaknesses. The 2010 Nordic Globalization Barometer continues to apply Michael Porter's framework (Porter et al., 2008) to conduct such a review for the Nordic countries, focusing on issues relevant across the individual countries.

While a full assessment of the current economic climate in the Nordic countries is not within the scope of the Barometer, a short overview of the main trends is important to understand the context facing policy makers in the region. The solid improvement of the **economic climate**, especially the fast recovery of sentiment, appears overly rapid given the economic fundamentals. Policy makers in the Nordic region face a balancing act of putting fiscal and monetary policy back on a path of long-term stability without eroding consumer optimism.

The **economic performance** of the Nordic region has suffered as a result of the crisis. The level of prosperity remains high but the reduction of prosperity has been significant, even in comparison to peers in the OECD and EU. Both on productivity and on labour mobilization the region has taken a toll. Continental European countries have chosen a policy response that has accepted high falls in productivity while keeping employment levels up. The US has instead relied on a dramatic adjustment on the labour market, keeping labour productivity more stable. Which of these approaches will proof to be more effective in the long-term depends on the length of the crisis and the level of structural change it will induce.

The **competitiveness** of the region has not changed dramatically. The high level of overall competitiveness supports the high level of prosperity that the region is enjoying. The relative position on especially macroeconomic competitiveness has even improved as other countries turned out to have less robust policies or institutions. The Nordic countries also remain strong on company sophistication, the innovation system, and physical infrastructure. Areas of weakness, too, are largely unchanged. The context for competition provides relatively weak incentives. While the overall education system is perceived as strong, there are concerns about the quality of the science and math education. Patenting rates are high but develop less dynamically than in global innovation leaders. - Nordic Solutions?



On **globalization readiness**, the Nordic countries have been clearly impacted by the global crisis. Export market shares dropped more than proportionally. FDI data is one year behind but shows the focus shifting from international engagement to domestic growth in the run-up to the crisis. It is still too early to assess whether the gradual resumption of growth in the global economy will enable the Nordic countries to regain their previous position on exports and FDI. An issue of concern remains the flexibility of the economy: The Nordic countries continue to do well in allowing exit and the labour market rules might enable more flexibility than international assessments suggest. But the regulatory burden on starting a new business remains high; despite the many efforts to support entrepreneurship, the Nordic region has fallen behind further on these measures.

The Robustness of the Nordic's Innovative Capacity

Innovation is a critical foundation for the Nordic's current and future prosperity. It takes many forms, from basic research to applied development, from introducing new products and services to new ways of organizing companies and serving customer needs. Corporate R&D activities are only one aspect of overall innovation in the economy. But they are a good signal of broader trends, highlighting more general features of the innovative capacity across countries.

The **level of corporate R&D activity** in the Nordics is high and one of the key drivers of the region's strong position on innovation relative to global

Global Pressure

peers. Companies in the Nordic countries are relatively R&D intensive, to a large degree driven by the nature of the industries they are in. Given the size of the Nordic economies, the absolute size of R&D spending in the region is modest on a global scale. The spending and patenting activity of the Nordic business sector is more skewed towards a few companies than in other economies. Cross-Nordic R&D activity is relatively limited. The strong position of Nordic countries in international rankings of innovative capacity is a reflection of the region's strong overall competitiveness. The Nordics are strong on fundamental inputs into the innovation system but often fail to take full advantage of these inputs. In particular, the innovation system works well in its traditional focus on science outcomes and large company R&D activity but much poorer on high-growth entrepreneurship in innovation-driven companies.

The outlook for corporate R&D in the Nordics is likely to be more challenging. R&D activity, traditionally located at a company's home base, has globally experienced significant dispersion over the last couple of years, driven largely by MNCs. Market access, skill availability, local R&D, and the presence of dynamic clusters have been identified as the key determinants of companies' R&D localization decisions. A series of semi-structured interviews with R&D intensive Nordic MNCs confirms these patterns: Their research activities are disproportionally located in the Nordics, while development has often been moved to larger markets elsewhere. There are only limited short term threats to the current level of activities, but in the long term their role is likely to fall in relative terms, maybe even in absolute size. The Nordics key advantages - and the reasons for the strong current level of corporate R&D activities - are the availability of skilled human capital at competitive costs, the sophistication of local demand, and the presence of dynamic clusters of specialized companies and universities. But the advantages are under threat: There is rising skill supply abroad and growing shortages at home. Existing cluster structures are not optimally aligned with new innovation needs. Technological trends are in some important fields moving away from areas of traditional Nordic leadership. Other locations are becoming more sophisticated markets, and there is insufficient action to translate leading Nordic demand into international standards that could create competitive advantages. While the legacy effect of the installed base reduces the risk of dramatic short-term changes, the long term threats are obvious. And there are signs that the more gradual migration of strategic research activities from the Nordics to other parts of the world has already started.

China has witnessed a dramatic increase in its research and innovative capacities in the past decade, with far-reaching implications for the global knowledge and innovation geography. The Nordic countries are principally well positioned both to compete and cooperate with China, particularly in the field of climate and energy. However clearer strategies and better models for cooperation are required, particularly at national and university level, to allow the Nordic countries to realize this potential.

Nordic Solutions?

Recommendations

The Nordic Globalization Barometer aims to identify policy issues that are (a) important for the future success of the Nordic region and (b) in which collabouration on the Nordic level can make a real difference.

The analysis of **global competitiveness** has shown that he Nordic region cannot rest on its laurels. The global crisis has highlighted the need for actions along different time dimensions:

- In the short term, the Nordic countries share the macroeconomic challenge of gradually reducing the emergency measures introduced throughout 2009. *Strong Nordic* coordination on the timing and communication of key macroeconomic policy steps could help stabilize expectations and stay on a sustainable growth path.
- In the medium term, the Nordic countries continue to face the *structural challenges* identified in some detail in the previous two Barometers. The most powerful tool at the Nordic level to address these issues is *market integration*, followed by policy learning in the several areas in which national policies have to change.
- In the long term, the Nordic countries are facing the tensions of how to manage the *structural policy imbalance* between high exposure to global shocks but low influence on the decisions about the policy and regulatory context in which these shocks emerge. Coordination is crucial for a group of relatively small economies to gain or retain appropriate influence.

The analysis of **corporate R&D activities** puts some of these competitive challenges facing the Nordics into clear focus. Actions are needed both on competitiveness and on globalization readiness:

- *Highly skilled employees* and *world-class research* are the bedrock of Nordic competitiveness and a key reason for the high level of R&D intensity in the region. In both areas, the region is in danger of falling behind markets needs, not the least because of a lack of global perspective and Nordic integration. If there is one critical issue that the Nordics need to get right, it is this one.
- The Nordics have many efforts to *strengthen clusters*, but have failed to sufficiently trigger high-growth entrepreneurship. The Nordic level can be a forum for policy learning and discussion about the necessary changes in taxation, administrative procedures, and research institutions.
- The attraction of *foreign skills* and *foreign companies* is increasingly critical to retain and develop the position of the Nordics as a basis for corporate R&D. Nordic collabouration has significant potential in marketing, efforts to increase the region's attractiveness, and policy learning on issues that require national action.
- Local demand sophistication needs to be translated into international regulations and standards to create economic opportunities. Nordic collabouration could help in achieving the necessary impact in Brussels and elsewhere.

The analysis of China's **rapidly increasing knowledge and innovative capacities** clearly underline theses points. In particular, we can see a significant expansion of Nordic multinationals' R&D activities in China in recent years. More action is needed to take advantage of the opportunities this creates.

• More effective innovation linkages between the Nordic countries and China require the creation of a *strategic dialogue* between the relevant policy communities on both sides. Efforts at the level of individual companies or even individual Nordics countries are not enough.

A crucial dimension for competitiveness upgrading is the ability to move from analyses – like the one's presented in this Barometer – to action. The consensus-oriented nature of **Nordic decision making** is good for action once agreement is reached, but bad for timely decisions to get there. The Nordic Globalization Forum could in this context be leveraged not only as a platform to discuss *what* needs to be done but also *how* it can be put into practice. Why not make the different national experiences in this area a topic for Nordic discussion as well?



- Nordic Solutions?

Chapter 1

Introduction

The 2010 Nordic Globalization Barometer is the third in its series. When the Nordic Prime Ministers launched this effort at their June 2007 meeting in Punkaharju (Finland), the globalization process had driven economies around the world to increasingly high levels of performance. At the time, the challenge at the top of the agenda was how to prepare the Nordic countries for the increasing competition from abroad, especially from the fast growing emerging economies.

Less than three years later, the longer-term challenges of globalization have in the public debate been pushed aside by the short-term consequences of the global economic and financial crisis. Late 2008 and much of 2009 were dominated by the policy efforts to avert a collapse of the financial system and then programs to stimulate demand. Over the last few months, the focus has gradually started to shift towards longer-term issues: Much of the damage done by the crisis, for example the huge debt burden that countries around the globe are left with, are impossible to address without solid and sustainable long-term growth. And this leads back to the agenda that has been the focus of the Nordic Globalization Barometer from the start: global competitiveness. Only economies that achieve high levels of competitiveness and globalization readiness can hope to achieve the growth rates necessary to put their economies can on a sustainable track. While last year's Barometer discussed the role of globalization in the emergence of the crisis, this year's Barometer thus returns to the role of global competitiveness in overcoming its consequences.

The Nordic Globalization Barometer 2010 is structured in two parts: Chapter 2 looks at the global competitiveness of the Nordic countries. Following up on last year's Barometer, the chapter provides an assessment of how the global competitiveness of the Nordic countries has changed over the course of the last year. It looks at four separate dimensions that provide complimentary insights into global competitiveness:

- First, the chapter provides an overview of the macroeconomic climate in the Nordic countries. These short-term trends have limited direct impact on long-term competitiveness. But they set the context in which policy choices affecting competitiveness have to be made.
- Second, the chapter tracks the changes in economic performance, the ultimate way in which competitiveness translates into prosperity. The indicators closely match those that were covered last year. The short term changes of these indicators reflect the impact the current crises has on economic conditions. The longer-term patterns of levels for these indicators give important insights into strengths and weaknesses of underlying competitiveness.
- Third, the chapter covers the main drivers of competitiveness. Competitiveness is set by all those fundamental factors that drive the potential prosperity an economy can generate. While these fundamentals tend to not change rapidly in the short-term, trends in their relative strength and weakness provide important information for policy.

Global Pressure

• Fourth, the chapter covers indicators of a country's ability to project its competitiveness globally. The broad categories to measure 'globalization readiness' follow closely those that were introduced last year. Some of the performance related indicators on trade and investment are highly affected by the global crises. The structural indicators of flexibility are subject to more gradual changes as a consequence of policy action across countries.

Chapter 3 of the Barometer deepens the discussion on a dimension of competitiveness that is particularly crucial for the Nordic countries: the region's innovative capacity. As a high-wage location, there is broad agreement that innovation is the only way in which the region can earn its high standard of living in the future. Innovative capacity was also highlighted in the 2008 Barometer as one of the dimensions through which the Nordic countries could position themselves in the global economy (Ketels, 2008). The chapter focus on corporate R&D, an important part of innovation in the Nordics and the one most exposed to global competition. While the government activities and framework conditions set the context, it is ultimately corporate R&D that provides the crucial linkage to wealth generation. The chapter looks at three different dimensions:

- First, the chapter summarizes key data on corporate R&D activities in the Nordic countries. The description of the status quo provides the baseline for any discussion of future trends. The chapter also provides an overview of a number of international reports on innovative capacity. These reports give a sense of the context in which companies are conducting their Nor-dic R&D activities.
- Second, the chapter discusses the issues that will determine future changes in the level of corporate R&D in the Nordic countries. It first highlights key findings of the academic literature on global R&D. It then draws on a series of semi-structured interviews with executives from leading Nordic corporate R&D spenders. This perspective on the trends and drivers of their companies' global R&D footprint gives fundamental insights into the challenges that corporate R&D in the Nordic countries is facing.
- Third, the chapter includes a discussion of the emerging role of China in the global R&D market and the linkages between China and the Nordics on innovation, and the way both of these issues play out in the field of environmental technologies. This part of the chapter is authored by Nannan Lundin and Sylvia Schwaag Serger, two internationally known experts of the Nordic and Chinese innovation systems.

The Barometer concludes with a number of summary remarks on the main findings and policy conclusions.

Chapter 2.

Global Competitiveness of the Nordic countries

The global crisis has left deep economic wounds around the globe. Unemployment has gone up significantly; government budgets are in deep deficit. The initial wave of policy reactions was focused on limiting the direct impact of the global shock. But now the focus is shifting towards policies that can lead economic out of the crisis towards a new, more sustainable growth path. Growth is crucial, because without it there is no hope of reducing unemployment and consolidating public sector finances. But what is driving sustainable growth in the global economy?

The framework introduced in the 2008 Nordic Barometer (building on Porter et al., 2008) is based on a pragmatic answer to this complex question that has engaged generations of economists and politicians in the past and present. The framework acknowledges the breadth of factors that have an impact on long-term sustainable growth. It organizes these factors into categories that are driven by their different roles in the overall process of supporting prosperity improvements and by the different policy architectures that determine their quality. Crucially, the framework does not propagate a generic set of policy priorities, but requires locations to identify the specific challenges they face based on an in-depth review of their respective strengths and weaknesses. The Barometer makes a contribution to such a review for the Nordic countries, focusing particularly on issues that are relevant for the entire region.



Global Pressure

The 2010 Nordic Globalization Barometer continues to apply this framework with marginal adjustments to some individual indicators used depending on data availability. To analyse the position of the Nordic countries in the global economy, their position on three sets of indicators is reviewed:

- **Economic performance**, in particular a high standard of living, is the ultimate objective of economic policy. The Barometer tracks overall measures of prosperity and prosperity generation, including GDP per capita, labour productivity, labour mobilization, and local price levels.
- **Competitiveness** is the combination of factors that set the level of productivity that companies can reach in a given location, the key long-term determinant of the standard of living a location can sustain. Based on the refined framework introduced in the new Global Competitiveness Index (Porter et al., 2008), the Barometer differentiates between macroeconomic and microeconomic competitiveness.
- **Globalization readiness** describes the ability of a location to successfully engage with the global economy, bringing to bear its full competitiveness. The Barometer tracks three categories of relevant indicators: The ability to sell globally, the ability to attract globally, and the ability to react to global shocks.

As in the previous year, the Nordic Globalization Barometer aims to strike a balance between accessibility, i.e. being sufficiently brief to enable decision makers to use the data, and relevance, i.e. providing sufficient breadth and depth to enable a meaningful discussion about actions. It draws on existing data and research rather than extensive primary analysis. The positions of the Nordic countries individually and on aggregate are summarized through the simple colour scheme below. The sources for the detailed data are provided in the list of references at the end, in some cases also with the direct links to the online data.

Green for a position better than the OECD and EU-15 average, or a rank within the global top 10, or an improvement

Yellow for a position between the OECD and EU-15 average, a rank between 10 and 20 globally, or no change

Red for a position below the OECD and EU-15 average, a rank lower than 20 globally, or a deterioration

2.1 Economic Climate

The Nordic Globalization Barometer does not aim to provide an in-depth assessment of the current economic climate in the Nordic countries. Many government agencies, research institutions, and banks are focused on this task. Instead, the Barometer discusses medium-term data related to the level of economic performance that the Nordic countries will be able to achieve over time. The short-term fluctuations of the economy provide only very limited information on these trends. They do, however, set the context in which many policy decisions with longer-term implications are being made. This year's Barometer therefore includes a short overview on the current economic climate and trends affecting business cycle conditions in the Nordic countries.

Real GDP growth rates (in %)						
	2006	2007	2008	2009	2010*	
NORDIC	3.7	2.9	0.4	-4.4	1.7	
Denmark	3.4	1.7	-0.9	-5.1	1.2	
Finland	4.4	4.8	1.2	-7.8	1.5	
Iceland	4.3	5.6	1.3	-6.5	-0.5	
Norway	2.3	2.7	1.8	-1.5	1.6	
Sweden	4.5	2.7	-0.5	-4.4	2.3	
EU	3.2	2.8	0.7	-4.2	0.8	
OECD	3.0	2.6	0.4	-3.4	2.0	

Unemployme	ent (in %)		Œ		Read
	2006	2007	2008	2009	2010*
NORDIC	5.5	4.6	4.3	6.0	7.3
Denmark	3.9	2.8	1.8	3.5	5.2
Finland	7.7	6.9	6.4	8.2	10.0
Iceland	1.3	1.0	1.6	8.0	11.7
Norway	3.5	2.5	2.6	3.2	3.7
Sweden	7.1	6.1	6.2	8.3	9.7
EU	8.5	7.4	7.2	9.3	10.5
OECD	6.2	5.8	6.1	8.3	8.8

Government budget balance (in % of GDP)						
	2006	2007	2008	2009	2010*	
NORDIC	7.5	7.8	7.6	0.9	-0.5	
Denmark	5.0	4.4	3.4	-3.0	-5.8	
Finland	4.0	5.2	4.5	-2.2	-4.0	
Iceland	6.3	5.4	-0.6	-9.0	-7.0	
Norway	18.5	17.7	18.8	9.7	9.3	
Sweden	2.2	3.4	3.1	-1.6	-3.0	
EU	-1.4	-0.8	-2.2	-6.7	-7.6	
OECD	-1.1	-0.6	-2.0	-7.3	-8.1	

* Predicted value.

The Nordic countries had been growing strong than its European peers in the run-up to the current global crisis. As small open economies, they had all benefited strongly from the trade and investment growth in an increasing global economy. The current account was positive for the region, very significantly so for Sweden and Norway, reducing the dependence on global capital markets. Earlier than many of their peers the Nordic countries had focused on solid fiscal policies with government surpluses in the year's of high economic growth. The financial industries were generally sound and had limited direct exposure to the US markets. Monetary policy structures ranged from Finland as a Euro-Zone member, Denmark with an objective to keep exchange rate stability to the Euro, and the other Nordic countries with combinations of exchange rate and domestic inflation oriented policy objec-

Source: EIU (2010)

tives. This differences in exchange rate policy were one important factor in the different developments in unit labour costs relative to other economies; Denmark and Finland experienced significantly rising relative unit labour costs, while Swedish unit labour costs were fluctuating significantly with a downward trend over the medium term. Inflation had been increasing as the Nordic countries approached the peak of their domestic business cycles.

The current outlook for the Nordic countries is more positive than for the European Union, almost matching the expected growth rate for the aggregate of the OECD. But it has a significantly different profile: No other region is experiencing growth that is as much driven by domestic consumption. This is largely a reflection of the much more positive sentiment reported in the Nordic economies; fiscal stimulus packages are also playing an important role. Exports are starting to contribute to growth, but not distinctively more than in the rest if Europe. Investment activity, traditionally a key ingredient of self-sustaining growth, is much less dynamic in the Nordic countries than in the EU-27 or the OECD.



Source: European Commission DG Economic and Financial Affairs, 2010

Policy makers in the Nordic countries now need to return fiscal policy to a sustainable path and avoid sowing the seeds of a future bubble by keeping monetary policy at expansionary levels for too long. Their challenge is to implement these changes without undermining the resurgence of domestic demand that is driving economic growth. It is under these conditions that the Nordic countries have to discuss how they can also improve the supply side conditions in their economies that will determine the long-term growth rate of GDP.

Denmark had been hit by a domestic slow-down of the economy already in early 2008, when consumer confidence started to wane and weak private sector spending slowed down the economy. The government's reaction, in particular tax reductions, came into force just when the global downturn hit. In addition, the Danish government launched two packages to stabilize the banking system, first by providing guarantees on deposits to avoid a bank run and then capital injections to strengthen the financial foundations of Danish banks. In early 2010, consumer confidence has regained ground and is driving consumption but also wage demands. Exports and investments remain weak. The resumption of growth now visible is so far relatively fragile and lacks a surge of investment to become truly self-sustainable. The further trend will depend on the impulses from global trade but also from the reaction of the domestic economy to the end of emergency measures in the financial system and the gradual shift from fiscal stimulus to contractionary policies necessary to regain stability in public finances.

Finland had over the last few years been a poster-child of export-driven growth. Its focus on investment goods placed it well given the increasing demand from emerging economies and a generally growing global economy. When the crisis hit, Finland was hard hit by the dramatic slump in manufacturing exports. As the European country with the highest share of exports going to markets outside of the EU, it was also dramatically affected by the appreciation of the Euro, which reduced the price competitiveness of Finnish companies relative to their American and Asian peers, but also relative to EU members outside of the Euro-Zone like Sweden. Industry-specific factors in the paper and electronics industries played an additional negative role. The Finnish government reacted with tax cuts and let the strong stabilizers inherent in the social security system work to full effect. But as long as Finnish consumers had negative perceptions about the future, this drove up the savings rate with limited impact on domestic consumption.

In early 2010, there are signs of a sluggish resumption of growth but also considerable concerns about the medium term outlook. The last quarter of 2009 saw a disappointing fall in GDP. Private consumption is slowly picking up but by less than in other Nordic countries. Investment remains low and has benefited less from public stimulus programs than elsewhere. Exports are starting to pick up, but some observers expect the crisis to have enhanced structural changes in key industries that would see more activities leave Finland. On the labour market there are worries about an increasing skill mismatch. And the labour disputes in the ports do not bode well for efforts to address these issues, apart from their painful short-term effect on exports.

Iceland experienced an era of historic growth that turned into overheating and overleveraging. The recently published review of the crisis also points to significant policy mistakes and in some cases criminal behavior that contributed to the build-up of the crisis (SIC, 2010). When the global financial crisis unfolded, Iceland's banking sector was unable to refinance its debt obligations and the government took over liabilities valued at a multiple of the country's GDP. Iceland had to ask for foreign financial help and introduce capital controls in the face of a free-fall of its currency. The domestic real estate sector collapsed and consumption contracted sharply. Apart from the short-term emergency measures, the government also decided to apply for EU membership with a view to eventually adopt the Euro.

In early 2010, Iceland is gradually entering into a new reality. The government has successfully stabilized the domestic financial sector and is on track to meet the conditions agreed with the IMF and other donors (IMF, 2010b). Some companies are doing well competing internationally. The Central Bank is gradually reducing interest rates. The country remains, however, deeply in conflict about the crisis that hit it. President Grimsson declined to sign the agreement that the government had negotiated with the UK and Dutch governments to cover the obligations from the IceSave bankruptcy. In the subsequent referendum, the population overwhelmingly rejected the agreement that the parliament had confirmed. While some concessions are on the table, the fundamental disagreement about how should take responsibility for the disaster remains unsolved. And without any closure on this issue, the path to EU membership will be long and uncertain.

Norway had benefited from the growing demand for oil and some of its other exports, including the traditionally strong shipping. The global crisis took a significant toll on the Norwegian economy, even though the downturn was not as dramatic as in many other Nordic and European economies. Fiscal policy provided a solid stimulus to reduce the impact on employment in Norway. Monetary policy also contributed to the policy response, providing low interest rates to companies and consumers.

In early 2010, Norway is returning to growth based on solid domestic demand. The Central Bank rate remains unchanged. A key discussion in policy circles concerns the investment strategy of the oil fund, which had lost during the crisis in part due to its active investment approach. Since then, much of the losses have been recouped.

Sweden had seen strong export-led growth over the last few years. In the run-up to the global crisis, there were also increasing concerns about rising real estate prices that led the Swedish Central Bank to rise interest rates a last time when other Central Banks had already started to loosen monetary policy in response to the global crisis. The crisis then hit very hard in late 2008 and early 2009. Exports slumped and the exposure of the financial sector to the Baltics was seen as a major risk factor. The automotive sector, an important part of especially Sweden's western region, was drawn into the crisis of its US owners. The Swedish government reacted with strong fiscal policy measures while the Central Bank reduced interest rate to historically low levels. The financial system was stabilized through credit guarantees and the introduction of a stability fund that banks have to finance. Throughout 2009 the Swedish economy started to stabilize, consumer confidence started to rise, and the real estate market turned again to brisk growth as low interest rates fuelled demand. A weak currency helped to stabilize export revenues and exporters' profit rates at higher levels than their peers in Euro-Zone countries.

