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Industrial Policies in Germany and Sweden – The Example of the Chemical and Pharmaceutical Industries A comparative study

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1. Introduction

The starting point

The European economy is facing fierce and powerful competition from other world regions. Today's globalisation means a shift in the world's economic focus. Most of the growth in the world economy is in developing countries, which are consequently increasing both their offerings and their demand for knowledge and innovation. In 1980, Germany had 6.7 per cent of the world GDP; in 2014, it is 3.7 per cent. Countries like China, India and Indonesia are climbing rapidly up the global value chains, competing with expertise, excellent innovation environments, and low production costs. Between 1980 and 2014, China increased its share of global GDP from 2.2 per cent to 16 per cent (www.gfmag.com).

Both Germany and Sweden have long been viewed as countries in which the manufacturing industry is important for growth and wealth. The industry represents about 22 per cent of GDP in Germany and about 15 per cent in Sweden. The chemical and pharmaceutical sectors as parts of the overall manufacturing industry are not only important in size (employment, export) for the two countries; they also produce strategic products and are in the forefront for driving innovation.

Industrial policy to promote innovative and sustainable industry

The purpose of this study of industrial policies in Germany and Sweden, in relation to the EU policy, is to describe and compare how industrial policy has been used to improve the performance of the chemical and pharmaceutical sectors during the last years. Very often, the state has played a leading role in generating innovation and economic growth in modern capitalism[1].

To date, modern industrial policy

- Is based on the coordination principle "market", but it is shaping these markets – not in a restrictive, overregulated manner, but more in a sustainable/reliable, promoting and challenging way
- Comprises different levels of politics (EU, national, regional (in Germany: state) and local (in Germany and Sweden: cities and counties), according to the multi-level theories. Here, the implementation of clusters should be one of the prominent targets. At each of the four levels, policymakers have different rights and possibilities with regard to shaping industrial policies

[1]Mariana Mazzucato (2013) highlights, through detailed case studies of investments that led to IT revolution (biotech, emerging "green"), the entrepreneurial – risk-taking – investments that global public agencies have made along the entire innovation chain *before* the private sector invested.

- Comprises all kinds of innovation policies: Beyond the classical tools like taxation policies, R&D policies, labour market policy et al, health policy, labour relations policy, energy and resource policy (all based on the principle of sustainability)
- Comprise different actors – not only policymakers, but companies and associations (industry/employers' associations, trade unions). Thus a good industrial policy should integrate all of the stakeholders concerned
- Should integrate the different fields and actors, as some elements of industrial policy are contradictory to each other. What is urgently needed is a matrix of all fields/tools and actors of industrial policy, drafting from a streamlined/common basis for industrial policy (keyword: integrated industrial policy). In particular, the German Federal System, with its various policies on different levels (federal, state, community), should be reorganised accordingly (tax, education, industrial location programmes, R&D, labour market, infrastructure, etc.)

Coordinating all levels of politics and actors requires a strategy and an understanding of industrial policy as a process that is dynamic, transparent and up to a certain extent risk-taking as well. The current EU innovation policy, and to some extent the industrial policy in Germany and in Sweden as well, follow the main principle of precaution for all legal decisions. This creates a low level of readiness to take risk – meaning that from the very beginning of the so-called "necessary" innovation processes, these processes will not be started. This damages the global competitiveness of the chemical and pharma sectors.

Germany and Sweden: Different, but equal

Germany and Sweden are different in size and industrial structure, but both have experienced relatively good growth since the 2008 crisis.
For the chemical and pharmaceutical sectors, it is important to have access to cheap and reliable energy, raw materials and, as is the case for most industries, well-educated employees and ongoing R&D.

The target of this study

What measures have Germany and Sweden implemented in order to drive innovation and growth in the chemical and pharmaceutical industries when it comes to education and training, R&D, energy and other actions that can be of importance for the industry? The topics we compare in this study are the capability of attracting international investments, education and training support, how R&D and innovation are promoted, energy systems and industrial policy and its implications for the chemical and pharmaceutical sectors.
The main question has been how industrial policy can promote sustainable industrial renewal and innovation and what learnings can be drawn from Germany and Sweden. Of course the interdependencies between the industrial policies at the national level and the EU level will be considered as well.

The empirical basis of this study

For this study, we conducted interviews on industrial policy with stakeholders from industry/employers' associations, trade unions and policy, both on national (Sweden and Germany) and EU levels. Parallel to this, we organised broad desk research comprising not only studies listed in the libraries but many non-official papers as well.

2. The chemical[2] and pharmaceutical industries in the EU

The share of manufacturing added value (as a percentage of GDP) in Europe has continued to decrease over the last decades: in Sweden from 22.07 in 1980 to 14.83 in 2013; in Germany from 29.75 in 1980 to 21.8 in 2013 – the EU-28 average was 15.1 per cent in 2013. This could be seen as an alarm bell for not losing more shares of manufacturing to the global competitors, especially in the field of advanced and knowledge-based manufacturing.

Since 2012 (directly after the first peak of the Euro crisis), the EU Commission, in addition to the EU Strategy 2020 (which includes the strategies "Integrated Industrial Policy" and "Energy 2020") as a general strategy for the EU economy, has been attempting to reindustrialise the European economy.

European trade unions are supporting these efforts and launching their own demands through the "Manifesto to put industry back to work! – a roadmap for re-industrialising Europe and for ensuring the future of European industrial employment and sites" (IndustriAll Europe 2013).

In October 2012, then again in January 2014, the European Commission (EC) tried to develop its industrial policy further. Europe should be revitalised by a "Third Industrial Revolution". The share of manufacturing should be increased by 20 per cent of the GDP by 2020, and the share of investment should increase up to 23 per cent. The "Horizon 2020" research programme from 2013 supported this strategy. But the share of manufacturing in the EU has in fact shrunk – and consequently it looks as if the target for 2020 is unlikely to be achieved.

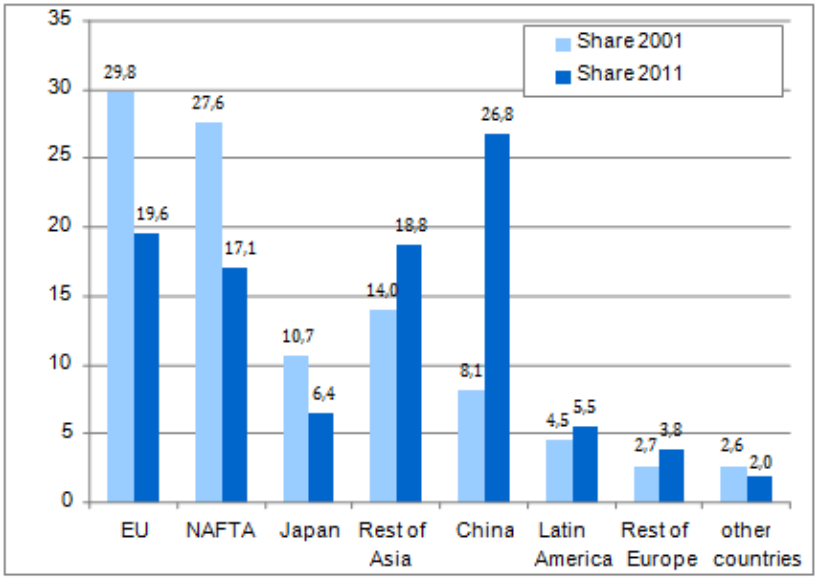
2.1 The chemical industry

The global turnover for the chemical industry has doubled between 2001 and 2011, from 1,407 billion euros to 2,744 billion euros – that is, an annual growth of 7 per cent (Cefic 2012 and Cefic 2013). But the distribution of growth between world regions is rather unequal: the EU, North America (NAFTA) and even Japan have had to accept a drop in share, whereas Asian countries have enjoyed above-average growth rates.

In other words, world chemicals sales have increased at a much faster pace than those in Europe. As a consequence, the EU chemicals market share has halved in 20 years, dropping from 35.2 per cent in 1992 down to 17.8 per cent in 2012.

[2] When we talk about the "chemical branch", we are referring to both chemicals and chemical products. In order to make it easier for the reader, hereafter we encompass it all under the term "chemical products/goods".

Table 1: Share of the global turnover of chemical goods, world regions, in per cent, 2001 and 2011



Source: Cefic 2012

In 2001, 29.8 resp. 27.6 per cent of the global turnover came from the EU resp. NAFTA; in the year 2011, only 19.6 resp. 17.1 per cent. China, with a growth rate of 18.7 per cent, is at the top of the global growth dynamic; with a turnover of 735 billion euros in 2011, it has left behind Japan (175 billion euros), Germany (156 billion euros) and even the USA, which had a turnover in 2011 of 409 billion euros[3]. China has increased its share almost four times to 30.5 per cent of the world chemicals sales market share in 2012, and at the same time the EU chemical industry has decreased its share by about one-third to 19.6 per cent.

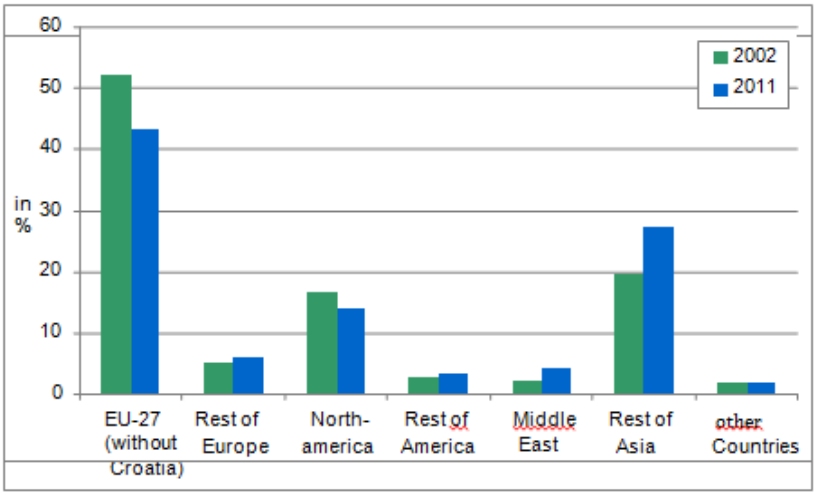
The annual production growth rate of the EU chemical industry was 0.6 per cent between 2001 and 2012. After the global financial crisis, the chemical sector followed the recovery trend that occurred in 2010.

The growth in global exports of chemical products between 2002 and 2011 of 12 per cent annually reflects somewhat the shifts of the above-described global structures of the production of chemical products. Though in 2011 the EU was still the largest exporter of chemical goods, with 43.4 per cent, it has lost larger portions compared with the figure from 2002 (52.2 per cent). Winner on the export markets were again the Asian countries: The countries from the Middle East succeeded to double their share from 2.1 per cent (2002) up to 4.2 per cent (2011). The rest of Asia (including China) increased its share by 10 per cent (coming from 19 per cent in 2002 to 27 per cent in 2011). The third largest export region is North America, with a slight loss (16.9 per cent in 2002 to 14.0 per cent in 2011).

[3]See Cefic (2012),Cefic (2013),Cefic (2014), Gehrke, B.; von Haaren, F. (2013a), IG BCE (2012),IndustriAll Europe (2014), NACE Rev.2 (2013b),VCI-Oxford Economics Study (2013)

Intra-EU sales climbed from 127 billion euros in 2002 to 270 billion euros in 2012 – a 72 per cent increase over the last 10 years. 28 per cent of chemical products are exported out of the EU market (primarily to neighbouring EU countries, the NAFTA trade bloc and Asia).

Table 2: Share of selected world regions in the global export market for chemical goods, per cent, 2002 and 2011



The classification of world regions follows the German Central Bank (2013).
Source: Comtrade Database, quoted in Gehrke, von Haaren 2013a

Employment (direct) in the EU chemical industry decreased from 1.42 Mio in 2002 to 1.18 Mio in 2011. In 2010, the chemicals and chemicals products manufacturing sector generated 111.0 billion euros as value added, which was a much higher share of the non-financial business economy (1.9 per cent) and manufacturing (7.0 per cent) totals than recorded for employment. Highly educated and trained employees, coupled with continuously high investments in the workforce, have turned the EU chemical sector into a leading industry with high labour productivity.
Large companies (employing 250 or more persons) contributed 65.1 per cent to the EU-27´s chemicals and chemical products manufacturing value added.

The European chemical sector's R&D intensity between 2006 and 2012, when compared to other world regions, shows that the global ranking system did not change in this field. Japan maintains its lead (R&D as a percentage of sales):

Table 3: R&D spending intensity, as a percentage of sales/in billion €

	Japan	USA	EU	India	S. Korea	China
2006	4.4/7.4	1.6/13.0	1.6/18.6	1.6/2.0	1.4/3.6	0.9/27.4
2012	4.0/9.8	1.7/24.7	1.6/19.0	1.6/3.4	1.3/5.4	0.8/133.8

Source: Cefic 2014, IndustriAll Europe 2014

But in the longer term, the outlook for Europe appears gloomy: in relative terms, the portion of R&D spending on sales (= R&D intensity) of the European chemistry industry has been declining by about 30 per cent, down from 2.2 per cent registered in 1996 to 1.6 per cent in 2012 (Cefic 2013).

With regard to the energy sector and greenhouse emissions, in 2011 energy intensity – energy consumption per unit of production – in the chemical industry (plus pharma sector) in Europe was 48.7 per cent lower than in 1990 – that is, a drop in energy intensity on average by 3.1 per cent per year (Cefic 2013 and 2014).

Over the last two decades, the EU chemical industry has made an enormous effort to minimise the environmental impact of its production. Greenhouse gas (GHG) emissions per unit of energy consumption fell by 43 per cent between 1990 and 2011. GHG intensity – GHG emissions per unit of production – fell by more than two-thirds (71 per cent) from 1990 to 2011.

Greenhouse gas intensity (the chemical industry's greenhouse gas (GHG) emissions per unit of energy consumption) during the last two decades (1990 to 2011) fell by 48 per cent. GHG intensity – the GHG emissions per unit of production – fell by more than two-thirds (= 71 per cent) from 1990 to 2011.

The greatest challenges for the EU chemical sector are:

- the growing dominance of the Chinese sector
- the demographic trends (risk and opportunity)
- energy policy (prices, emissions trading, etc.)
- access, securing and prices of raw materials
- regulatory framework
- shareholder value (short-term profit as opposed to sustainable business policy).

According to Cefic, there are two hypotheses about the increased competiveness of the chemical industry in the EU. The shale gas boom in the US has increased the competiveness for their chemical industry, and innovation is crucial in order to remain competitive on the global market, to compensate for the higher costs. Two actions that could be implemented in the short term are reducing energy costs and encouraging more R&D investment. Cefic lists eight important actions for industrial policy in the EU:

- Co-ordinated, competitive energy policy
- Responsible climate policy
- Innovation policy
- Regulatory stability and consistency
- Open markets
- Access to raw materials
- Addressing skill and people mobility
- First-class logistics

IndustriAll's "Manifesto to put industry back to work" suggests that reindustrialisation in Europe can be achieved through strong, smart and sustainable policies. The manifesto is for the whole industry. IndustriAll suggests the following:

- Restart the economy through investments
- Stop internal devaluation and make the system of economic governance socially and democratically responsible

- Develop collective bargaining, social dialogue and the social dimension of industrial policy
- Put the banking sector on a sounder footing to restore access to finance
- Explore the synergies between industrial policy and environmental policy and create new green jobs
- Support the knowledge economy as the main driver of industrial policy
- Reinforce the role of traditional industrial sectors
- Maximise the societal and economic benefits of information technologies
- Ensure that industrial policy addresses the demand side
- Strive for sustainable, affordable and secure energy
- Take education into account
- Make global trade work for workers
- Get the institutional framework right

What has the EU done so far to assist the chemical sector? Focusing on the chemical industry, the European Commission instigated a high-level group on the competitiveness of the European chemicals industry (EC 2009), which proposed 56 measures to improve the industry's competitiveness. Two years later, the European Commission presented a report on the implementation of the recommendations of this high-level group (EC 2011). The following is an excerpt from this report:

"*Most of the actions and initiatives are mid to long term and it is rather early to draw conclusions on which recommendations have been implemented most successfully. However, it is fair to say that implementation is still rather uneven, both in terms of individual recommendations and actors involved."*

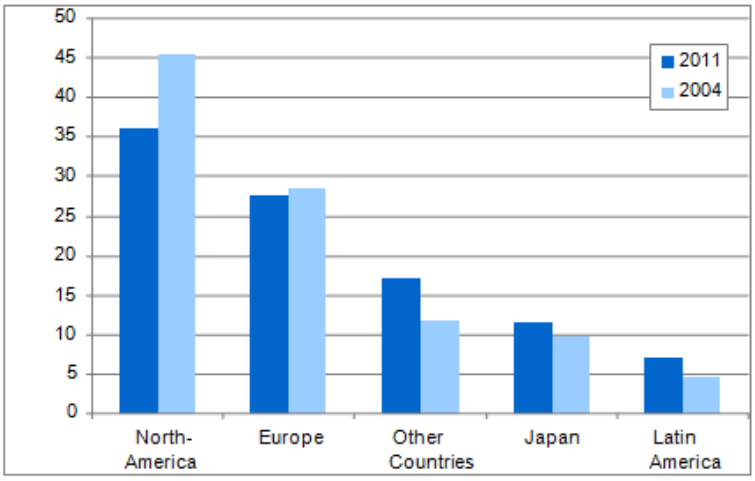
This may not sound not very encouraging to supporters of an active industrial policy.

2.2 The pharmaceutical industry

Let us look now at the pharmaceutical industry[4].
In general, the global *turnover* of drugs as at 2011 had nearly doubled since 2004, with approximately 684 billion euros in 2011 compared with 392 billion euros in 2004.

[4] See EFPIA (2012),EU Commission (2014),European Economic and Social Committee (2014),Gehrke, B.; von Haaren, F. (2013b), IG BCE (2012), NACE Rev.2 (2013a)

Table 4: Share of the global turnover of drugs, world regions, in per cent, 2004 and 2011



Source: BPI 2012 and 2005 based on data from IMS World Review 2012 and 2005, quoted in Gehrke, von Haaren 2013b

In 2011, more than three-quarters of the global turnover for selling drugs was covered by North America = USA and Canada (36 per cent), Europe (28 per cent) and Japan (12 per cent). But during the period 2004-2011, considerable shifts occurred: whereas Europe kept its share, North America lost 25 per cent. Japan, Latin America and the other regions (in particular Asia, not including Japan) increased their shares. During the following years, it is expected that primarily India and China may increase the turnover, whereas high-developed regions could shrink because of the need to reduce public expenditure for healthcare. According to EFPIA, there is an ongoing large transformation of the market conditions for drugs, with three drivers:

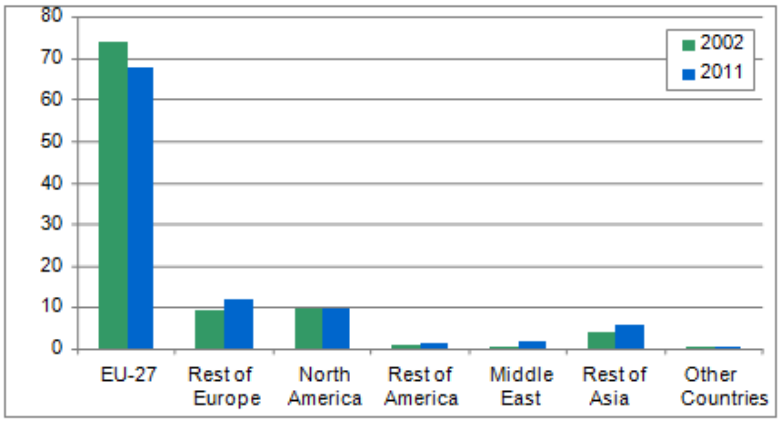
- Pharma is a becoming a global industry
- The market conditions change and it is getting harder to get new drugs accepted in healthcare
- There are large new opportunities with big data such as bio banks to develop new medicine.