In early 2010, growth is driven by growth in private consumption and exports. Investment activity continues to be low and the public sector is reducing its expansionary stance. The relative fragility of the recovery became obvious when GDP dropped back into recession in the last quarter of 2009. New owners have been found for the Swedish car industry but their future in Sweden remains uncertain. Exporters are facing an increasingly strong currency that is expected to appreciate further throughout 2010. The Central Bank has signalled rate increases that could have an impact on consumer demand; Swedish consumers have already one of the highest debt rates in the Nordic countries.

2.2 Economic Performance

Integration in the global economy is not an objective per se. It is only relevant because it enables higher standards of living than would be possible in a closed economy. This is why the ultimate test of the ability of a country to succeed in the global economy is the standard of living its citizens can enjoy. The central indicator to measure **prosperity** is the average GDP per capita, adjusted by local price differences, the so-called purchasing power parity (PPP). Labour productivity and labour mobilization determine together with local price levels prosperity in an accounting sense.

Prosperity	33	王王	
	Level	Growth	Growth Dynamism
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

Prosperity is measured by GDP per capita, adjusted for purchasing power parity; level data is for 2009, growth is relative to 2008, and growth dynamism is the change of the annual growth rate from 2008 to 2009. Colouring is relative to OECD/EU. Source: The Conference Board, 2010

> There is an increasing awareness that prosperity is not fully measured by average GDP per capita (CMEPSP, 2009; Legatum Institute, 2009). The quality of the environment, access to basic health care and education, equality, social mobility, and the absence of discrimination are only some of the other key elements of importance to accurately measure the standard of living in a society. While in most countries there tends to be a positive relation between these indicators and average GDP per capita, the relation is not automatic and does not hold in any individual case.

> The Nordic countries continue to register a strong position on GDP per capita (PPP), a measure that captures the longer term fundamentals of an economic and does not change rapidly over time. The region overall and each individual Nordic country register higher levels of average prosperity than the OECD and the EU-15. The short term view on 2009 growth and the change of growth rates between 2009 and 2008, measures of the short term dynamics that are more a reflection of short-term shocks and business cycle changes, is considerable less benign. The Nordic countries also continue to do well on many of the other aspects relevant for the standard of living in society (Legatum Institute, 2009). Previous Barometers discussed some of these areas, like the environment and gender equality, in more detail. All Nordic countries experienced a decrease in prosperity levels, with the relative reduction higher than in either the EU-15 or OECD. The reduction was small in Norway but significant in Finland and Iceland. Even Denmark and Sweden registered a decrease in excess of their international peers. Denmark entered the crisis earlier and saw less of a relative worsening than Sweden.

The Nordic countries continue to register solid **productivity** rates, measured by GDP (PPP adjusted) per hour worked. However, the high value for Norway – driven to a significant extent by the share of oil and gas revenues in the country's GDP – drives this result as last year. Sweden was just above the EU-15 and the lower OECD average. Denmark and Finland continue to register productivity levels below the EU-15, Iceland even below the OECD. Productivity growth in the Nordic region has been negative in 2009, but the drop was slightly less than in 2008. The EU-15 had registered stable productivity in 2008 but dropped at pretty much the same rate as the Nordic countries in 2009. The OECD, with North America playing an important role, registered broadly flat productivity growth in both 2008 and 2009.

Among the Nordic countries, Norway and Denmark registered the smallest fall in productivity in 2009. For Denmark, this was a significant improvement relative to 2008, when productivity had dropped much more significantly. A longer term concern for Denmark is the weak performance in total factor productivity growth (OECD, 200b9). The fall in productivity was more pronounced in Sweden, but also here 2009 was an improvement relative to the previous year and in comparison to the EU-15/OECD average. Finland remains in a precarious situation: The productivity level has dropped behind Denmark and is now the lowest of the mainland Nordic countries. The drop of productivity in 2009 was at -2.5% more dramatic then in peer countries and represented a dramatic worsening relative to 2008. Iceland, suffering from the dramatic crisis that engulfed its economy last year, continues to register poor productivity levels and growth compared to advanced economy peers.



The Nordic countries position on **labour input**, here measured by hours worked per capita – a summary measures that captures the impact of demographics, unemployment rates, and working hours by employees – remains favourable compared to other advanced economies. It has, however, dropped below 800 hours, falling back almost to the levels last seen in 2006. The drop was more dramatic than in the EU-15, where countries like Germany used temporary policy interventions to keep employment levels up. The OECD aggregate experienced a stronger drop, however, driven by the dramatic worsening situation on the US labour market. As a consequence, the Nordic countries have further added to the labour input advantage relative to the OECD that they first gained in 2008.

Among the Nordic countries, Iceland remains at now 1020 hours worked per capita and year far ahead of its peers in terms of labour input. In absolute terms, Icelandic labour input dropped the most in the Nordic regions by 42

Labour productivity is measured by GDP per hour worked; level data is for 2009, growth is relative to 2008, and growth dynamism is the change of the annual growth rate from 2008 to 2009. Colouring is relative to OECD/EU. Source: The Conference Board, 2010. hours. But in relative terms, this is slightly less than in Finland and Denmark, and significantly less than in the US. Denmark continues to come second in the region on labour input, with 812 hours per year and capita. After some labour input growth in 2008, the country saw a significant worsening in 2009. The same is true for Finland, which, however, started out from a significantly lower starting position. Sweden and Norway are now at almost identical levels of labour input, ranking a whisker above and below the OECD average. For Sweden, this is the result of a significant drop in 2009, while Norway's labour input held up better than in peer regions.

Labor Input						
	Level	Growth	Growth Dynamism			
Nordic						
Denmark						
Finland						
Iceland						
Norway						
Sweden						

Labour input is measured by annual hours worked per capita; level data is for 2009, growth for the relative change 2009 to 2008, and growth dynamism for the change in percentage change in 2009 to 2008. Colouring is relative to OECD/EU. Source: The Conference Board, 2010.

Three key factors have an impact on the level of labour input countries reach: Working hours per employee, unemployment among the working age population, and the share of people with working age in the total population. On **working hours per employee**, the Nordic countries remain below the average of their peers in the EU-15 and OECD. In 2009, this gap continued to shrink, however, as hours dropped more strongly in the OECD and the EU-15, where companies switched to part-time employment and reduced overtime, in the EU-15 often to avoid lay-offs. Norway was one of the few countries in the global economy that continued rising working hours per employee in 2009. Sweden and Denmark saw the most dramatic worsening in the Nordics but also across the EU-15, turning from rising working hours at the end of the cycle in 2008 to significant reductions in 2009.

On **employees per population** the Nordic countries remain ahead of their European and OECD peers. The gap to the EU-15 decreased slightly in 2009, due to a much stronger shift from rising to falling employee shares in the Nordic countries. Among European peers, only Spain registered a larger decrease on this measure in 2009.Within the Nordics, Iceland saw the largest drop in the rate of citizens working. Norway experienced the most dramatic cooling from high growth in 2008 to a small drop in 2009. Finland and Sweden struggle with the highest unemployment rates in the Nordic region. Finland remains to have relatively high unemployment benefits for long-term unemployed and provides unemployment benefits as quasi early retirement schemes (OECD, 2010a; OECD, 2010c). Sweden and Denmark also continue to register a much higher share of people outside the active workforce on disability benefits than its EU and OECD peers (OECD, 2010). Denmark registered some modest increase in unemployment during 2009, but from a very low initial level. Norway's unemployment rate also rose only marginally.

Nordic Solutions?

In Iceland unemployment jumped and is set to reach the highest levels of all Nordic countries in 2010.

On the **demographic profile**, the Nordic countries face clear challenges from aging populations, but their position is more benevolent than in many other advanced economies.

The Nordic countries continue to register relatively high **local cost levels.** In 2008, the latest year for which Eurostat provides comparable annual data, the cost level in the Nordic region was 28% above the EU-27 average and 23% above the EU-15 average. So while the higher GDP per capita level in the Nordic region explains some of the price difference, it leaves a significant part to be driven by other factors like taxes and local market conditions. For Denmark, for example, the restrictive regulation on opening hours in the re-tail sector might play a role (OECD, 2010). Compared to 2007, price levels in the Nordics rose relative to both the EU-27 and the EU-15, ending a longer period of price convergence. This is most likely a temporary effect as prices dropped quickly in countries outside of the Nordics that were affected earlier or more dramatically by the global recession.

Domestic Price Levels					
	Level	Rel Change			
Nordic					
Denmark					
Finland					
Iceland					
Norway					
Sweden					

Within the Nordics, price levels in Iceland dropped dramatically as a consequence of the crisis hitting hard in the last quarter of 2008. Iceland, previously the region's most expensive location to live in, had at the end of 2008 the second most affordable cost level of the Nordics with prices at 17% above the EU-27 level. Sweden remains to have the lowest prices in the Nordics at 14.5% above the EU-27 level. It continued the convergence to EU-27 levels, but at a somewhat lower rate than in previous years. Finland experienced the highest relative price level increase at 4.4% relative to the EU-27, followed by Denmark.

2.3 Competitiveness

While labour productivity, labour input, and price levels explain prosperity in an accounting sense, they cannot give an explanation of the ultimate causes of prosperity. All three are intermediate indicators that reflect some other underlying characteristics of the economy that are the foundations of prosperity. These underlying characteristics are the focus of the competitiveness assessment of the Nordic region.

Level is normalized price level of a set basket of goods and services relative to the EU-27 average in 2008; changes are changes in this relative price level between 2007 and 2008. Source: Eurostat, 2010. Competitiveness is measured in the Barometer based on the refined framework introduced in the 2008 Global Competitiveness Report (Porter et al., 2008). The new Index is organized as a pyramid of indicators at different levels, to allow policy makers to easily identify specific action priorities. The different groups of indicators, at the highest level macroeconomic versus microeconomic indicators, cover different policy areas but are also differentiated by the policy process and the responsibilities that are needed to address them. The 3rd Nordic Globalization Barometer is the only publication that presents these rankings of the Nordic countries to a wider audience.

The traditionally strong position of the Nordic countries in aggregate measures of competitiveness is confirmed by the 2009 results. Two Nordic countries are among the global top five, and four are among the global top ten. While this remains a very strong position, it still represents a significant drop relative to last year.

Overall Competitiveness					
	Level	Change			
Nordic					
Denmark					
Finland					
Iceland					
Norway					
Sweden					

Among the four Nordic countries that experienced a deterioration relative to 2008, Iceland was the country hit most, dropping from 9th to 24th rank. Last year's data was to a large degree collected before the crisis hit the Icelandic economy with full force. This year's data now captures the dramatic changes that have occurred since then. Last year's Nordic Globalization Barometer provided an in-depth discussion of the Icelandic crisis. Finland and Denmark, last year ranked 1st and 2nd respectively, are now in 6th and 4th position globally. That is still very respectable. But for Finland it is the first time since 2001, the first year for which data has been systematically collected in this way, in which the country is not among the global top three. Norway experienced a less significant drop, falling from 8th to 10th position. Sweden, the largest economy in the Nordic region, conversely improved four ranks to now top the global listing.

On macroeconomic competitiveness, the Nordic countries continue to have a very strong position. Traditionally this has been the result of their remarkably strong institutions, i.e. good governance, effective government, and reliable legal systems. But relative to peer countries the Nordics registered in 2009 also a better performance on macroeconomic policy. While the pressure on government budgets has been strong everywhere as a result of the global financial crisis and the reactive action taken especially in fiscal policy, the Nordic countries were able to take advantage of their more solid initial position in this area.

Overall business environment quality is measured by the aggregate ranking on competitiveness using the new GCI methodology presented in the Global Competitiveness Report 2009. Change is measured by the change in rank on this measure between 2009 and 2008. Colouring is relative to absolute rank and rank change. Source: Unpublished analysis, Global Competitiveness Report, 2009.

Macroeconomic Competitiveness					
	Level	Institutions	Macro. Policy		
Nordic					
Denmark					
Finland					
Iceland					
Norway					
Sweden					

Denmark continues to rank best among the Nordic countries on macroeconomic competitiveness, and remains globally in 2nd place. Especially the quality of Danish institutions is ranked highly and is now perceived as the best in the world. Finland has slightly dropped from its global pole position of 2008 and now ranks 3rd. Sweden now follows in 4th rank after a meaningful improvement in both the perceived quality of institutions and the position on macroeconomic policy. This is the best position Sweden has registered in this dimension of competitiveness since 2001. Norway has dropped somewhat but remains in the global top ten. Iceland has experienced a dramatic decline. In macroeconomic policy, this is the natural result of the implosion of the Icelandic banking system. In institutional quality, it is driven by rapidly falling trust in politicians and the effectiveness of the lawmaking bodies. It will remain to be seen whether this is a short-term reaction to the crisis or becomes a structural problem if politicians are perceived to be unable to deal with the challenging situation Iceland has found itself in.

On microeconomic competitiveness, the Nordic countries continue to rank high even when the overall position of the region is not quite as strong as on macroeconomic competitiveness. The position on business environment quality and company sophistication is relatively balanced. This sets the region apart from peers like Japan that traditionally rank much stronger on company performance than on the environment in which companies operate. The relative balance in the Nordic countries indicates that the strong overall outcomes are not only the result of benevolent government policies, reflected in macroeconomic competitiveness and business environment quality. The high performance of companies provides an equally important contribution.

Microeconomic Competitiveness					
	Level	Business Environment	Company Sophistication		
Nordic					
Denmark					
Finland					
Iceland					
Norway					
Sweden					

Level is measured by the 2009 GCI rankings on Macroeconomic competitiveness, Institutions by the rankings on social infrastructure and political institutions, and Macroeconomic Policy by the rankings on macroeconomic policy. Colouring is relative to absolute rank. Source: unpublished analysis; Global Competitiveness Report, 2009.

Level is measured as the overall 2009 GCI rank on Microeconomic Competitiveness; Business Environment and Company Sophistication as the rank on the respective subrankings. Colouring is relative to absolute rank. Source: unpublished analysis, Global Competitiveness Report, 2009. Sweden leads the Nordic countries with first rank globally on overall microeconomic competitiveness. This is the best ranking the country has reached in this area since 2001; only in 2007 did the perception if business leaders reach almost as high positive marks. Denmark remains among the global top five countries on microeconomic competitiveness, despite a small drop relative to last year. The current rank is at the level the country has normally registered over the last five years. Finland now ranks 7th overall on this element of competitiveness. Especially on company sophistication the ranking has gradually dropped over the last three years. Finland seems to be reaching a new level at the lower level of the global top ten, compared to the leading positions it used to occupy in the first half of the last decade. Norway remains within the global top twenty, as last year. While this is unchanged to 2008, it is a clear improvement compared to previous years. Iceland dropped out of the global top twenty, the first time since data has been collected from 2001 onwards. A combination of less optimistic perceptions and real concerns about deteriorating conditions as a consequence of drastically reduced government investment capabilities are the likely reasons behind this change.

Education and science

The changes in the global economy have increased the benefits of higher levels of skill. And the ability to innovate is becoming increasingly important to capture significant parts of the value generated in global economies chains. For both, the quality of the local education and science system are critical.

A first indicator is the **quality of education system.** The Nordic countries all continue to boast high enrolment rates at all levels of education. Last year's Barometer pointed out that the actual attainment was more mixed. The OECD data that provided hard comparable data in this area has not been updated since then. The TIMSS study, an alternative global effort on educational attainment, does not cover all Nordic countries. In their latest survey, Iceland and Finland did not participate. The remaining three countries ranked broadly comparable to the international average but far behind the global leaders. The results in science were somewhat better than in math. While the TIMSS and similar studies test students directly, the GCR data used this year is based on company executives' perceptions about the education system.

The overall Nordic region continues to rank well on the quality of the educational system. After a slight deterioration in 2009 it now comes just at the bottom of the global top ten. In math and science education, the perception continues to be much weaker. Here the Nordics' average rank puts them on 26th rank globally. Level is measured as the overall 2009 GCI rank on thee quality of the education system; change is measured as the change in rank between 2009 and 2008. Quality of match and science educations is measured by the 2009 rank on this indicator in the GCR. Colouring is relative to absolute rank and absolute rank changes. Source: Unpublished analysis, Global Competitiveness Report, 2009.

Education System						
	Overall	Change	Math & Science			
Nordic						
Denmark						
Finland						
Iceland						
Norway						
Sweden						

Denmark now ranks 5th on overall education system quality, a slight improvement relative to last year. In the perceptions about math and science education the improvement has been much more pronounced; here Denmark jumped from 24th to 11th. Finland remains just in the global top ten of countries on the perceived quality of the overall education system. Within this group, however, it has dropped from the top to the bottom. The position on math and science education has also weakened somewhat but remains much stronger at 3rd rank globally. Sweden has just moved ahead of Finland on the overall quality of the education system, following a solid gain relative to last year. The score on math and science education is still much weaker but even here Sweden moved from 44th to 25th rank globally. Norway dropped slightly on the measure of educational system quality but remains among the global top twenty. On the quality of math and science education, however, it remains at an alarmingly low level of 55th. For Iceland, the quality of the education system remains one of the bright spots: the country kept a stable ranking among the global top five on this measure. On math and science education Iceland's ranking is somewhat weaker but still among the global top twenty.

A broader measure of the available **innovation infrastructure** is calculated using a number of indicators of skills and science capability. The Nordic region managed to slightly increase its position in the global top ten on this composite indicator, driven by significant improvements in Norway and Sweden. The quality of research institutions, a key indicator of the scientific backbone of research, remains to be ranked slightly lower, just below the top ten.

Innovation System					
	Overall	Change	Quality of Resesearch		
Nordic					
Denmark					
Finland					
Iceland					
Norway					
Sweden					

Level is measured as the overall 2009 GCI rank on innovation infrastructure; change is measured as the change in rank between 2009 and 2008. Quality of research is measured by the 2009 rank on the quality of scientific research institutions. Colouring is relative to absolute rank and absolute rank changes. Source: Unpublished analysis, Global Competitiveness Report, 2009. Denmark's overall ranking on the innovation infrastructure remains unchanged at 7th rank. On the quality of its science institutions, the country registered a significant positive trend and now ranks among the global top ten. Finland ranks third on the quality of its overall innovation system; a slight drop from the 1st position it held last year but still very strong in absolute terms. Somewhat of a concern is the drop in the perceived quality of the scientific research institutions, where the ranking changed from 7th to 14th. Sweden registered modest improvements in the measures of innovation infrastructure quality that were enough to move it solidly into the global top ten. This brings the country back to the level it had early in the decade before losing some position more recently. Iceland dropped slightly, falling just outside of the global top ten. The quality of research dropped a bit more; Iceland now ranks 26th on this indicator. Norway gained some position on innovation infrastructure measures and is now in the global top twenty on the perceived quality of scientific research institutions. There are a number of global rankings of universities that consistently show the Nordics to be home between 20 and 25 of the world's 500 top universities (AWRU, 2009). There is more disagreement on the Nordic's position among the 100 leading universities, with some rankings showing the Nordics above and others below their share in global GDP.

In terms of the output of the education and science system, **patenting** remains an important measure. It is clearly biased towards scientific rather than commercial innovation but it is important to note that the vast majority of patents is awarded to companies that see commercial value in protecting their intellectual property this way. On the level of patenting the Nordic region remains strong, significantly ahead of the EU-15 and the OECD (without the US) in terms of US patenting per capita. The trend of slowing patenting rates by the Nordic countries in the US has continued, but is now at a very slow pace. In comparison, the OECD has seen per capita patenting rates rising and the EU-15 falling at a somewhat higher rate than the Nordics. This trend from last year has been broadly in line with the patterns of the last decade. Innovation activity is shifting to Asia, a trend that will be discussed some more in part B of this year's Barometer.

Patenting	3 20	1/E	
	Level	Change	Rel Change
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

Norway continues its catch-up towards the Nordic (and global) innovation leaders. 2008 has been the first year in which Norwegian per capita patenting rates have gone beyond the EU-15 average. Despite this positive trend, its per capita patenting rates remain at 1/3 of the Finnish and ^{1/2} of the Swedish

Patents are measured as patents filed per capita in the US. Changes are changes in the patenting per capita activity 2008 versus 2007; relative change is change in patenting activity relative to the OECD (without US) and EU-15. Colouring is relative to absolute numbers. Source: USPOT, 2009. level. Finland and Sweden remain the Nordic innovation leaders, and are both firmly among the global top ten on per capita patenting. Finland's position dropped more significantly in 2008 but had been gaining strongly in the years before. Sweden's last year drop was much smaller, only slightly higher than for the EU-15, but comes after a longer period of decline. Swedish patenting rates in the US are now back at the level of 1997. Denmark's position on patenting remains stable at about 60% of the Swedish level. Iceland's patenting intensity improved significantly and is now in the middle between Denmark and Norway. Given that this change is driven by a relatively small absolute change in the number of patents awarded, only future years will confirm the robustness of this positive trend.

Infrastructure

Infrastructure remains an important driver of competitiveness and company productivity. While it is for advanced economies increasingly hard to gain true competitive advantages from infrastructure, weaknesses in this area can limit growth and drive economic activities towards alternative locations.

On the quality of the **logistical infrastructure** the Nordic region ranks generally well. Port infrastructure is a particular strength. The World Bank data also shows that the Nordic countries are able to combine strong physical infrastructure with efficient procedures and advanced services, areas in which emerging economies continue to find catching up a complex task.

Physical Infrastructure				
	Logistical (GCI)	Logistical (World Bank)	ICT (GCI)	
Nordic				
Denmark				
Finland				
Iceland				
Norway				
Sweden				

On the respective composite indicator in the GCI, Denmark and Finland are stable among the leading countries in the world. Sweden returned into the top ten after having dropped out last year. Somewhat behind, Iceland moved ahead of Norway, both countries with a challenging geography for transport. Norway dropped out of the top 20 countries, suffering particularly from increasing concerns about the quality of the road network. Norway does significantly better on the World Bank's Logistics Performance Index which includes a wider range of transportation and logistics-related factors. Here Sweden ranks the highest as the 3rd ranked country in the world, up one from 2008. Norway (10th) has moved beyond Finland (12th, up three) and Denmark (16th, down three). Iceland has been covered the first time in this assessment at rank 42nd.

On the presence and quality of the **information and communication infrastructure**, the Nordic region does even better, reaching an aggregate rank

Logistical (GCI) is measured by the rank on logistical infrastructure in the 2009 GCI, Logistical (World Bank) by the rank on the World Bank's Logistical Performance Index, and ICT (GCI) by the rank on the Communications Infrastructure index in the 2009 GCI. Colouring is relative to absolute rank. Source: unpublished analysis, Global Competitiveness Report 2009, World Bank Logistical Performance Index, 2010. among the global top ten (counting also the two Nordic countries in the top ten individually). Here internet penetration is a particular strength of the region. Sweden ranks highest on the composite ICT indicator, and is 2nd in the world just as last year. Iceland follows as 8th, also unchanged. The other Nordic countries are all among the global top twenty, with stable rankings compared to last year.

Access to Capital

Financial capital is, alongside the human and physical capital discussed in the previous two sections, a critical third input factor needed by business. A strong financial system is crucial to allocate capital productively and provide promising business ideas with the necessary financing. During the current crisis, the importance of a robust financial system for economic growth has been highlighted dramatically.

The Nordic countries continue to rank well on the overall quality of their **capital market infrastructure.** The average rank for the region remained almost stable among the global top ten. Stockholm remains an established transnational centre ranked 38^{th} globally in a study for the City of London, a marginal drop from last year (Z/Yen, 2010). Copenhagen follows as 41^{st} (=0) in the next group of "transnational diversified centre. Oslo is ranked 45^{th} (+11) and Helsinki 50th (+9). Reykjavik, ranked 75th, was among the five financial centres most often mentioned as affected by the crisis, behind London, New York, and Dubai.

Among the Nordic countries, the crisis had a highly differential impact. Norway and Finland improved a few ranks each and are now both in the global top ten. Sweden slipped marginally but remains in the top ten group as well, falling behind Norway. Denmark registered a dramatic drop by more than ten ranks but is still placed among the global top twenty. Iceland dropped by a staggering 68 ranks as a consequence of the implosion of its financial system documented in last year's Barometer.

Capital Market Infrastructure			
	Level	Change	Soundness of Banks
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

The global crisis has put much more focus on the medium-term soundness of the banking system. In the past, the short-term effectiveness in mobilizing capital for new investment had been almost the only factor taken into account when looking at countries' financial systems. Overall, the Nordic

Level is the ranking on the GCI Capital Market Infrastructure category in 2009; change is the change in rank between 2008 and 2007 on this measure. Soundness of banks is the respective indicator in the 2009 GCI dataset. Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009. Global Pressure

Nordic Solutions?

region does in the perspective of business executives not rank well on the soundness of its banks.

The differences across the Nordic region are huge and the short-term impact of current events on perceptions plays a significant role. The poor ranking of Iceland fits well with the assessment of international experts and rating agencies. But the poor positions of Denmark and Sweden are more of a surprise. For Denmark, the structural features of the banking system with many small regional banks with limited own capital is the main concern. As discussed earlier, the Danish government has been able to limit negative repercussions through its two banking packages. But the real test will come when these temporary measures are being withdrawn in part by the end of this year. For Sweden, the concerns at the time of the survey were squarely focused on the exposure of Swedish banks, particularly Swedbank and SEB, to the Baltic countries. With the situation in the Baltics now more under control after a combination of broad-based external support and drastic internal policy measures these concerns have significantly fallen. The Swedish government's domestic policy response has played its part through initially providing guaranteed access to capital and later setting up a stability fond fuelled by contributions from the financial sector. Finland and Norway saw almost no effect of the crisis on the perceived soundness of their banking systems.

Conditions for doing business

The context for strategy and rivalry that companies face determines whether government rules and regulations make it more or less attractive for companies to engage the available factor inputs in creating valuable products and services.

On the **ease of doing business,** i.e. the administrative rules and regulations that affect the cost at which companies can operate, the Nordic countries continue to do generally quite well. This measure provided by the World Bank based on input from specialist in all covered countries reflects the rules and regulations legally in place. Denmark and Norway continue to rank among the global top ten, with the other Nordic countries coming in between rank ten and twenty. Relative to last year, Finland and Iceland registered a small deterioration of their position while the other Nordic countries staid in a virtually in the same position.

Rules and Regulations for Business			
	Level	Change	Administrative Infrastructure
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

Level is the overall ranking in the World Bank Doing Business 2010; change is the change in rank between 2010 and 2009. Administrative Infrastructure is the ranking on this category in the 2009 GCR. Colouring is relative to absolute rank. Source: World Bank Doing Business 2010, unpublished analysis, Global Competitiveness Report, 2009. On **administrative infrastructure**, the Nordic region does even better. This composite indicator calculated in the GCI captures how company executives perceive the actual implementation of rules and regulations by the public administration. The Nordic countries benefit from a relatively efficient public sector, not just from more efficient rules and regulations. This profile is consistent with their strong position on social infrastructure and political institutions discussed above. Among the Nordic countries, Sweden was the only one that registered an improvement of how executives perceived the administrative infrastructure relatively to global peers. All other Nordic countries saw modest deteriorations, with Iceland taking the biggest hit and a drop of nine ranks. Ranked 13th globally, Iceland continues to do well in an absolute sense, however. In the Nordics, it remains ahead of Norway, which dropped to 16th position globally.

Context for competition

The intensity and nature of competition on domestic markets is a core driver of the productivity and level of innovation an economy ultimately achieves. It is as much a reflection of government policies as of the decisions that companies take in response to the conditions they face.

The Nordic countries continue to receive good rankings for the overall **context for domestic competition.** After slight deteriorations in Denmark and Finland and a dramatic slump in Iceland (minus 33 ranks), the region now is just below the global top ten on the overall quality of the context for competition. With the exception of Iceland all Nordic countries rank among the global top twenty. After a gain of four ranks, Sweden now tops the region as the 3rd country globally.

Context fo	r Competition		
	Overall	Change	Competitive Intensity
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

The Nordic countries have always received relatively good grades on the absence of trade barriers (the non-EU members Iceland and Norway continue to be exceptions to this rule. Iceland is also still ranked poorly on barriers for FDI, despite some improvements in recent years (OECD, 2010). But due to their small market size and possibly the impact of taxation structures (see below), the actual intensity of local competition has traditionally been a problem. In 2009, this problem has become somewhat less pressing, at least in part of the region. Both Denmark and Sweden registered a significant improvement in the actual rivalry on domestic markets. This could be the result of the cyclical situation on these markets, where production capacity

Overall is the ranking on the GCI Context for Strategy and Rivalry score, change is the change in rank between 2009 and 2008 on this measure. Competitive Intensity is the ranking on the GCI indicator for Intensity of Domestic Competition in 2009. Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009. Nordic Solutions?

outstripped local demand. But it is remarkable that the market climate in these two countries developed so differently from their Nordic peers.

On the level of **government interference in markets**, the Nordic region continues to rank similar to many of its peers among advanced economies and better than many other European countries. Overall, the Nordic countries are viewed as having very open markets with equal conditions for all companies. However, the large size of the government sector is seen as limiting opportunities for private companies.

Denmark is ranked among the global top ten, Finland and Sweden among the global top twenty. Changes have been modest, even for Iceland which dropped four ranks. Sweden improved its position and reached rank 21st, its best rank recorded since this index has been calculated the first time in 1995. Norway dropped nine ranks and continues to come last in the Nordic countries as the 37th country globally on economic freedom.

Economic Freedom				
	Level	Change		
Nordic				
Denmark				
Finland				
Iceland				
Norway				
Sweden				

An import element of economic freedom is the level and structure of taxation. Despite some improvements, the Nordic countries continue to rank poorly on the incentive effects of taxation. In Sweden there has been some improvement but the overall perception is that the burden of taxes remains high. In the other Nordic countries the relative situation was perceived to have even deteriorated compared to global peers. The Nordic countries continue to tax labour much more highly than capital. This has a clear impact especially for low skill, labour intensive activities Denmark, Finland, and Sweden have taken steps to reduce the high marginal tax on labour somewhat (OECD, 2010). Sweden has also introduced special tax deduction schemes to limit the impact of the taxation system on services that had to a large degree migrated into the grey economy. The distortive effects of taxes and social security contributions, i.e. differential rates across activities or types of companies, were perceived to be modest compared to peers. Iceland has dropped on this measure, but remains close to the global top twenty. It continues to provide very high subsidies for agriculture (OECD, 2010).

Market institutions are measured by the aggregate ranking in the Heritage Economic Freedom index. Level data is for 2010, changes for 2010 relative to 2009. Colouring is relative to absolute rank. Source: 2010 Index of Economic Freedom, Heritage Foundation, 2010.



Incentive effect is the ranking on the GCI indicator '(low) impact on incentives to work and invest' in 2008; change is the change in rank between 2009 and 2008 on this measure. Distortive Effect is the ranking on the 2009 GCI indicator '(low) distortive effect of taxes and subsidies on competition. Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009.

Cluster presence

Clusters are regional agglomerations of producers, suppliers, services providers, research and educational institutions, etc. related through input-output relations, knowledge spillovers, shared use of input markets, and other linkages. If there is active collabouration in addition to pure geographic proximity, the strength of these linkages and their benefits for company productivity can be even higher.



On the presence of **related and supporting industries**, the foundation of dynamic clusters, the Nordic countries continue to get overall solid marks. Sweden's position in the survey improved significantly, pushing the country among the global top ten on cluster presence. All other Nordic countries saw some deterioration, although only by a few ranks. Finland remains in the global top ten alongside Sweden. Denmark (13th rank) and Norway (20th) follow in the top twenty. Iceland comes last in the Nordics but its 34th rank is still remarkable given the small absolute size and remoteness of the economy which both make cluster emergence much harder.

Note: Fully colored boxes indicate clusters strong in size and speciallization; other boxes are clusters strong in only one of these dimensions.

Source: European Cluster Observatory (2009)

- Nordic Solutions?

On the presence of **cluster policy**, i.e. government programs to support and develop the competitiveness of clusters, there are surprisingly strong swings in public perception. This is an issue, because the impact of cluster policy depends on the visibility it has, not just for companies participating in specific cluster efforts, but also others. Sweden ranked low last year but much higher this year, without any noticeable change in the government's policy towards clusters. Norway experienced a strong drop in the perceived intensity of cluster policy which again is hard to explain given actual government programs. In the remainder of the Nordics the perceptions of cluster policy remained relatively stable.

Related and Supporting Industries				
	Level	Change	Extent of Cluster Policy	
Nordic				
Denmark				
Finland				
Iceland				
Norway				
Sweden				

Level is the ranking on the GCI Related and Supporting Industry category in 2009, change is the change in rank between 2009 and 2008 on this measure. Extent of Cluster Policy is the ranking in the 2009 GCI on this indicator. Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009.

Global Pressure

Demand conditions

Demanding customers and regulatory standards put pressure on companies. While this can be a burden in the short term, it can lead to higher productivity and innovative dynamism over time.

The Nordic countries continue to benefit from strong demand conditions. Iceland lost position and is now ranked 24th globally. All other Nordic countries remain in the global top ten on this composite indicator, despite some modest drops in rank for some countries. Sweden was the only country that gained position and is now ranked best as the 2nd globally. Part of this is driven by the sophistication of consumers with high disposable income, a strong tendency to adopt new technologies, and a significant focus on brands and fashion trends. But part of this is also a reflection of government policy that sets demanding standards for companies. As long as these standards foreshadow changing conditions on global markets, they can be positive drivers of commercially valuable innovations. Denmark has lost position on overall regulatory standards but remains strong on environmental demands.



Level is the ranking on the GCI Demand Conditions category in 2009; change is the change in rank between 2009and 2008 on this measure. Regulatory Standards is the ranking in the 2009 GCI on the Presence of Demanding Regulatory Standards indicator. Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009.

Company sophistication

The sophistication of companies, i.e. their adoption of new management methods and their way of competing, marks the final step to realize productivity levels that fully mobilize the potential inherent in the quality of a country's business environment.

Company Sophistication		I.E.	
	Level	Change	Competitive Advantages
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

The Nordic countries continue to have a strong position in overall **company sophistication.** Three of them rank among the global top ten; Sweden leads globally after a solid improvement relative to last year. Denmark and Finland lost only marginal position, while in Iceland the crisis seems to have shattered the confidence in the sophistication of the business community more broadly. Still, with rank 25th overall Iceland's position on company sophistication remains quite solid compare to other aspects of the country's competitiveness. Companies in Denmark, Finland, and Sweden are all perceived to compete on unique strategies, often driven by innovative technologies. For Norwegian companies this remains to be less the case; there has even been a slight deterioration on this indicator since last year. Icelandic companies were already in the past not seen as particularly strategic, and this perception has taken significantly more hold this year.

The GCI indicators on company sophistication can be further organized by measures of strategy and operational effectiveness, organizational practices, and internationalization. Overall the Nordic countries get the highest scores on organizational measures. This is in line with the literature on flat management structures in Nordic countries. The relatively weakest scores are registered in measures related to internationalization, specifically the control

Level is the ranking on the GCI Company Operations and Strategy category in 2009, change is the change in rank between 2009 and 2008 on this measure. Competitive Advantages is the ranking in the 2009 GCI on the Nature of Competitive Advantages indicator, Colouring is relative to absolute rank. Source: Unpublished analysis, Global Competitiveness Report, 2009. of distribution channels and the breadth of international markets. The absolute rankings in this area are still solid, mostly within the global top twenty. These relative weaknesses are likely the consequence of the small absolute size of the Nordic economies.

2.4 Globalization Readiness

In a global market, having strong competitiveness fundamentals is not enough to sustain and develop high prosperity. Countries also need to engage actively with the global economy, create outward and inward linkages, and prepare for the shocks that might affect them through these channels. This is why the Nordic Globalization Barometer introduced the notion of 'Globalization Readiness' as a measure of how well the Nordic countries are performing on these three dimensions.

Selling on foreign markets

Exports of goods and services are the traditional way to leverage domestic strength on a global market. It also provides local companies with crucial exposure to global knowledge and competition, both key drivers in reaching higher levels of performance. This is particularly important for small economies that in these dimensions often suffer from their limited absolute size.

The Nordic countries are highly export oriented with a world export market share of 3.7% (2009). This share remains high compared to the Nordics' share in global GDP (2.35%). But it represents a significant drop relative to the last decade, when it had been relatively stable between 4.0% and 4.1%. Total exports from the Nordic countries dropped by 26%, compared to 21% for global trade. The only other time trade values fell before over the last decade was 2001, when Nordic exports dropped by 3% and global trade by 3.3%. The Nordic's market share losses where widespread across both goods and services. In absolute terms, the fall in exports was more dramatic in goods (-28.5% versus -19.5% for services). But in services, an area where the Nordic countries have traditionally higher world export market shares than in goods (5.4% versus 3.3% in 2009) the export fall led to a stronger fall of market share as global trade in services held up more strongly.

Change in Exports World Market Shares				
	Overall	Goods	Services	
Nordic				
Denmark				
Finland				
Iceland				
Norway				
Sweden				

Overall is measured by the relative change between 2009 and 2008 in total world export market share. Goods and Services are measured the same way for the respective subcategories of total trade. Colouring is relative to absolute changes. Source: WTO, 2010.
Finland was the Nordic country hardest hit by the global downturn in trade. Goods exports dropped by -35% and services by -21%; the country's total world export market share fell by 16% to .55%. Norway lost almost 10% of its overall market share, largely driven by the price effects on its oil and gas exports. Sweden's goods exports dropped by 28% but service exports held up much better. Denmark suffered in its service exports driven by the high exposure to shipping but managed to achieve world export market share gains. Iceland was the only Nordic country that gained overall export market share, driven entirely by rising service exports. Presumably this was the result of the devaluation on the tourism industry.

Outward foreign direct investment (FDI) is another way to export knowledge and capabilities, but also to tap into foreign knowledge pools. It becomes more important as economies move towards more knowledge intensive activities where value is embodied in the intellectual capital used rather than in the production process per se.

For 2008, the latest year for which globally comparable data is available, the Nordic countries continued to register a strong outward FDI position. They owned roughly 5% of all foreign owned company assets globally, more than double their share in global GDP and higher than their share in global exports. Companies from the Nordic countries have moved towards serving foreign markets through local subsidiaries and production facilities, not just exports, much in line with their economies' stage of economic development. The Nordic's share of outward FDI flows has traditionally been lower than their share of stocks; that the Nordics' outward FDI stock still increased is an indication of independent growth in the value of foreign assets. Relative to total domestic GDP, outward FDI stocks (and flows) started to drop in 2008. The change was not as dramatic as in the average of the advanced economies, but still significant. Looking back, this is consistent with economic growth becoming increasingly domestic demand driven in the run up to the crisis that is currently affecting the global economy.

Change of Outward Foreign Direct Investment						
	Stock	Flow	Stock relative to domestic GDP			
Nordic						
Denmark						
Finland						
Iceland						
Norway						
Sweden						

Iceland had over the last decade experienced a dramatic increase in its outward FDI activity. Much of this foreign expansion had been credit financed and become unattainable when global credit market conditions started to worsen in 2008. While the collapse did occur in 2009, already in 2008 outward FDI stock equivalent to almost 50% of GDP was sold off or in its value

Share is measured by change of world market share of outward FDI stock between 2008 and 2007. Flow is measured by change of world market share of outward FDI flows between 2008 and 2007. Stock relative to domestic GD is measured as percentage change of outward GDP stock relative to domestic GDP. Colouring is relative to absolute changes. Source: UNCTAD, 2010. adjusted to the new market conditions. At the end of 2008, Iceland remained with an outward FDI stock broadly equivalent to the size of its domestic GDP. Among the continental Nordic countries, Sweden registers the strongest outward FDI activity with an FDI stock abroad valued at 66% of domestic GDP. Sweden accounted for about 2% of the global outward FDI stock and accounted for roughly the same share of 2008 outward FDI flows. Relative to 2007 this represented an increase in relative flows but given the strong growth of the domestic economy a relative decline of the role of the outward FDI stock. Denmark registers an outward FDI stock of about 56% of its GDP, a doubling relative to the values early in the decade. Norway also doubled its relative outward FDI stock during this period, now reaching 38%. Both countries registered dynamic outward FDI activity in 2008. Finland's outward FDI stock has over time growing slowly but dropped in 2008. It is now at 42% of GDP, back to the level of the beginning of the decade.

Attracting foreign interest

In the global economy, no economy can compete based on its own inherent resources and capabilities alone. It also needs to attract investment capital, human capital, and ideas. And it has to retain its own companies and people as far as they can choose where to invest or live and work. Attracting global interest is both an indicator and enabler of global competitiveness, just like the ability to see internationally: Only competitive locations are able to attract foreign interest. And the inflow of foreign capital and skills makes a location more competitive.

Change of Inward Foreign Direct Investment						
	Stock	Flow	Stock relative to domestic GDP			
Nordic						
Denmark						
Finland						
Iceland						
Norway						
Sweden						

The Nordic countries host about 4% of the global **inward foreign direct investment (FDI)** stock, a share that has been gradually growing over time. Inward flows have tended to be somewhat lower at about 2.5%–3% of global flows over the last decade. The value of the foreign owned FDI is equivalent to about 40% of the Nordic countries' GDP. In 2008, foreign investment flows dropped globally and this affected the Nordic countries as well. Compared to other advanced economies, the Nordic countries held up quite well as more FDI activity shifted to emerging and developing economies. Falling equity valuation also took their toll on the value of FDI stocks, in the Nordics again slightly more than in the global average but less than in other advanced economies. Given that domestic growth continued unabated in 2008, these trends led to a drop of inward FDI stocks (and flows) relative to Nordic GDP by about 10%.

Share is measured by change of world market share of inward FDI stock between 2008 and 2007. Flow is measured by change of world market share of inward FDI flows between 2008 and 2007. Stock relative to domestic GDP is measured as percentage change of inward GDP stock relative to domestic GDP. Colouring is relative to absolute changes. Source: UNCTAD, 2010. Sweden continues to be the dominant destination for foreign FDI coming into the Nordic region, accounting for 41% the region's total foreign FDI stock in 2008. The country was successful in attracting foreign investment in 2008 but the stock of foreign owned assets in the country still fell slightly due to the slump on equity markets. Denmark has at 24% of the regions FDI stock moved ahead of Norway at 20%. Denmark had a very successful year in terms of FDI attraction in 2008, while Norway and Finland both registered negative inflows as foreign companies sold and revalued assets. In 2010, Norway registered a highly visible inflow when in the IT/telematics industry US-based Cisco acquired Tandberg. Both Norway and Finland saw the value of inward FDI drop as a percentage of their domestic GDP; for Norway this measure now stands at 27%, for Finland at 32%. Iceland saw a 72% drop in the value of its inward FDI stock. At 22% of domestic GDP the inward FDI stock remained above the historical average of 10% or less.

Flexibility

The ability to adapt to changing conditions is increasingly important in the global economy. While this is sometimes seen as a contradiction to the need for specialization, it is in fact closely connected to it. Regional economies can only succeed in the global economy if they reach the high level of productivity that economic specialization is needed to achieve. But specialization in turn exposes regional economies to the impact of external shocks. High levels of prosperity can only be sustained where regions are able to transfer their productive resources to new economic activities. In the short term, being more flexible can seem as a disadvantage as companies find it less costly to reduce employment in flexible rather than in rigid economies. In the long term, however, it creates much more attractive conditions for companies to make investments that create competitive employment opportunities.

The Nordic countries continue to present a mixed picture in terms of key formal rules and regulation affecting their flexibility. On labour market **flexibility**, the World Bank assessment continues to give all Nordic countries with the exception of Denmark very weak scores. Previous years' Barometers already pointed out that the actual flexibility of the Nordic labour markets might be significantly higher. It is still remarkable, that for Sweden, for example, labour market flexibility was the only one of all policy area in which the OECD had suggested action for the country over recent years to boost growth in which not significant action was registered (OECD, 2010). On the costs associated with **closing down businesses**, the Nordic countries have traditionally been quite strong. This continues to be the case and is one of the reasons why unemployment has reacted more strongly to the crisis than in some continental European countries. On the costs of starting a **business**, the Nordic countries continue to look weak. Despite the strong political rhetoric and many programs for new entrepreneurs across the Nordic countries, on the laws and regulations for starting new businesses all Nordic countries have lost further position relative to their global peers.

- Nordic Solutions?

Labour Market is measured by the World Bank Doing Business 2010 rank on Labour Market Flexibility. Closure of Business is measured by the World Bank Doing Business 2010 rank on this indicator. Registration of Business is measured by the World Bank Doing Business 2010 rank on this indicator. Colouring is relative to absolute rank. Source: World Bank, 2010.

Flexibility	3.5	赵庄	
	Labor Market	Closing a Business	Starting a Business
Nordic			
Denmark			
Finland			
Iceland			
Norway			
Sweden			

2.5 Overall assessment

The 2010 edition of the Nordic Globalization Barometer tracks the development of the Nordic countries' competitiveness during a deep global economic crisis. While last year's Barometer was focused on the initial impact of the crisis, this year the focus is starting to shift towards the recovery and the longer term impact of the crisis.

The relatively solid **current economic climate**, especially the fast recovery of sentiment, appears optimistic relative to the economic fundamentals. The relatively strong recovery of growth in the Nordic region is to a significant degree driven by domestic demand, while in Europe and the OECD exports and a slow recovery of investment play a relatively more important role. Policy makers in the Nordic region face a balancing act of putting fiscal and monetary policy back on a path of long-term stability without slowing the economy so much that consumer sentiment drops and growth slows down.

The **economic performance** of the Nordic region has suffered as a result of the crisis. The level of prosperity remains high but the reduction of prosperity has been significant, even in response to the peers in the OECD and EU. Both on productivity and on labour mobilization the region has taken a toll. The continental European peers have chosen a policy response that has accepted high falls in productivity while keeping employment levels up. The North American economies in the OECD have instead reacted with more dramatic changes on the labour market, keeping labour productivity more stable. Which of these policies will provide more effective in the long-term, depends on the length of the crisis, the nature of changes it will lead to, and the profile of the respective economies. The approach followed in continental Europe, especially Germany, is effective if the crisis is relatively short lived and a cyclical downturn rather than a driver of faster structural change. For Germany, an additional factor is the concern companies have about the availability of skilled employees in the future, which encourages them to keep on to their employees even if that creates short-term costs. If, however, the crisis will lead to more structural changes, for example in Sweden by reducing the long-term level of activity in the automotive industry, then a policy that accepts more short-term pain in the form of higher unemployment is the more effective approach, especially if it is combine with active measures to facilitate the transition of these employees into new activities.

The **competitiveness** of the region has not changed dramatically. The high level of overall competitiveness supports the high level of prosperity that the region is enjoying. The relative position on especially macroeconomic competitiveness has even improved as other countries proved to have less robust policies or institutions. The Nordic countries also remain strong on company sophistication, the overall innovation system, and physical infrastructure. Areas of weakness, too, are largely unchanged. The context for competition provides relatively weak incentives. While the overall education system is perceived as strong, there are concerns about the quality of the science and math education. Patenting rates are high but develop less dynamically than in global innovation leaders.

On **globalization readiness**, the Nordic countries have been clearly impacted by the global crisis. Export market shares dropped more than proportionally. FDI data is one year behind but shows the focus shifting from international engagement to domestic growth in the run-up to the crisis. It is still too early to assess whether the gradual resumption of growth in the global economy will enable the Nordic countries to regain their previous position on exports and FDI. An issue of concern remains the flexibility of the economy. The Nordic countries continue to do well in allowing exit and the labour market rules might enable more flexibility than the international assessments suggest. But the regulatory burden on starting a new business remain high; in fact, despite the widespread intention and many efforts to support entrepreneurship, the Nordic region has fallen behind further on these measures.

The crisis has put a number of challenges high on the agenda that are shared across the Nordic region even though their solution remains a firmly national task. This is particularly the case for the **macroeconomic policy challenges** immediately ahead. The relevant policies are controlled at the national level and in the area of monetary policy there are also significant differences in decision making structures and objective functions. But it seems at least likely that coordination, at least in terms of communicating policy decisions, could increase the impact of national policies in these areas.