Regardless of this, the USA is the worldwide number one for this market with 33 per cent, followed by Japan (12 per cent), China (7 per cent) and Germany (5 per cent)[5].

The growth of global *exports* of drugs between 2002 and 2011 by 13.5 per cent annually (in USD) reflects the above-described shifts of the global structures of the production of drugs (see Gehrke, von Haaren 2013b). Between 2002 and 2011, an increase of 13.5 per cent annually (counted in USD) was noted in global exports of pharma goods.

[5] Switzerland is not included in these figures. In Switzerland we find large, research-intensive pharma companies, which contribute greatly to the national GDP (Interpharma 2012, EFPIA 2012/2013, both quoted in Gehrke, von Haaren 2013b)

Table 5: Shares of selected world regions in the global export market for pharma products, per cent 2002 and 2011



Source: Comtrade Database; Berechnungen des NIW, quoted in Gehrke, von Haaren 2013b

In 2011, the largest share of global exports came from the EU-27 (67.8 per cent) and the rest of Europe (12.2 per cent). This overwhelming position of the EU, especially compared with the US, comes partly from the fact, that, although the EU is seen as a single (domestic) market, the statistics count inter-EU trade as well, whereas this is not the case for the US.

In total, Europe's share in global pharma exports decreased by 4 per cent between 2002 and 2011. North America's share remained at 10 per cent, but the Asian share grew over-proportionally between 2002 and 2010, practically doubling.

In April 2013, the pharma sector in the EU-27 (not including Croatia) was characterised by its small number of large, capital-intensive enterprises. In total, there were 4,000 companies in this sector (in 2010); together they employed 542,000 persons across EU-27 and generated 85.9 billion euros of added value[6].

What has the EU done so far to assist the pharma sector? Only the headlines will be presented here (EU Commission 2014).

- Ensured long-term sustainability for the pharma sector (including identifying priorities with regard to the development of medicines, health technology assessment (HTA), fostering public-private cooperation, facilitating the availability of and access to specific medicinal products)
- Fostered transparency and ethical behaviour
- Improved access to medicines worldwide.

According to the EU Commission, what are the major drivers and challenges in this sector?

- Demographic change
- New and old health threats
- Investment in pharmaceutical R&D
- European intellectual property regimes

[6] According to EFPIA (2012), the pharma industry employed over 700,000 people in the EU in 2012.

- Constraints in public budgets
- Policy consistency regarding the pharma sector
- New challenges and competitors in the global market.

The next steps of the EU Commission will be:

- Synergising and monitoring the implementation of European and national innovation policies to create incentives/rewards for a sustainable and competitive pharma sector
- Improving patients´ access to medicines by exploring interactions between regulatory, HTA and pricing/reimbursement dialogues at an early stage
- Improving availability and affordability of medicines for smaller EU markets and populations
- Reaping the potential of biosimilars and vaccines for public health
- Improving external dimensions including trade and development policies (EU Commission 2014, 25)

In April 2014, the influential European and Social Committee recommended a new Life Sciences Strategy, which comprises three elements:

- Societal policy recommendations – focusing on the sector's contribution to meeting an ageing Europe's challenges of chronic disease management, as well as the need to reduce healthcare inequality
- Scientific policy recommendations – where serious effort should be devoted to developing a better-coordinated, more strategic, pan-European research effort
- Economic policy recommendations, where there is more explicit recognition that investment in healthcare, including in medicines, matters for all segments of society. The Committee recommends that all EU member states work with the industry on agreements that could ensure all European consumers (i.e., patients) have equal access to modern medicine

Furthermore, the ESC claimed that the role and independence of the European Medicines Agency (EMA) should be reinforced; Europe should look more to strengthen and consolidate its position as a global leader in pharmaceuticals through partnerships that stretch beyond its borders. The EU Commission should include intellectual property as part of its forthcoming communication on industrial policy for the pharma sector.

The pharma sector is the most research-intensive industry in Europe; research is therefore an important part of an industrial policy for competitiveness. For innovation to occur, there must be ways for the research results to reach companies and the market. Clinical trials are important, as are incentives for collaboration between universities and the industry.

Besides strategies for R&D, there are other areas that need to be strengthened within the pharma sector. EFPIA highlights in particular the need for a modern, cost-effective regulatory model for new drugs, in order to build trust for the sector, as well as European patents and policy for data privacy when big data comes more into play.

In the short term, it is most important that the EU improves the regulatory frameworks and continues to work with open innovation projects. The EU can also encourage member states to start dialogue with their industries about how the industrial policy can be more competitive. The EU Commission can play a role in sharing best practices between member states.

The EU is a large market in itself for chemical and pharmaceutical products. But the markets for these sectors are becoming more and more global, making competition even fiercer. The EU, and indeed all policymakers, must therefore develop strategies and actions to make it an attractive region for investments in the chemical and pharmaceutical sectors.

EU policy can provide a platform for disseminating good practices. According to IndustriAll, a priority for Europe is to develop its own industrial policy because of the ongoing globalisation of manufacturing, since such a European strategy is hindered by the overarching domination of competition policy, the shortage of competencies (the EU has almost no financial resources to implement its policies) and the lack of coordination between the Commission and the member states.

There are many political levels that influence conditions for the industry. The most important actions in industrial policy, such as education, R&D, taxes, infrastructure and energy, are taken by national parliaments. The EU should focus its work on the areas in which the EU has competence to improve rules, regulations and the common EU framework. Another important role for the EU is to spread good examples of successful policy work among the member states, since many of the policy instruments are decided at the national level.

3. Case study Sweden with focus on the chemical & pharmaceutical industries[7]

3.1 Global markets and international investments

In comparison to other EU countries, Sweden has a relatively high share of manufacturing industry, accounting for about 15 per cent of GDP and 77 per cent of the export. The industry has approximately 650,000 in the workforce, corresponding to about 550,000 full-time employees. As the industry focuses on core business, areas such as R&D and IT services have been increasingly outsourced to firms specialising in such fields. Thus, the industry employs about 350,000 people in the business service sector. This means that the manufacturing industry generates about a million jobs, 20 per cent of Sweden's total employment.

Sweden is dependent on large companies. The 20 largest multinationals account for 35 per cent of Sweden's total exports, 50 per cent of corporate R&D and 24 per cent of industry employment. In the high-tech industry, the large multinationals' domination is even greater; the eight largest companies operating in the high-tech industry account for 92 per cent of R&D costs, 67 per cent of all employees with long university education and 72 per cent of all PhD graduates in this industry.

Sweden is a country with a small domestic industrial market. Sweden's exports exceeded 1700 BSEK in 2013, equivalent to 49 per cent of Sweden's GDP. The ten largest exporters are all manufacturing industries and the industry exports 64 per cent of its production (2011). The largest export markets are the Nordic countries with 25 per cent and the rest of Western Europe with 39 per cent. Consequently, global value chains are important for Sweden, and many major Swedish export companies are dependent on imports of components and intermediate products. This leads to increased specialisation in order to enable them to compete successfully on international markets.

Business Sweden, the main trade promotion agency in Sweden, which is co-owned by the state and the Swedish business society, has listed ten reasons for international companies to invest in Sweden:

- Sweden is a world leader in innovation
- The Nordic market is part of the EU
- It's easy to do business in Sweden
- Productivity is high and English is spoken by almost everybody
- It has a prime location in northern Europe
- It has a modern workplace with skilled labour
- R&D is world-class
- First-rate infrastructure
- Attractive corporate taxation
- Quality of life

According to expert interviews, this list is about right. But experts also emphasise that, if the goal is to bring more investments to Sweden, politicians must show more

[7] The information for this case study comes from a desk study and 7 expert interviews with representatives from industry associations, trade unions and companies.

interest for the industry and firmly engage in building relations with big international actors. Moreover, the expert interviews indicated the need to:

- Set up a national export strategy including a plan to ensure Sweden's visibility in new growth-driven markets
- Ensure that export promotion is more based on business conditions and needs
- Implement a higher degree of coordination between government policy for R&D, innovation, commercialisation and export
- Ensure that corporate tax is not higher than in other countries, to keep IPR and R&D in Sweden
- Establish a national strategy that attracts more hard as well as soft investments to Sweden

The chemical and pharmaceutical sectors

Employment in the chemical and pharmaceutical sectors in Sweden has today reached 28,000.

The number of employees in the pharmaceutical industry halved between 2001 and 2013 to about 12,000, while the number of employees in other chemical sectors decreased from 20,000 to 16,000 during the same period. Globally, the number of employees working for big pharma has decreased by about 200,000 since 2008. In terms of employment in the business sector in Sweden in 2013, this represents about 0.3 per cent for the pharmaceutical industry and about 0.4 per cent for chemical industries. Companies with more than 200 employees represent about 70 per cent of the decrease during the last five years.

The share of total exports of goods is much higher, at 5 per cent for the pharmaceutical industry and about 7 per cent for the chemical industry. These figures have been quite steady over the last years.

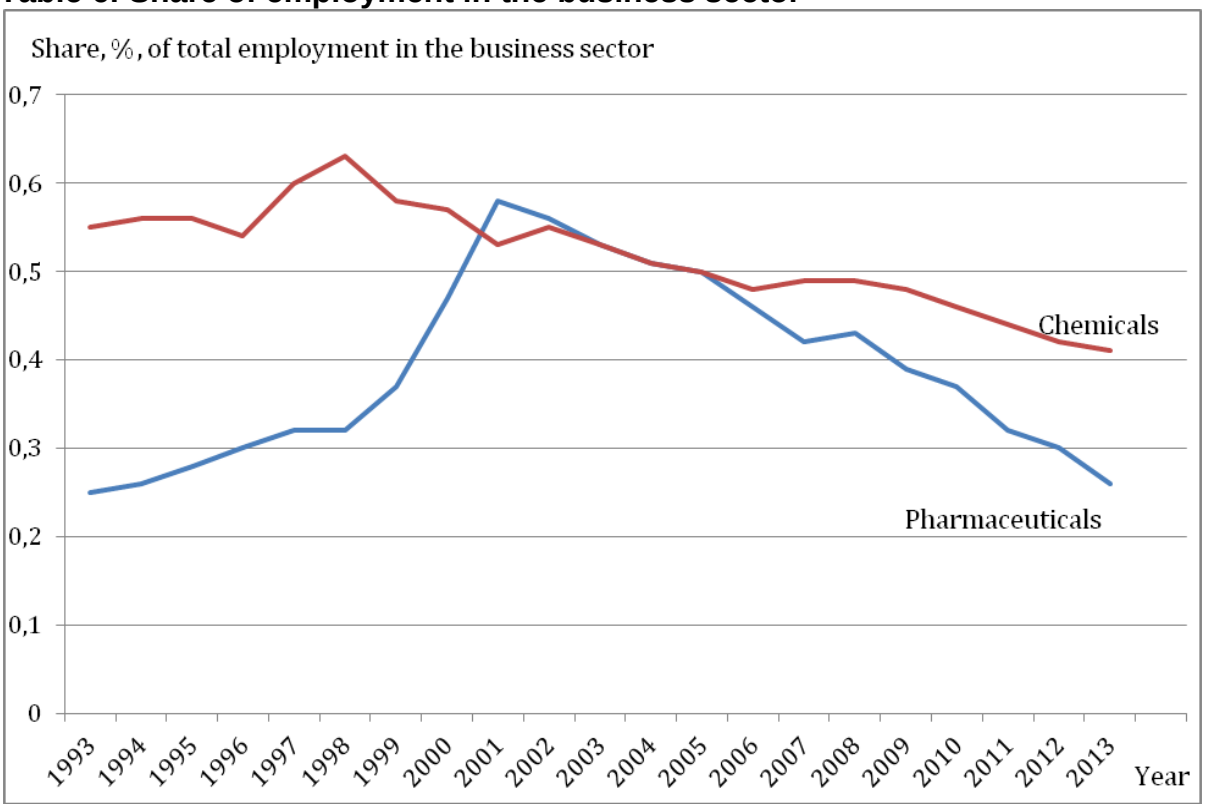
The Swedish pharma and chemical industries are to a large extent located in three clusters. The pharmaceutical industry is 70 per cent located in the Stockholm area. Half of these employees work at AstraZeneca´s plant in Södertälje. This is the world's largest pharmaceutical plant, which handles 3.8 per cent of Sweden's export of goods. The research is concentrated in Stockholm/Uppsala and the Gothenburg regions where AstraZeneca has one of its three global research centres. AstraZeneca conducts 25 per cent of its global research in Sweden.

Basic chemistry is clustered in the Gothenburg region, concentrated particularly in the small coastal town Stenungsund and the northern Skåne region. Other chemical companies are more evenly spread throughout the country.

Sweden is a small open economy that is home to many international companies. During the structural changes of the last decades, most Swedish pharma and chemical companies have been integrated into international groups. Today, the chemical and pharmaceutical firms in Sweden are to large extent owned by big international groups.

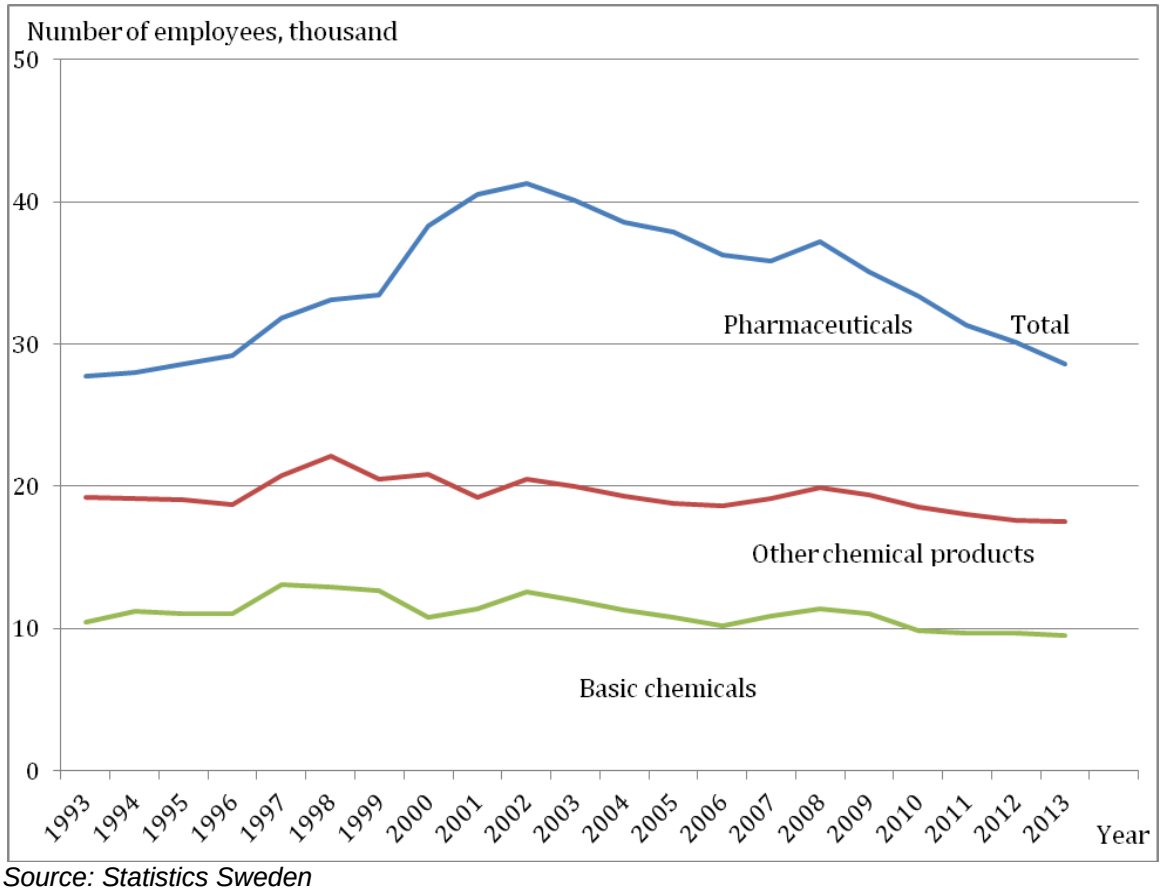
In 2013, export from the Swedish pharma sector reached 56 BSEK, the lowest level since 2005. On the other hand, Danish pharma export grew from 46 BSEK to 86 BSEK from 2005 to 2013. In 2013 alone it grew five BSEK. Looking at R&D expenditures, we can see another dramatic shift: the Swedish level was much higher than the Danish for 2005. In 2013, the situation is the reverse: R&D expenditure in the Danish pharma businesses sector reached 13 BSEK while the level for the corresponding Swedish sector had shrunk to just below 9 BSEK.

Table 6: Share of employment in the business sector



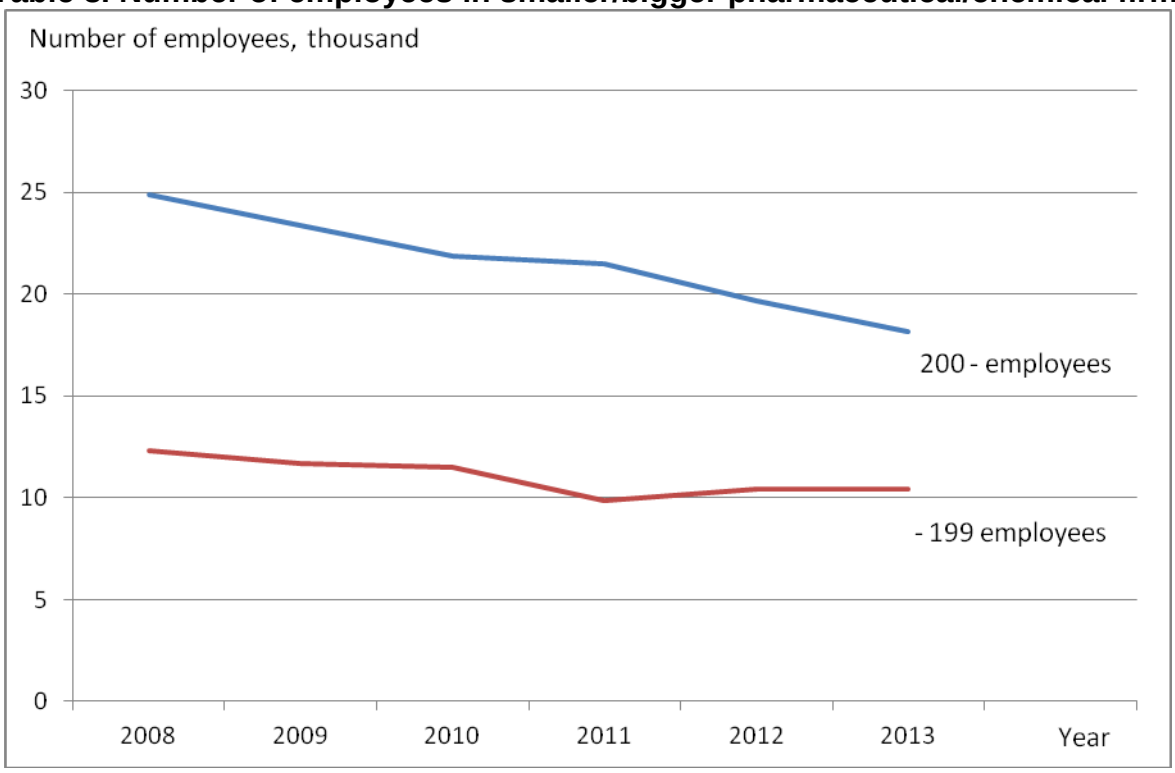
Source: Statistics Sweden

Table 7: Number of employees in smaller/bigger pharmaceutical/chemical firms



Source: Statistics Sweden

Table 8. Number of employees in smaller/bigger pharmaceutical/chemical firms



Source: Statistics Sweden

Table 9: The pharma and chemical companies in Sweden

	Number of companies		
	1-49 employees	**50-199 employees**	**-200 employees**
Pharmaceutical companies			
2008	50	11	10
2014	63	11	9
Basic chemistry companies			
2008	87	24	15
2014	92	18	13
Other chemical companies			
2008	226	37	7
2014	264	29	10

Source: Statistics Sweden

Table 10: Geographical distribution of employment in companies with more than 50 employees

	Percentage of employees		
	Pharmaceutical industry)	**Basic chemical industry (%)**	**Other chemical industry (%)**
Stockholm/Uppsala/Södertälje	70	24	34
Gothenburg region	18	44	28
Skåne region	10	22	15
Other	2	10	23

Source: Vinnova

Table 11: Ownership of the pharma and chemical industries in Sweden. Firms with more than 50 employees

	Percentage of employees working in:	
	Swedish-owned companies	**Owned by foreign companies**
Pharmaceutical industry	17	83
Basic chemicals	6	94
Other chemical products	25	75

Source: Statistics Sweden

The main explanation for these dramatic differences during the last 15-20 years can be found in attitudes to and changes in ownership. On the Danish scene, long-term strategies based on ownership stability that is secured by core ownership by Danish foundations have been key to market success. On the Swedish scene, the situation has been almost the opposite with many firms, from small to large, being acquired and/or merged by foreign actors.

According to IKEM, the organisation for Swedish innovation and chemical industries, the perspective in Sweden is too much on export and too little on attracting investments. IKEM conducted an interview study in 2014 that examined how foreign

industrial groups view Sweden from an investment perspective. The study found the following:

Table 12: Important factors for investment decisions

Very important factors for investment decisions	Factors with low importance for investment decisions
Close to markets and customers	Cultural proximity
Low and stable energy prices	Access to renewable energy
Competitive and stable company taxation	Collaboration with universities
Consequent and easy legislation	Costs for environmental permits
Proactive industrial policy	Subsidies for R&D and innovation
A stable currency	
Access to raw materials	

Source: IKEM

One conclusion that can be drawn from this study is that the chemical industry is facing large challenges. Many international companies don't see a potential for growth in the small Swedish market, even if the climate for investment in Sweden is generally good.

3.2 Employment and training support

Critical professional roles for industrial companies are qualified, skilled workers, technicians and engineering graduates. Education for these roles is through the public education system. A well-functioning education system is therefore crucial in enabling the industry to remain competitive. As production and services become more advanced, the need for employees with lengthier, more advanced training increases.

Over time, the educational backgrounds of employees in the Swedish manufacturing industry have shifted considerably towards people with at least three years of secondary education and tertiary education.

Table 13: Educational level in the manufacturing industry 1993-2011

Level	1993 (%)	2011 (%)	Change (%)
Primary school	31	13	-55
Upper secondary school < 2 yr	35	30	-15
Upper secondary school 3 yr	16	26	+55
Tertiary education < 3 yr	11	13	+22
Tertiary education > 3 yr	7	17	+144

Source: The Industrial Council

Structure of the primary and upper secondary school

Municipalities (290) are responsible for pre-school, primary school and upper secondary school education, according to the Education Act. Schools can be run either by municipalities or as independent schools managed by associations, cooperatives, foundations and companies. All education, including independent schools, is financed by taxes through the municipalities and is free of charge. Municipal and independent schools can develop their own profiles – for example, Montessori, English classes or cultural and sports profiles. Independent schools are open to all and the education should correspond to that provided by municipal schools. 27 per cent of pre-schools, 17 per cent of primary schools and 33 per cent of upper secondary schools are independent. The Swedish Schools Inspectorate inspects all schools and authorises independent schools.

Compulsory schooling lasts for a period of nine years. The next stage is an upper secondary school, which lasts for three years and aims to give pupils a good foundation for vocational activities or for further studies. In ninth grade, pupils choose between the following alternatives for upper secondary school:

- 18 national programmes divided into foundation subjects, subjects common to a programme, orientation, programme specialisations and a diploma project. Five programmes lay the foundations for higher education and 13 prepare the pupils for work or vocational higher education.
- Five introductory programmes to follow on from primary school
- Special national approved programmes for pupils who are not eligible for a national programme (grade not attained based on national recruitment/national programmes. This can include special variants such as maths and science, as well as sports programmes.

In 2012, 51 per cent of pupils attended a programme that prepares them for higher education, 31 per cent attended vocational programmes and 18 per cent attended an introductory programme.

An example of a vocational upper secondary school is the so-called “Teknikcollege”. These play an important role in educating pupils for industry and showing them what the industry can offer. Teknikcollege seeks to raise interest in technically oriented education at secondary and tertiary levels based on the industry’s future needs. These colleges were started by industrial organisations together with municipalities, educational institutions and businesses, and today exist in over a hundred locations in Sweden, with colleges in 28 regions, attended by about 10,000 students. According to industrial organisations, additional “Teknikcolleges” are needed in order to fulfil the demand from the industry for skilled workers.

Higher vocational education and adult education

A higher vocational educational college provides post-secondary school education, either as higher vocational education courses or qualified vocational courses. The courses are designed in consultation with employees and are tailored to meet the manpower needs of the labour market and lead to jobs. The content and direction of the courses may vary over time depending on labour market needs. An education or a course can last from between one and three years, with most lasting two years.

About a third of the training is workplace experience.

Higher education

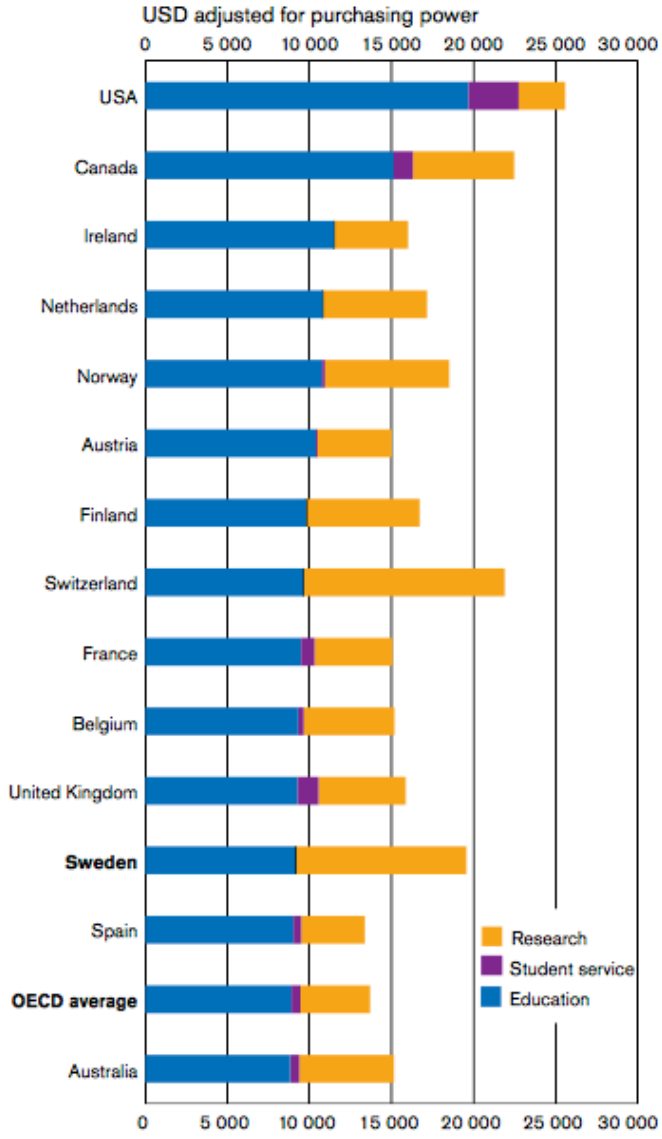
Public or independent higher education institutions (HEI) offer higher education. There are 14 public universities, three independent universities, 17 public university colleges and nine independent education providers. Public HEIs are agencies and report directly to the government. Higher education is free of charge for students from Sweden and the EU.

Admission to higher education requires specific knowledge, depending on the course or the programme. The Swedish Council for Higher Education is responsible for pooled admissions for the HEIs, even though the HEIs decide admissions.

Investments in HEI education and research represent 1.8 per cent of GDP. In the OECD, the average country invested 1.6 per cent in tertiary education and research of which 70 per cent (1.1 per cent of GDP) was public funding. In Sweden, this portion is 91 per cent.

Across the OECD, the proportion of adults with tertiary education has increased by about 10 per cent since 2000. In Sweden, the proportion is 43 per cent for those aged 25-34 and 35 per cent for ages 25-64. Within the OECD, Sweden is in 14th place in terms of proportion of the population with tertiary education, with Korea, Japan and Canada at the top of the list.

Table 14: Expenditure by education providers' expenditure per student for tertiary education and research divided between different activities (Figure for countries with highest total expenditure per student over the OECD average. Information about Germany, Denmark and Japan is not available)



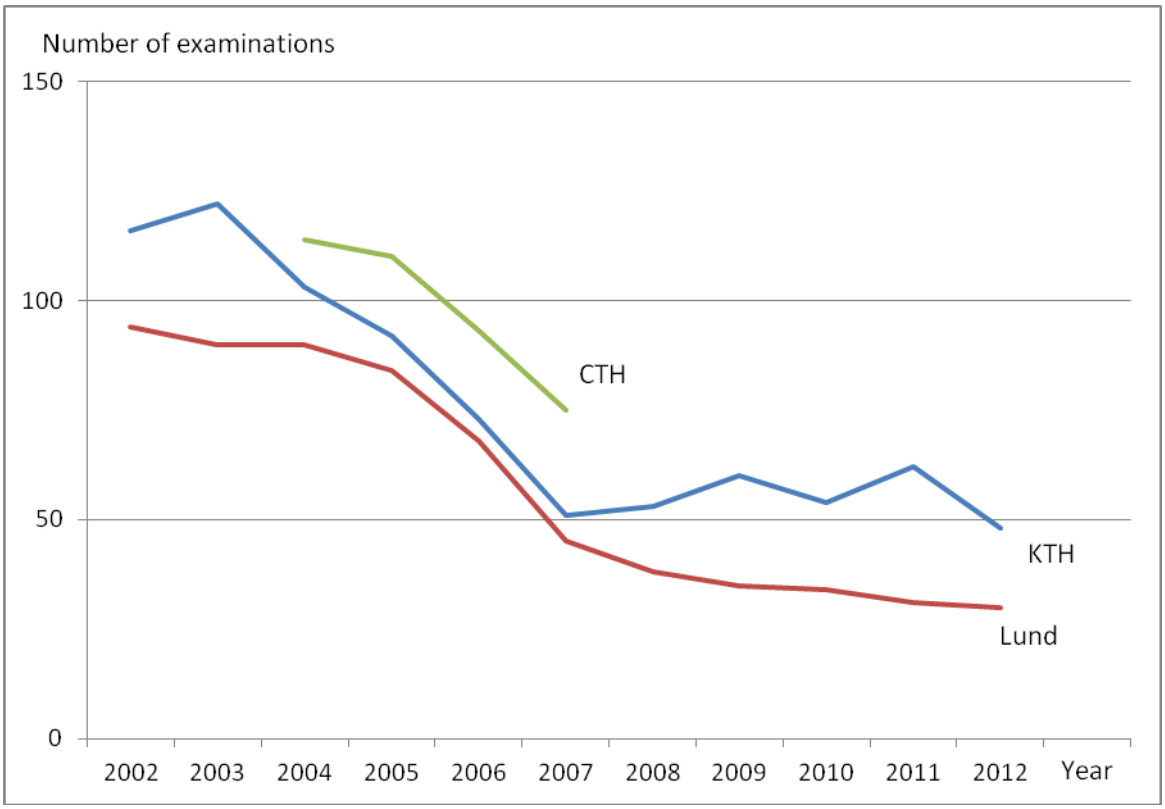
Source: Higher Education in Sweden 2014, status report

Higher education in chemistry and examination of market demand

The Swedish HEI system has expanded significantly over the last 20 years. The expansion is most visible for education in economics, social sciences and humanities but is also sizeable in technical universities and natural sciences.

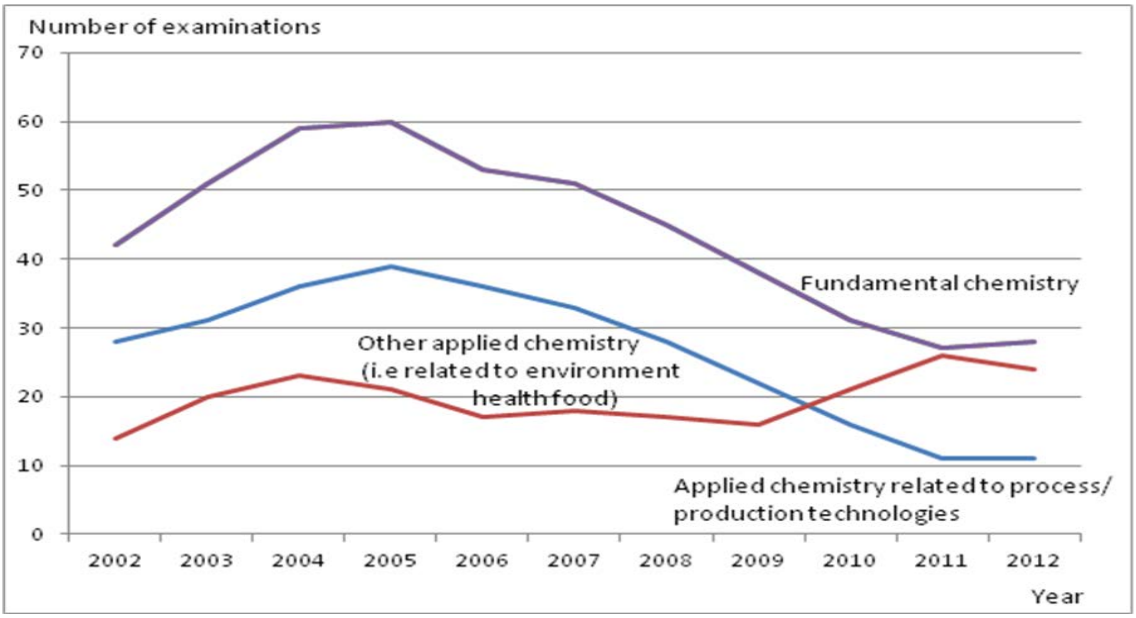
Looking at chemistry-related education, these trends are in almost all aspects nonexistent. On the contrary, chemistry-related education seems to have greatly lost its attraction over the last ten years. The following are some observations illustrating this, related to supply/examinations:

Table 15: Examinations of engineers (”Civilingenjörer” corresponding to “Diplomingeneur”) from chemistry-related educations at leading Swedish technical universities.
Measure: Three-year averages



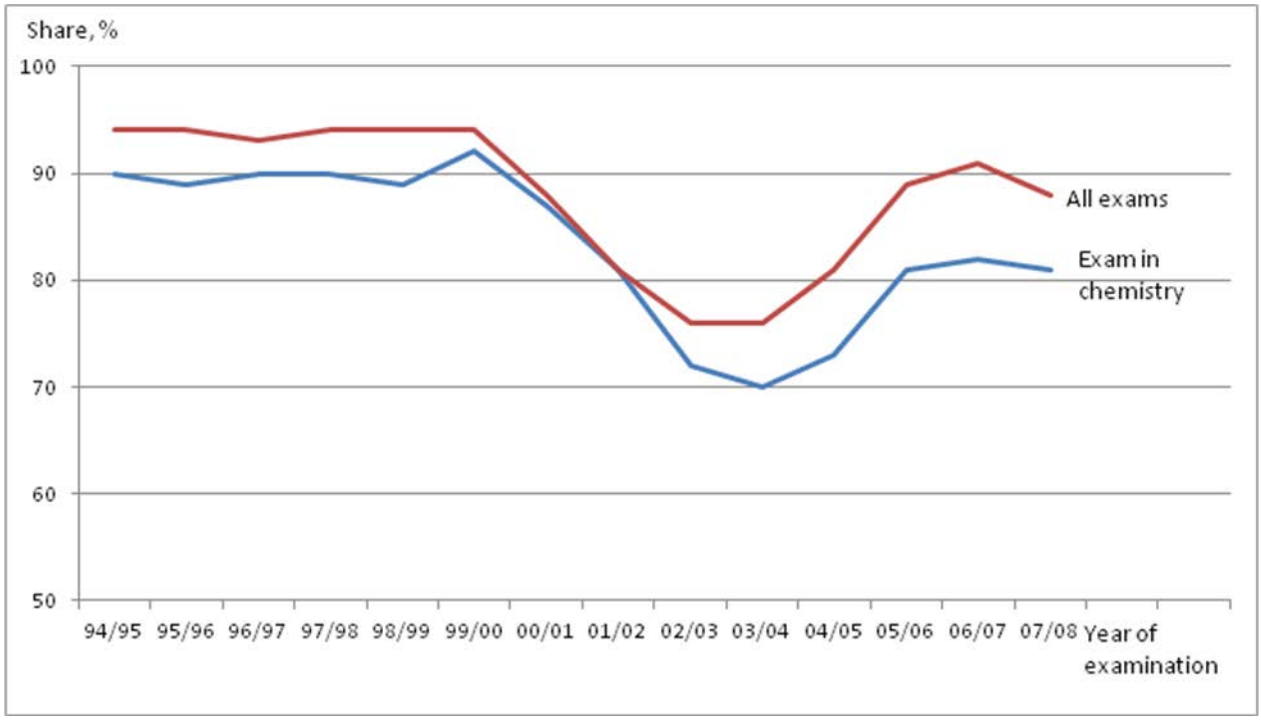
Source: Annual reports

Table 16: Doctoral examinations in chemistry at Swedish HEI
Measure: Three-year averages



Source: Central HEI authority

Table 17: Perspective on demand and supply for academic engineers ("Civilingenjörer"). Establishment in the labour market one year after examination.



Source: SCB Temarapport 2013:1. "Ingenjörerna"

- Chemistry-related examinations at technical universities in Sweden ("civilingenjörer" corresponding to "Diplomingeneur") reached about 300 per year 15 years ago. Today that number has halved.
- Doctoral exams related to basic chemistry dropped from 160 in 2005 to 110 in 2013.
- Doctoral exams related to applied chemistry have halved, from 60 to 30 a year, since 2005. This reduction pertains to exams related to product/process technologies. Exams related to environment, health and food did not decrease.

Looking at the demand side, it would appear that the reductions on the supply side were at least reasonable. Some observations regarding newly examined graduates from technical universities ("civilingenjörer"):

- Today, 90 per cent of all examined graduates are established on the labour market one year after examination. For those with exams related to chemistry, the corresponding level is 80 percent. A difference has existed for at least 20 years (partly due to higher share for female students) but it has increased.

- 20-30 per cent of employees indicate that they experience deficiencies in supply as a whole. Only 5 per cent of employers seeking newly examined graduates in chemistry experience deficiencies.

The education system for the future

A good educational system is a cornerstone in an industrial strategy. Skilled labour is an important factor for companies that are deciding whether or not to make an investment. Sweden invests heavily in the educational system and has a wealth of different schools and pedagogies suitable for different pupils. But Swedish investment in the education system as a whole is just above the OECD average, at 6.3 per cent of GDP, compared with 6.1 per cent of GDP. Sweden is ranked high in research and innovation but higher education has the potential to be further developed.

A challenge for Sweden and its education system is the lack of interest for math and science among the younger generations, which results in lower results in the international comparisons of skills, and too many pupils with incomplete grades. As for industry, vocational education in upper secondary schools is important, but the interest for this type of education is decreasing.