On **competitiveness**, the list of key issues hasn't markedly shifted over the last three years. There seems also general agreement across the Nordic countries on many, maybe all of the issues identified. The challenge is how to move from analysis to action. In the EU, the Lisbon Agenda that has just been replaced with the new 2020 Agenda has been an example of sensible objectives failing to reach impact because of a poor implementation and governance structure. The Nordic globalization process is not directly comparable in structure and intention. But the need to focus on action and structure as much as on identifying the right objectives is a similar challenge faced in both contexts.

The crisis has also highlighted the limits individual Nordic countries face when **affecting important policy decisions** that shape the architecture of the European or global policy or regulatory environment. On issues from reshaping the regulatory system for the financial industry to whether and how fiscal rescue packages for EU countries in need should be designed, the ultimate decision power ultimately resides outside of the Nordic countries. The Norwegian Foreign Minister has already called for a Nordic seat in the G20 (Norwegian Ministry of Foreign Affairs, 2009). This might be one of the most complex longer term issues facing the Nordic countries: How can a governance system be implemented that gives the Nordic countries a voice on issues of European or global importance that have a profound impact on the Nordic countries?

Chapter 3.

The robustness of Nordic innovative capacity

Innovation is a critical foundation for the Nordic's current and future prosperity. It takes many forms, from basic research to applied development, from introducing new products and services to new ways of organizing companies and serving customer needs. The Nordic countries are in international rankings regularly listed among the most innovative countries in the world. Governments across the Nordic countries and the Nordic Council of Ministers have identified innovative capacity as one of the central planks of economic policy to drive competitiveness.

This part of the Nordic Globalization Barometer aims to take a critical view at corporate R&D. Corporate R&D activities are only one aspect of overall innovation. But they are a good signal of broader trends, highlighting more general features of innovative capacity across countries. High levels of business R&D are a key strength of the Nordic innovation systems, not the high R&D spending of governments as one might assume. But how robust is this strong business R&D activity?

- The first section will summarize data on the current status of business R&D activity in the Nordic countries and present key findings from a range of international assessments of innovative capacity across countries. Last year's Nordic Innovation Monitor provided an in-depth analysis specifically for the Nordic Globalization Forum. The intention here is much more limited: What are the key takeaways from these assessments on the robustness of business R&D, focusing particularly on challenges that the Nordic countries need to address?
- The second section will explore the drivers and trends behind the geographical footprint of business R&D activities across locations. After a short review of the relevant academic literature, the section discusses findings from a series of interviews conducted with some of the largest corporate R&D spenders in the Nordic countries. While not a statistically representative sample, the interview series covered companies representing a significant share of Nordic R&D spending, and cut across countries and industries. The intention is to gain insights into the thinking and perspective of these countries as to the current and future nature of business R&D in the Nordic countries.
- The third section then provides outside perspective on the R&D position activities in the Nordic countries. Written by Sylvia Schwaag-Serger and Nannan Lundin, two renowned analysts of both the Nordic and the Chinese innovation system, it puts the Nordic countries into the context of a globally changing landscape for R&D activities.
- A short fourth section provides an overall assessment, drawing on the data and analysis from all three previous pieces.

- Nordic Solutions?

3.1 Current status of Nordic Business R&D

Business R&D activity in the Nordics: The statistical evidence

The business sector in the Nordic countries is significantly more R&D oriented than either the EU or the OECD average. Relative to GDP, companies spend more on R&D (with the exception of Norway) and have a higher share of researchers in the workforce. The growth rate of R&D spending has been higher in all Nordic countries than among their advanced country peers, even though in most Nordic countries the initial level of spending was already high.

Relative Level of Business R&D Activity						
	Spending	Spending Growth	People			
Nordic						
Denmark						
Finland						
Iceland						
Norway						
Sweden						

Spending is defined as Business $R \Leftrightarrow D$ expenditures as % of GDP in 2007, spending growth as the growth rate of business $R \Leftrightarrow D$ between 2003 and 2007, and people as the share of business researchers in the labour force. Colouring is relative to EU/OECD. Source: OECD, 2010.

> The high R&D intensity of the corporate sector in the Nordic countries is broadly in line with the high total R&D intensity of their economies. The average share of business in total Nordic R&D funding is between the OECD and the EU level. There is a clear relationship between the share of business in total R&D spending and a number of indicators of innovative capacity, from total R&D spending to patenting and many other indicators of R&D activity and performance.

According to the OECD, Finland and Sweden, the Nordic countries with the highest share of business R&D in total R&D spending, rank globally in the group of OECD countries a with higher than average share of business R&D. The more recent data from the national statistical offices in the two countries show roughly a 10%-point higher share of business in total R&D spending for 2008 (Statistics Finland, 2009; Statistics Sweden, 2009), which would put them in the global top group. This adjustment would raise the Nordic average close to the level of the OECD. Given the different sources, the figures might, however, not be directly comparable.



Source: OECD Service, Technology and Industry Scoreboard 2009

While the relative R&D intensity of the Nordic economies is impressive, absolute business R&D spending in the Nordics accounts for only 3% of total R&D spending in the OECD. US-based companies spend in total 14 times as much on R&D than Nordics-based companies. The ratio is 3.9 for China and 2.6 for Germany.



Source: OECD Service, Technology and Industry Scoreboard 2009 The \$19bn (PPP adjusted) spend by companies in the Nordics on R&D in 2007 compares to \$25bn in the UK and \$15bn in Russia. Swedish business R&D spending, which accounts for about 45% of the Nordic total, is smaller than Italian business R&D spending. Norway, the Nordic country with the lowest intensity of business R&D, registers less company R&D spending than the Czech Republic and only marginally more than South Africa.

For 2010, the forecast is for total R&D spending (PPP adjusted) in the Nordic countries to account for about 2.34% of the global total (Batelle, 2009). This is higher than the region's share in GDP, but falls short of its share in global trade and FDI (see chapter 2). The trend is downward; despite an absolute increase of R&D expenditures expected for the Nordic countries this year, the region's global share will fall below the 2.5% reached in 2008.

Table 1: Top 25 Nordic companies byGlobal R&D Spending, 2008							
Global rank	Company	Sector	Country	2008 R&D spending	2008 R&D spending as % of sales		
8	Nokia	Telecom equipment	Finland	5,321.00	10.5		
29	Ericsson	Telecom equipment	Sweden	2,975.46	15.7		
65	Volvo	Trucks	Sweden	1,479.40	5.4		
87	Novo Nordisk	Pharmaceuticals	Denmark	994.94	16.3		
252	Lundbeck	Pharmaceuticals	Denmark	300.07	19.8		
309	StatoilHydro	Oil & gas producers	Norway	230.47	0.3		
314	Vestas	Alternative energy	Denmark	223.00	3.7		
315	Sandvik	Industrial machinery	Sweden	222.53	2.6		
347	Genmab	Biotechnology	Denmark	191.16	190.9		
349	Electrolux	Household goods	Sweden	190.33	2.0		
389	Danfoss	Industrial machinery	Denmark	159.35	4.4		
396	Atlas Copco	Industrial machinery	Sweden	156.30	2.3		
398	Vattenfall	Electricity	Sweden	155.76	1.0		
403	DONG Energy	Oil & gas producers	Denmark	154.65	1.9		
421	Grundfos	Industrial machinery	Denmark	149.12	5.8		
441	Hexagon	Industrial machinery	Sweden	141.65	10.8		
469	Novozymes	Biotechnology	Denmark	133.69	12.2		
475	SAAB	Aerospace & defence	Sweden	130.92	6.0		
479	Metso	Industrial machinery	Finland	129.00	2.0		
486	Nordea Bank	Banks	Sweden	127.00	1.5		
505	Wartsila	Trucks	Finland	121.00	2.6		
549	SKF	Industrial machinery	Sweden	109.08	1.9		
573	Telenor	Telecommunications	Norway	103.16	1.0		
578	TeliaSonera	Telecommunications	Sweden	102.53	1.1		
605	Danisco	Food producers	Denmark	96.61	39		

Among the 1000 **top R&D investing companies** in the EU and their 1000 top counterparts outside of the EU, there are 185 companies from the Nordic countries. 70 companies are from Sweden, 58 from Finland, 47 from Denmark, 9 from Norway, and 1 from Iceland. Note that this data covers all R&D spending by company, irrespective of location. Together, these 185 companies account for 4.1% of all R&D spending of the 2000 included companies. The ten highest R&D spenders account for close to 70% of all R&D

Source: European Commission – Joint Research Centre (2010)

Global Pressure

spending by Nordic companies, with Nokia and Ericsson alone registering 46% of all spending.

At an industry level, the evidence is mixed as to whether companies from the Nordics are more or less R&D intensive than their global peers. In automotive and trucks, Volvo registers the highest R&D spending relative to sales in its industry. In pharmaceuticals and biotechnology, the Nordic companies R&D spending was in line with the average of the industry. The same is true for telecommunication equipment. In industrial machinery, there is significant variation across companies but the R&D intensity of the average of Nordic companies is similar to the global industry average.

In Sweden, foreign-owned companies account for 42.3% of all business R&D spending, compared to 17% in Finland. In both countries the R&D intensity of foreign-owned companies (R&D spending relative to revenues) is relative high compared to companies from other OECD countries. Looking at outward FDI flows, the foreign operations of Swedish and Finnish companies also register a relatively high R&D intensity. There is little solid data on other Nordic countries (Bloch et al., 2008, show some data on Denmark from the EU Community Innovation Survey CIS but question its reliability)

A final measure of the R&D activity of Nordic companies is their **patenting activity in the US.** The US is the largest market to commercially exploit knowledge that can be patented, and is therefore a good benchmark, especially for companies. For all Nordic countries, companies are by far the most dominate patentees in the US, with research institutions playing only a small role. To a large degree this is the consequence of the regulations around IP assignment in universities and publicly funded research institutions.

About 202 Nordic-based entities from roughly 170 companies have registered at least one patent in the US over the last five years for which this data has been published (2003 - 2007). This data includes patents assigned to operations of foreign companies in the Nordics but does not include patents assigned to operations of companies from the Nordics elsewhere in the world. Swedish entities dominate the list with 178 or close to 90% of all Nordic patenting entities. The top ten companies account for 62% of the 6409 patents assigned to corporate patentees from the Nordic countries in this time period. Nokia and Ericsson lead the ranking, together accounting for 44% of all patents from Nordic countries. Many of the top patentees from the Nordics register patents from subsidiaries in more than one Nordic country, although one location tends to dominate clearly. Ericsson is the only company that registers patents from organizations in all five Nordic countries; its Swedish operations account for 90% of all of these patents. Nokia, Borealis Technologies, and Sun Microsystems register patents to entities in three Nordic countries, in every case including Sweden. About a dozen companies register patents from sites in two Nordic countries, again in every single case with Sweden as one of the two countries.

Global Pressure

Table 2: Top 25 Nordic companies by US Patentsregistered from Nordic locations, 2003-2007							
Company	Nordic Patentee locations	US patents, 2003-2007					
NOKIA CORPORATION	DK/FI/SE	1592					
TELEFONAKTIEBOLAGET LM ERICSSON	DK/IS/FI/NO/SE	1209					
METSO	FI/SE	293					
SANDVIK AKTIEBOLAG	SE	176					
ASTRAZENECA AB	DK/SE	158					
ASEA BROWN BOVERI AB	NO/SE	153					
SCA HYGIENE PRODUCTS AB	SE	136					
VOLVO LASTVAGNAR AB	SE	108					
ST. JUDE MEDICAL AB	SE	81					
BOREALIS TECHNOLOGY OY	FI/NO/SE	70					
TETRA LAVAL HOLDINGS & FINANCE S.A.	DK/SE	70					
OUTOKUMPU OYJ	FI/SE	64					
DELAVAL HOLDING AB	SE	58					
FORD GLOBAL TECHNOLOGIES, L.L.C.	SE	58					
SECO TOOLS AB	SE	57					
ALFA-LAVAL AB	SE	56					
AKZO NOBEL NV	SE	55					
SAAB AKTIEBOLAG	SE	55					
ANOTO AB	SE	53					
SCANIA CV AKTIEBOLAG	SE	52					
AKTIEBOLAGET ELECTROLU	SE	47					
MICRONIC LASER SYSTEMS AB	SE	47					
NEUROSEARCH A/S	DK/SE	44					
INFINEON TECHNOLOGIES AG	SE	42					
PHARMACIA AKTIEBOLAG	DK/SE	42					

Source: USPTO, 2010

The Nordics in international assessments of innovative capacity

Policy makers need to understand the business environment drivers of business R&D. This is the level at which governments can take action; they don't control business R&D and patenting directly. Over the last few years, different research groups have generated a large number of aggregate rankings of countries' innovative capacity. They do provide useful overall information but have clear limitations. None of them provides a clear conceptual model or an empirical test that proves the relationship between the indicators covered or the overall index and some aggregate measure of innovation (Furman et al.(2002) is a noticeable exception but has not been updated). Many of these studies draw on similar sets of primary data which is then organized in different ways.

The **European Innovation Scoreboard** 2009 (EU DG Enterprise, 2010) is based on a combination of statistical data on R&D spending and outcomes as well as on the European Innovation Survey that tracks the innovationrelated activities of companies through the EU. It organizes the data in three categories: Enablers (human resources and financial support), firm activities (R&D investment, linkages through R&D active SMEs, and throughputs in the form of patents and other codified results of R&D), and outputs (innovation by companies, R&D related employment, sales, and exports). Among the roughly 35 countries covered, Sweden is ranked 2^{nd} (=0), Finland 3^{rd} (=0), and Denmark 6^{th} (-1 rank relative to 2008). These three countries are all classified as innovation leaders, the highest group in the assessment. Iceland, ranked 14^{th} (-1), is in the group of innovation followers. Norway, ranked 19^{th} (-1), is classified in the next group as a moderate innovator, together with southern and central European countries. Finland and Iceland are classified as moderate growers, with the other Nordic countries as slow growers.

Denmark is strong on throughputs and enablers, weak on economic outcomes, with the recent changes enhancing the differences between strengths and weaknesses. Finland is strong on firm investments and enablers, weak on outputs and throughputs, which recent changes reducing the weaknesses, especially on innovators and throughputs. Sweden is strong on firm investments and enablers, weak on outputs and throughputs, which recent changes strengthening throughputs but weakening other firm activities and outputs. Iceland is strong on financial enablers and linkages, weak on outputs, throughputs, and human resources. Recent changes enhanced enablers and throughputs. Norway is strong on enablers and weak on outputs, firm investments and throughputs. Recent changes enhanced enablers and throughputs.

The **Knowledge Economy Index** 2009 (World Bank, 2009b) provides statistical data on the economic incentive regime, innovative activity, education, and ICT use. The economic incentive regime is based by tariff and non-tariff barriers, regulatory quality, and the rule of law. Measures of innovative activity include royalty and licensing revenues, patenting, and publications. Education is the average of the adult literacy rate, and the secondary and tertiary enrolment rates. ICT use is measured by phone, computer, and internet penetration rates.

Among the 145 countries covered, Denmark is ranked 1st (=0), Sweden 2nd (+2 ranks since 1995), Finland 3rd (=0), Norway 5 (+4), and Iceland 13th (+5). Compared to all high income countries, Denmark ranks best on education and economic incentives but lags on ICT. Sweden's position is relatively balanced, with more pronounced strengths in innovation and somewhat weaker positions in education and economic incentives. Finland comes out strongest on education and innovation, but lags on the ICT measures used. Iceland has a more varied profile, with pronounced strengths in economic incentives and education but weaknesses in innovation and ICT. Norway has the same relative profile of strengths and weaknesses, but the absolute differences among them are not as high.

The **Global Innovation Index** 2010 (INSEAD, CII, 2010) draws on a combination of statistical and survey data drawn from a number of international sources, including the Global Competitiveness Report, covering many aspects of the general business environment seen as conducive to innovative activity. The index organizes indicators into the two main pillars of innovation inputs and innovation outputs. Innovation inputs cover institutions, human capacity, ICT, market sophistication (which is largely financial market regulation and access), and business sophistication (which covers indicators from company sophistication to cluster dynamics to market openness). Innovation output is broken up into science outputs (from measures of knowledge creation to application to exports) and creative outputs (covering trademarks but also exports ultimate prosperity levels). Among the 132 countries covered, Iceland is ranked 1st, Sweden 2nd, Denmark 5th Finland 6th, and Norway 10th. Iceland ranks stronger on outputs (2) than on inputs (8). Detailed strengths in ICT, science outputs, human Capacity, and creative outputs; weaknesses in market sophistication, business sophistication, and institutions. Sweden ranks stronger on inputs (1) than outputs (4). Detailed strengths are in business sophistication, institutions, ICT, human capacity, and creative outputs, weaknesses in market sophistication and, to a much lesser degree, in science outputs, especially the exports it drives. Denmark ranks stronger on inputs (2) than on output (8). I has strengths in human capacity and institutions, but weaknesses in market sophistication and science outputs. Finland ranks stronger on inputs (4) than on output (11). Detailed strengths are in human capacity, weaknesses in market sophistication, ICT, creative outputs, and science outputs. Norway's position is pretty balanced on inputs (9) and outputs (10). Detailed strengths are in human capacity, ICT, and creative outputs, weaknesses in business sophistication and science outputs.

The **International Innovation Index** 2010 (BCG, NAM, Manufacturing Institute, 2010) combines indicators of innovation inputs and outputs drawn from internal publicly available statistics to arrive at an overall ranking. Indicators of innovation inputs include the three categories of fiscal policy (overall taxation level, R&D tax credits, government R&D spending), other policies (five categories from trade policy to education to infrastructure), and the innovation environment (workforce skills, infrastructure, and business rules). Innovation outputs include R&D results (from R&D investments to generation and transfer of IP), business performance (exports, market capitalization, and labour productivity), and public impact of innovation (employment and investment indicators).

Among the 110 countries covered, Iceland ranked 4th, Finland 7th, Sweden 10th, Denmark 11th, and Norway 17th. Iceland ranks 2nd on innovation inputs and 5th on innovation performance. Finland ranks 3rd on innovation inputs and 11th on innovation performance. Sweden ranks 15th on innovation inputs and 9th on innovation performance. Norway ranks 9th on innovation inputs and 25th on innovation performance.

Last year's **Nordic Innovation Monitor** (FORA, 2009) provided an additional in-depth analysis, applying a model developed with the OECD to the Nordic countries. The model identifies measures of framework conditions and of innovation performance in four areas: Entrepreneurship, Human resources, ICT, and Knowledge Creation.

Among the 25 OECD countries ranked, Denmark ranks 4th based on the 2008 data used (+s 8 ranks compared to 2003) on innovation performance and also 4th (+6) on framework conditions. Denmark's strengths are in management, organization, skill development, and ICT. Weaknesses exist in access to skills, attractiveness to foreign talent, public R&D spending, and areas of entrepreneurship. Sweden ranks 5th (+1) on performance compared to 9th (+2) on framework conditions. It is strong in HR, knowledge creation, and the presence of ICT, but has weaknesses in entrepreneurship. Iceland ranks 6th (+1) on performance and 2nd (+4) on framework conditions. The country has a high share of advanced skills, is strong on ICT, and shows

the strongest position on entrepreneurship among all Nordic countries. A concern is the extent of education investment and the effective use of ICT. For Finland the balance is 7th (-4) on performance and 5th (+3) on framework conditions. It is strong in available skills and R&D investments, but fails to get full value from these assets, partly due to lower rankings on management and organization Its position on entrepreneurship is respectable compared to Nordic peers but falls behind global leaders. Norway's framework conditions are ranked 12th (+2) and performance 15th (+2). Norway's strengths are related to ICT and investments in education but the country lags behind its peers on entrepreneurship and overall innovative capacity.

Key observations

Overall, this data provides a more nuanced understanding of the realities of current business R&D activity in the Nordic countries. The general profile is one of considerable strength. But it is still significantly more balanced than the exuberant assessments provided by the standard assessment of innovative capacity:

- Companies in the Nordic countries are relatively R&D intensive. This overall intensity at the economy level is to a significant degree driven by the specialization patterns of the Nordic economies. Within their respective industries, Nordic companies are in most cases not significantly more R&D intensive than their global peers (Mathieu/van Pottelsberghe, 2008, find the same for Finland but see a positive country effect on R&D intensity for Sweden)
- The absolute size of R&D spending in the Nordic countries is modest. This is not surprising given the size of the Nordic economies. But if there are economies of scale in overall R&D activity, this highlights clear challenges for the Nordic countries.
- The spending and patenting activity of the Nordic business sector is highly dependent on a few key companies. This high concentration seems significantly stronger than in other countries
- The strong ranking on innovative capacity is largely a reflection of the Nordic countries strong overall competitiveness as measured in chapter 2 of the Barometer. The Nordics are strong on fundamental inputs into the innovation system but often not able to take full advantage of these inputs. In particular, the innovation system works well in its traditional focus on science outcomes and large company R&D activity (spending, patenting) but much poorer on high-growth entrepreneurship of innovation-driven companies.
- There are significant differences across the Nordic countries in terms of business R&D activities. Sweden is strongest, followed by Finland and Denmark. The differences in innovative capacity, especially the framework conditions, are much smaller.
- There is limited evidence of cross-Nordic R&D activity. While many of the largest Nordic R&D spenders operate in more than one Nordic country, they tend to concentrate their activities in one location. The large tail of Nordic companies with relatively small R&D expenditures focuses their research activities completely on one Nordic country.

Nordic Solutions?

3.2 Drivers and outlook for Nordic business R&D

Many Nordic companies are highly global in their operations. In the first instance, this has led to a geographical imbalance between where sales are taking place and where the production is happening. Over time, this has led to a relocation of many manufacturing activities away from the Nordics towards more important markets or more cost-attractive locations. This process is not eliminating the strong role of the home country in Nordic companies' operations, but has clearly led to a rebalancing.

The key question for the robustness of Nordic innovation is whether the same process will now take place in business R&D. And if this is the trajectory on which the locational footprint of business R&D will change, how fast will it materialize? This section will first provide a short summary of the global academic literature on the drivers of companies' decisions on where to locate R&D activities. It will then provide key findings from a series of interviews with key executives from leading corporate R&D investors in the Nordic region.

A short review of the literature

Companies' R&D activities are becoming much more international. This is the clear evidence reflected in many case studies but also of broad-based statistical analysis (Kuemmerle, 1999). While in the past companies conducted R&D activities only at one central location, traditionally at the company's main site, R&D activities are now more often distributed across different locations and/or separated from the headquarter.

The majority of R&D activities outside of companies' home locations is taking place in other advanced economies (UNCTAD, 2005). R&D activity is growing outside of the OECD. But the growth in R&D activity in non-OECD countries tends to be in addition to rather than instead of R&D in the more traditional locations. There are large difference between activities in research and activities in development. In research, there is little evidence of dispersion of activities. In development, however, there is a much stronger tendency for innovation spending to follow the growth of markets (Ark et al., 2008; Johansson/Lööf, 2006). And there are large differences across industries, which some experiencing high growth of R&D in new locations while others see virtually no change to the established patterns with dominance of R&D in core OECD countries (Tellis et al., 2008).