The research project Relevance of Science Education (ROSE) shows that the higher the degree of industrialisation in a country, the lower the interest of young people for a scientific or technical career. This appears to be correlated with what is valued most highly. In Sweden it is often personal, identity-bearing interests that influence the young citizens' career dreams. Many young people see themselves in a profession where that benefits society and where they work in teams. In scientific and technical careers, young people may have difficulties seeing such value dimensions even – indeed, if they are even there – and therefore choose other professions. Increasing interest for science and technology is therefore an important task that Sweden shares with many other EU countries.

The latest PISA (2012) survey of skills in reading, science and math involved 65 countries, including all OECD countries. Overall, Sweden is doing poorly in all three areas and is now well below the OECD average. Since previous surveys, Sweden has dropped in position. Consequently, there is a broad ongoing political debate in Sweden about how the school system can be improved. From an industry point of view, it is important to participate in this debate and to establish working values for modern industry, as well as to outline the competencies that will be required by industry in the future.

Over time, the proportion of pupils in Sweden with incomplete grades from primary school has been around 20-25 per cent, while the proportion of students who are not certified in the core subjects of Swedish, English and/or mathematics has increased. For Grade 9 (spring 2012), the proportion of students who did not attain certification was 17 per cent for mathematics, 3.3 per cent for English and 2.6 per cent for Swedish.

According to the experts interviewed for this study, it is essential to raise the quality of elementary and upper secondary education and to develop more attractive vocational education. There is also a need for more interest in math and science. In higher education, it is important to promote interdisciplinary education and research that responds to the long-term needs and challenges of industry and society. This will lay the foundations for high-quality education, research and innovation within both industry and strategically important areas in society. The allocation of resources to

higher education should therefore promote a systems approach that integrates the knowledge triangle elements – education, research and innovation – to leverage the public benefit of education.

3.3 Promoting R&D and innovation

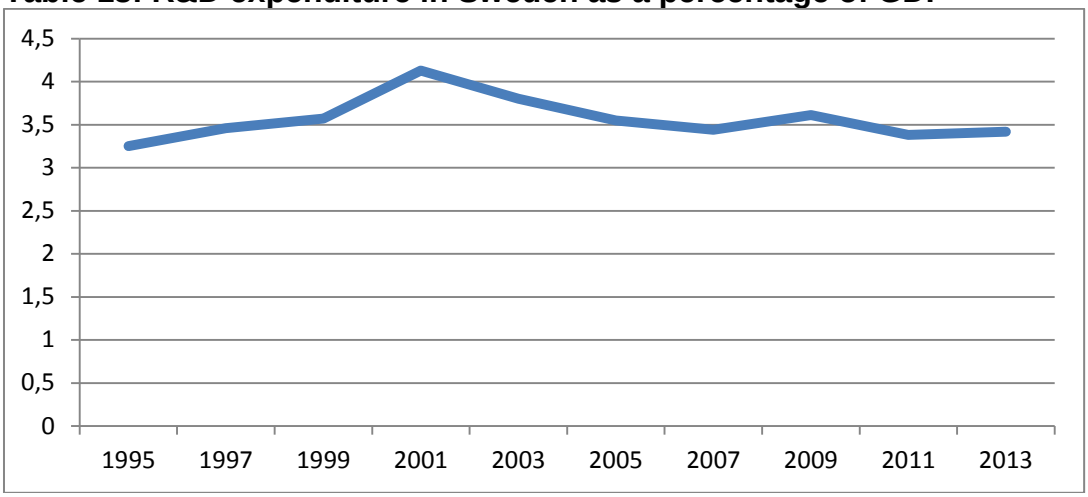
Sweden is ranked high in international indexes for innovation, and has been ranked in the top three of the Global Innovation Index Sweden for the last four years.

Innovation requires knowledge, entrepreneurship and a market. R&D and education are ways to build knowledge. In 2013, Sweden's total expenditure in R&D was 3.4 per cent of GDP, the fourth highest in the OECD. R&D expenditure hit a peak in 2001 when it reached 4.1 per cent of GDP. This all-time high was to a large extent due to exceptional levels within the ICT/telecom sector, especially within Ericsson.

One measure of the output from R&D is triadic patents families, volumes for the three largest patent markets Europe, Japan and USA. According to the OECD Factbook 2014, Sweden has 74 such families per million inhabitants. Germany has 61, and the OECD average is 34. Japan is at the top with 107 per million inhabitants.

Research is conducted by universities, research institutes as well as the business sector. There are 14 public universities, three independent universities and 17 public university colleges. In 2013, total R&D expenditure reached 124 BSEK. About 70 per cent of the total R&D is conducted in the business sector. Manufacturing firms in transport equipment, pharmaceutical and ICT/telcom industries dominate. But the knowledge-intense service sector has considerably increased its share during the last ten years.

Table 18: R&D expenditure in Sweden as a percentage of GDP



Source: SCB (Statistics Sweden)

Besides costs for their own R&D, firms have costs for R&D services purchased from external firms and organisations. These purchases reached nearly 32 BMSEK in 2013, more than 50 per cent higher than in 2005. Almost all of this increase is due to expanded purchases from foreign firms by the own concern. This means that in 2013, 67 per cent of these purchases targeted foreign R&D concern resources. In 2005 this share was just 50 per cent. In the Swedish pharma sector the increase in

such purchases went from 0.3 to 3.5 BSEK; in the ICT sector it went from 8.7 to 14.3 BSEK. In total, the purchases (total 31.8 BSEK) had the following distribution in 2013:

Table 19: R&D services purchased from external partners

Purchases from partners	Swedish partners	Foreign partners
• Within own concern	13.1%	69.6%
• Other firms	5.6	7.0
• In U&H	1.9	0.8
• In R&D institutes	0.9	} 0.9
• Other partners	1.1	
Total	21.7%	78.3

In comparison with most OECD countries, the share for Swedish R&D institutes is strikingly low. This reflects what has been the Swedish model since the 1940s, with low public emphasis on building R&D resources outside the HEI sector. Looking at total R&D expenditures in the business sector, the R&D institutes share is below two per cent.

Table 20: Perspectives on R&D in the Swedish business sector

	Person years thousand		Expenditure BMSEK	
	2013	2005	2013	2005
Total amounts	56,4	56.1	85.9	77.0
Distribution, per cent				
Production of goods	67.9	72.5	71.6	75.2
• Electronics, optics	20.0	22.9	20.4	20.4
• Transportation equipment	19.4	20.5	21.1	20.5
• Pharmaceuticals	4.3	9.6	8.1	16.1
• Other chemistry including refineries	3.0	2.7	2.3	2.3
• Other	21.2	16.8	19.7	15.9
Production of services	32.1	27.5	28.4	24.8
• ICT-related	17.1	14.0	12.7	10.3
• R&D institutes belonging to the business sector 1)	2.4	2.3	1.7	1.9
• Other	12.6	11.2	14.0	12.6

1) Co-owned by public and market interests.
Source: Statistics Sweden

R&D in the chemical and pharma sectors

In 2000, medicines and other pharmaceutical products accounted for around 20-22 per cent of total R&D expenditures in the business sector. Around 90 per cent was performed in companies in the manufacturing sector, and 10 per cent in companies

in the service sector. Today, the share for the pharma industry has dropped to 10-12 per cent. Other chemical products currently account for around 1.3 per cent of the cost for companies' own R&D. In 2000, the proportion was higher than 2 per cent.

Table 21: R&D expenditure in the pharma and chemical sectors

	All products		All business sectors	
	Pharmaceuticals	**Chemicals**	**Pharmaceuticals**	**Chemicals**
Average 2009-2013				
• R&D BSEK	9,0	1,3	7,0	1,9
• Percentage (%) of own R&D, whole industry products/industries	10,0	1,6	8,5	1,3
Average1999-2003				
• R&D BSEK	11,8	1,2	10,5	1,4
• Percentage (%) of own R&D, whole business sector	21,2	2,1	15,7	2,0

Source: Statistics Sweden

Life Science is important for Sweden. SciLifeLab was launched in 2013 – a large investment in a national resource and a collaboration between four universities to strengthen research and education. The goal is to be an internationally leading centre that develops, uses and provides access to advanced technologies for molecular biosciences with a focus on health and environment.

SciLifeLab might create new platforms for growth in the Swedish pharmaceutical business sector; however, in comparison with recent developments in neighbouring Denmark, there are many hurdles to overcome. During 2000-2013, the number of employees in the Danish pharmaceutical industry grew by close to 10,000 persons, up more than 80 per cent. During the same period for Sweden, the figures were in decline, at minus 10,500 persons, almost a 50 percent reduction. In 2013 alone, employment in the Danish pharma sector grew 8 per cent, while it shrunk nearly 12 per cent in Sweden.

Clinical trials are one pillar for the life science sector. The national health policy and how healthcare works with research is important when it comes to clinical trials and the introduction of new medicines. During the last decades, the Swedish healthcare system has been more focused on the production of healthcare, and the opportunities for clinical trials have decreased. The number of trials by life science companies decreased by 29 per cent between 2007-2013.

Sweden has high-quality healthcare but it is not a coherent system, due to the fact that there are 21 county councils responsible for this sector. The interest for clinical research and trials is decreasing, despite the fact that these can improve healthcare in the long run.

R&D and innovation for the future

The life science and chemical sectors are experiencing a transformation into global industries where the focus shifts to emerging markets or, in the case of life science, to hotspots like Boston and Cambridge. It is also a challenge in the life science area, with new market conditions putting pressure on prices and more focus on the usefulness of new drugs.

According to many of the experts interviewed, Sweden needs a common view on research, production and the market for new drugs. The low interest in the healthcare sector for clinical trials is a challenge, as are the complicated processes for conducting clinical trials and introducing new drugs.

Collaboration is key for continued success in the life science sector. Sweden needs to improve the incentives for the healthcare sector to work with research and clinical trials. Today, the county councils don't see the benefit of working with these issues to drive innovation.

The Swedish authorities must focus on the work permit situation, and collaboration should be increased between the different agencies involved. One expert said, "Why can't Sweden set up a target to halve the time it takes to handle different permits?"

Sweden needs a common vision for how the life science sector can develop. Strong areas where collaboration between healthcare and life science companies can be developed are, for instance, diabetes, oncology, resistance to antibiotics and cancer treatments.

If it is to become an attractive location within the global market for R&D, Sweden needs to shape up these processes and also market the country globally. The quality of healthcare, absence of corruption, stable policies, high productivity through good organisations and a skilled workforce are among the positive elements that many experts point to as attractive attributes for Sweden.

3.4 Energy

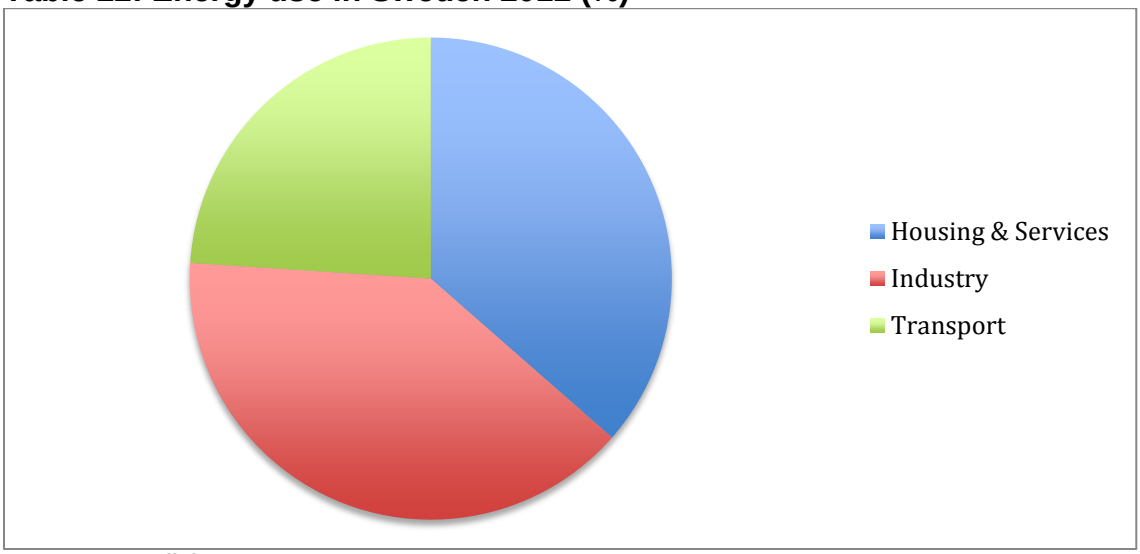
Energy prices are an important factor in investment decisions for energy-intensive industries like the chemical industry. Sweden enjoys low electricity prices due to early large investments in hydropower and nuclear energy. The Swedish electricity market was deregulated 1996 and the Nordic countries have a common market for electricity.

The Swedish energy system

The total final energy use in Sweden in 2012 was 377 TWh. Electricity is the main energy carrier, with 128 TWh and oil products accounting for 100 TWh. Nuclear

accounted for 65 TWh (after conversion losses) and hydropower for 79 TWh of electricity, while wind power produced 7 TWh. The use of energy was allocated to sectors as follows: housing, public sector and other services 35 per cent, industry 38 per cent, and transport 23 per cent. The share for renewable energy is 51 per cent for all energy use including transport in Sweden.

Table 22: Energy use in Sweden 2012 (%)



Source: Swedish Energy Agency

Energy policy

Even if Sweden possesses a large proportion of renewable energy, energy policy is an ongoing political hot topic in Sweden. The policy is in line with the three-pillar energy strategy in the EU, in which competiveness, sustainability and securing supply are the drivers. Sweden's long-term energy goals for 2020 are:

- 50 per cent renewable energy
- 10 per cent renewable energy in the transport sector
- 20 per cent more effective use of energy
- 40 per cent reduction in greenhouse gas emissions for the non-ETS sector, two-thirds of which to be in Sweden

The Swedish Energy Agency follows these goals annually. In 2012, 51 per cent of the energy was renewable. For the transport sector this share was 16 per cent. The goal for energy efficiency is set from 2008. By 2012, energy intensity had decreased by 5.5 per cent. The reduction of greenhouse gases is based on levels in 1990. Between 2005 (when the trading mechanism ETS started) and 2012, greenhouse emissions from the non-ETS sector had decreased by 14 per cent.

Since the 1980s, different instruments have been used to reduce greenhouse gas emissions. The energy and carbon dioxide taxes have played a significant role, as well as other measures within the framework of energy, transport and waste management.

One of the latest policy measures in energy policies is the electricity certificate system. This was introduced in 2003 as a market-based system to support renewable electricity production in Sweden and Norway. The goal is to increase production in Sweden by 25 TWh by 2020. For every produced MWh, producers of renewable energy receive a certificate. These can be sold, thus providing extra revenue. Suppliers of electricity are obliged to buy a share of the certificates based on their sale of electricity.

Energy use in the industry

A competitive edge for Sweden has been cheap energy. This is crucial for industries such as the chemical industry where about 7 per cent of the costs energy-related. This is more than twice as much as for the manufacturing industry.

Production in the Swedish manufacturing industry has been streamlined and energy consumption per unit of output has halved in the last twenty years. Swedish industry uses as much energy in relation to production as does the industry in Europe, but Swedish industry uses electricity more than gas and other fossil fuels; today, only about 20 per cent of the energy use in industry is fossil-derived.

Table 23: Energy use in the Industry 2012, TWh

Industry	TWh
Electricity	53
District heating	4
Oil products	12
Natural gas, town gas	4
Coal, coke	14
Biofuels, peat	58
Total	**145**

Source: Swedish Energy Agency, Energy in Sweden 2014

The energy policy for the future

The role of the energy policy should be to create long-term, stable conditions for investments and to stimulate the development of efficient products and services. Today Sweden has a large share of renewable energy. The challenges, according to industry, relate to security of supply and obtaining low energy prices. Taxes and other costs related to energy use are high in Sweden. Interviewed experts see the political signals about reducing energy use and phasing out nuclear energy as an uncertainty that threatens investments.

The future of nuclear energy in Sweden is a hot topic since many nuclear plants are growing old and will need to be replaced during the coming decades. Obtaining environmental permits takes many years and the building time is long, so the decision about the future for nuclear energy is important for the industry, especially for energy-intensive industries such as the chemical industry.

Some proposals from the experts interviewed are:

- The Government should use the principle of free trade as a basis for working toward a common European electricity market by calling for the implementation of the proposed directives in EU countries, increased transmission capacity between countries and EU-wide guidelines to support energy production and technology development.
- The government should ensure future investments in network capacity based on business needs and should welcome innovative solutions, including promoting the development of smart grids.
- The government should implement a programme to encourage energy efficiency in the industry.
- Specific policy instruments should be developed for small and medium-sized business needs and should include, inter alia, support for skills development.
- Public procurement can provide important references for new technology and therefore need to be more sustainable and innovation-friendly; for example, taking energy into account from a lifecycle perspective.

Experts also stressed that Swedish energy policy should be based on technology neutrality and market-based mechanisms for the promotion of renewable electricity generation and control of emissions. Promotion in the form of subsidies can be used for a limited time at the market introduction of new technologies, and then abolished. Taxes on emissions, subsidies for renewables, and conditions for additional power generation should be aligned throughout the EU in order to create a common market.

3.5 Industrial policy in Sweden and its implications for the chemical and pharmaceutical sectors – a summary

In a globalised world with open markets, a competitive industry is key to building wealth. Industrial policy becomes important but it is not a single-policy area. Factors that can contribute are education, energy systems, infrastructure and tax systems.

In history, the Swedish state has played an important role in industry development, notably through the construction of infrastructures such as railways, organisation of research collaborations with large firms, and as an early demanding customer. Several historical market successes for Volvo, SAAB, Scania, Ericsson and ASEA (now ABB) are related to innovative collaboration between firms and the state.

Industrial policy today

Even if the industrial sector (including related parts in the service sector) employs about 20% of the employees in Sweden, there is no general industrial policy. Much of the focus in the political debate is on SMEs and entrepreneurship, often with focus on young research-based firms with their roots in universities.

Sweden has a long tradition as a strong country in terms of production. Availability of skilled workers, leadership in advanced technology and strong productivity growth have been key success factors for the pharma sector and other industries. Swedish companies have long been characterised by flat organisations with decentralised decision-making, and good relations between employers and unions have created an open climate of trust. This provides good opportunities for problem-solving, cooperation and development and promotion of knowledge-intensive, creative and

customised production. So, what is the policy's role in further developing the industry?

Different ministries and agencies are responsible for different policy areas such as education, infrastructure, economy/taxes, labour market and energy and environment. Unlike most other European countries, the Swedish Government has small ministries while the agencies are larger and possess most of the expertise. Therefore, governmental committees are important in the policymaking process. Committees conduct the first investigations and suggest action such as legislation to the government. The government then sends the proposal for referral to stakeholders before submitting a bill to the parliament.

As said, there is no general industrial policy or specific policies for the chemical and pharma sectors. But the government has produced many strategies/policies for other areas that influence the industry, including:

- National Strategy for Regional Growth
- National Innovation Strategy
- National Strategy for E-Health
- National Strategy for Mining

A closer look at these strategies shows that they are more about ambitions and collaboration than powerful measures to drive the development towards the goals. An example is the innovation strategy, which has long-term goals and ambitions but no financing or concrete actions.

The OECD 2012 evaluation of the Swedish innovation policy notes that Sweden is generally at the top of the international innovation indexes. The innovation policy area is, however, weak in Sweden compared to, for example, higher education. The OECD observes that the government as a whole lacks a holistic picture of this policy area, and points at a number of threats against Sweden's capacity for innovation-driven growth for the future:

- Failing to maintain high productivity
- Drops in competitiveness when new global players enter the scene
- Failing to retain existing comparative advantages such as clinical research
- Failing to fully benefit from the country's knowledge base and drain the innovative capacity in global competition
- Incompletely structured processes for "technology transfer" of knowledge and links between research and industry
- Failure to make emerging sectors grow
- Increasing fierce competition for international top talent at Swedish universities
- Offshoring of production and leading company research centres
- Overstressing on building consensus when decisions need to be taken quickly

Some of the most important areas to develop according to the OECD are leadership and incentives for increased cooperation between leading Swedish universities and industry. Other challenges are rooted in a traditionally conscious, incorrupt but slow bureaucracy in the Swedish agencies. According to the expert interviews, an

illustrative example is the way the process for environmental permits works: the average time to get a permit is 3-4 years. Such delays lead to uncertainty, which in turn threatens international cooperation and investments.