Multinational companies (MNCs) are the key drivers in the internationalization of corporate R&D activities (UNCTAD, 2005; Johansson/Lööf, 2006). MNCs have created global value chains where activities are disbursed across different locations, with many sites outside the home location serving markets other than their home country. MNCs are often key drivers in the innovation systems of their home countries, and like these up with foreign knowledge hubs (Friberg, 2006). Smaller companies have internationalized more traditionally by serving foreign market through a mix of exports and direct investment into local production capacity. Activities across the value chain within the company are either at home or in the foreign market. Other locations become only involved through the outsourcing of activities to external companies. The literature has identified four key factors that drive the decisions of MNCs as to where they place their R&D activities:

- Market access; as companies enter foreign markets, they are often faced
 with different market needs or different regulations that require them to
 set up local development capabilities (Kuemmerle, 1999). Where market
 entry has been done through the acquisition of local companies, this
 has in some cases also left the new owners with R&D activities (Zander/
 Håkansson, 2007). As markets have grown rapidly in emerging economies
 outside of the OECD, this has naturally led to a rebalancing of R&D
 activities towards these countries. Foreign companies have often been
 faced with the expectation from host governments that if they sell in their
 markets they should also contribute to the local economy. Traditionally
 this has happened through setting up production facilities but increasingly
 governments press for more advanced activities in R&D.
- *Skills;* a critical condition for R&D in new locations to be possible is the availability of relevant human capital (Tellis et al., 2008). While this has traditionally been the key limitation for the growth of R&D activities outside of the OECD, a number of emerging economies have become significant providers of skilled employees from engineering to biology. At the same time, companies have started to face bottlenecks in skill supply in their home locations (Zander/Håkansson, 2007). While the lower cost of skills in emerging economies plays a temporary role, it is evaporating fast. The key driver is the shifting availability of human capital, not cost differences across locations (Jones/Teegen, 2003).
- Science base; beyond the pure availability of skilled personnel, the presence
 of local R&D activities is of importance (Kuemmerle, 1999; Erken/Kleijn,
 2010). Especially if there is not also an attractive local market or a significant supply os skilled labour, the scientific research needs to be excellence
 in order to attract R&D activities of MNCs (Abramavosky et al., 2006).
 While existing skills provide the opportunity for companies to undertake
 existing R&D tasks, excellent scientific research provides ideas that can be
 more effectively tapped into if a company has own R&D activities close
 by.
- Clusters; locations are even more attractive as sources of ideas, if they have developed beyond a narrow scientific base and the presence of skilled labour, and have become home to a dynamic combination of interacting companies and research institutions (Cantwell/Piscitello, 2005). MNCs tap into clusters worldwide and then internalize the innovations in their global value chains (Alcacer/Zhao, 2010). There is emerging evidence that private R&D is more strongly associated with clusters, while public R&D is more aligned with other factors, like urbanization (Sölvell/Protsiv, 2008).

In many locations, a combination of these factors is at play to attract R&D from MNCs (Siedschlag et al., 2010). Over time, the purpose of R&D internationalization has shifted from adaption to local market needs towards generation of new ideas. Accordingly, the presence of clusters, the quality of local R&D capabilities, and the availability of skills have become relatively more important.

Nordic Solutions?

The perspective of Nordic R&D leaders

A relatively limited number of Nordic MNCs is responsible for a significant share of all business R&D in the Nordic countries. For this Barometer, a number of semi-structured interviews were conducted with a cross-section of executives from some of the largest corporate R&D spenders in the region, representing different industries and countries. While not statistically significant, the insights from these interviews provide an important perspective on the pattern of their R&D spending across locations, on the trends they see, on the key strengths and weaknesses they see in the Nordic countries, and on the key challenges the Nordic region has to address in their view.

For all of the companies interviewed, **innovation plays a critical role** in remaining competitive in the global market place. Somewhat more surprisingly, the vast majority did not see the level of their R&D expenditures as exceptional compared to their leading peers internationally. Most of the companies operate in industries where significant levels of R&D are a necessity of competition, not a choice. The strategic positioning within these industries then tends to occur in other dimensions, for example the focus on specific market segments (geographic, customer needs) or the provision of a specific set of product/service features.

Among the companies interviewed, the levels of **geographic dispersion of R&D activities** differ, even though all of them have R&D activities in more than one location. One driver of dispersion is the nature of markets in the respective industries; the more markets are distinct by geography (analysts call this "multi-local" rather than "global" markets), the higher the share of R&D activities that is being dispersed across individual markets. Differences in local regulations or needs across geography are important drivers of such market separation. This often leads to a two-tier system where research on fundamental innovations or "global platforms" is conducted in one or very few central locations, while development activities are highly dispersed, matching the companies' global market presence.

A second driver of dispersion is related to company-specific factors. Companies that have an M&A-driven growth strategy, tend to have a wider portfolio of R&D locations as a legacy of their acquisitions. In cases where the acquisitions were made to achieve market access/share, these locations are likely to be phased out over time, leading to consolidation of R&D activities in a few central locations to increase efficiency. In cases where they were made to get access to the specific competence of the acquired target, for example to enter a new technology area, they are likely to stay.

A third set of drivers are the changing conditions in locations outside of the companies' home base. On the one hand, the context for conducting R&D activities has significantly improved in many countries, with rising numbers of university graduates, increasing competence of research and educational institutions, a more reliable policy environment, and an overall upgrading of competitiveness in many emerging economies. On the other hand, countries like China have become much more adamant about pressing companies to invest in local R&D activities, not just production, if they register significant sales in this market.

At present, the vast majority of all interviewed companies reported a strong dominance of the home country in their R&D activities. This applies particularly to the research activities, while a significant part of the development activities has been relocated. Companies in research-intensive industries have the highest share of R&D in the Nordics, while companies in which development dominates have already relocated most of their R&D activities away from the Nordic home base. Very few of the interviewees saw a dramatic near-term threat to current level of R&D activities in their respective Nordic home country. Development activities will with all likelihood to an even larger degree be relocated to other locations with larger local markets. But research activities might even flow back, as companies consolidate their portfolio of research activities, especially across Europe, and in some cases increase centralized work on global platform technologies to gain competitive advantages across local markets. For foreign-owned MNCs with strong Nordic operations, this can, of course, also imply a reduction of research in the Nordics. At the same time, almost all of the interviewees mentioned the increasing supply of skills and academic research in emerging economies, especially Asia. No global MNC can afford not to tap into this pool of new competences.

There is a visible dichotomy in many of the responses between the short and the long term. In the short term, almost none of the interviewed executives expected a dramatic reduction of R&D activities in the home location. In the long term, however, the trends seen on key factors driving the distribution of R&D activities across locations are consistent with a much more dramatic rebalancing. At some point, the presence of these two views suggests, there could be a dramatic "tipping point" at which the long term becomes the short term and many companies start to relocate R&D activities. In a few cases this process seems already under way.

The **attractiveness of the home country** for R&D activities is clearly a crucial factor for whether and when such a "tipping point" will be reached. This attractiveness is a key reason for Nordic MNCs to so far keep a disproportional (compared to sales and often also production) share of their R&D activities in their home country.

MNCs continuously optimize the distribution of their activities across geographies. But because change is not cost-less, the legacy of an existing portfolio of sites plays an important role. While some of the companies would not locate their R&D activities in the Nordics when starting anew, the benefits of relocating them are often not sufficient to outweigh the significant costs of disrupting existing R&D operations and investing into new facilities, employees, and organizations.

This is a factor that is ultimately not sufficient to keep R&D in the Nordics – if this legacy is a disadvantage, the MNCs with Nordic R&D operations will suffer in the marketplace – but it has a strong impact on the speed of change.

A key advantage that almost all interviewed companies identified for the Nordics is the *availability of skilled human capital at competitive costs*. The current workforce has technical but often also process/ management capabilities that are attractive also in global comparison. While wage levels are not low, **Global Pressure**

they are competitive relative to other advanced economies. Emerging economies provide a short-term cost advantage, but apart from often still lower productivity, they are also characterized by high wage pressure and much stronger fluctuation in the workforce.

Some companies are concerned, however, whether the future supply of skilled employees in the Nordics will be sufficient. Apart from the technical skills, there is also scepticism as to whether new generations have the same dynamism and "hunger" as their peers in other parts of the world, especially Asia. There are differences of opinion across countries and industries, but these are issues mentioned repeatedly.

The Nordics are home to *sophisticated demand* from wealthy consumers that are interested in brands and trends and willing to adopt new product technologies and service offerings. The notion of the Nordics as a test market was already discussed in the first Globalization Barometer and in earlier work on company operations in the Baltic Sea Region (Ketels, 2007; 2008). This feature is particularly important for the R&D activities, both as an incentive to develop new solutions and as a source of ideas and feedback on innovations. A number of government programs aim to support user-driven innovation to leverage these opportunities.

Worryingly, the interviews revealed that in some key areas the Nordic markets are no longer the most sophisticated. In others, there are concerns that there is no effective strategy to translate the leading demand in the Nordics into international standards. Such standards are crucial to be able to translatee the innovation pull from Nordic demand into competitive advantages on large global markets. Some interviewees saw a lack of activity and coordination among Nordic countries to influence international industry bodies and regulators at the EU or other levels.

Many of the interviewed companies have deep and often long-running collaborations with universities and research institutions that are specialized in areas highly relevant to the companies' own R&D activities. Specialized suppliers and service providers often exist as well, creating the ingredients of *dynamic clusters* on which the companies can rely. In a significant number of cases, there is also mutually reinforcing collaboration across related clusters, for example between IT, telecommunication equipment, and industrial machinery. In some of the technology areas traditionally core to these clusters, Nordic research institutions are among the global leaders.

Not all companies see the reality of Nordic clusters in this way. Some experience the collaboration with universities as far from optimal, with academics having too limited incentives to collaborate with companies. Others are concerned that while in the past the portfolio of related clusters and technological competencies available in the Nordics provided reinforcing strengths, demand and technology trends are driving competence needs into new areas in which the Nordics are less well positioned.

Maybe the most fundamental concern, however, is that the existing innovation systems in the Nordics are poorly equipped to succeed in a new innovation environment. The old system was based on the collaboration between universities and the central R&D divisions of key MNCs. The new system emerging in many countries is to a much larger degree driven by growthoriented small and medium-sized companies. Recent policy initiatives have focused on the creation of start-ups, especially around universities, but very few of them have shown the ability to grow to meaningful size. And universities have not found the right instruments to work with these new types of partners. One of the challenges is the difference in time horizons: while universities and to some degree also MNCs in their research activities take a medium- to long-term view, SMEs tend to be much more short-term oriented given their smaller resources. Innovation policy in the Nordics gets overall mixed reviews. Some interviewees highlighted especially Finnish efforts as a model, but there were repeated concerns about a lack of Nordic coordination and sufficient openness of the system to global needs.

Key observations

Overall, the combination of general insights from the academic research on the globalization of corporate R&D and the specific impressions from the interviews of Nordic MNCs with high levels of R&D investments in the region leads to the identification of a number of key issues the Nordic region is facing to sustain the strong level of corporate R&D activity it currently hosts. Borrowing from a classic paper on cluster dynamics (Barthelt et al., 2004) these issues can be organized into two broad categories:

Upgrading local dynamism

- The Nordic countries have to retain their current advantages in terms of a highly *skilled workforce* in competence areas relative to the global MNCs operating here. The strong growth in skill supply in other parts of the world is nothing that the Nordic region can affect. But the threat of eroding strengths in in the Nordics needs to be addressed. The task is not just to retain current strengths in specific fields of research and technology but also to develop new skills in areas that have become more critical as industries and markets have changed. This will require a concerted effort from government and business, in which the Nordic level can play an important supporting role.
- The Nordic countries have to adapt the *nature of their innovation systems* to the changing realities of innovation processes. This will require further developing the role of universities in innovative clusters. And it will at its core require a fundamental review of the business environment conditions for high-growth entrepreneurship. Most of these changes will have to be made at the level of individual countries. But the Nordic level can support this process as a forum for policy learning and discussion. And a fully integrated Nordic market is, as has been discussed in previous Barometers, a powerful driver for more entrepreneurship.
- The Nordic countries need to review how the current *portfolio of competences and clusters needs* to be systematically developed to meet the emerging needs of companies in global markets. Traditional industry boundaries are shifting rapidly, and this will mean that new combinations of skills will be necessary to succeed. The Nordics have in the past been able to build on a reinforcing set of related clusters. They now have to review how these portfolios need to evolve.

Global Pressure

• While the local *demand sophistication* continues to be high, determined action is required to keep it that way. Also, there needs to be a clear strategy, involving government, to ensure that the advanced Nordic demand informs or even drives international regulations and standards. Only then is it commercially sensible for MNCs to invest into Nordic R&D with a global impact.

Upgrading global linkages

- While developing the local supply of skills is important, it will not be enough. The *attraction of foreign skills* needs to be significantly enhanced. The educational institutes in the Nordic countries already get an inflow of foreign students that could be further development. Much more is then needed to make it possible and attractive for these students to stay once they have finished their degrees. For experienced foreign staff, the complex issue of taxation has been on the agenda on and off in some Nordic countries. It will not go away.
- Apart from individuals, the Nordic countries also need to attract the R&D activities of foreign companies. The Nordic region is very open to FDI (see chapter 2 of this Barometer) and it has, as the interviews with the Nordic MNCs confirmed, important strengths. Foreign companies can strengthen existing clusters that in some cases have become highly reliant on one or a few companies. Some interview partners saw the foreign take-over of Nordic companies as a threat, eroding the cluster, while others hoped for better linkage into new geographies. What is needed to successfully attract foreign companies that are willing to invest in Nordic R&D, is a much better coordination of efforts across the Nordic region. The individual countries are often too small to attract attention, especially from Asian companies and research institutions that have little prior knowledge of the Nordics.
- A final aspect is the relationship to the *neighbouring emerging economies*, especially Russia. Russia has significant science resources, even though they have lost some lustre over recent years. Many Nordic MNCs have looked exclusively towards China and India when tapping into the R&D potential of emerging economies. Activities in Russia would provide the benefits of proximity, which makes it easier to integrate R&D activities in Russia with those in the Nordic countries. To get there, changes are needed in Russia as well as in the strategic orientation of the Nordics and of Nordic MNCs. But it would be clearly beneficial for both sides to explore these opportunities more aggressively than is happening today.

On both of these dimensions, a better strategic policy dialogue is a critical condition to make progress. The opinions differ among interview respondents across countries and industries, but there are a significant number of voices that see the need for a much more systematic discussion between government and companies about the trends and action requirements in specific sectors, especially in research and innovation policy. The outcome would be a better alignment of the steps taken by the public and the private sector, based on a shared vision of the future.

Policy dialogue is only meaningful, if it leads to decisions and ultimately action. Decision making in the Nordics can be a slow process because there is a strong orientation towards achieving consensus. This has advantages through involving many people and their respective knowledge. Consensus also leads to much more effective implementation and consistency of action. But it also has costs in terms of slowing down the decision making process. As the world – or at least some key sectors in which Nordic MNCs operate – is becoming faster paced and less predictable, this is an increasing concern.

There are significant differences across the Nordic countries in terms of the realities and the challenges of corporate R&D; this is obvious from the assessments of innovative capacity across the Nordics as well as from the interviews. But the issues identified above indicate that the Nordic level can play an important and in some areas leading role in improving the robustness of corporate R&D across the Nordic countries.

3.3 Nordic innovation – a Chinese perspective

by Sylvia Schwaag-Serger and Nannan Lundin

A country's or region's capacity to innovate is determined by its ability to generate and disseminate knowledge, and by its ability to transform knowledge into new products, services and processes and thus into economic growth and welfare. Nowhere else in the world has the ability to create knowledge grown as quickly as it has in China over the past decade. Much of the discussion on China's increasing power focuses on its economic might and the size of its foreign exchange reserves. In this section, we take a closer look at what we argue will be an even more important determinant of China's place on the future global stage, namely its rapidly growing scientific and innovative assets and in particular its targeted investments in energy and clean technologies.

Industrialized countries (North America, Europe and Japan) have for a long time dominated the global R&D landscape, accounting for the majority of global knowledge resources both in terms of R&D investments and human resources for science and technology. This dominance is increasingly being challenged as growth and transition economies increase both their supply and demand for knowledge and innovation. China, Brazil and India are perhaps the most prominent examples of countries where domestic investments in R&D and the number of students, engineers and researchers are growing dramatically at the same time as large domestic markets are attracting R&D investments of foreign companies. China's share of global R&D expenditure (PPP adjusted) is projected to increase from 9.5% in 2007 to 12.5% in 2009, at the same time as the shares of the US, Japan and Europe are all projected to decrease (Battelle 2009). As a result, the centre of gravity for knowledge and innovation resources is shifting, with transition and developing countries, rapidly increasing their position (OECD 2008 and Battelle 2009) and their importance as innovation drivers, both because of their growing technology strength and their large and growing markets. In particular, we see a growing number of European, Japanese and US companies setting up

R&D activities in China and India (see, for example, Schwaag Serger 2009). China's rapidly increasing scientific might is reflected in the rising number of Chinese academic publications. China and other "emerging scientific nations" are rapidly increasing their scientific production, thus "challenging the leading sciento-economic powers" (Glaenzel et al. 2008, p.71).

China's ability to become a world leader in innovation is still hampered by a number of significant weaknesses and shortcomings but, despite these, China is well on the way to building internationally strong research and knowledge environments within areas of relevance to the Nordic countries (telecoms, nanotechnology, electronics, clean technology, etc). In the face of the global financial crisis, China has made impressive progress and taken the lead of the "green economic recovery". Under China's fiscal stimulus plan, a large amount of spending has been allocated for investment in strategic and high-tech areas such as energy efficiency, renewable energy, rail transportation, and electric vehicles.



Source: A Climate for Recovery, HSBC (2009)

Through its increasingly strong and dynamic national innovation system, as well as driven by ambitious energy-saving renewable energy policies, China will be able to build up a solid basis for speeding up and scaling up its low carbon development potentials. If China achieves its energy intensity target of 20% set in the 11th Five-Year-Plan (2006–2010), it will have avoided a total of 150 billion tonnes of CO2 emissions by 2010. If China achieves its 15% target for renewable energy by 2020, it will become one of the world leaders in solar and wind energy.

At the same time, similar to its development in S&T and innovation, China also faces unique challenges in the exploration of medium and long term low carbon development strategies and transformation. This is mainly reflected

in its coal-dominated energy structure and its need for high rates of industrialisation and urbanisation. For example, around 70% of China's electricity comes from fossil fuels, which will remain the case in the medium term. In addition, China produces 48% of the world's cement and 35% of the world's steel to meet the needs of its ongoing rapid urbanisation. In the transition to a low carbon and innovation-driven economy, China needs to address not only the common challenges faced by industrialised countries in moving from a high carbon development to a low carbon development, but also the key issue of large-scale poverty alleviation. What is required is not a transition from a 'low income and low emission' to a 'high income and high emission' pathway, which would lock in high carbon development for decades to come. Instead, there are plenty of opportunities for China to 'leapfrog' old models of high carbon growth to become a 'high income and low emission' country – In other words, these challenges can also be potential for China's new "low carbon growth and innovation opportunities".

The Nordic countries regularly feature at the top of international innovation rankings (see chapter 3.1 above). One important determining factor for the Nordic countries' strong innovation capacity is large investments in knowledge (both in terms of R&D expenditure and a highly skilled labour force). Despite the large differences in the socioeconomic context and resource endowments, in the face of the global challenge of climate change and energy security, there is both a unique linkage and complementarity between Nordic countries and China. While China is on often regarded as "the biggest problem", the Nordic countries are widely seen as "the best solution"; while Nordic countries are well-known for their climate-friendly innovations, China has become the most dynamic market for the use and production of such innovative solutions.

How will the Nordic countries position themselves in this new innovation landscape in which China's share of global knowledge resources is increasingly rapidly? How are the Nordic countries positioned to compete and cooperate with the new research and innovation hubs, such as Bangalore, Beijing and Shanghai? This chapter provides a brief assessment of China's growing innovative capacity. Furthermore, it assesses research and linkages between the Nordic countries and China and identifies challenges and opportunities of China's development for the Nordic countries. In particular, we examine the energy, climate and clean technologies as a field of common interest for the Nordic countries and China. The Nordic countries and China are currently exploring different ways for cooperating are keen to offer solutions in the fields of energy, climate and clean technologies. We provide a critical assessment of the Nordic countries' ability to cooperate, and compete, with China in this highly strategic field. Finally, we draw some conclusions and offer some recommendations for future interaction with China in the field of innovation, climate and energy.

- Nordic Solutions?

China's increasing innovative capacity

Dramatic increase in China's knowledge inputs and outputs...

Since the latter half of the 1990s, R&D expenditure has increased dramatically. China's R&D expenditure as a share of GDP has been growing much more rapidly than in any other country in Europe, the US and Japan. This growth is even more impressive when considering that, at the same time, China's GDP has grown by close to 9% per year on average. As a result, China today has the third-largest expenditure on R&D in terms of purchasing power parity, trailing only the US and Japan, according to the OECD (OECD 2005).

Whereas China's R&D expenditure (PPP adjusted), was roughly the same as the total R&D expenditure in the Nordic countries in 1997, by 2007 China's R&D expenditure was nearly 3 times the size of the Nordic countries' total R&D expenditure. While the Nordic countries' combined R&D expenditure increased by around 7% per year on average, China's R&D expenditure increased by around 22% per year.¹



Source: Unesco Institute for Statistics (UIS) database, accessed April 2010

> In the past decade, China's R&D expenditure has increased twice as rapidly as China's GDP growth. As a result, China's R&D expenditure as a percentage of GDP has increased from 0.6% of GDP in 1997 to 1.5% of GDP in 2008. While China's R&D expenditure as a percentage of GDP is still far below that of the world leading countries, it is rapidly closing the gap with Norway and the EU-27. On current trends, China's R&D expenditure as a percentage of GDP is projected to surpass the EU average in the coming 3–5 years.

¹ Correcting nominal R&D expenditure for purchasing power parity is not easy, thus particularly comparison of absolute figures should be done with caution; it is extremely difficult, for example, to account for large regional cost differences within China. However, the data is useful for comparing trends over time.



Source: Eurostat and China Statistical Yearbook

At the same time as R&D expenditures have increased, China's R&D system has undergone far-reaching structural transformation. Business sector's share of total R&D expenditure increased from 30% in 1994 to 72% in 2007 (MOST 2008). China's traditionally large research institute sector has been significantly reduced. While the number of government research institutes has dropped, China's research institute sector continues to receive more funds for R&D than the university sector.

In addition to R&D expenditure, human resources in science and technology have increased dramatically. The number of university graduates has grown by around 20% per year on average since 1999, from 850 000 in 1999 to 5.1 million in 2008. In terms of doctoral degrees in natural science and engineering, China overtook the US in 2007, awarding more than 26 000 PhDs in natural sciences and engineering compared with close to 24 000 in the US. By comparison, the Nordic countries awarded around 3700 doctoral degrees in natural sciences and engineering in 2006, whereas the European Union as a whole awarded around 44 000. - Nordic Solutions?



Source: National Science Foundation S&E Indicators 2010, China Yearbook of Statistics 2009.

Global Pressure

Finally, China has rapidly become one of the most attractive locations for foreign corporate R&D activities. During the past five years, hundreds of new R&D centres have been established by foreign companies in China and in several recent surveys, executives from multinational companies rated China as the most attractive country for future R&D investments (Schwaag Serger 2009).

Knowledge outputs have also grown, albeit not at the same pace as inputs. China has jumped from 13th place in the mid 1990s to 2nd place in terms of share of world total publications. Patents filings in China have grown by around 24% per year on average between 1995 and 2007 (World Intellectual Property Organization 2010). China has become a large exporter of high technology products, which accounted for 29% of its total exports in 2007.

... but significant challenges remain

China's research and education system still faces considerable challenges. While business sector R&D has increased rapidly, R&D expenditure as a share of value-added remains low (MOST, 2008). Furthermore, a large share of China's business expenditure on R&D is carried out in large state-owned enterprises (SOEs) whose ability both to innovate and to absorb knowledge is often low (Kwan, 2006). Finally, basic research accounts for a small share of total R&D, compared with many other countries.

Chinese universities have been struggling to cope with a dramatic expansion of students which has occurred at the same time as public funding for education has stagnated. This, combined with the introduction of tuition fees and the partial privatization of education, has led to large inequality in terms of access to and quality of education. Furthermore, academic corruption is a serious problem which is increasingly receiving attention. Also, several indications currently point to a fundamental mismatch between the education offered by many of Chinese universities and the skills demanded in the labour market. The education system is producing university graduates at a rapidly accelerating pace; yet, a significant number of these graduates cannot find employment even though there is severe shortage of highly skilled labour (Farrell and Grant, 2005). Finally, China's strategy of attracting foreign technology and knowledge is regarded by domestic and foreign observers as having been only partially successful. One of the most important goals of China's technology and research policy so far has been to construct a domestic capacity to produce high technology goods. By combining foreign direct investments with the development of theoretical technical expertise, the government has tried to trigger a chain reaction leading from import to assimilation to the ability to generate own technology. Within many sectors, this goal has not yet been reached. Thus, a large share of China's high tech export still consists of the import of high-tech components which are assembled in China and then exported abroad.