Sweden has good potential to use globalisation as a driver for development. According to the OECD, this can be built on strong research, incentives for SMEs, development of new services, demand-driven innovation and a holistic perspective. These factors could also be drivers in an industrial strategy.

A new government took office last year and it has announced that it will develop a strategy for export with special focus on SMEs. The government has also set up a council for innovation with representatives from different industries, entrepreneurs and academia. The prime minister is the chairman for the council. The role model for this has been the Innovation Council in Finland.

Due to the reductions in life science, the government has started to work with a life science strategy. In January 2015, a government-appointed coordinator presented a report as a starting point. The report is based on a broad dialogue with 80 companies and organisations about the future for life science in Sweden.

Industrial policy for the future

A holistic perspective is needed on industrial development, especially for the life science sector. According to the expert interviews, high ranking in international innovation scoreboards today is no guarantee for future success. Sweden possesses good conditions for innovation, with good skills in organisations, skilled workers, stable policy and very low corruption. But to benefit from these factors, Sweden needs a common vision and an ambition for how industry can be developed.

The chemical and pharma sectors are important for export and as producers of strategic products for other industries such as the forestry industry. In an international context where the companies in Sweden are in many cases parts of international groups, it is important to have good conditions for the industry to invest here. During 2013-2014, there was a dialogue between the Industrial Council (industrial organisations and trade unions) and the ministry for enterprise and innovation. The suggestions from the Industrial Council were within five policy areas:

- Improved conditions for the industry in Sweden
- Improved education system
- More innovation in SMEs and more collaboration between industry and academia
- Sustainable industry and increased export of clean tech
- Export as a driver for growth

In all of these areas, there are suggestions for specific policy measures such as improved VC financing, ways to improve education for industry through greater collaboration, and ways the research institutes can act as a bridge to the industry and so on.

The challenge for Sweden is not to find the ideas but the leadership that is needed to take action and develop adequate policy measures for this. As an example, the chemical cluster in Stenungsund formulated a long-term strategy, “Sustainable chemistry 2030” but this failed to capture the interest of the government or agencies. In dialogues with the government, AstraZeneca points out that visions coupled with leadership in public health policy are needed to improve healthcare and find new drugs in areas like diabetes and oncology.

4. Case study Germany – with focus on chemical & pharmaceutical industries[8]

4.1. Global markets and international investments

Compared with other EU member states, the share of the overall manufacturing industry in Germany of the whole national GDP is rather high (21.8 per cent in 2013, compared with the average 15.1 per cent of EU-28).

Furthermore, the contribution of German manufacturing industry to the total EU-27 manufacturing industry in 2012 (at that time without Croatia) was 29.9 per cent – so nearly one-third of the overall EU manufacturing came from Germany.

One of the strengths of the German manufacturing industry is its network between the different branches/sectors (VCI o.J.). The diversity of industry and manufacturing, with its various competences and short communication channels, greatly promotes innovation – and innovations are the core of the chemical and pharma sectors in Germany.

Furthermore, and as opposed to other national economies, German manufacturing is characterised by a successful mixture of large and medium/small companies. Drivers of the industrial production are strong key branches, which are successful on the global markets due to their high competitiveness: car industry, machinery, electronic and electric industry, chemical, pharma and plastic industries.

Two conclusions should be drawn here:

- Industrial policy in Germany is (or should be) very concerned about manufacturing – as was the case during the global financial crises and the ensuing Euro crisis (starting in 2008)
- At the EU level, there could be a conflict of targets regarding a joint and coherent European Industrial Policy, since in other EU member states the importance of manufacturing is not as strong as it is in Germany.

Table 24: The German chemical and pharma sector at a glance, 2008-2013, important indices

[8] The information for this case study comes from desk study and 7 expert interviews with representatives from the industry associations, trade union and the federal government.

	2008	2009	2010	2011	2012	2013
Total turnover, in billion euros	169.3	145.2	171.1	184.2	186.8	190.6
Production Index, 2010 = 100	100	90	100	102	99	101
Employees, in 1,000	429	416	415	429	434	438
Exports, in billion euros	139.2	123.2	142.4	153.2	162.1	166.3
Imports, in billion euros	97.4	86.8	101.6	111.3	111.4	109.4
Domestic investments, in billion euros	7.1	6.1	5.8	6.2	6.3	6.4
Investments abroad, in billion euros	6.3	5.4	5.5	6.2	7.7	-
R&D expenses, in billion euros	8.3	8.7	8.3	9.0	9.7	10.5

Source: Statistisches Bundesamt, Deutsche Bundesbank, quoted in VCI-Oxford Economics Study 2013

In order to take a closer look at the situation in Germany related to the focus of this study, we will first examine the chemical sector[9].

The chemical sector

The chemical sector is one of the most important manufacturing branches in German economy. In terms of turnover this sector is ranked number four (behind the car and machinery industries and just after the electrical and electronic industries); in terms of number of employees, chemistry ranks number five in Germany.

As we learned in Chapter 2, the German chemical sector is ranked number four worldwide and spent more than 10 billion euros for R&D in 2013.

Germany is one of the few countries with strong basic chemistry as well as large special chemistry. Functioning structures of associations and coordinated supply

[9]See the following: Gehrke, von Haaren (2013a), VCI-Prognos-Studie (2014) VCI (2014a), VCI (2014b), VCI (0.J.), VCI-Oxford Economics Study 2013, IGBCE (2012, 2013), Cefic (2012, 2013, 2014), Voß (2011), Voß (2013)

chains are also promoted by “chemistry parks” and clusters – the clusters are regional and partly transnational clusters (see the so-called “Rheinschiene”, which comprises companies in the German North-Rhine Westphalia, the Netherlands and Belgium).

In 2012, Germany had 324,000 people working in 1,583 chemical companies. This is a share of 5.5 per cent of all employees in Germany’s manufacturing industry. The turnover in 2012 was 144.9 Mio euros[10]. This means a share of 8.3 per cent of the overall turnover in the manufacturing industry and indicates the high productivity of the chemical sector. Nearly 60 per cent of the turnover came from export.

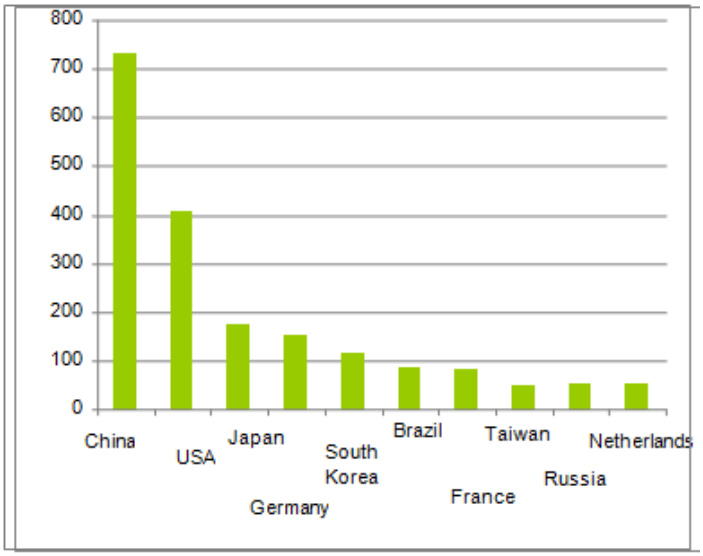
The chemical sector has six sub-sectors, according to the statistic definition. The most import sub-sector is basic chemistry, with 54 per cent of all employees and a turnover of more than two-thirds of the overall branch.

From the outside, it appears that the chemical sector is dominated by a few large international corporates; in fact, however, this sector is characterised by a high share of large companies compared with the rest of manufacturing. Whereas 4.0 per cent of companies in manufacturing employ more than 400 people each, the share in the chemistry sector is nearly twice as high (7.4 per cent).

The global position of the German chemical sector is rather good to date: in 2011, China was ranked in lead position for chemical goods production, followed at a significant distance by the USA, and then – again at a significant distance - by Japan and Germany.

[10] There are different figures for employment and turnover for the German chemical industries: Theyindicatefor 2013 an employment of 438.000 and a turnover of 190 billion euros (VCI 2014a, 2)

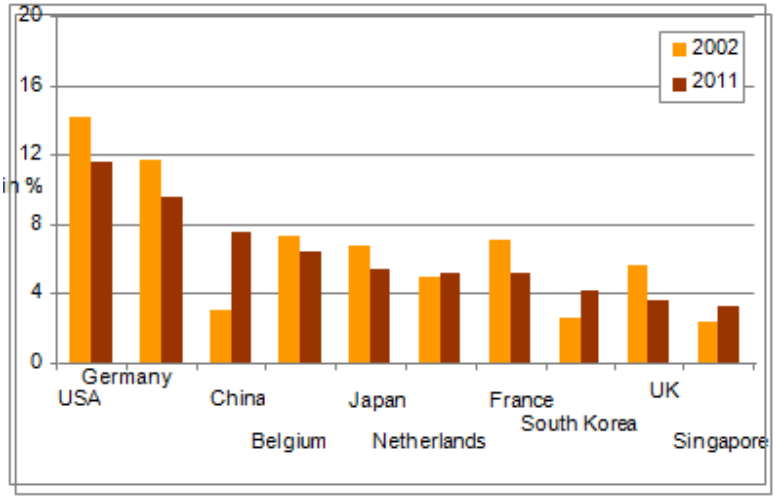
Table 25: Turnover of chemical goods production, 10 largest countries, 2011, in Mio euros



Source: Cefic 2012

A closer look at export in the German chemistry sector reveals that the USA and Germany have maintained their leading positions as exporters of chemical goods. But both countries have lost considerable shares (USA – 2.5 per cent, Germany – 2.3 per cent). With the exception of the Netherlands, this trend accompanies a general decline in exports from Europe – France and the UK in particular were hit by this trend. China was able to increase its share of the global export of chemical goods from 3.0 per cent in 2002 to 7.5 per cent in 2011 and consequently improved its global ranking, moving from number eight to number three. South Korea and Singapore also improved their positions.

Table 26: The 10 largest exporting countries of chemical goods (share of global exports as a percentage), 2002 and 2011

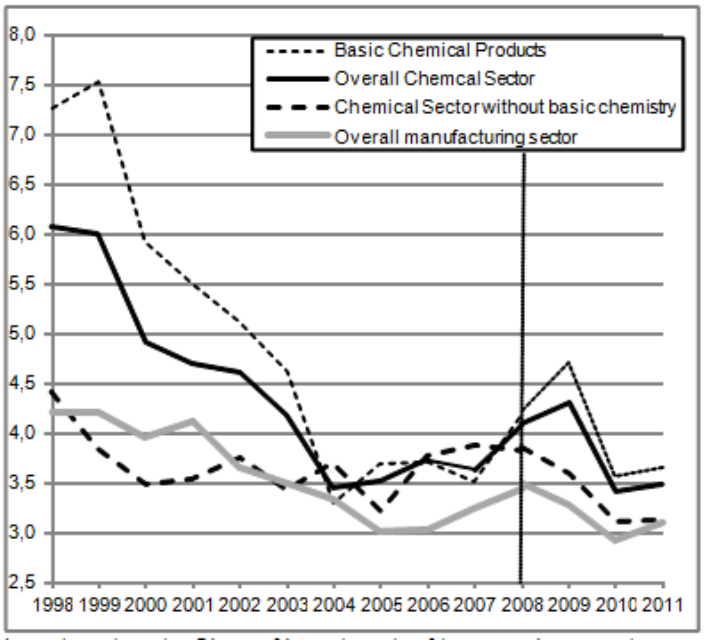


Source: Comtrade Database, quoted in Gehrke, von Haaren 2013a

Germany is also a net exporter of chemical products. In 2011, the value of exported chemical products was 95 billion euros, whereas the value of imported chemical goods was 78 billion euros. The primary export drivers are superior products from special chemistry.

The chemical sector as a capital-intensive sector is dependent on regular investments in fixed assets. But even at the beginning of 2000, the propensity to invest in the chemical sector has dwindled (see the next table). A similar trend could be seen for the pharma sector in Germany as well.

Table 27: Investment quotas for the chemical sector and the overall manufacturing industry in Germany 1998-2011



Investment quota: Share of investments of turnover, in per cent
Source: Gehrke, von Haaren 2013a

In comparison, direct investments by the German chemical and pharma sectors *abroad* were increased by 65 per cent during the same time period. This development fosters the thesis that German companies are increasingly globally active in using location advantages worldwide. Separate figures for direct investment for the chemical and for pharma industries are available only for the years 2010 and 2011. For both sectors the investment quotas in fixed assets are 80 per cent.
With a few exceptions, the main trend in Germany has been basic investments (like maintenance investments) by German chemical companies, whereas investments in strategic growth projects have mainly been done in so-called emerging markets outside of Germany and the EU.

The special chemistry will increasingly gain importance for German chemical companies, and R&D in this field will be increasingly relocated to locations abroad (emerging markets).

Whether one of the reasons for sluggish domestic investment by the industry itself is the poor public image of the chemistry industry as an industry with “dangerous” ingredients/unknown products (as opposed, for example, to the car industry, where the product is well known) cannot be answered here.

Another very important investment and innovation trend is the efficiency of energy and resources. To date, investments in these fields have been made by the German chemical sector at a remarkable level (e.g., in the field of renewable energy).

The skilled labour force in the chemical sector (blue-collar workers as well as academics) is another reason for the global competitiveness of the German chemical sector (and likewise the pharma sector), though for the future, the shortage of skilled workers is worrying (see chapter 4.2. below).

Last but not least, the R&D infrastructure in Germany with its three pillars (R&D activities of the companies, universities and other research institutions) is to date rather strong, despite the fact that there is no tax relief for R&D in Germany – a clear disadvantage compared with other competing countries (see below chapter 4.3).

Today, the somewhat painful restructuring processes in the German chemical sector that took place between 1990 and 2005 (reduction of staff, more efficient organisational structures like outsourcing of services, new products – special chemistry) are showing some benefits:

- Good economic situation in Germany
- Improvements in regions/companies – in particular the two “big players” (BASF, Bayer) are now in a better competitive shape than before.

Challenges for the German chemical sector from now to 2025/30 will come from:

- a shift of growth centres away from Europe, due to the growth of the global population from now to 2030, especially in Africa, Asia and Latin America (though this trend is decelerating). The empirical formula is to produce 80 per cent in the countries in which you will sell the products. This affects not only production, but R&D, which follows the relocation of production sites. So the largest chemical company in the world, BASF, is planning to shift 20 per cent of its R&D activities to China
- cheap energy prices, particularly in the US
- the setting of new capacities of basic chemistry outside the EU, and combined with this,
- the emergence of new players
- the relocation of some manufacturing branches into low-labour-cost countries – due to this, the chemical sector has to follow this trend (VCI-Prognos-Studie 2014). This leads to increasingly competitive pressure for the chemical locations in Germany
- the partly bureaucratic procedures to implement new products. The EU directive REACH of 1 June 2007 is on the one hand a burden, but guarantees on the other hand a level playing field in the EU
- demographic development could lead to a lack of skilled blue-collar workers (Facharbeiter).

In order to keep the chemical sector competitive for the next 20 years, it needs to increase its innovation efforts as well as its efficiency in terms of resources and productivity. Here are keywords:

- networked supply chains = vertical cooperation plus
- cooperation between the chemical companies = horizontal cooperation.

In the future, improved economic and industrial policies established as framework conditions will become increasingly important.

According to representatives from the sector, it is necessary to:

- improve the educational system due to demographic development
- promote the migration of skilled labour
- extend bio-based chemical production (getting away from oil-based production), and to focus on nanotechnologies
- protect intellectual property rights
- improve public research conditions as well as enhance the acceptance of technology by society
- strengthen cooperation between suppliers and customers (e.g., in the field of R&D and as strategic partnerships)
- improve the image of this branch vis-à-vis the public
- shape the energy policy (focus on renewable energy) to make it more cost-effective, as in other countries (USA, Brazil, Russia, etc.) energy prices are much lower than those in Germany[11].

It is expected that the German chemical sector will grow between now and 2030 by 1.8 per cent annually (this will be more than the overall growth of the German economy). Exports will grow by 2.1 per cent annually – that means that in 2030, 60 per cent of the total chemical production will be exported (in 2011: 52 per cent). The main customers might come from France, Italy and Belgium. But China will become the second most important customer for German chemical products by 2030.
The high competitiveness of the German chemical sector is reflected by the high share of pre-products coming from German industry. Although in the future, larger parts of chemical pre-products will come from abroad due to the lack of crude materials in Germany, in 2030 at least 64 per cent of all chemical pre-products will come from Germany.

Combined with this, in 2030, Germany will be one of the few countries with strong basic chemistry as well as large special chemistry – but the special chemistry (which is more customer- oriented and research-intensive than the basic chemistry) will gain importance compared with the basic chemistry.

All these trends will be favoured by good horizontal as well as vertical cooperation between the companies. This development will be supported by the further development of “chemical parks” with all their cluster effects. Beyond the demand by the chemical sector itself, there will be a growing demand by the plastics procession industry, the car and the aviation industries (e.g., fibre composites). Furthermore, the insulation of buildings is gaining in importance as well as the increasing demand for an “energy move”, today known worldwide as “German Energiewende” – and

[11]Many of these demands are not only focused on the chemical sector, but come from the pharma sector as well.

consequently the fast-growing wind energy industry (off- and onshore) and the photovoltaics industry will need chemical components and products.

The pharmaceutical sector

Let us look now at the pharmaceutical (short: pharma) sector[12], which is primarily research-intensive. It is a key industry because of its contribution to therapy and medical treatment/progress. But the pharma market is highly dependent on public health policy. In Germany (as well as other countries), several provisions have been launched to reduce healthcare costs in the health sector and have influenced the framework conditions and development potential of the pharma sector, especially for highly innovative companies.

In 2012 in Germany about 105,000 people were working for the pharma sector (in companies and respective plants with more than 50 people) – i.e., 2.1 per cent of all employees in the German manufacturing industry come from the pharma sector. In 2012, the turnover was 31.3 billion euros (= a share of 2.3 per cent of the overall turnover of manufacturing in Germany).

Though this branch comprises different special sectors, public statistics only distinguish between the production of basic pharmaceutical goods (= 13 per cent of all employees in the pharma branch; from here, three-quarters of the turnover comes from export) and others – primarily drugs and pharmaceutical specialities (= 87 per cent of all pharma employees and 90 per cent of the overall pharma turnover; two-thirds of the turnover comes from export).

Table 28: Production of pharma goods in Germany, 2012

WZ 2008	Employees	Turnover in Mio. €	Share of Export in %
Pharmaceutical Industry, total	104,667	31,279	67.7
From that			
Pharmaceutical basic products	13,983	3,207	73.7
Pharmaceutical Specialitiesandotherpharmaproducts	90,685	28,071	67.0

Plant sections with 50 employees and more
Source: Statistisches Bundesamt, quoted in Gehrke, von Haaren 2013b

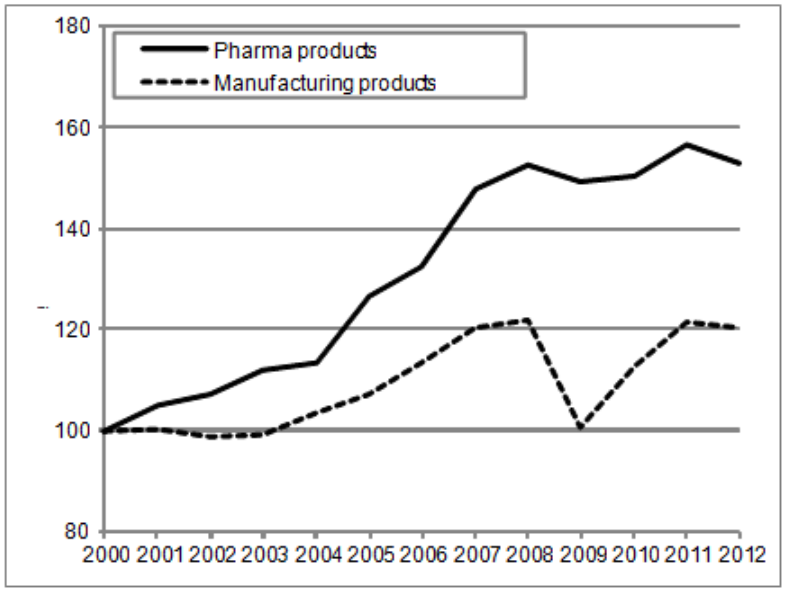
Compared with the overall manufacturing industry in Germany, the pharma branch is characterised by fewer small companies: only 44 per cent of companies have less than 100 employees (in manufacturing: 72 per cent). Because of this, the majority of employees in the pharma sector work in large companies with more than 500 employees (in manufacturing: only 40 per cent).

In 2011, the German pharma sector spent nearly 5.3 billion euros on R&D. This sector is ranked number four (with 9.7 per cent of all R&D expenditures and 7 per cent of the workforce) in the overall manufacturing industry in Germany.

In the last decade, the pharma sector has been one of the driving forces of the manufacturing sector in Germany.

[12] See in the following EFPIA (2012), EU Commission (2014), Gehrke, von Haaren 2013b, IGBCE (2012, 2013)

Table 29: Production of pharma goods and goods from the overall manufacturing industry, production indices (basis: 2000 = 100), 2000-2012

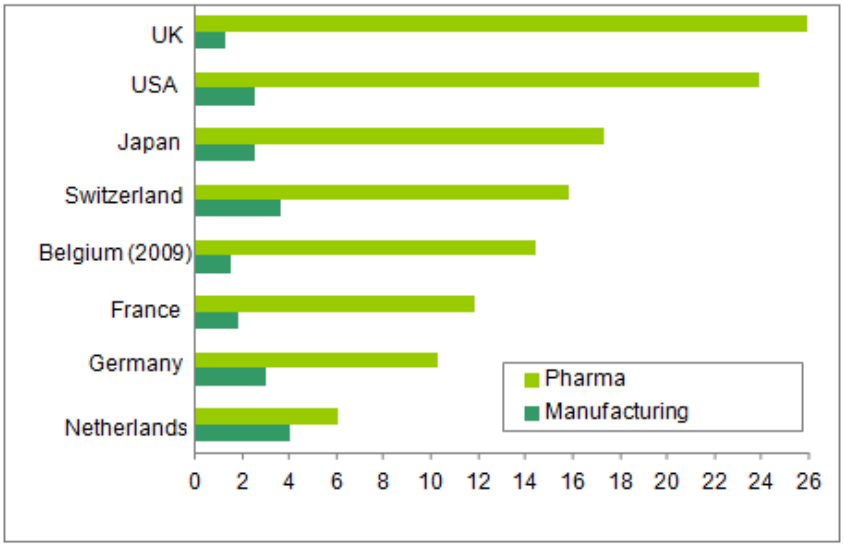


Source: Statistisches Bundesamt, Genesis-Online, quoted in Gehrke, von Haaren 2013b

In 2012, the physical output (in terms of the production indices) from the pharma sector in Germany was 50 per cent higher than in 2000. Consequently, this sector has a decisively higher expansion dynamic than the average manufacturing industry in Germany. Primarily, this growth comes from the growth of exports (see below), as the domestic market in principle is decreasing.

An international comparison, however, shows that the German pharma sector is not as R&D-intensive as its main competitors.

Table 30: R&D Intensity in the pharma sector and in the manufacturing industry in selected countries, 2010, internal R&D expenditures as a percentage of the production value

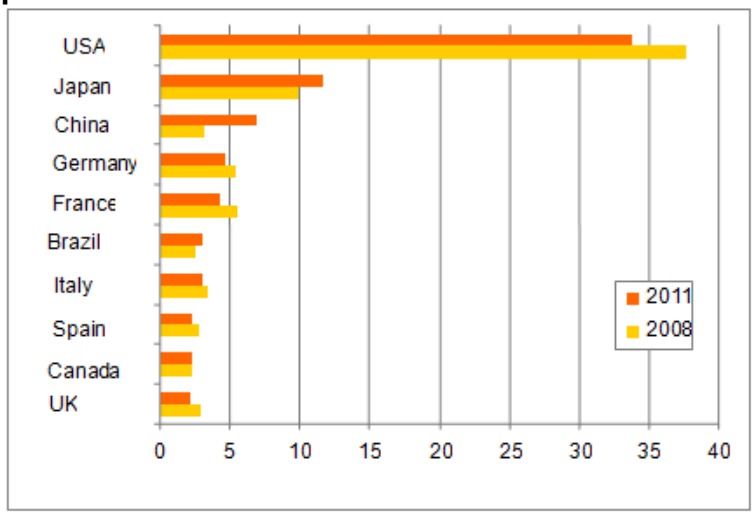


Source: OECD, STAN Database for Structural Analysis. – OECD, Business enterprise R-D expenditure by industry. -National Center for Science and Engineering Statistics. – Minister's Secretariat, Ministry of Economy, Trade and Industry (METI). – EFPI member associations (for Switzerland); quoted in Gehrke, von Haaren 2013b

In terms of internal R&D expenditures as a percentage of the production value, the UK and USA in particular have a high-intensity R&D of more than 20 per cent, whereas Germany is lagging far behind with around 11 per cent.

In terms of turnover, the German pharma sector maintained its global position as number four, behind the USA, Japan and China.

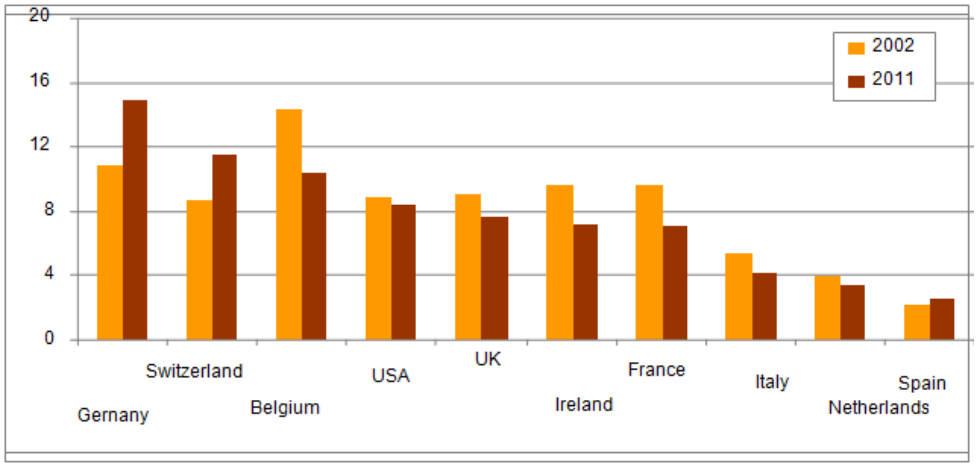
Table 31: Share of the global turnover of drugs, countries, 2011 and 2008, in per cent



Source: BPI 2012 and 2009 based on data of IMS World Review 2012 and 2009, quoted in Gehrke, von Haaren 2013b

But what is worrying is the fact that, together with the other leading European drug producer, Germany has lost market shares in favour of East Asian and American countries. This concern is very much fostered by the fact that the German pharma sector is highly focused on the global markets: more than two-thirds of the entire turnover comes from export. This picture will be confirmed by taking a closer look at the 10 countries with the largest export shares:

Table 32: The 10 largest export countries for pharma products, 2002 and 2011, as a percentage of the respective national turnover for pharma products



Source: Comtrade Database; quoted in Gehrke, von Haaren 2013b

The ten largest export countries for pharma goods are EU member states. Germany is the country with the largest export share and has been able to expand this share during the past years (11.0 per cent in 2002 up to 15.0 per cent in 2011), whereas Belgium has lost its top position since 2002. It is striking that, with the exception of Germany, Switzerland and Spain, the other top export countries have lost export shares in the last 10 years.

The overwhelming share (61.7 per cent) of the pharma goods exported from Germany goes into the EU (figures from 2011) – in 2002 this share was just 52.3 per cent.

Germany has improved its balance of trade in the sector for pharma products during the past few years: in 2002, import and export volumes were nearly balanced (at about 17 billion euros); the volume of exports was considerably increased between 2002 and 2011, by 17.5 per cent (imports only 13 per cent p.a.). As such, a positive trade balance of 14.5 billion euros was achieved in 2011. The majority of exports went into EU countries (in 2002: 52.5 per cent; in 2011: 61.7 per cent).

The German pharma sector's focus on foreign markets is evident when we take a closer look at their direct investments: similar to the chemical sector in Germany, direct investments in fixed assets were decreased from a 5.7 investment quota in 2000 down to 3.1 in 2011, but at the same time direct investments by German pharma companies abroad increased by 65 per cent.

In general, the pharma sector in Germany is benefiting (to date) from its well-qualified workforce (in the near future a shortage of skilled blue-collar workers will occur – see section 4.2), good conditions for R&D, and networks established between the basic pharma companies and the companies producing specialities. One of the cons is the laws and regulations in the public healthcare sector in Germany, which create uncertainties about planning and thus increase the risks for R&D in Germany.

What is remarkable – yet threatening at the same time – is the fact that none of the German pharma companies are in the global "top ten" – a very different situation to that of 10 years ago. But, again, the reality is more complex than it looks from the outside. For example, the pharma giant Sanofi is listed as a French company, when it is in fact comprised of the former pharma giant Hoechst/Germany, and the largest R&D investment made by Sanofi was in the Sanofi sites in the US and Germany.

According to representatives of the German pharma sector, the growth perspectives for the sector appear bright, despite the concerns. The main reasons for this are:

- the growing demand for pharma products due to the massive growth of the global drug market as a result of the growing population worldwide (emerging markets), the ageing population, particularly in Europe, Japan and China, and the increasing trend for unhealthy nutrition, which leads to an increase in the number of chronic illnesses. Parallel to this, new markets are emerging in developing countries
- the efficiency of resources and energy. Whereas the demographic change and the increase of so-called "diseases of civilisation" create new challenges, demands as well as opportunities for the pharma sector, the respective companies need to properly address shortages of resources and increasing energy costs
- the growing importance of biotechnology, which is even today a basis for special drugs. This line will have a bright future, especially in Europe, because of the fact that biopharmaceuticals (genetically modified drugs) are extremely effective against allergies and chronic illness. Unfortunately, the large German pharma companies carry out the R&D in this field mostly in the US
- the trend for "individual medicine/treatment" – i.e., a treatment concept that contributes very fast to an individual therapy plan. Individual medicine is only possible with the help of digital technology ("Digital Health Market"). Here, the concepts of "smart factory" (focused on the production level) and individual medicine come together. It is expected that the global digital health market (WLAN, Bluetooth, RFID) will grow from 60.8 billion USD to 135.9 billion in 2017 USD up to 233.3 USD in 2020. But in this field the pharma sector in Germany is a latecomer for the moment, with the large pharma companies in particular in a kind of "start-up fever"

Though the pharma branch is relatively independent from economic cycles, risks for the branch come from:

- the global financial crisis from 2008, the economic crisis and the Euro crisis, which led to public budgets (also for health) shrinking. This policy promotes the production of generic and "parallel imports"
- the relocation of the production of "mass" drugs into low-labour-cost countries,
- demographic development could lead to a lack skilled blue-collar workers (Facharbeiter) – as is the case for the whole manufacturing industry

- and the restrictive (reform) public health policy overall; e.g., AMNOG regulation[13], which leads to uncertainty amongst pharma companies in terms of the stability of the framework as well as cost pressures. As (health) laws and regulations are always additive, these laws are somewhat contradictory.

What is the reaction of the pharma sector in Germany in the face of these risks/challenges?

- In recent years, there has been a trend towards the strategies of company merger and license takeover. Implementing this horizontal and vertical integration leads to reduced costs and increased product range.
- Due to the pressure on production costs, more and more drugs are produced in (low-labour-cost) countries inside[14] and outside[15] of the EU. Consequently, ever-larger volumes of drugs are being transported, which requires a globalisation of delivery chains and complex management
- Parallel to this, production becomes more flexible, with producers expected to react more quickly to market changes
- Not only parts of the production are being relocated, but R&D, as the core of the pharma sector, too, especially to China and India
- Companies try to meet these challenges by launching more complex production strategies but because of this international cooperation, competition and exchange, the importance of intellectual property rights is becoming increasingly evident
- But despite of these trends, the experts emphasise that R&D in the field of active pharmaceutical ingredients and the production of special drugs will mainly be kept in Germany for the future

4.2. Employment and training support[16]

Its comprehensive approach means that “industrial policy” comprises topics such as “education”, “qualification” and “labour/labour market” as well. Educational policy and active labour market policy are integral parts of industrial policy.

Consequently, before presenting results for employment and training support, which also covers the topics “labour force” and “manpower”, we should take a brief look at the schooling and vocational training systems in Germany as a basis for employment and training support. In order to manage the challenge of knowledge-based production in the future, the education and qualification of employees is (or should be) increasingly in the focus of companies and state institutions.

[13] ANMOG: Since 1 January 2011, new licensed drugs with new active ingredients must be *immediately* evaluated in terms of additional uses, as soon as they are distributed to markets.

[14] Ireland is the second largest producer of drugs in Europe because of low labour costs, but once the current patents expire, the profits coming from drug export will collapse.

[15] India has become one of the largest producers of active ingredients worldwide, as a result of its 70 production sites having been approved by the FDA (= US Federal Drug Agency, which sets global standards). Currently the purity of some of these ingredients has come under scrutiny, but this seems only to be a transitional problem.

[16] See Gehrke, B.; von Haaren, F. 2013a and 2013 b; Vassilidades o.J.; VCI 2014; ZEW, NIW 2014.

Though Germany in the last years has spent more on education (in 2011, public expenditure in this field was 9.7 per cent of overall public spending), this share is behind the UK's and US's share of above 11 per cent each.

Responsibility for the German educational system lies primarily with the states (*Länder*) while the federal government plays only a minor role in this field.

Optional Kindergarten (nursery school) education is provided for all children between two and six years of age, after which school attendance is compulsory. The system varies throughout Germany because each state (*Land*) decides its own educational policies (schools, universities etc.).

School system

Most children first attend primary schools (Grundschule) from the age of six to ten.

German secondary education includes five types of school. The *Gymnasium* is designed to prepare pupils' education and finishes with the final examination, Abitur, after Grade 12, in most cases year 13. The *Realschule* (secondary modern school /superior grade) has a broader range of emphasis for intermediate pupils and finishes with the final examination, MittlereReife, after grade 10; the *Hauptschule* (secondary modern school /lower grade) prepares pupils for vocational education and finishes with the final examination Hauptschulabschluss. Consequently, there are two types of Grade 10: the higher level, type 10b, and the lower level, type 10a; only the higher-level type 10b can lead to the *Realschule* and this finishes with the final examination *MittlereReife* after Grade 10b. This new path of achieving the *Realschulabschluss* at a vocationally oriented secondary school was changed by the statutory school regulations in 1981 – with a one-year qualifying period. During the one-year qualifying period of the change to the new regulations, pupils could continue with class 10 to fulfill the statutory period of education. After 1982, the new path was made compulsory.

This trinomial German school system ("Hauptschule", "Realschule", "Gymnasium") is gradually being replaced by two school types, the *comprehensive school* ("Gesamtschule/Stadtteilschule"), and the "*Gymnasium"*. This action was taken in response to the shocking results of the OECD comparisons of school systems, in particular of the "PISA" Study, which gave the German school system a bad ranking.

There are also special schools for promoting learning-disabled children "*Förderschulen/Sonderschulen*". One in 21 pupils attends a *Förderschule*. Nevertheless, the *Förderschulen/Sonderschulen* can also lead, in special circumstances, to a *Hauptschulabschluss* of both type 10a or type 10b, the latter of which is the *Realschulabschluss*. Meanwhile, these school types are losing importance the system of "inclusion" makes special schools obsolete (this differs from state to state).

As mentioned above, the mainstream trend is for a comprehensive-school education (Gesamtschule).

Even today, many German children only attend school in the mornings. There are usually no provisions for serving lunch. The amount of extracurricular activity is determined individually by each school and varies greatly; however, an increasing number of all types of schools are starting to offer not only lunch but lessons in the afternoon as well.

Some of the main criticisms are that the German school system is:

- anatomised (16 different politics by the 16 states)
- closed, in that it does not integrate migrants and children from lower classes

Higher Education

Many of Germany's hundred or higher-education institutions (universities, universities of applied sciences ("Fachhochschule") and others (such as academies) charge little or no tuition by international comparison. The usual practice is for students to prove through examinations that they are qualified.

In order to enter university, students are, as a rule, required to have passed the *Abitur* examination; since 2009, however, those with a *Meisterbrief* (master craftsman's diploma as the last step of vocational training schedules, see below) have also been able to apply. Those wishing to attend a "university of applied sciences" must, as a rule, have *Abitur*, *Fachhochschulreife*, or a *Meisterbrief*. Lacking those qualifications, pupils are eligible to enter a university or university of applied sciences if they can present additional proof that they will be able to keep up with their fellow students through a *Begabtenprüfung* or *Hochbegabtenstudium* (a test confirming excellence/above average intellectual ability).

In the last years, because of the prospect of a future shortage of qualified workforce and the enhanced qualification demands because of new technologies etc., many companies have added to the apprenticeship system (see below) a so-called "Duales Studium" = dual study. This combines study at a university/vocational academy with regular internships in a company or even an apprenticeship in a company. A precondition is that not only a university offers a place, but the company as well. There are four variations of this "Duale Studium".

The core of the German vocational system and one of the major pillars of German economy in general, particularly for manufacturing, is called the ***Dual System/***system of apprenticeship ***(=Duale Ausbildung*)*,** which allows pupils on **vocational** courses to do in-service training. This approach is held in high esteem by German society and is the driving force of the well-qualified workforce. It covers blue-collar as well as white-collar.

A dual education system combines apprenticeships (training) in a company and vocational education at a (state) vocational school in one course. As one part of the dual education courses, students are trained in a company for three out of five days a week. The company is responsible for ensuring that students get the standard quantity and quality of training set down in the training descriptions for each trade. The other two days per week are spent at state vocational schools (Berufsschule), to

widen the theoretical knowledge side. The apprentices, as company employees, are paid by the companies.

This system is practiced only in some European countries, notably in Germany and in Austria.

In the *Duales Ausbildungssystem* young German people can learn one of 356 (year 2005) apprenticeship occupations (*Ausbildungsberufe*), including doctor's assistant, mechanic, carpenter, dispensing optician or oven builder[17]. The precise skills and theory taught are strictly regulated and defined by national standards: all *Industriekaufmann* (industrial managers) will have acquired the same skills and taken the same courses in production planning, accounting and controlling, marketing, HR management, trade laws, etc. Coordination institutions are the federal institutes for vocational education/training (Bundesinstitut für Berufsbildung – BIBB), which do research and further development of vocational education/training.

After finishing these two to (in most cases) three years of education/training, the apprentices sit an exam, organised by the guilds and chamber of commerce, but also state-controlled.