Science, technology and innovation to solve economic and social challenges

China's determination, since the beginning of the 1980s, to strengthen the country's knowledge base and innovation capacity, is driven by a combination of real and serious challenges, and a strong - some would say excessive - faith in the ability of technology to help China overcome these challenges. China's research policy is strongly needs-driven: science and technology are seen as tools for combating environmental problems, epidemics and poverty, for meeting China's growing demand for raw materials, for securing the country's future competitiveness and growth, but also for realizing the government's political ambitions (Wolf et al 2002). The overarching goal of China's long-term plan is to maintain a high rate of economic growth and development but also to provide technological solutions to social and environmental challenges. In the latest 15-year plan, China has put energy and the environment at the top of the list of prioritized technology areas, acknowledging the challenge of combining continued growth with greater resource efficiency and environmental consideration. High unemployment in certain regions and sectors puts the government under pressure to maintain growth and avoid political unrest which might result from further increases in unemployment. Furthermore, high economic growth, which has long been the key indicator of success, is still one of the top goals of provincial and local governments who therefore often don't support, or even undermine, targets set at national level to restrain growth.

Chinese Science and Technology Policies: Striving for 'Independent Innovation'

Against the above described background, on February 9th, 2006, the State Council presented its strategy, or program, for strengthening China's scientific and technological progress in the coming 15 years (Schwaag Serger and Breidne, 2007). The strategy is an indicator of how China's political leadership aims to strengthen China's future economic and technical development – something which will undoubtedly also have a profound impact on the rest of the world. It reflects China's clear ambitions to make the country one of the world's most important knowledge bases and innovation countries. The most important aspects of the plan can be summarized in three points. Firstly, R&D expenditure as a share of GDP will be increased by 2020 to 2.5% of GDP (from the current level of 1.4%). In the same year, it plans to achieve another key goal, that is, the quadrupling of GDP compared with 2000. Secondly, China's domestic innovative capacity is to be strengthened and its dependence on foreign technology to be reduced. The declared intention to strengthen 'independent' or 'indigenous' innovation is perhaps the most striking feature of the new plan, and certainly the one most widely discussed by foreign firms and experts. This has raised concerns over the rise of so-called 'techno-nationalism' or 'neo-techno-nationalism' and of what this new emphasis means for China's future economic openness but also for the protection of foreign intellectual property in China (Suttmeier and Yao, 2004). One of the declared aims is for China to establish its own technology platforms, to identify and lay a claim to new technology areas where China can take the lead, and to play a greater role in setting standards for consumer products (Kennedy 2006). The desire to reduce dependence on foreign technology is partially driven by the current dominance of foreign technology in strategic areas such as processors and software and by the desire to avoid paying high licensing fees. An additional motivation is that homemade technology within a number of areas can provide important bargaining leverage when acquiring technology in other areas. Last but not least, the aim to reduce reliance on foreign technology is also a question of national prestige.

Thirdly, companies are identified as being at the heart of and the most important driving force of the innovation process. One of the most noteworthy methods suggested in the plan is the introduction of tax incentives for Small and Medium-sized Enterprises (SMEs). These and other financial incentives are intended to encourage companies to invest in R&D and even to establish R&D activities abroad. The latter is particularly interesting and quite unique, and is likely to lead to an increased presence of Chinese companies in science or technology parks in the US and Europe.

Nordic countries' knowledge and innovation linkages with China

In this section we examine how well the Nordic countries are 'linked up' with China, which has been identified as one of the new 'innovation hot spots' (Kao, 2009). Saxenian (2006) identified linkages with China and India as one of the key determinants of Silicon Valley's enduring position as global technology and innovation hub and also its ability to renew itself. In particular, she pointed to the crucial role of the Chinese and Indians – whom she calls the 'new Argonauts' – who 'commute' between Silicon Valley and their home countries, enriching both with their networks, competencies and other resources. In this section, we examine three indicators of innovation linkages: co-publications, student flows and Nordic multinationals' R&D operations in China.

In recent years, *research and academic cooperation* between China and the Nordic countries has increased rapidly. For example, there are currently more than 120 co-operation agreements between Swedish and Chinese universities, half of which have been signed since 2003.

International co-publications are an indicator of research cooperation. Between 2004 and 2008, North America had 35% more co-publications had more co-publications with China than Europe. Furthermore, North America's co-publications with China grew considerably faster than Europe's. When examining co-publications with the best Chinese universities, North America's edge over Europe becomes even more prominent, both when it comes to absolute numbers and percentage increase. North American co-publications outnumbering Europe's by 64% in total numbers and grew by 207% compared with 131% for Europe.



Source: Thomson Reuters Web of Science accessed June 2009



Source: Thomson Reuters Web of Science accessed June 2009

Turning to the Nordic countries' co-publications with China, Sweden has a high number of co-publications with China, compared with the other Nordic countries but also compared with other European countries, when population size is taken into account. Thus, Sweden has more co-publications with China than the Netherlands even though the latter's population is 80% larger than Sweden's. With the exception of Norway, all Nordic countries' co-publications have grown faster than for Europe as a whole.

Co-publications with China

oo pa	Silociolo		United		/	1				1.	
	Nordic countries	Denmark	Finland	Norway	Sweden	Iceland	UK	Germany	Nether- lands	France	Canada
2004	527	97	75	107	266	2	1637	1157	296	570	858
2005	629	108	94	119	339	7	1880	1236	316	734	1020
2006	751	129	96	136	423	7	2138	1392	400	810	1297
2007	810	148	116	125	481	7	2238	1530	413	940	1432
2008	928	193	154	111	533	10	2671	1668	511	1087	1771
2004-2008	3645	675	535	598	2042	33	10564	6983	1936	4141	6378
Percent	76%	99%	105%	4%	100%	400%	63%	44%	73%	91%	106%

Note: Articles only. Nordic countries' total co-publications is smaller than the sum of each of the Nordic countries since some publications with China include several Nordic countries.

Source: Thomson Reuter Web of Science accessed April 2010.

On the Chinese side, international research cooperation is traditionally a top-down process, with the Ministry of Science and Technology (MOST) identifying suitable topics and partners for cooperation both on the Chinese and foreign side. On the European side, research cooperation with China, tends to be bottom-up process, often driven by researchers' individual interests and contacts. While this may be the optimal approach for research cooperation in general, in the case of China it might be worthwhile to reflect upon the need for a more strategic approach to research cooperation. Rather than viewing research excellence only, in the Chinese context it should be viewed as an important trump card in wider economic and political negotiations.

Student flows involving China have increased dramatically over time. Since the economic opening began in 1979, around 1.2 million Chinese have gone abroad to study, the vast majority at their own expense. In recent years, several European countries have experienced a significant increase in the number of Chinese students seeking to study in Europe, with the UK attracting by far the largest number of Chinese students, close to 50 000 in 2007, followed by Germany, at around 24 000 and France, at around 19 000 (Unesco Institute of Statistics). Overall, Europe currently hosts around 100 000 Chinese students, or one fourth of all Chinese students abroad. The Nordic countries hosted around 5 500 Chinese students, or 5.5% of total Chinese students in Europe.

When it comes to Nordic countries' outward student mobility in general, it is noteworthy that, while the number of incoming students has increased

continuously, the number of Nordic students studying abroad has decreased (in the case of Denmark and Sweden) or at least stagnated (Norway). The total number of Nordic students in China is estimated at around 1300 in 2007/2008. It is very difficult to obtain accurate and comparable figures for the number of Nordic students in China, but overall it seems that whereas the Nordic countries receive more Chinese students than the European average, the share of Nordic students in China is somewhat smaller than the European average.

For Chinese students, the combination of a good education and the ability to find a good job after graduation in a given country determine their choice of location for foreign study. Currently, difficulties in getting residence permits but also difficulties in entering the job market mean that the Nordic countries are not the most attractive choice for Chinese students seeking to study abroad. In a recent survey, 43% of students identified the United States as their most preferred destination, followed by the United Kingdom and Australia, and the prospects of finding a good job are frequently listed as an important reason for choosing particularly the United States (People's Daily, Jan.27 2010).



Note: Data for Nordic students in China is from 2009. Data for Chinese students in Nordic countries is for 2007. Source: UNESCO Institute for Statistics Database (Chinese students abroad), Chinese Ministery of Education (Nordic students in China).

> Many universities or countries lack the administrative resources or competencies to process an increasing number of applications from Chinese students. Thus, embassies' visa sections are frequently already overstretched. Of the Nordic countries, Denmark currently stands out as the only country which has a strategy for scientific cooperation with China. Many universities also lack a strategy for how to benefit from their Chinese alumni, in terms of future networks, branding and funding. Furthermore, if Nordic universities intend to target Chinese students as an important source of income or funding, they often need a much better idea of the expectations and needs of the Chinese students.

Foreign companies' establishment of $R \otimes D$ centres in China is a relatively recent but rapidly growing phenomenon (Schwaag Serger 2006 and Schwaag Serger 2009). In the 1980s and 1990s there were relatively few R&D activities by foreign companies in China and they consisted primarily of product development and adaptation to the Chinese market. In the past decade, foreign corporate R&D in China has increased dramatically.

While adaptive R&D continues to dominate foreign firms' R&D activities in China, a large number of multinational companies, many of whom are technology leaders in their fields, are increasingly locating innovative R&D in China.² Today, foreign firms rank China as one of the most attractive locations for future R&D investments.

The Chinese Ministry of Commerce stated that by late 2005 there were more than 750 foreign-established or foreign-invested R&D centres in China. More recently, official statistics put the number as high as 1000. For several reasons mentioned, the number of operative centres actually carrying out R&D is likely to be considerably smaller (Gassmann/Han, 2004; Schwaag Serger 2009). According to von Zedtwitz, there were 199 operative foreign R&D facilities in China in the beginning of 2004. The number has increased rapidly since then, and is estimated to amount to around 600 by 2009.

It is even more difficult to assess how many of these companies are carrying out innovative or global R&D, i.e. R&D which is of relevance to the firms' global R&D operations, rather than only being aimed at adapting products to the domestic Chinese market (see also Reddy 2005). Adaptive R&D can be argued to be location-specific, determined by the need for proximity to market or production. Innovative or global R&D, on the other hand, refers to activities which, in theory, could be carried out elsewhere in the world. The trend towards establishing global or innovative R&D centres in China is a more complex and strategically more relevant phenomenon than when companies' R&D in China consists merely of 'localization' of to the Chinese market.

We see a number of companies that are choosing China as one of a select group of countries for setting up a global R&D centre. Nokia's research centre in Beijing, for example, is one of the company's eight research labs in the world, with the others being located in Finland (Helsinki and Tampere), Germany (Bochum), Hungary (Budapest), Japan (Tokyo) and the US (Cambridge and Palo Alto). Unilever lists its research centre in Shanghai as one of six global R&D sites. Of Fujitsu's seven R&D laboratories, two are in China (Beijing and Shanghai), three in the US, one in the UK, and one at the headquarters in Kawasaki, Japan. A number of European companies have been among the pioneers, both when it comes to establishing R&D activities in China and when it comes to locating innovative R&D in China. Examples

² The term 'innovative' is used to differentiate between R C D activities devoted merely to adapting products to the Chinese market (adaptive R C D), and operations with a scope and nature that exceeds the domestic Chinese market. Centres with innovative R C D functions are also sometimes referred to as 'global R C D centres'.

that can be mentioned include Ericsson, Nokia, Siemens, Novo Nordisk and ABB. Of the roughly 40 foreign firms with global R&D centres in China, approximately half are European.

The extent to which foreign companies locate innovative or global R&D functions in China differs significantly according to industry. So far, telecommunications and IT or personal computer companies are at the forefront, whereas life-science companies have been less likely to locate such functions in China. A number of pharmaceutical companies have established, or make use of, clinical trial capabilities in China, but few have located innovative R&D there. The Danish company Novo Nordisk was one of the first to establish a global R&D centre in China, when it opened its lab in Beijing in 2002. Whereas, initially, R&D investments were concentrated within high technology industries and activities, lately, a number of foreignowned or foreign invested global product design centres have sprung up in the Shanghai area. Philips, Sony, GM, Omron and Motorola are examples of companies that have established design centres in China, and a number of companies report concrete plans to do so in the near future. A growing number of companies with design operations are attracted to China because it offers good and inexpensive designers. Some are also starting to view the Chinese market as strategically important, not only because of its size, but because it is a dynamic and rapidly changing country that is assuming an increasingly significant role as global trendsetter. Thus, for example, Coca Cola recently developed a new soft drink at its facility in Shanghai, which is targeted at consumers in developing countries.

A number of Nordic or Nordic-related companies have established strategic R&D operations in China. Ericsson, Nokia, Novozymes and Novo Nordisk are among the pioneers in their fields, in setting up R&D centres in China which form part of their respective companies' global R&D system.

R&D operations of Nordic or Nordic-related companies in China									
Company	R&D location, year of establishment	focus	country	sector	Other R&D locations				
ABB	Corporate Research Centre Beijing, 2005, Robotics Research Centre Shanghai, 2005	manufacturing technologies, power systems, robotics	Switzerland	industrial and farm equipment	Sweden, Finland, Norway, Germany, India, Poland, Swit- zerland, USA				
Astra Zeneca	clinical trials, Shang- hai, 2002, Innova- tion Centre China, Shanghai 2007	cancer, biomarkers, genetics, alternative compound resources	UK	pharmaceuticals	Sweden, UK, USA, Canada, France, India, Japan				
Electrolux	Hangzhou, 2003?		Sweden	electronics, electrical equipment, house- hold appliances					
Ericsson	Ericsson China R&D Institute Beijing (1997/2002) and Shanghai, Joint Research Centre with ZTE in Nanjing (2005), Guangzhou (2005)	mobile technologies and network solutions	Sweden	network and other communications equipment	Sweden, Germany, India, UK, USA				
Nokia	Nokia Research Cen- tre Beijing (1998)	context computing architectures, context data modeling and management, mobile social networks	Finland	network and other communications equipment	Finland, UK, USA, India, Switzerland, Africa				
Novo Nordisk	Beijing, 2002	diabetes, molecular biology, protein chemistry, cell biology	Denmark	pharmaceuticals	Denmark, USA, Switzerland				
Novozymes	Novozymes China R&D Centre, Beijing, 1995	new enzyme research and applications	Denmark	pharmaceuticals	Denmark, USA, UK, Brazil, India, Japan, Australia				
Sony Ericsson	Development Centre Beijing, 2002	user interface devel- opment	Japan /Sweden	network and other communications equipment	Sweden, UK, France, Netherlands, India, Japan, USA				

Source: Company websites, newspaper articles, press releases, interviews.

Looking at the reverse phenomenon, we see that a number of Chinese firms have chosen Nordic locations for their foreign R&D locations. Examples include telecoms provider Huawei, which in addition to its R&D centre in Stockholm has just announced its intent to open an R&D centre in Lund, and ZTE which has a research centre in Stockholm.

Given the large benefits from establishing R&D in China - proximity to a large and strategic market, proximity to production (most of the firms who establish R&D in China already have production there), and availability of a large pool of highly-skilled and relatively cheap labour force - it would be counterintuitive or even harmful for Nordic policymakers to attempt to hinder Nordic companies from establishing R&D in China. Nonetheless, several policy challenges arise. Firstly, how can Nordic countries ensure that this development has positive spillovers for knowledge creation, growth and employment at home? The question seems particularly relevant with regard to the recent decision by Astra Zeneca to shut down its research facilities in Lund, which stands in contrast to its recent massive investment in an R&D centre in Shanghai. Secondly, how can Nordic countries remain attractive as R&D locations for both Nordic and foreign companies? Thirdly, Nordic companies face considerable challenges when it comes to protecting their in-
tellectual property rights (IPR) in China. This is a particularly daunting challenge for small and medium-sized enterprises (SMEs) which do not have the financial or other means to defend themselves against piracy. Furthermore, the establishment of R&D activities in China requires large up-front costs and may take a long time to become a profitable operation, something which SMEs are much less likely to be able to afford than large firms. This partially explains why the phenomenon of outsourcing R&D, particularly to countries like China, has so far been completely dominated by large multinational firms. If it is important for firms' competitiveness to establish R&D abroad, including in China, then policymakers need to think about whether market or other circumstances are introducing a bias against SMEs which might warrant a policy response.

Climate security, low carbon energy and sustainable development – a strategic focal point for Nordic-China cooperation

To tackle global challenges, from shouldering global responsibility for climate and energy security to developing innovative and climate-friendly energy systems, has been a political agenda of the highest priority in Nordic co-operation since the Nordic prime ministers met in Punkaharju in 2007. In the meanwhile, climate and energy are also gaining increased strategic importance as a research and innovation agenda in individual Nordic countries as well as for the Nordic region as a whole. In the face of the global financial crisis, green economic recovery and green jobs are the key to revitalising the growth engine worldwide. Especially, the positive and rapid development in the climate and energy sectors brings about both new insights and innovative approaches to turn the triple challenges of climate, energy and economic security into green and low carbon growth opportunities. In such a context and in pure technical terms, the Nordic region has every opportunity to be a leading player. The advantageous Nordic position is supported by a strong industrial base, clusters of climate-friendly technologies such as renewable energy and energy efficiency, and a leading research area with uniformly high R&D intensities and innovation capacity among individual Nordic countries.

The current development in China and in Nordic countries – Common interests and complementary strength

At the National People's Congress (March 2009) the concept of "Green and low carbon Economy (LCE)" was discussed and endorsed as a basis for China's long-term sustainable development strategy.³ For Chinese policy makers, a low carbon economy implies a complex transformation of the overall economic system and structure. It is not only about energy saving, development of renewable energies and the cap-and-trade system. It includes fundamental changes in policy framework, economic structure and energy structure, as well as the development of low carbon technology and low carbon industries.

³ See http://www.chinadaily.com.cn/bizchina/2010-03/05/content_9542319.htm for details.

To build the foundation for a low carbon economy in China, R&D, innovation, commercialisation, and industrialisation of "green and low carbon technologies" are considered the key driving force. A highly coherent promoting framework with four keystones has rapidly emerged and is effectively supporting the development China's green and low carbon competitiveness.

Framework for China's Green and low carbon Transition



Investment in climate- and energy related R&D

In the 11th Five Year Plan, the 863 programme set up 10 focus areas, of which energy is one of the high priority. A total of 1.1 billion Yuan (approx. \$172 million) has been invested and the majority of the funding devoted to four top priorities: hydrogen, energy efficiency, clean-coal technology and renewable energy technologies.

863 Program's energy focus - 11th Five Year Plan		
Priorities	Funding (million Yuan)	
Hydrogen & fuel cell	75 million /year	
Energy efficiency	75 million /year	
Clean coal	45 million/year	
Renewable energy	29 million /year	

Source: Ministry of Science and Technology (2006)

Under the national basic research programme 973, energy, natural resource conservation and environmental protection have always been the core focus since its inception in 1997. From 1998 to 2008, the 973 programme funded 382 research projects with a total funding of 8.2 billion Yuan (approx. \$1.3 billion), of which 28% went to the above-mentioned focus areas (Ministry of Science and Technology, 2008, MOST-973 Programme News).

In an international comparison, the amount of public funding in these national programmes is by no means impressive; but it does provide a longterm and strategic signal to both the research community and the business sector. In comparison, in two major Asian economies Japan and South Korea, the government Energy R&D investment in 2008 alone reached \$3.9 and \$0.6 billion respectively while the US had invested \$4.3 billion. (Breakthrough Institute and The Information Technology and Innovation Foundation, 2009)

The policy makers in China are clearly aware of the need for increased financial resources for R&D and innovation as well as the leverage and stimulus effects that these measures can bring to the green and low carbon economic recovery in the face of the global financial crisis. It is hard to estimate how much of China's stimulus package in 2008 had been directed towards energy R&D, but there are clear signs that the Chinese government is making a concerted effort to boost R&D and innovations in some key technologies. Examples include the following:

- Renewable Energy Development Fund: The amendment to China's Renewable Energy Law (2005) has recently passed with a new fund to support renewable energy R&D. The fund would be financed partly by a small surcharge on electricity end user (RMB 0.004 per kWh in the end of 2009) and partly financed by the Ministry of Finance. According to the official estimates the fund would be able to generate around \$689 million in 2009 and \$1 billion in 2010, and part of the resources will be used to finance renewable development projects. This is not an insignificant amount compared to, with necessary PPP-adjustment, for instance the \$15–30 billion per year in federal clean energy R&D expenditure proposed by some energy experts in the US.
- Support for alternative fuel vehicles: To reduce China's dependence on exported oil, reduce urban pollution, and make Chinese automobile companies globally competitive the alternative fuel vehicles have become a strategic priority. In 2008, the Ministry of Science and Technology mandated that 10% of Chinese cars will run on alternative fuels by 2012 and called for 10 billion Yuan (US\$1.5 billion) in research subsidies over the next three years for research and development of alternative fuel vehicles. Furthermore, the Ministry of Finance announced a new commitment to promote alternative fuel vehicles in China's 13 largest cities in 2008. The mandate calls for public services to begin adopting alternative fuel vehicles in these cities and provides subsidies for the production and purchase of alternative fuel cell vehicles, including 50 000 Yuan per hybrid and 60 000 Yuan per fully-electric model produced by domestic car manufacturers. According to some industry forecasts, by 2012, China, Japan, and South Korea plan to produce 1.6 million hybrid gas-electric or electric vehicles annually compared to North America, which is projected to produce 267 000, less than a fifth of the number in Asia (see, e.g. Breakthrough Institute and The Information Technology and Innovation Foundation, 2009).

Low carbon innovation and investment in a globalisation context

In 2007 the Ministry of Science and Technology (MOST) and the National Development and Reform Commission (NDRC) jointly launched the International Science and Technology Cooperation Programme on New and Renewable Energy. The programme aims to diversify the sources of China's

technology imports and to accelerate the technology transfer process from international technology suppliers in five fields.

Priority fields for International Collaboration			
Technology	Details		
Integration of solar power generation and building integrated solar technology system	Solar and PV power generation system Thin-film Solar cells Building integrated solar, low-cost, low-pollution & high-quality silicon material production Solar thermal utilisation for in industrial application		
Biomass fuels & biomass power generation	Non-food energy crops & ethanol from cel- lulosic material Energy forestry Bio-diesel Biomass briquettes and biomass gasification Biomass power generation		
Wind power generation	Wind energy resources assessment Large high-efficiency wind turbine Off-shore turbine and wind farms		
Hydrogen & Fuel cell	Technology for production, storage and trans- port of hydrogen Technology for new types of fuel cells and fuel cell automobiles		
Natural gas hydrate	Technology for the exploration, development, storage, transportation and utilisation of gas hydrate		

Source: MOST and DNRC, 2007

It is interesting to observe the similarities between the priority fields listed above and the programmes under the Strategic Energy Technology (SET) Plan introduced by the EU Commission in 2007 as well as the Nordic Top-Level Research Initiative from 2008, which is the largest joint Nordic venture for promoting regional cooperation and stimulating science-industry linkages among Nordic countries. Similar to China, major EU member states especially Germany regards the LEC transition as a "new green industrial revolution". Nevertheless, the potentials for strategic synergies in the global transition to a LCE have not been fully explored in the European and the Nordic context. China, through its medium and long term development strategy and its engagement with the business sector, is actively developing the potential for developing low carbon technology and future engines of growth and competitiveness in the global market. In this process, foreign R&D centres in the climate and energy related sectors are the forerunners in taking advantage of the globalisation of low carbon technologies and investments.