This qualification is held in high esteem in Germany and is one of the two major gateways in Germany for securing a good job (school-to work transition). The second most important gateway is graduation from the institutions of higher education. It happens quite often that young people in Germany combine the two, first passing the system of apprenticeship and then studying at university.

Advantages of dual education

The apprentice is an employee of the company from the beginning and receives tasks according to his/her growing abilities. If a company is willing to enter into an employment contract with the apprentice following his dual-education, the company will get an employee who knows the company's workflow. The apprentice can also benefit from the knowledge of his/her more experienced co-workers in both hard and soft skills; he/she can develop his/her abilities and qualifications under real conditions. This enables him/her to gain the insight required to decide whether he/she would be willing/able to do this job quite early and not after exams. Furthermore, the apprentice earns money from the beginning.

Compared with other European countries with a high rate of youth unemployment, this system greatly facilitates the "school-to-work-transition" for young people. It provides not only a high level of vocational qualifications, but creates intrinsic motivation (identity) in young people to do the work to the best of their abilities and qualifications.

Problems with dual education

One problem comes from the fact that a growing number of pupils, after having left school education, are not eligible to enter the dual system. Very often these young people come from migrant families. So the task of education policy as a part of

[17] The pharma sector offers a wide range of different qualifications within the dual system, including "Chemikant, Pharmakant, Chemielaborant, Elektrotechniker, etc."

industrial policy is to tailor the migration policy much more closely to the standard requirements of education and qualification needs.

Moreover, although the dual education system is generally considered to be exemplary, an increasing number of young people – especially those who did not obtain a vacancy at a company – are taking vocational education and training (VET) courses at training sites and schools rather than in real companies. To counter this, the government considered making it compulsory for firms to take on apprentices. This idea, however, was dropped when the trade associations agreed to a voluntary training pact.

The reasons behind the shortage of places on dual education courses include:

- companies that take on apprentices have to comply with a large number of regulations
- the training itself is very expensive
- the requirements for several positions have become more complex and many school graduates do not provide a fitting level of education
- for the less complex positions, only graduates with a very low level of education are willing to apply, but they are not able to keep up with the course
- companies that are highly specialised (mostly SME) and thus are unable to train apprentices in all the required areas

Recently, some attempts have been made to overcome these difficulties, but as yet with no success. Two solutions put forward so far are “contractual education” (*Auftragsausbildung*) and state-run courses. The former would involve companies training apprentices whom they do not plan to employ; the contract would also not be an employment contract. The latter solution would involve training outside of companies, in schools and colleges.

In order to overcome these difficulties, the *chemical sector* (employers and trade unions) has achieved a collective agreement (from 15 February 2014), which guarantees a high share of apprenticeship training positions (related to the overall employment in this sector): employers in the chemical sector guarantee to offer 9,200 apprenticeships for the years 2014, 2015 and 2016 each. The first evaluation shows that this figure has even been exceeded.

In 2014, 9.367 apprenticeships were offered by chemical companies. Roughly 60 per cent of all companies in the chemical sector offer apprenticeships. In total 27,500 young people went through the dual system (an apprenticeship normally lasts 3 years). In 2014, about 90 per cent of all apprentices in the chemical sector who had passed their exam successfully were offered an employment contract by the respective companies (roughly 40 per cent on an unlimited contract; the other 60 per cent a time-limited contract).

A third system is the **further (vocational) qualifications schemes**, either offered by companies (in-company or with external academies) or by the state (very often by the Public Employment Agency, mostly for unemployed or those whose employment is in danger). Often these schemes are under critique for several reasons.

Let us look now at the circumstances in the two sectors we are interested in. If we take a closer look at the employees in the chemical sector in Germany, we see that these employees have a higher qualification level than those working in the overall manufacturing industry. In 2011, nearly 66 per cent of all employees in the chemical sector hold a (non-academic) vocational degree (dual system), compared to only 62.5 per cent in the overall manufacturing industry. As for employees with an academic degree, in the chemical sector in 2011 this share was roughly 50 per cent higher (14.1 per cent) than in the overall manufacturing industry (10.5 per cent). In general, the share of academics has increased by 3.5 per cent within 11 years (of all employees in the chemical sector). This trend towards more academic jobs is the same for the manufacturing industry, and for the whole economy in Germany.

As we have learned, the core of the vocational training systems within the German economy is the “dual system”. In the chemical sector in 2011, 66 per cent of all employees had successfully passed this scheme. On 30 June 2012 about 10,200 apprentices were employed in the chemical sector in Germany – the quota is a little lower than for Germany’s overall manufacturing industry. This difference could be explained by the fact that quite often in the chemical sector specialist companies (not listed as *chemical* companies, but as training companies) organise the training systems (dual system) but these apprentices are not counted under the chemical companies, but under the education sector.

There is a well-developed network of industry-wide training academies (a level beyond Higher Education) in the chemical sector.

If we look at the (vocational) qualifications schemes in the chemical sector, we can see that the expenditures of the chemical companies in this field rank second after the car sector. In 2012 (2006), expenditures for further vocational training in the chemical industries were 880 (700) EUROS per employee in the sector – the average expenditures in the manufacturing industry were 500 (450) EUROS (ZEW: Mannheimer Innovationspanel, quoted in Malanowski, N.; Brandt J.Ch. 2014, 18). Furthermore, the data indicate that efforts in this field have increased by 25 per cent in only 6 years (from 2006 till 2012).

But experts tell us that further qualification schemes within regular working time are not very common in either sector. Companies should be convinced, in their own interest, to introduce a *right* of employees to participate in these schemes.

The companies in Germany’s chemical sector have been promoting school and higher education since the1950s. In 2014, the funding amount for school sponsorship, scholarships for bright students and university sponsorship was 13.4 million euros.

Similar to the chemical sector, in the pharma sector we find a higher level of qualifications than in the overall manufacturing industry in Germany. In 2012, the share of employees with an academic graduation was double (23 per cent) as that for the overall manufacturing industry (10.5 per cent) due to the large investments for R&D in this sector. According to data, the share of employees in the pharma sector

holding a (non-academic) vocational degree (dual system) is with 60 per cent smaller than in the overall manufacturing industry (62.5 per cent).

Similar to the chemical sector (and in the overall manufacturing industry), the share of academics has increased by 5.0 per cent (of all employees in the pharma sector) within 11 years, compared to 2000; in the chemical sector the respective growth rate is 3.5 per cent and in the overall manufacturing industry 2.5 per cent. Similar to the chemical sector, the share of apprentices in the pharma sector (in total in 2012 4,050) was lower than in the overall manufacturing industry in Germany; the explanation for this has already been discussed in relation to the chemical sector. Compared with the year 2007, the share of apprentices of all employees in the pharma sector had increased by 9 per cent by 2012.

Coming to the further (vocational) qualifications schemes in the pharma sector, we can see, that the expenditures of the pharma companies in this field ranks third behind the car and the chemical sectors: In 2012 (2006) the expenditures for further vocational training in the pharma sector were 680 (880) EUROS per employee in the sector – the average expenditures in the manufacturing industry were 500 (450) EUROS (ZEW: Mannheimer Innovationspanel, quoted in Malanowski, N.; Brandt J.Ch. 2014, 18). In difference to the chemical sector, in the pharma sector the efforts in this field have been decreased by 23 per cent within 6 years.

Forecast till 2030

According to industrial associations and experts, the German educational system will become a decisive location factor in worldwide competition, as in the future the country will keep its rather good higher education system.

The school system needs to further promote the subjects of maths, computing, pure sciences and engineering – in Germany these subjects are called MINT. Furthermore, better coordination is urgently needed between the different school policies of the 16 states.

In parallel to this, the dual system will secure the need for good qualified workers (Fachkräfte). From now to 2030, participation further vocational training schemes will rise. This means that the share of academics will rise, and further vocational training schemes both in-company and external, will be improved. The opportunities for and willingness of employees to enter into lifelong learning will also increase.

One of the greatest challenges for the future will be demographic development in Germany.

Even if nothing happens in Germany´s labour market, in the long run Germany´s economy will experience a considerable shortage of skilled workers. This will hit especially the manufacturing industry.

In order to address the shortage of qualified employees, additional potential will come from increased integration of women and elderly persons (rise of pension age to 67 years) and migration of skilled workers (net migration of 200,000 skilled workers annually).

In 2014, the (average) number of employees in Germany was 42.6 million (unemployment rate 7.2 per cent in 2014). Even if all of the above-mentioned

measures were implemented, by 2030 the number of employees will have decreased by 2.9 million, and the unemployment rate will be 3.7 per cent. This is more or less a situation of full employment. And for the year 2030, it is forecasted that GDP will rise by 30 per cent compared with 2011. That means that fewer employees will be producing a much higher GDP.

What does it mean for the chemical sector till 2030? Because of the predicted rise in productivity, more efficient structures and an increased number of outsourcing processes, this sector can reduce its need for a qualified workforce by 50,000 employees. This means an annual reduction in the demand for workforce by 0.6 per cent – which may be achievable. In any case, there will be a shortage of blue-collar workers in particular – not as much in the case of academics.

Because the share of academics in the pharma sector is higher than in the chemical sector, the pharma sector will not suffer too much at the hands of the predicted shortage of skilled blue-collar workers.

Due to the fact that the salary levels are higher in both sectors than the respective levels in the overall manufacturing industry in Germany, both sectors are well equipped for “competition for the prime qualified workforce”. A disadvantage especially in the chemical sector is the high proportion of shift work due to the requirements of the production process. Often the introduction of flexible working hours and part-time work, and consequently the enhancement of the attractiveness of this sector, seems to be rather difficult here.

Furthermore, in both sectors as well as in the overall manufacturing industry, it is necessary to organise a good transfer of knowledge between older employees and new entrants in companies. In this instance, calling upon this “experience knowhow” calls for a transition to a flexible age limit as well as flexible working hours and good remuneration for older staff members.

Though, for example, the age structure in the pharma sector is better than that in the overall manufacturing industry, in 2012 the share of employees in the pharma sector who were older than 55 years was 13.6 per cent[18].

Challenges for the German education and training system

With the demographic developments and increased demands from the (global) markets, companies need to implement modern human resource management/policies (HRM). These should cover not only employee qualifications, motivation and performance, but also the need for participation and co-determination in companies. All this should be promoted by a modern education/training policy by the federal government and the states including an intelligent policy of migration (see the above-mentioned comments on the growing numbers of pupils not eligible to enter the dual system).

[18]The general pension age in Germany has been increased from 65 to 67 years. This process was started in 2012 and will be completed in 2031

4.3. Promoting R&D and innovation[19]

R&D, as the heart of innovation, can and should be conducted by companies as well by universities and other research institutions. Consequently, innovation policies should be outlined by companies *and* politics. A well-organised innovation policy is a major precondition for the creation of clusters (horizontal as well as vertical). As such, we use the term *innovation* very broadly, as comprising the entire innovation process, from the creation of new products, the production process (e.g., the concept of "smart factory") and distribution of products and services into markets.

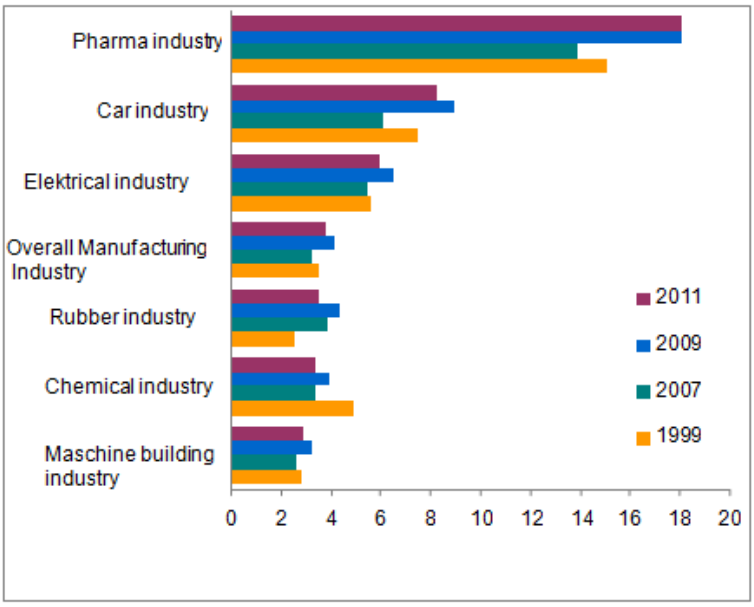
According to the *Innovation Indicator 2014* (Deutsche Telekom Stiftung 2014), Germany is ranked number six worldwide with 56 points (behind Switzerland – 76 points, Singapore – 65 points, Finland – 60 points, Belgium- 56 and Sweden – 56 points). Germany started its catching-up process in this field in 2005 (when it was ranked number 10). In 2013, Germany ranked number three, but then fell back. After 2010, Germany saw less venture capital investments, a less dynamic international patent application and sluggish growth of companies' R&D expenses. The government's contribution toward innovation performance was increased, and in 2014 Germany ranked number eight in this field. This was achieved through intensified efforts in the field of education and increased financing for scientific research. The only area in which the government is reluctant to step in is that of companies' R&D (e.g., granting tax relief for R&D).

Now we will take a closer look at the two branches we are particularly interested in. A comparison of R&D expenses for the chemical and pharma sectors with other manufacturing sectors in Germany enables us to draw two conclusions:

a) the pharma sector as a research-intensive sector is well above average for the manufacturing industry (actually at the top), showing a rise compared to the year 1999
b) the chemical sector is below this average, showing a decrease in 2011, compared with the year 1999

Table 33: R&D expenses as a percentage of the turnover from its own products, Germany, 1999, 2007, 2009, 2011

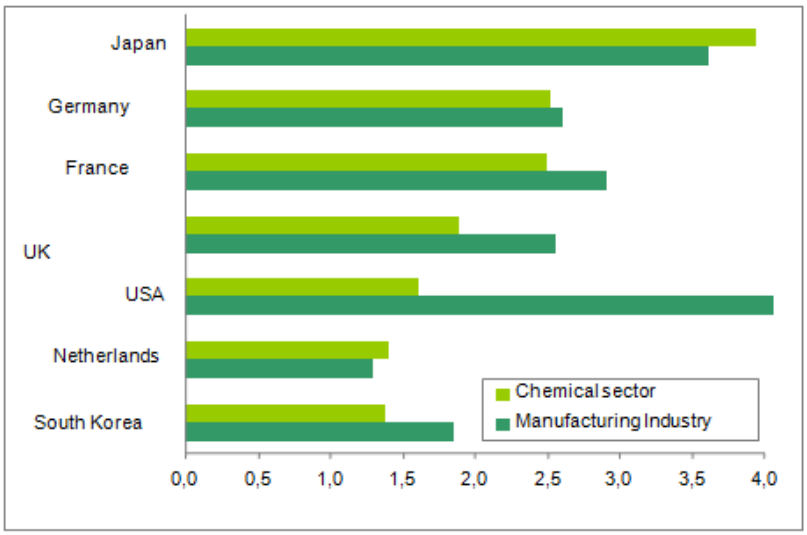
[19] See VCI-Prognos-Studie 2014, VCI 2014b, Gehrke, B.; von Haaren, F. 2013a and 2013b, VCI-Oxford Economics Study 2013, Vassilidades, M.o.J., IGBCE 2012 and 2013, EFPIA 2012, Sauer, D. 2014, Hessman, T. 2013, Hirsch-Kreinsen, H. 2014,Buhr, D. 2014, BITCOM, Fraunhofer IAO 2014, Deutsche Telekom Stiftung 2014, BMBF (Federal Ministry of Education and Research) 2014; Malanowski, N.; Brandt J.Ch. 2014;VCI 2014; ZEW, NIW 2014



Source: Gehrke, B.; von Haaren, F. 2013a

An international comparison, however, reveals a more positive outlook for the *chemical sector* in Germany.

Table 34: R&D intensity in the chemical sector/overall manufacturing industry in selected countries, 2010



Research intensity = share of R&D expenses of the production value
Source: OECD, STAN Database for Structural Analysis, Business enterprise R-D expenditure by industry. National Sources, quoted in: Gehrke, B.; von Haaren, F. 2013a

Though the chemical sector in Germany is not very research-intensive compared with other branches in the country, an international comparison shows that the R&D intensity of the chemical sector in Germany is ranked number two worldwide, just behind Japan.

Nearly 24,000 employees work in R&D for the chemical sector – with 5,000 of them employed by BASF in Ludwigshafen, the largest chemical company in the world. In 2013, the German chemical sector spent 4.0 billion euros on R&D.

With regard to international patent applications in the field of chemistry, Germany ranks third with a share of 15 per cent, though has fallen behind Japan in recent years (for 2011).

R&D in the chemical sector is today becoming increasingly internationalised. About one-quarter of all R&D expenditure by German chemical companies is for locations abroad.

The share of the 15 largest chemical companies in overall R&D expenses of the chemical sector in the OECD countries rose from 16 (in 2005) to almost 21 per cent (in 2013). The majority of this growth was a result of mergers, acquisitions and the expansion of R&D at locations abroad.

There are special R&D programmes by the federal government for the chemical sector as part of industrial policy; for example, the IGF (Industrielle Gemeinschaftsforschung), Go-Inno, CIM and CIS. Some of these programmes are for the whole economy.

There exists a scenario for the chemical sector in Germany which assumes more incentives by industrial policy to promote R&D (VCI-Oxford Economics Study 2013). If R&D expenditures by companies were tax-deductible, R&D intensity would increase from 2.5 per cent in 2013 up to 3.5 per cent in 2018. As such, after some years, new products will not only be developed, but introduced into the market. The export shares would be stabilised and this could well stop the current downward tendency.

In total, the companies in *the chemical and pharma sectors* spent 17.5 per cent (= 10.5 billion euros and 44,500 researchers) of all R&D expenses for the overall manufacturing industry in Germany in 2013. This is far more than the turnover share of these two sectors. Today, however, we are seeing an increase in relocation of R&D (parallel to that of production sites); according to Deutsche Bank (2013), the global market for relocated R&D will grow from 8 billion euros in 2012 to 20 billion euros in 2020. Host countries are mainly India and China.

Because of the EU restrictions, larger companies are shifting their research centres for future products to countries outside of the EU; for example, BASF has relocated its Green Tech Research Center (GMO) to Canada.

But according to our expert interviews, the research for active pharmaceutical ingredients (agents) and for special drugs will be kept in Germany.

One of the strengths of R&D in Germany is the *collaborative research*; i.e., cooperation between companies, universities, other research institutes (e.g., Fraunhofer, Max-Planck, Helmholtz, etc.) and hospitals, and within regional clusters (e.g., excellence cluster M^{4}Munic, Rhein-Neckar, Berlin).

In general, the German Government is supporting innovation through its “High-Tech Strategy”.

An obstructive factor to the implementation of this and other strategies is the partly technique-hostile stance of the public. The chemical sector has a public image as an industry using “dangerous” ingredients and producing unknown products for the broader audience; and the pharma sector is suspected of selling its products to customers/patients for exorbitant prices – overlooking the fact that pharma product sales/prices are commanded by public health policy under what some experts refer to as a “planned economy”.

In both the chemical and pharma sectors, only a joint effort by all three main actors – companies/industrial associations, trade unions and policymakers – could bring more objectivity into the public discussion in order to reduce public prejudices.

What is also worrying for both sectors is the low propensity to invest. The chemical sector is a very capital-intensive industry that needs regular real investments. But since the beginning of this century, the propensity to invest has been weakening considerably.

A specificity of the *pharma sector* is its dependency on the regulation by the public health policy. In Germany, as in other EU member states, the public price policy is very restrictive and spending budgets have been cut in the past, with negative impacts on R&D in the pharma sector. Additional regulations and clinical studies not only cause additional costs but extend development times. Together, these factors lead to increasing costs for R&D, making it unattractive for pharma companies to conduct research. Consequently the innovation capability of this sector is endangered.