Low carbon technology R&D activities undertaken by multinationals, domestic enterprises and R&D institutions of various sizes in China are gaining an increasingly solid ground, which will help to accelerate a low carbon transition in China. The direction of R&D development by multinationals is broadly in line with the international trend where huge investments are put into renewable energy and CO2 capture technology. The current foreign energy R&D facilities in China are dominated by the giants in energy- and new material related fields from the US, such as GE, Dow Chemicals, Applied Materials, DuPont, Honeywell and IBM, etc. Multinationals originated from the EU or the Nordic countries are relatively few, presented by ABB, Siemens and BP (Lundin/Ng, 2009).

Taking into account the principles of 'In China, For China' and 'LCE with Chinese characteristics', solar, wind, clean coal and integrated coal resource use have become the main focuses of future low carbon technology development in China. For these foreign R&D centres, the market size of China creates favourable conditions for the acceleration of R&D, small-scale testing, large-scale demonstration and real-life modelling of low carbon technology.

Two particular interesting observations that can be made are the integration of R&D centres in China with the global networks and the new mode of cooperation between Chinese research institutes and foreign multinationals. For instance, GE China Technology Centre (CTC) is one of GE's four (China, US, Germany and India) global R&D centres, which was opened in 2003. CTC is paying a close attention to the current development of CCS technology and Integrated Gasification Combined Cycle (IGCC) technology in China, and maintains close communication and interaction within its global R&D network and with GE's R&D centre in Germany in relation to low carbon and renewable energy technologies.

As the second example, China Academy of Sciences (CAS) is China's largest and most influential R&D institution. It owns more than 100 specialised research institutes, six of which carry out important energy technology R&D and are distributed throughout the country (Beijing, Shanxi, Dalian and Guangzhou). The new Shanghai Clean Energy Technology Development Centre is recently built in Zhangjiang Hi-Tech Park, and is CAS's first energy-related R&D centre in Shanghai, which will function as a 'bridge' between CAS and the business community. Since it inception, CAS has quickly entered into partnerships with multinationals such as BP, Shell, Samsung and GE. Its joint venture with BP, Shanghai Bi Ke Clean Energy Technology Co Ltd (CECC), is of particular interest. CECC is an innovative and multifunctional (technology, engineering, capital and market) business-R&D joint venture providing a commercial win-win model for international technology cooperation. It brings together the advantages of CAS and BP:

- The combination of 'coal conversion' technology R&D capacity (CAS) and the actual engineering and commercial application experiences (BP).
- The combination of actual investments in copyright and IPR (CAS) and international IPR management and operation (BP).
- The combination of technology and product R&D capacity (CAS) and market prediction and operation capacity (BP).

Green race and the "China-speed" – the achievement of China's Green and low carbon development strategic

In 2009, China led the world clean energy investment for the first time and became the second in the world for installed capacity of clean energy of 52.5 gigawatts, just behind the US, which had 53.4 gigawatts of capacity in 2009. This development is largely driven by the ambitious renewable energy targets. China is expected to generate between 15 to 18 percent of its electric-

ity from renewable sources by 2020; and Chinese officials have recently indicated this amount could reach 20 percent by 2020. It is important to note that, the dominating share in China's renewable energy is hydropower. A more justified measure is to look at renewable sources other than hydropower. China aims to increase the share of wind, solar and biomass energy to 8 percent of its electricity generation by 2020, compared to less than 4 percent currently in China and the US.

The installed renewable capacity in China (2009)

Installed clean Energy (2009)	
Total Renewable Energy Capacity	52.5 GW
Total Power Capacity	4%
Wind power generation	
Wind	30 000 MW
Biomass	2 880 MW
Solar PV	140 MW

Source: The Pew Charitable Trust (2010)

Medium-term renewable energy targets of Ch	nina (2020)
Key clean Energy Targets (2020)	
Wind	30 000 MW
Biomass	30 000 MW
Solar	1 800 MW

Source: The Pew Charitable Trust (2010)

In 2009, China spent a total of \$34.6 billion in clean energy, coupled with a rapid growth rate in the past years, while the US spent less than half as much, \$18.6 billion in 2009, and has a slower growth rate.

China is merging as the world's clean energy powerhouse with a strong manufacturing base, in particular in the solar and wind power sectors. It previously heavily targeted the export market, which has showed its vulnerability during the global financial crisis. Increasingly, the manufacturing base in China, including both Chinese and foreign producers, is shifting its focus towards domestic demand, which to a large extent is promoted by the mandatory renewable energy targets. Furthermore, China' biggest advantage may be its huge domestic demand for electricity, which has been rising 15 percent a year. To meet demand in the coming decade, according to statistics from the International Energy Agency (2009), China will need to add nearly nine times as much electricity generation capacity as the United States will. Chinese producers will continue to enjoy enormous efficiencies from largescale production.

Top 10 in Clean energy investment, 2009	
China	\$34.6 billion
United States	\$18.6 billion
United Kingdom	\$11.2 billion
Rest of EU-27	\$10.8 billion
Spain	\$10.4 billion
Brazil	\$7.4 billion
Germany	\$4.3 billion
Canada	\$3.3 billion
Italy	\$2.6 billion
India	\$2.3 billion

Source: The Pew Charitable Trust, 2010

Top 10 five- year growth in Clean energy inv	estment
Turkey	178%
Brazil	148%
China	148%
United Kingdom	127%
Italy	111%
United States	103%
France	98%
Indonesia	95%
Mexico	92%
Rest of EU-27	87%

Source: The Pew Charitable Trust, 2010

Smart grid - a new strategic green race

In addition to the large investments in renewable energy, smart grid has become another strategic field for investment. The Chinese government is investing heavily in smart grids to prepare for a twofold increase in national energy demand over the next decade. The State Grid Corporation of China, which provides power to 25 provinces in the country, is one of the utilities that invested in smart grid technologies. Last year, the utility ventured into a smart power grid programme which sought to boost flexible operations, effective energy transmission, power resource allocation, and renewable energy. According to some industry analysts, global investment in smart grid technologies will reach \$200 billion by 2015. China will overtake the US in smart grid investment in 2010 as it plans to roll out a \$7.32 billion investment plan, surpassing the latter's \$7.09 billion. This is followed quickly by both domestic and foreign stakeholders. For instance, according to IBM, the establishment of the E&U Solutions lab in China is the strategic move that IBM has made to respond to China's smart grid initiatives. The strategic collaboration between IBM and China to develop utility solutions that meet the unique energy demands in China targets both the power sector in China and the global market. Furthermore, GE, together with local partners, has started to plan for a smart-grid demonstration centre in Jiangsu Province that will work on improving the reliability and efficiency of the national grid. Other industry leaders such as Cisco, Accenture, Hewlett-Packard, ABB, Westinghouse and Oracle also plan to take a piece of China's smart grid market through similar projects in the near future.

Global Pressure

- Nordic Solutions?

An emerging key player as patent owner of energy technologies

Driven by the ambitious domestic policy and intensified competition in both the domestic and international market, and with active participation of both domestic and foreign stakeholders, there is a "return" of the policy- and market-driven innovation capacity building in China in the form of patent outputs in the energy sector.



Source: Chatham House (2009), pp 15.

In a recent study conducted by Chatham House (2009) based, the patterns of patent ownership and market adoptions in six energy technology sectors were investigated, namely wind, solar PV, concentrated solar power (CSP), biomass-to-electricity, clean coal and carbon capture. Across these six sectors, except carbon capture, China stands out as the only exception from non-OECD countries and is ranked fourth among the top 10 locations of patent assignees or ownerships. This is a clear indication of the technological and innovation capacity in China as a location for patent ownerships. However, when comparing the geographical location of the parent company of patent owners with more than four patents, China has a much lower share. This suggests that most of the patents filed in China are from Chinese subsidiaries of MNCs.



Source: Chatham House (2009), pp 15.

This raises a further question of what reasons lie behind this, or more explicitly, to what extent the pattern is market-driven and/ or attracted by the local innovation environment and infrastructure. Having this question in mind, a comparison of patent-filing destination may provide some indication of commercial and innovative attractiveness of different destinations. Despite the growth of China as an emerging market for low carbon energy and technologies, most patents are still concentrated in a few OECD countries. However, wind technology in China is a clear exception. Another interesting observation is that, in wind, CSP and clean coal sectors, the European Patent Office (EPO), which is one of the key patent filing locations, has less filings than China – which can be an indication for the growing importance of China as a market base for both Chinese and multinational producers in the technology sectors.



Source: Chatham House (2009), pp 16.

A Nordic-China cooperation perspective

Faced with the need to strengthen national competitiveness as well as to keep pace with the rapid development beyond the Nordic border, important initiatives have been taken in the fields of climate, energy, research and innovation in individual Nordic countries, in terms of both domestic actions and international cooperation.

In relation to research and innovation, there are increased interests and concrete efforts to take joint regional actions to address global challenges and to spearhead the leading Nordic position as an energy-efficient, climate-friendly and innovative region. As a result, Nordic cooperation has evolved considerably (Remoe, 2009). However, regarding regional cooperation with emerging economies such as China, the progress of creating a "knowledge-based approach to a Nordic Globalisation Initiative" has been less impressive. There is a significant diversity in the degree to which national programmes are open for participations from China and in the strategic sophistication of the collaboration with China (with Denmark and Norway as Nordic forerunners). Overall, international cooperation between the Nordic region and China is at a very early stage. The only targeted instrument at the regional level is the Asia NORIA-Net project, established in 2008 and running for two years of 2008–2009.

Built on the existing "institutionalised programmes" within the Nordic cooperation, there is a clear potential and possibility to enhance the "Nordic-China" dimension at the institutional level to combine the bottom-up research with more strategically directed initiatives. This will be a strategic and proactive move to achieve a strong impact and visibility of the Nordic region in the global R&D and innovation landscape.

Despite of the need for improvement in research and innovation agenda- and institutional setting, there are indeed great potentials for a more strategic and pragmatic Nordic-China cooperation in the fields of energy and climate changes. These potentials are motivated by common interests and the unique Nordic strengths, which can be best exemplified in the following two energy technology sectors.

Offshore wind is one of the most important energy sectors for Nordic countries, in particular in Norway and Denmark, which has developed the whole cluster of technologies along the production chain. The potential of off-shore wind resources as well as the recent take-off of the offshore wind market in China provide great business opportunities for Nordic players. The key Nordic player Vestas is responding to the rapid growth of China's market by building big, state-of-the-art factories in China. Vestas of Denmark has just erected the world's biggest wind turbine manufacturing complex in China, and has also introduced the new V60–850 kW wind turbine. In the case of Norway, new Centres of Excellence for Offshore Wind Energy (NOR-COWE, NOWITECH) have been set up, which aim at attracting research excellence and industrial players. Nevertheless, for small Nordic countries, the common barriers are also apparent, such as the limited domestic installed capacity, lack of domestic turbine manufactures and, not least the shortage of energisers.



Source: Azure International, 2010

The *smart grid* market in China is getting increasingly crowded, and larger players from both the US and other large EU Member States are making great stride in becoming "first-movers" in the Chinese market. However, despite intensive competition, Nordic countries have indeed unique advantages as leading technology suppliers as well as creator of future innovative solutions, derived from their huge experience in decentralised and combined heating and power generation. As forerunners in this area, smart grid is not only a "grid management issue" for Nordic countries, but also innovative solutions combined both advanced energy technologies and IT and communication technologies. The Nordic regional cooperation on smart grid (including Nordic countries and Germany) and the integration of smart grid with the transport system will become its future competitive edge in the global green race.

Denmark has already moved one step ahead by introducing a comprehensive Smart Grid Programme in China. This programme includes Danish participants from the Danish government (policy and regulations), universities and institutes (R&D), and industry (technology, equipments and software), and their counterparts from the Chinese side. By creating this platform for knowledge sharing and cooperation on research and development between Denmark and China, Chinese stakeholders will gain a better understanding of the smart grid frontier in Denmark. From the Chinese perspective, such experience and best practices are of great value to overcome its bottleneck of accepting and transmitting electricity generated from renewable sources, and provide useful guidance to the Chinese government and State Grid companies as they invest heavily in upgrading the national grid into smart grid. Although Denmark serves as a great show case in smart grid technology and deployment of renewable energy, setting up a smart grid will be more challenging and complicated in China as it is a much larger country and electricity has to be transmitted over longer distances. Consequently, knowledge

sharing, R&D cooperation and solution implementation by innovators and developers from Denmark and other Nordic countries will create not only business but also mutual learning opportunity.

Conclusions and policy recommendations Rising tigers...

China's development is part of a fundamental change currently transforming the global distribution of knowledge resources and the global innovation landscape. Overall, China's development is symptomatic of a shift in the global distribution of knowledge resources towards.

In the new knowledge and innovation landscape state-of-the-art technology and world-class scientists are no longer the prerogative of the triad of Europe, North America and Japan. Countries, which in many aspects might still be considered developing countries are claiming increasing shares not only of world trade, manufacturing and raw material consumption but also of global knowledge resources, both when it comes to highly skilled labour and to corporate R&D. In the fields of low carbon and energy technologies and innovation, which are the driving force for the global economic recovery and the sources of green growth opportunities, China has already become a powerhouse. The progress in this ongoing low carbon transformation is a result of a targeted and efficient combination of smart policy, strong manufacturing base, and not least demand-driven innovation and leapfrog technology opportunities.

Even if the country still faces challenges in becoming a world leader in science and innovation, China offers significant opportunities for mutually beneficial research and innovation cooperation and trade of knowledgeintensive goods and services. China's opening to the world, the government's prioritization of science, education and innovation and its recent new sustainable development strategy towards a low carbon economy, provide important opportunities and vehicles for establishing cooperation on issues of global relevance. As a matter of fact, the solutions to the grand challenges we face today, in particular in the field of energy, climate and environment –have to be solved together with countries such as China and India. In other words, instead of "burden-sharing" and "differentiated responsibility", there are great potentials for strategic partnership and win-win growth opportunities

... Nordic reactions and actions?

China's emergence as a magnet for, and increasingly also a source of, frontier-level science, high technology and investments in climate-friendly and energy technologies puts demands on other countries and regions to formulate strategies on how to relate to it and other emerging giants within international cooperation on research, innovation and climate change. In order to be able to design constructive and appropriate strategies for how to respond to the developments we are witnessing in China, and a number of other transition economies, we need a better understanding, both in the public and private sector, of modern-day China, its politics, economics and culture. Currently, Europe and the Nordic countries have a shortage of such expertise, in academia and in policymaking, both on a national and supranational level, particularly when compared, for example, with the United States. The Nordic countries need to decide how they intend to benefit, or avoid not benefiting, from China's science and technology development.

A paradox we can observe is that the "low-ambition coalition" between China and the US at the climate negotiation table is actually producing the most dynamic and strategic R&D and innovation cooperation on the ground in China at the moment. This is in stark contrast to the absence of more strategic cooperation between China and "the leader of leaders" from Nordic counties or the EU in the real R&D and innovation landscape on the ground. The EU (including Nordic countries) were sidelined at the climate negotiation table in Copenhagen; the risk of it being sidelined again in the global "green race" is high if it does not put its act together and take proactive steps.

With ambitions to be a "green valley of Europe" and to point the way forward as "leader of leaders" in the European context in the fields of both innovation and climate change, the Nordic region will need a refined political narrative and a proactive and integrated approach in its future cooperation with China. This is of great strategic importance for a more successful global deal on climate, hopefully, in the near future. At the same time, it is equally decisive for the overall competitiveness of the Nordic countries in an international context – not only within the EU, but also in the face of both intensified competition and increased collaboration opportunities from fastgrowing countries like China.

...Nordic-China cooperation requires trust and more informed policy dialogue

It is important to bear in mind that as a highly strategic political and global issue, R&D and innovation collaboration on climate and energy must have a solid foundation built on mutual understanding, trust and willingness to cooperate. CCS is the most demonstrative example that the barriers to international cooperation on climate change can sometimes be more economic and political than technical. The key issue is to engage China and engage with China in a constructive way to bridge the division between China's ambitious domestic low carbon actions and its defensive reactions in the international climate change negotiation. This requires both a systematic trust-building mechanism and a better informed policy dialogue between the Nordic countries and China.

Even though the lack of trust has been recognised as the key stumbling block, cooperation in research and innovation as a tool and mechanism for trust-building between the North and the South in the fields of climate change and energy has so far been underestimated and underutilised. Trust built on a long-term and close interaction is more solid and sustainable than the fragile and volatile "closed-door climate diplomacy". Trust and cooperative capacity built through R&D cooperation will enable the North and the South to not only create new technologies and solutions together but also identify and create mechanisms to diffuse and scale-up the use of these solutions at a global scale. The latter is actually the most prominent barrier in the global efforts of combating climate change.

Policy recommendation on creating a Nordic-China cooperation strategy

Facing both intensified competition and increased collaborative opportunities in China, Nordic countries need both new strategic thinking and innovative approaches in the current and future Nordic-China cooperation. This need rest on the synergies of the Nordic-China cooperation in three equally important and deeply interrelated areas, namely: R&D and innovation, manufacturing, and domestic and global market demand.

- The institutional and policy landscape in China in key strategic areas, such as research, innovation, climate change and energy is fast-changing and complex. There are evident communication gaps between the policy community in Nordic countries and the relevant Chinese government agencies. More institutional capacity and human resources from the Nordic side need to be devoted to facilitate a more informed Nordic-China policy dialogue.
- The Nordic countries are compared to other European countries wellpositioned to cooperate with China on research. Nordic multinationals are highly present in China (R&D centres). Europe as a whole lags behind North America when it comes to research cooperation with the best Chinese academic institutions.
- Nordic countries and actors should develop strategies for cooperation in science, technology and innovation with China. This would also allow them to realize more synergies and strengthen effective coordination of Nordic initiatives with China in research, innovation, climate and energy.
- Nordic countries should seek to strengthen human capital mobility and research and innovation cooperation between the Nordic countries and China; In particular, the Nordic countries should undertake initiatives to make the Nordic countries a more attractive destination for the best Chinese human capital (incl students)
- The solid research and innovation position as well as the strong political commitment and credibility provide a unique and strategic foundation for cooperation between the Nordic region and China (and also other emerging economies in the BASIC-block) in the fields of climate change and energy. However, several factors identified in this report prevent the Nordic countries from realizing their potential in this area.
- What is necessary is not only a "global carbon-trading system" and a "global climate deal", but also a "global innovation strategy"– built on common interests and the need for climate and energy security, rather than on a national innovation system driven by national competitiveness. In other words, when pursuing a "Global Green New Deal" a Global Innovation System for green and low carbon innovations is needed.
- There is a need to systemise bilateral collaboration policy framework, which combines the "top-down" policy dialogue on climate change and/or science and technology with "bottom-up" activities. This will engage local stakeholders in the R&D and innovation communities and enterprises in

a more efficient manner in order to create a science-industry linkage and business opportunities with clear objectives and targets.

 While Nordic multinationals are generally well established in China, Nordic SMEs face considerable challenges in establishing a successful presence in, and linkages with China. Often they lack competencies, resources (money and networks) and even the right products to succeed in China. With SMEs dominant particularly in the Nordic energy technologies sector, strong institutional capacity to build up networks and platforms is crucial. This requires engaging key government agencies from various ministries and building up private-public partnership in a coordinated way for a long-term strategic Nordic-Chinese cooperation.

3.4 Overall assessment

This year's edition of the Nordic Globalization Barometer takes a closer look at the robustness of corporate R&D in the Nordic countries. While previous Barometer's and the 2009 Nordic Innovation Monitor have looked at the overall profile of innovative capacity across the Nordics, none of them has specifically taken the company perspective.

The **corporate R&D activity** in the Nordics is high and one of the key drivers of the region's strong innovation position relative to global peers. Companies in the Nordic countries are relatively R&D intensive, to a large degree driven by the nature of the industries they are in. Given the size of the Nordic economies, the absolute size of R&D spending in the region is modest on a global scale. The spending and patenting activity of the Nordic business sector is more skewed towards a few companies than in other economies.

The strong position of Nordic countries in several **international rankings of innovative capacity** is largely a reflection of the Nordic countries strong overall competitiveness as measured in chapter 2 of the Barometer. The Nordics are strong on fundamental inputs into the innovation system but often not able to take full advantage of these inputs. In particular, the innovation system works well in its traditional focus on science outcomes and large company R&D activity (spending, patenting) but much poorer on high-growth entrepreneurship of innovation-driven companies.

There are significant differences across the Nordic countries in terms of innovative capacity and relatively limited evidence of cross-Nordic R&D activity.

Across the globe, **academic research** has found corporate R&D activity to be traditionally located at a company's home base. Over the last few decades, there has been a significant degree of dispersion R&D activities, driven largely by MNCs. Market access, skill availability, local R&D, and the presence of dynamic clusters have been identified as the key determinants of companies' R&D localization decisions.

Interviews with executives of a number of leading Nordic corporate R&D spenders put this general research into the context of the Nordic reality. The

behavior of the Nordic MNCs follows largely the patterns identified for their global peers. Their research activities are disproportionally located in the Nordics. While there is in most cases no immediate threat to these activities, the long-term trends clearly see their relative role decreasing; this might even culminate in an absolute reduction of research activity in the Nordics. In industries where development rather than research dominates - often industries with lower overall R&D intenisty-, this process has already gone much further than for the most R&D intensive companies. The Nordics key advantages - and the reasons for the strong current level of corporate R&D activities - are the availability of skilled human capital at competitive costs, the sophistication of local demand, and the presence of dynamic clusters of specizalized research and educa-tional institutions as well as related companies. But many of these advantages are eroding, either because of a lack of progress in the Nordics (skills) or because of broader changes in market needs (new technologies, demand) and innovation processes (new cluster structures). The key challenge is whether the Nordics are able to take decisions at the country and regional level quickly enough to enhance their ability to take advantage of these trends in the global economy that are a given.

The above-mentioned sense of urgency is reinforced by the dramatic increase in innovative capacities we are witnessing in countries such as **China** and India. China's growing attractiveness as a destination of foreign corporate R&D activities, and, among other things, its massive investments in green energy and climate-friendly technologies are increasing pressure on Nordic countries to take action to ensure continued high innovative capacities and to reinforce their key advantages. Such action is vital to maintain the Nordics' position as key partners and actors in global innovation processes and to strengthen their attractiveness to globally mobile knowledge and innovation resources (human capital, corporate R&D activities, etc). Furthermore, the emergence of new innovation hubs in countries such as China, puts demands on Nordic actors (firms, universities, regions and countries) to formulate strategies and develop new competencies in how to compete and cooperate with China.

The solid research and innovation position as well as the strong political commitment and credibility provide a unique and strategic foundation for cooperation between the Nordic region and China (and also other emerging economies in the BASIC-block⁴) in the fields of climate change and energy. However, as Chapter 3 has shown, several factors currently prevent the Nordic countries from assuming a role as a strategic partner and serious competitor for China – and thus in the global arena – in the field of clean energy and environmental technology.

⁴ BASIC-block is a coalition of non Annex-1 countries formed during the Climate Summit in December 2009 in Copenhagen, which includes Brazil, South Africa, India and China.

Chapter 4.

Conclusions

About 1 ¹/₂ years ago the global financial and economic crisis had its cataclysmic moment in the Lehman Brothers bankruptcy. After going through a deep downturn, countries in many parts of the world are now facing a difficult transition from crisis response to enabling sustainable growth while exiting from emergency measures.

The Nordic countries are in this situation as well. As highly open economies, they were disproportionally vulnerable to the global shock. As highly competitive economies, they were also better prepared to deal with it. Unemployment and government deficits have shot up during the crisis. But the situation is still better than for many peers, especially in Continental Europe. The policy response has been strong, on both fiscal and monetary policy. Given the still challenging conditions in the global economy, the post-crisis resurgence of growth in the Nordics has been surprisingly strong. Policy makers in the region now face a difficult short term challenge in finding an exit strategy from the aggressive fiscal and monetary policy responses to the crisis while avoiding any sudden cooling of economic activities and sentiments.

Growth is a necessary condition for regaining economic balance without suffering a dramatic loss of prosperity. And for this growth to be sustainable in the long term, it will need to be based on high levels of global competitiveness. This is why the analysis of the Nordic Globalization Barometer is highly topical.

4.1 Key findings

The data presented in this Barometer shows the full impact of the crisis on the **economic performance** of the Nordic countries. The drop in economic activity as a consequence of collapsing world trade and tightening financial conditions have had a significant impact on GDP and GDP per capita. Given the labour market institutions in the Nordic countries, this drop in output has been achieved by a combination of lower productivity and lower labour input. This puts the Nordic region somewhere between Continental Europe, where productivity took the brunt of the adjustment, and North America, where labour input was dramatically reduced. Both the length of the crisis and its impact on structural change will determine which of these three approaches will turn out to be the most appropriate.

The **competitiveness** of the Nordic continues to be strong overall and can sustain the current level of economic performance. While the data on competitiveness was collected in the midst of the crisis, there is no sign of any drop in the Nordic region's strong overall position. In some areas, other countries turned out to be less robust under the onslaught of the crisis, leading to relative improvements for the Nordics. But this has not removed any of the longer-term competitiveness challenges already identified in previous Barometers: The eroding performance on science skills and patenting, two traditional strengths of the Nordic countries, remains a serious concern. The economic cost of current taxation patterns and some other administrative barriers remain stubbornly high. The indicators of **globalization readiness** are dramatically affected by the global crisis. The Nordics remain well integrated in the global economy, through both trade and investment flows. But on trade, for which 2009 data is available, the region has suffered disproportionally. While it is too early to know for sure, this loss of position is at least consistent with a rise of Asia accelerated by the crisis. The FDI data, available only up to 2008, provides a picture of economies turning towards domestic sources of growth and struggling to remain attractive for foreign investors. The Nordics' position on flexibility, severely tested during the crisis, remains mixed. Exit is relatively easy. And the outcomes indicate that labour markets are more flexible in a deep crisis than the international comparisons suggest. But entry continues to be stifled by bureaucracy that falls increasingly behind the global standard.

The intensity of **corporate R&D** in the Nordics is high, both from domestic and from foreign-owned companies. This level of activity is consistent with the leading position of the Nordic countries in a whole battery of international rankings covering different measures of overall R&D activity and the quality of framework conditions. But the high R&D intensity seems largely a reflection of the industrial composition of the Nordic economies, not so much of Nordic companies being R&D leaders in their respective markets. And there are a number of threats to the robustness of this position: R&D spending is highly dominated by a small number of Nordic MNCs, for which the local market plays an increasingly limited role. The absolute level of corporate R&D spending in the Nordics is modest, in line with the size of the Nordic economies but still a concern for R&D activities that require high scale or are otherwise subject to economies of scale.

The **outlook** for the Nordic countries as a location for corporate R&D activities is mixed. The region continues to have a number of important assets that support a high level of private sector R&D activity: access to competent and affordable human capital, sophisticated demand, and dynamic clusters of specialized companies and universities. But again there are a number of challenges: On skill availability, rising supply in other locations, especially countries like China and India, and growing shortages at home are slowly eroding the traditional advantage of the Nordics. On clusters, changing demands of innovation processes driven by entrepreneurial high-growth small- and medium-sized companies (SMEs) are not well aligned with an innovation system that has grown around a small number of MNCs. And the convergence of technologies could reduce the advantages the Nordic countries have in their current portfolio of technological expertise and reinforcing clusters around and within IT, telecommunications, and industrial machinery/automotive. While the legacy effect of the installed base reduces the risk of dramatic short-term changes unlikely, the long term threats are obvious. There are signs that the more gradual migration of strategic research activities from the Nordics to other parts of the world, North America but increasingly also Asia, has already started. And in less research-intensive industries often not so visible in the public debate, this process has been long under way.

The **Chinese case** puts the challenges that the Nordics are facing on innovative capacity in dramatic focus. China's growing attractiveness as a destination of foreign corporate R&D activities, and, among other things, its massive investments in green energy and climate-friendly technologies are increasing pressure on Nordic countries to take action to ensure continued high innovative capacities and to reinforce their key advantages. However, several factors currently prevent the Nordic countries from assuming a role as a strategic partner and serious competitor for China – and thus in the global arena – in the field of clean energy and environmental technology.

4.2 Key policy implications

The Nordic Globalization Barometer aims to identify policy areas important for the future success of the Nordic region in which collabouration on the Nordic level can make a significant difference.

The analysis of **global competitiveness** has shown that he Nordic region cannot rest on its laurels. The global crisis has

- In the short term, the Nordic countries share the macroeconomic challenge of gradually reducing the emergency measures introduced throughout 2009. They all face this task despite the differences in current macroeconomic conditions and the macroeconomic policy architecture, especially on monetary policy. Both too slow and too fast exit from the emergency measures has the potential to undermine growth. Strong *Nordic coordination* on the timing and communication of key macroeconomic policy steps could help stabilize expectations and make it easier to stay on a sustainable growth path.
- In the medium term, the Nordic countries continue to face the *structural challenges* identified in some detail in the previous two Barometers. Some of the region's traditional strengths in education and the innovation system are eroding or under threat; the analysis of corporate R&D activities in this year's Barometer leads to some more concrete recommendations in these areas below. Some of the traditional weaknesses in low incentives, a lack of sufficiently effective domestic rivalry in some markets, and barriers for high-growth entrepreneurship, are increasingly costly. The most powerful tool at the Nordic level to address these issues is *market integration*, followed by policy learning in the several areas in which national policies have to change.
- In the long term, the Nordic countries are facing a discussion on how to manage the *structural policy imbalance* between high exposure to global shocks but low influence on the decisions about the policy and regulatory context in which these shocks emerge and are being managed. In the regulation of the financial sector, Sweden moved ahead with a stability fund financed through a levy on banks. But is still unclear, how other countries with strong financial sectors will act. In the management of fiscal policy, Finland has been part of the package put together for Greece. But the decisions were taken in Berlin and Paris. There is no easy way for a group of relatively small economies to gain influence on issues that significantly matter for them. But coordinating action is a way to start; the Norwegian initiative for a Nordic membership in the G20 is an effort that deserves to be build on.

The analysis of **corporate R&D activities** puts some of the competitive challenges facing the Nordics into clear focus. It highlights the need for policy action to develop rather than squander the solid current position. Actions are needed both on competitiveness and on globalization readiness:

- A workforce of *highly skilled employees* is the bedrock of Nordic competitiveness and a key reason for the high level of R&D intensity in the region. If there is one critical issue that the Nordics need to get right, it is this one. While there is wide agreement on this in rhetoric, the data suggests that the outcomes differ significantly across the Nordics, especially at the level of secondary education.
- Conditions that actively enable the evolution of *dynamic clusters* are important for small economies that lack size and market pull, especially in the area of innovation. The Nordics have a number of such clusters with specialized research institutions and strong anchor companies, and an increasing number of policy programs that aim to facilitate stronger collaboration. While these efforts make clusters more effective, they don't change their profile to include more high-growth entrepreneurial SMEs. And this is the type of change that is required to align Nordic clusters with the realities of modern innovation processes. The Nordic level can be a forum for policy learning about the necessary changes in taxation, administrative procedures, and incentives/organizational structures in research institutions. And a fully integrated Nordic market is, as has been discussed in previous editions of the Barometer, also a powerful driver for more entrepreneurship.
- The attraction of *foreign skills* and *foreign companies* is increasingly critical to retain and develop the position of the Nordics as a basis for corporate R&D. On both aspects, the modest absolute size of individual Nordic countries creates significant opportunities to do better through Nordic collaboration. Joint marketing of the region is one step, and is fully compatible with competition among the Nordic countries and regions later on. Joint efforts to increase the attractiveness of the region is another, for example by offering Nordic educational or research programs that foreign students and companies in the region can benefit from. And there are a number of issues, for example the taxation of foreign experts or the rules and programs to retain foreign students after their studies, in which Nordic dialogue could significantly improve the quality of policies at the national level.
- While the local *demand sophistication* continues to be high, determined action is required to keep it that way. And there needs to be a clear strategy, involving government, to ensure that the advanced Nordic demand informs or even drives international regulations and standards.
- More effective *innovation linkages between the Nordic countries and China* require the creation of a strategic dialogue between the relevant policy communities on both sides. The Nordics are well positioned through their MNCs, and their research capabilities, especially in environmental technologies. But to succeed in China in the long-term, more is required than efforts at the level of individual companies or even countries.

Global Pressure

An increasing number of countries around the world are trying to identify action lists much as the one above. This is a critical first step for achieving and sustaining high levels of global competitiveness. But it is not sufficient. The countries that really stand out in their ability to upgrade competitiveness are the ones that have the ability to move from analysis to action.

The Nordic countries have strong institutions and a public sector that is often credited with solid performance. This puts the region in a good position to also be a global leader in managing the link between analysis and action. But this process is not automatic, as the Nordic Globalization Barometers of the past three years attest. Three years may not be a long time to make significant progress on key competitiveness issues, especially when a global crisis intervenes. But it is still striking how similar the list of existing challenges has remained over this period. The world is changing at an ever more rapid pace. The current crisis has created new opportunities for changes that would otherwise take decades to happen in years or even months. Only countries that are able to adjust their decision making routines to this new reality, enabling fast fact-driven action, will be able to succeed in global competition.

One last recommendation is therefor to address this issue head-on, and use the Nordic Globalization Forum not only as a platform to discuss what needs to be done but also how it can be put into practice. This is not only a technical or organizational question, but also a political one. Denmark with its Globalization Council and Finland with its Science and Technology Council, both over time reformed, are internationally studied as interesting examples of managing the 'how'. Why not make this experience a topic for Nordic discussion as well. Global Pressure

- Nordic Solutions?

References and further reading

- Academic Ranking of World Universities ARWU (2009), Data available at http://www.arwu.org/index.jsp
- Alcacer, Juan, Minyuan Zhao (2010), Local R&D Strategies and Multi-Location Firms: The Role of Internal Linkages, Harvard Business School Strategy Unit Working Paper No. 10-064, Harvard Business School: Boston.
- Ark, Bart Van, Sean M. Dougherty, Robert Inklaar (2008), The structure and location of business R&D: recent trends and measurement implications, International Journal of Foresight and Innovation Policy, Vol. 4, No.1/2, pages 8 – 29.

Azure International (2010), "China, Norway and Offshore Wind Development", presentation at Offshore Wind China 2010, March 15.

Barthelt, H., Malmberg, A. and Maskell, P. (2004) 'Clusters and knowledge: Local buzz, global pipelines, and the process of knowledge creation', Progress in Human Geography, 28, 31-56.

Battelle (2009), 2010 Global R&D Funding Forecast, Battelle: Columbus.

Bloch, Carsten, Peter S. Mortensen, Frank Foyn, Oyvind Formeland Salte (2008), Chapter 9: Innovation Indicators for globalization and the role of multinationals, nind Policy Relevant Nordic Innovation Indicators, Nordic Innovation Centre: Oslo.

Boston Consulting Group/National Association of Manufacturers/The Manufacturing Institute (2010), The Innovation Imperative in Manufacturing, BCG: Boston.

Breakthrough Institute and Information Technology and Innovation Foundation (2009), "Rising Tigers, Sleeping Giant: Asian Nations Set to Dominate the Clean Energy Race by Out-Investing the United States". 2009.

Cantwell, John, Lucia Piscitello (2005), Recent Location of Foreign-owned Research and Development Activities by Large Multinational Corporations in the European Regions: The Role of Spillovers and Externalities, Regional Studies, Vol. 39, Issue 1, pages 1–16.

Chinaview (2007), "Number of Chinese students abroad exceeds one million", February 27.

Commission on the Measurement of Economic Performance and Social Progress CMEPSP (2009), Report on the Measurement of Economic Performance and Social Progress, CMEPSP: Paris.

Danish Government (2009), Denmark's National Reform Program: First Progress Report, The Danish Government: Copenhagen.

Erken, Hugo, Marcel Kleijn (2010), Location factors of international R&D activities: an econometric approach , Economics of Innovation and New Technology, Vol. 19, Issue 3 April 2010 , pages 203–232.

European Cluster Observatory (2010), Cluster mapping database, data available online at www.clusterobservatory.eu

European Commission (2010a), Recommendation for a council opinion on the updated convergence programme of Sweden, 2009–2015, SEC (2010) 295, European Commission: Brussels.

European Commission (2010b), Recommendation for a council opinion on the updated convergence programme of Finland, 2009–2015, SEC (2010) 298, European Commission: Brussels.

- **European Commission** (2010c), Recommendation for a council opinion on the updated convergence programme of Denmark, 2009–2015, SEC (2010) 350, European Commission: Brussels.
- **European Commission DG Enterprise** (2010), European Innovation Scoreboard 2009, PRO INNO Europe Paper No. 15, European Commission: Brussels.
- **European Commission DG Economic and Financial Affairs** (2010), ESI/ BCI Update 29 March 2010, European Commission: Brussels.
- European Commission Joint Research Centre (2009), The 2009 EU Industrial R&D Investment Scoreboard, European Commission: Brussels, data available online at http://iri.jrc.ec.europa.eu/research/scoreboard_2009.htm
- European Commission Joint Research Centre (2008), The 2008 Survey on R&D Business Investment Trends, European Commission: Brussels European Commission (2009), Interim Forecast Autumn 2009, European Commission: Brussels
- **Eurostat** (2010), Structural Indicator Database, Eurostat: Luxembourg. Data available at http://epp.eurostat.ec.europa.eu/portal/page/portal/structural_indicators/introduction
- Farrell, Diana and A. J. Grant (2005), "China's Looming Talent Shortage," The McKinsey Quarterly, 2005:4, pp. 70–79
- **Finnish Ministry of Finance** (2009), The Lisbon Strategy for Growth and Jobs 2008 – 2010: Finland National Reform Program – Implementation Report 2009, 36c/2009, Ministry of Finance: Helsinki.
- Friberg, Daniel (2006), National Innovation Systems and Domestic Multinationals, Nordic Council of Ministers: Copenhagen.
- Furman, J. L. M. E. Porter, and S. Stern (2002). "The Determinants of National Innovative Capacity," Research Policy, Vol. 31, pages 899–933.
- **FORA** (2009), The Nordic Innovation Monitor 2009, ANP: 2009:721, Nordic Council of Ministers: Copenhagen.
- **Gassmann**, Oliver and Zheng Han (2004) "Motivations and Barriers of Foreign R&D Activities in China," R&D Management, Vol. 34, No. 4, pp. 423–237.
- **Gylfason**, Thorvaldur, Bengt Holmström, Sixten Korkman, Hans Tson Söderström, and Vesa Vihriälä (2010), Nordics in Global Crisis, The Research Institute of the Finnish Economy (ETLA), Helsinki, Finland.
- **Holmes**, Kim R., Edwin J. Feulner, and Mari Anastasia O'Grady (2010), 2010 Index of Economic Freedom, The Heritage Foundation: Washington, D.C. Data available online at http://www.heritage.org/Index/
- **HSBC Bank** (2009)"A Climate for Recovery The colour of stimulus goes green", 2009.
- Huggins, Robert, Hiro Izushi, Will Davies, Lou Shougui (2008), World Knowledge Competitiveness Index 2008, Centre for International Competitiveness: Cardiff.
- Håkanson, Lars, Udo Zander (2007), International management of R&D: The Swedish Experience, R&D Management, Vol. 18, Issue 3, pages 217 – 226.
- **International Monetary Fund** (2010), IMF Country Report 10/24: Norway, IMF: Washington, D.C.
- Johansson, Börje, Hans Lööf (2006), Global Location Patterns of R&D Investments, CESIS Paper No. 60, KTH: Stockholm.

Jones, Gary K., Hildy J. Teegen (2003), Factors affecting foreign R&D location decisions: management and host policy implications, International Journal of Technology Management, Vol. 25, No.8, pages 791–813.

International Energy Agency (2009)" World Energy Outlook 2009".

INSEAD/CII (2010), Global Innovation Index 2010, INSEAD/CII: Paris. Data available at http://www.gii.networkedreadiness.com/main/analysis/

Kaufman, Daniel, Aart Kraay, and Massimo Mastruzzi (2009), Governance Matters VIII: Aggregate and Indivudal Governance Indicators 1996 – 2008, World Bank Policy Research Paper No. 4978, World Bank: Washington, D.C.

Kennedy, Scott (2006), "The Political Economy of Standards Coalitions: Explaining China's Involvement in High-Tech Standards Wars", in Asia Policy, July, pp.41–62

Ketels, Christian (2007), State of the Region Report 2007: The Baltic Sea Region as a Place to Do Business, Baltic Development Forum: Copenhagen.

Ketels, Christian (2008), The Nordic Globalization Barometer 2008: Global Pressure – Nordic Solutions?, ANP2008:277, Nordic Council of Ministers: Copenhagen.

Kuemmerle, Walter (1999), The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation, Vo. 30, No. 1, pages 1 – 24.

Kwan, Chi Hung (2006), "Who Owns China's State-Owned Enterprises? Toward Establishment of Effective Corporate Governance", China in Transition, RIETI, July 28.

Legatum Institute (2009), The 2009 Legatum Prosperity Index, Legatum Institute: London.

Lee, B., I. Iliev and F. Preston (2009), "Who Owns Our low carbon Future? Intellectual Property and Energy Technologies." Chatham House, 2009.

Lundin, Nannan and Shinwei Ng (2009), "Feasibility Study on EU-China low carbon Technology and Investment Demonstration Zones" E3G, 2009.

Mathieu A. and B. van Pottelsberghe de la Potterie (2008), A note on the drivers of R&D intensity, CEPR Discussion Paper 6684, CEPR: Brussels.

MOST (Ministry of Science and Technology) (2006), "National High-Tech Science and Technology Research and Development Program".

Norwegian Ministry of Foreign Affairs (2009), Call for Nordic Membership in the G20, Ministry of Foreign Affairs: Oslo.

OECD (2010a), Economic Policy Reforms: Going for Growth 2010, OECD: Paris.

OECD (2010b), Economic Survey of Norway, OECD: Paris.

OECD (2010c), Economic Survey of Finland, OECD: Paris.

OECD (2009a), OECD Science, Technology and Industry Outlook 2009, OECD: Paris, data available at http://www.oecdilibrary.org/content/book/ sti_scoreboard-2009-en

OECD (2009b), Economic Survey of Denmark, OECD: Paris.

Porter, Michael, Mercedes Delgado, Christian Ketels, Scott Stern (2008), Towards a New Global Competitiveness Index, Global Competitiveness Report 2008, World Economic Forum: Geneva.

Remoe, Svend Otto (2009), "Nordic cooperation and an open European Research Area: Lessons for international cooperation in Science and Technology", DG Research, European Commission: Brussels.

Global Pressure

Kao, John (2009), "Tapping the World's Innovation Hot Spots", Harvard Business Review, March, pp.109–115.

- **Saxenian**, AnnaLee (2006), The New Argonauts: Regional Advantage in a Global Economy, Harvard University Press: Cambridge.
- Schwaag Serger, Sylvia (2006), "China: From Shopfloor to Knowledge Factory?" in Magnus Karlsson, Internationalization of Corporate R&D; Leveraging the Changing Geography of Innovation, Swedish Institute for Growth Policy Studies (ITPS)
- **Schwaag Serger**, Sylvia and Magnus Breidne (2007), China's 15-year plan for scientific and technological development a critical assessment, research note, Asia Policy, Nr.4, July.
- **Schwaag Serger**, Sylvia (2009), "Foreign corporate R&D in China: trends and policy issues", Chapter 4 in Anthony D'Costa and Govindan Parayil, eds, New Asian Dynamics in Science, Technology and Innovation. China and India in Perspective, Palgrave Macmillan.
- Siedschlag, Iulia, Donal Smith, Camelia Turcu, Xiaoheng Zhang (2010), What Determines the Location Choice of Multinational R&D Firms?, Working Paper, Forum for Research in Empirical International Trade.
- **Simpson**, Helen (2006), University Research and the Location of Business R&D, WP07/02, The Institute for Fiscal Studies: London.
- Statistics Finland (2009), Press Release 26 Nov 2009: Research and development expenditure EUR 6.9 billion, Statistics Finland: Helsinki.
- Statistics Sweden (2009), Press Release 1 Sep 2009: A forecast of R&D in Sweden 2008, Statistics Sweden: Stockholm.
- **Sölvell**, Örjan (2008), Sergiy Protsiv, Cluster strengths and regional innovation, mimeo., Centre for Strategy and Competitiveness, Stockholm School of Economics, Stockholm.
- **Special Investigation Commisssion SIC** (2010), Aðdragandi og orsakir falls íslensku bankanna 2008 og tengdir atburðir, Alþingi: Rejkjavik
- Suttmeier, Pete and Xiangkui Yao (2004), China's Post-WTO Technology Policy: Standards, Software, and the Changing Nature of Techno-Nationalism, NBR (National Bureau of Asian Research) Special Report.
- **Sveriges regeringen** (2009), Sveriges handlingsprogram för tillväxt och sysselsättning uppföljningsrapport 2009, skr. 2009/10:34, Swedish government: Stockholm.
- Swedish National Board for Higher Education (2007), Studentmobilitet högskolestuderandes internationella rörlighet, Högskoleverket: Stockholm.
- **Tellis Gerard J.**, Andreas B. Eisingerich, Rajesh K. Chandy, Jaideep C. Prabhu (2008), Competing for the Future: Patterns in the Global Location of R&D Centres by the World's Largest Firms, ISBM Report 06-2008, ISBM: University Park.
- The Conference Board and Groningen Growth and Development Centre (2010), Total Economy Database, March 2010, Data available online at http://www.conference-board.org/economics
- **The Pew Charitable Trust** (2010), "Who's Winning the Clean Energy Race?Growth, Competition and Opportunity in the World's Largest Economies", 2010.
- **Tremblay**, Jean Francois (2006), "R&D Takes Off in Shanghai", Chemical & Engineering News, Vol. 84, Nr. 34, August 21, 2006, pp.15–22.
- **UK Department for Business Innovation & Skills BIS** (2009), The 2009 R&D Scoreboard, BIS: London, Data available at http://www.innovation. gov.uk/rd_scoreboard/?p=46

UNCTAD (2009), World Investment Report 2009, UNCTAD: Geneva. Data available online at http://www.unctad.org/Templates/Page. asp?intItemID=3277&lang=1

UNCTAD (2005), World Investment Report 2005: Transnational Corporations and the Internationalization of R&D, UNCTAD: Geneva.

United States Patenting Office (2010), Patents By Country, Patentee, and Year – Utility Patents, USPTO: Washington, D.C. Data available online at http://www.uspto.gov/go/taf/cst_utl.htm

von Zedtwitz, Max (2004), "Managing Foreign R&D Labouratories in China," R&D Management Vol. 34, Nr. 4, pp. 439–452.

Wolf, C. Jr., K. C. Yeh, B. Zycher, N. Eberstadt and S-H. Lee (2002), Fault Lines in China's Economic Terrain, MR-1686, RAND Corporation

World Bank (2009a), Doing Business 2010, World Bank: Washington, D.C. Data available online at http://www.doingbusiness.org/

World Bank (2009b), Knowledge Economy Index, Washington, D.C. Data available online at http://info.worldbank.org/etools/kam2/KAM_page5. asp

World Trade Organizaton (2010), International trade statistics, WTO: Geneva. Data available online at http://stat.wto.org/Home/WSDBHome. aspx?Language=E

Z/Yen (2010), Global Financial Centres 7, City of London: London.

Global Pressure



Store Strandstræde 18 DK-1255 Copenhagen K www.norden.org

The 2010 Nordic Globalization Barometer is the third in its series, again designed to serve as input to the Nordic Globalization Forum. Less than three years after these Fora were launched, the longer-term challenges of globalization have in the public debate been pushed aside by the short-term consequences of the global crisis. Over the last few months, the focus has gradually started to shift from emergency crisis measures towards longer-term growth and the agenda that has been the focus of the Nordic Globalization Barometer from the start: global competitiveness.

While last year's Barometer discussed the role of globalization in the emergence of the crisis, this year's Barometer thus returns to the role of global competitiveness in overcoming its consequences. In this context, the Barometer continues to track the global competitiveness of the Nordic region. As a special topic for this year, it looks at the status and trends of private sector innovation in the Region, contrasting the situation in the Nordics with the developments in China.

ANP 2010:714 ISBN 978-92-893-2059-7