The federal government has long-standing programmes to promote R&D in this sector, especially in the fields of development of new drugs and active ingredients. The Federal Ministry of Education and Research has developed different promotion tools (BMBF 2014):

- projects such as individual medicine, drugs, therapy, etc.
- structures such as high-level cluster competition, biopharma competition, etc.
- support of research institutions such as Helmholtz, Fraunhofer, Max-Planck, etc.
- complementary formats such as start-up initiatives, biotechnology, SME, innovative biotechnologies, etc.

This is accompanied by the EU research programmes (Innovative Medicines Initiative Joint Undertaking, IMI-JU, Joint Programming Initiative Antimicrobial Resistance (JPI AMR) and the Horizon 2020 programme (themes: “Health” and “Health, Demographic Change and Wellbeing”).

What should be done by industrial policy, promoting R&D in the pharma sector, according to some experts?

- Creation of sustainable/reliable framework conditions (public health policy)
- Tax relief for R&D, especially for SME (big pharma companies like Bayer, Boehringer-Ingelheim and Merck-Darmstadt are not as dependent on this, and furthermore, the larger companies are outsourcing R&D risks to SMEs)
- Promotion of venture capital
- Promotion of framework conditions for transfer of knowledge between companies, universities and other research institutes and within regional clusters (collaborative research) – this transfer of knowledge should comprise the (time-/project-limited) exchange of researchers
- Simplification of the application process to give SME a chance to participate in this field, accompanied by a resolving of the numerous programmes
- Improvement of technology transfer
- Promotion of public acceptance of this sector (first steps have been done by introducing the "Health Satellite Account" (Gesundheitssatellitenkonto), which indicates the direct and indirect welfare effects induced by the pharma sector)
- Coordination between public health policy and R&D policy.

The pharma companies themselves should strengthen their cooperation with universities/other research institutes and develop a kind of "stock exchange" to identify partners for further development of innovations (outsourcing of licenses).

A look at the *future innovation* trends for the *pharma sector* in Germany suggests that the focus of R&D will be on cancer and Alzheimer's disease, as well as on infectious disease, cardiovascular disease, diabetes, stroke and other thromboses-related diseases. Moreover, a trend towards "personal medicine" can be observed. This is a concept involving treatment that contributes faster to appropriate therapy for the single patient.

As for the *future innovation* trends for the *chemical sector* in Germany, a positive incentive could come from the exit of nuclear and fossil-fuel energy in Germany – the so-called "German Energiewende" (see section 4.4. below), which, although risky, is at the same time an opportunity for the chemical sector. Because of this, there is a rising demand for high-quality chemical products as upstream products for other sectors (electric mobility, windmills, solar panels, housing insulation).

In addition to this, another major innovation trend can be seen in the fields of health and nutrition as well as in pre-products for green gene technique and biotechnology.

Excursus "Smart Factory/Industry 4.0"

The concept of *"Industry 4.0"* promotes the computerisation of the manufacturing industry. The goal is the creation of the intelligent factory (Smart Factory), which is characterised by adaptability, resource efficiency and ergonomics as well as the integration of customers, business partners and value processes. The technological bases are cyber-physical systems and the Internet of Things.

Experts believe that Industry 4.0 or the fourth industrial revolution could become a reality in about 10 or 20 years. The IT sector in the US is trying very hard to obtain

global leadership for Industry 4.0, which means that the manufacturing industry worldwide might become the sub-sector of the IT sector in the US, which has launched an initiative known as the "Smart Manufacturing Leadership Coalition". This SMLC, as a non-profit organisation of IT and technology companies, manufacturing practitioners, suppliers, universities, government agencies and laboratories, aims to enable stakeholders in the manufacturing industry to share an infrastructure that facilitates the broad adoption of manufacturing intelligence. The US Government spent 1.6 billion euros in 2013 to promote this concept; China plans aid of 1,200 billion euros in this field.

Though this type of initiative is not commonplace in Europe, the opportunities for German industry to benefit from Industry 4.0 are promising. With German Government programmes (total budget of 200 Mio euros) and events such as the annual CEBIT fairs in Hanover, this concept is very well-known in Germany. A study by the High-Tech Sector Association BITCOM and the Fraunhofer research institute shows that Germany in particular, as the largest economy in Europe and its well-elaborated network of manufacturing industries, will benefit very quickly from this trend. Companies that adopt this concept will increase their productivity by 30 per cent.

From 2013 to 2025, the gross value added as a result of the implementation of "Industry 4.0" will be increased by 267 billion euros. The *chemical sector* alone will benefit from that, with additional growth of 13 billion euros.

A new study clearly shows, however, that the concept of "Industry 4.0" is only just starting to be implemented in the chemical sector in Germany (Malanowski, N.; Brandt J.Ch. 2014). Furthermore, this concept does not play such an important role in the chemical industry as it does in other sectors of the manufacturing industry. The reason for this lies in the nature of the production processes[20].

4.4. Energy[21]

A sustainable industrial policy should also comprise the fields of energy (costs, CO_2-emission & energy efficiency), as energy costs and reliable energy supply will greatly determine global competitiveness for the manufacturing industry.

We will first take a brief look at energy transition policy in Germany ("German Energiewende"), which means a switch from nuclear and fossil energy to renewables and efficiency. There have been and will continue to be controversial discussions about the pros and cons of this move, the legal core of which lies with the

[20]The platform "NAMUR" could offer a link to "Industry 4.0".The Namur platform is an international association of companies with a focus on automatization techniques to be implemented into the productions process (https://books.google.de/books?id=QcI17oxBGTIC&pg=PA765&lpg=PA765&dq=Plattform+Namur&source=bl&ots=cVBL1Lx5Q3&sig=gQLKFqzEdmSCZdU2ws6_5sBX5QM&hl=de&sa=X&ei=p1rnVNijJsS0UYm_gpgJ&ved=0CE8Q6AEwBw#v=onepage&q=Plattform%20Namur&f=false)

[21]See VCI-Oxford Economics Study 2013, VCI-Prognos-Studie 2014, Gehrke, B.; von Haaren, F. 2013a and 2013b

"Erneuerbare-Energien-Gesetz" EEG (Renewable Energy Act), last reversed in August 2014 by the Grand Coalition in Germany.

The target of this policy is to increase the share of renewable energies (electricity) by up to 40-45 per cent in 2025 and to 55-60 per cent in 2035, from 25 per cent in 2013.

Two basic points have been fixed by this law:

1. The obligation of the grid owner to source electricity from renewable energy
2. The fees for supplied electricity should be floated market prices that are dependent from the current electricity price at the bourse

The end users of electricity must pay for the difference between the sales revenues of the EEG electricity and the fixed fees (this difference is called "EEG-Umlage" = EEG allocation).

The EEG allows exceptions for manufacturing companies with high energy consumption in order to reduce energy costs for these companies so that they can retain their international competitiveness. But for 90 per cent of all chemical companies in Germany (mostly SMEs) the EEG does not allow exceptions – they have to pay the full price.

The Federal Government has established a Monitoring Commission for the "energy move", whose four experts evaluate the annual report by the German Ministry for Economy and Energy. Their conclusion is that, because of the rise of productivity of the overall manufacturing industry, the energy costs per unit that companies in Germany have to pay are globally competitive.

Cons of the new energy policy

The fear of the German manufacturing industry, and in particular the *chemical sector,* being an energy-intensive sector, are due not only to the high energy prices but insecurity about energy supplies due to the planned switch-off of nuclear power plants in Germany by 2022.

In the chemical sector, US-based companies and production sites, with their widely used shale gas (fracking), are thus in a better competitive position than the German companies[22].

In Germany, the chemical sector uses roughly 25 per cent of the overall energy consumption of the whole manufacturing industry – oil, gas, electricity (the share of the output by chemical companies is 11 per cent of the overall output of the whole industry). The petrochemistry industry in particular is affected by high energy prices.

The cost burden for the chemical sector in Germany has risen, partly due to the energy policy since 2011(see above). Between 2000 and 2011, the share of energy costs for the chemical sector in terms of total gross production value was double (4.4 per cent) that of the share for the overall manufacturing industry (2.1 per cent) – but mostly coming from the production of basic materials and chemical fibre/plastic.

[22] See (ever-changing) price differences between US shale gas and "European" gas http://www.eia.gov/naturalgas/weekly/

There is a scenario about the future energy policy with its impacts on the chemical sector in Germany (VCI -Prognos-Studie 2014): An overstressing by high energy costs would damage the energy-intensive network of the chemical companies in Germany. Though some sectors, such as photovoltaic and windmill producers, will benefit from the “German Energiewende”, the German energy-intensive sector will be relocated to other countries. The added-value chains would be ruptured. By 2030, the damage to Germany’s national economy would amount to 440 billion euros.

On the other hand, the falling oil prices in 2014 helped the chemical sector to maintain a balance.

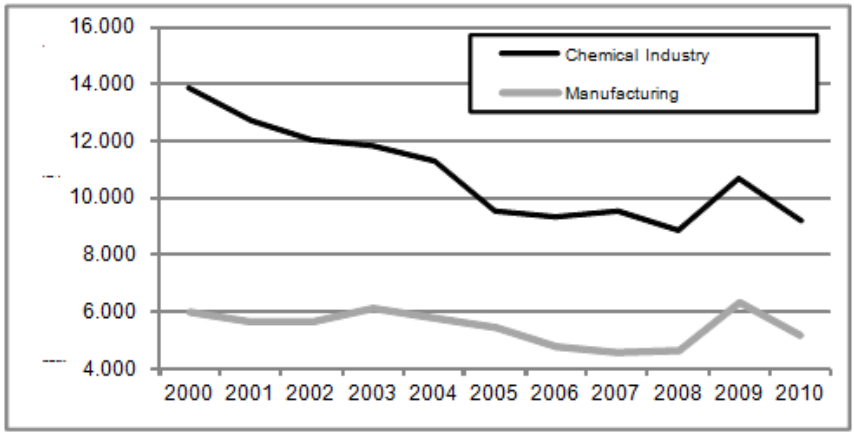
Furthermore, the large chemical companies are partially independent from the national grid/national energy policy, as they produce their own energy or the “chemical park” produces energy for its member companies (partly by using combined heat and power generation).

Pros of the new energy policy

In addition to the reduction of CO_2 emissions, the energy policy and its targets is more than just a cost burden; it opens new fields for business in the chemical sector; e.g., coating for houses, production of windmills, parts for photovoltaic.

Furthermore, energy efficiency in the chemical sector has increased disproportionally (i.e., energy intensity has fallen), thus reducing costs.

Table 35: Energy intensity in the chemical sector and in manufacturing, 2000–2010, measured in T Joule/billion euros



These figures include the chemical and pharma sectors. But as the energy costs of the pharma sector are very small (only 1.3 per cent of the gross value added), they do not have a major impact.

Source: AG Energiebilanz.- Statistisches Bundesamt, Volkswirtschaftliche Gesamtrechnungen, quoted in Gehrke, B.; von Haaren, F. 2013a

The energy intensity of chemical companies in Germany has decreased by roughly 40 per cent within one decade – much more than the energy intensity of the overall manufacturing industry.

By the year 2030, it is expected that the German chemistry sector will see a growth in production of 40 per cent, with energy consumption growing only by 8 per cent. This is not only an outcome of resource efficiency, but also a change in the production portfolio. In the future, an increasing number of superior-grade products will be produced, whereas the production of resource-intensive basic products will slow down, and increasingly pre-products will be imported.

In addition to the improved technical processes (which save energy consumption) and a change in product portfolio, the production of energy itself by chemical companies (e.g., through extended use of combined heat and power generation) saves costs, thus enhancing companies' competitiveness.

Parallel to this, the ongoing resource efficiency offers market opportunities for the German chemical sector as well. Chemical companies will increasingly become "solution providers", increasing their expenses for R&D in the special chemistry by 100 per cent by 2030 (see chapter 4.3). Furthermore, new products such as bio-based chemicals from microbial biomass are becoming part of the strategies of the future, and industrial policy could assist here as well.

Demands by our experts are:

- to achieve real consensus of all actors about energy policy
- to secure energy supply in the face of the unsteady supply of electricity coming from renewable energy (particularly wind energy and photovoltaic)
- to organise energy (electricity) supplies especially for SMEs for reasonable prices
- to coordinate a European policy for grids (in terms of laws and technique) and energy (creation of a European-wide level playing field).

In the German *pharma sector,* in addition to the health and nutrition areas, energy and resource efficiency are also future fields for growth. Though the costs for energy are not as high as those for the chemical sector, German pharma companies are disadvantaged by rising energy costs in comparison with their competitors from other countries. Consequently, innovations in the fields of processing and products that save energy and resources could provide competitive advantages.

4.5. Industrial Policy in Germany and its implications for the chemical and pharmaceutical sectors – a summary

A positive factor is a common/basic understanding about the necessity for industrial policy amongst all of the political parties in the *current* German Parliament (Deutscher Bundestag), though with different views within different political parties.

Before going into detail for the two sectors, we would like to highlight a few points that are important in terms of a modern industrial policy in Germany:

- The high share of the manufacturing industry in Germany is a traditional domain for the German economy. The value-added chains are in good order and shape
- Complementary to the regional economic clusters, there is a productive mixture of SMEs and large companies

- Productive interlocking of the traditional manufacturing industry and industry-oriented service is growing increasingly important and evident
- Key sectors of the overall manufacturing industry such as the car, machinery, and chemical sectors are the driving engine of the economy, alongside the less well-known sectors such as pharmaceutical, glass, paper, and plastic processing. In other words, *all* sectors of manufacturing are important and create the strength of Germany's economy –not only the high-tech sectors
- R&D expenditures by companies are rising in order to secure global competitiveness. But more and more SMEs are hesitating, for a variety of reasons, to invest in this field. Promoting R&D through tax relief for SMEs, as is common in other parts of the world (e.g., USA, Canada) should be considered as part of the industrial policy, as well as a simplification of the application processes (the first steps have taken in this direction by the EU REFIT programme, especially the chapter for simplification of processes for SMEs[23], but critics say that there is only a minimal impact)
- A globally oriented economy like the German one should not only foster export but should attract foreign direct investment by offering a good framework of conditions. What is currently attractive for FDI is the efficient R&D network, the highly skilled workforce, well-functioning labour relations and reliable laws and regulations
  The federal government tries to bring these advantages to the attention of the public by running advertising campaigns abroad such as "Invest in Germany – Land of Ideas", first launched in 2006 in the wake of the football World Cup in Germany[24]. Furthermore, the (public) federal agency "Germany Trade&Invest" (Bundesagentur für Außenwirtschaft and Standortmarketing)[25], handles the promotion of domestic industrial locations and of export
- The demographic change in Germany could lead to a shortage of skilled labour; industrial policy includes migration policy as well as education and qualification policies
- Energy and resource policies should be shaped by the leading ideas of sustainability and global competitiveness
- As one of the key drivers of Germany's economic and social progress, good labour relations within companies and at the trans-company level should be maintained and further developed to meet new challenges (e.g., from the IT sector)
- For Germany, "integrated industrial policy" not only covers innovation policy, labour market policy, public health policy, tax policy, education and qualification policy, but first and foremost better coordination between industrial policies at the national, regional (states) and local (cities, counties) levels

[23] See for further details http://ec.europa.eu/smart-regulation/better_regulation/key_docs_en.htm; for the SMEs simplification process in detail see http://ec.europa.eu/smart-regulation/better_regulation/documents/1_en_act_part1_v4.pdf
[24] See https://www.land-der-ideen.de/projektarchiv/invest-germany/invest-germany-land-ideas
[25] http://www.gtai.de/GTAI/Navigation/DE/trade.html

There are many elements of an industrial policy, already described in detail in the previous sections, 4.2 – 4.4. In addition to this, the following three tools of the industrial policy's governance strategy at the federal level should be mentioned here:

- The High-Tech Strategy by the German Government (Bundesregierung 2013, BMBF 2014b)[26], which is focused on sectors (including the chemical and pharma sectors)
  The Alliance "Future of the Industry" (BMWi 2014a). The target of this alliance, formed as a high-level group in November 2014 by the Ministry, industry associations and trade unions, is to define industrial policy according to the challenges of structural changes in the global economy. The partner of this alliance will establish a foundation "Zukunft der Industrie" (future of industry/manufacturing), to accompany the alliance scientifically, organising a citizens' dialogue and promoting the acceptance of industry/manufacturing by the broader public. The first meeting of the high-level group took place recently, on 3 March 2015 in Berlin

  Furthermore, four thematic workshops will be organised:

  1. Attractive Industry
  2. Investments and Industry
  3. Future of labour in industry and industry-oriented services
  4. Value-added chains in future (globalisation and digitisation)
- The sectoral dialogues (see below for details related to the chemical and pharma sectors) organised by the Federal Ministry of Economy and Energy (BMWi 2014b) for the various sectors of the manufacturing industry started in December 2014. Like the alliance for the "future of industry", the sector-based dialogues comprise the respective employers/industry associations, trade unions and the federal government. These dialogues are organised as a "three-step development":
  1. Public online consultations
  2. Expert discussions at the working level
  3. High-level group for the respective sector

There are also *regional* programmes of industrial policies by the 16 federal states (Bundesländer) and numerous *local* industry policy programmes (cities, counties), partly shaped by the national programmes, partly not.

Policy for the chemical sector

Let us look now at sector-specific issues, starting with the ***chemical sector:***

The sectoral dialogue for chemistry started already in 2010 (BMWi 2010), now revitalised by the new (since October 2013) federal government. Alongside the

[26] The new High-Tech Strategy by the Federal Government from August 2014 (a first attempt had been implemented in 2006) aims to speed up the process of commercialisation of creative ideas. In the year 2014 alone, 11 billion euros were invested for this. This new strategy is accompanied by a board, the members of which come from academia, economy and society. The two presidents are the CEO of the pharma company Boehringer-Ingelheim (also president of the Association for the Promotion of Science and Humanities in Germany) and the president of the Fraunhofer Society.

government's representatives, participants include stakeholders of this industry, mainly industry/employers' associations (VCI/BAVC) and trade unions (IG BCE). This new process started at the end of 2014 and it is as yet too early to evaluate any results.

A possible link for this dialogue could be the initiative "Chemie^{3}" (VCI, IG BCE, BAVC 2013) by the industry/employer associations and trade union to improve the production process and product/site safety.

National strategy "Bio Economy 2030" (BMBF 2010):

The chemical sector in Germany in particular is the increasing use of renewable raw material (in 2011 it was 12.4 per cent). Though the use of these materials is limited for some chemical production processes, the bio-based chemical sector should be promoted more actively through industrial policy (especially in the fields of R&D and broadening market demand) – EU industrial policy plays a role here as well.

The main location factors of the chemical sector, influencing the competitiveness of the respective manufacturing sectors, are costs for energy and basic materials, R&D expenditures by the sector, transport infrastructures, investments, currency exchange rates, taxation, costs for regulation and the density of industrial networks (VCI-Oxford Economics Study 2013). Based on this, experts from the chemical sector in Germany propose that the following points be implemented into a modern industrial policy (see previous sections, 4.2.-4.4., for more field-specific issues):

- Shaping the *energy policy*, together with a moderate *climate protection policy* (see chapter 4.4 for more details)
- Strengthening *innovation potentials* (see chapter 4.3 for more details)
- Maintaining and developing the *transport infrastructure*
- Promoting the *public acceptance of technology*
- Implementing a coherent investment acceleration law to organise the approval process for *new* production sites[27] quicker[28]
- Promoting the level of *qualification of employees* (see chapter 4.2 for more details)
- Sustaining the high quality of *labour relations* (good social partnership between industry/employers' associations and trade union)[29].

Pharma-specific issues of the industrial policy are:

1) *The sectoral dialogue for the pharma sector*, having been started in July 2014 (IG BCE 2015). Stakeholders/participants are as follows:
- Federal Ministry of Health (leading)

[27] If "Chemical Parks" already exist, the general licence applies for new factories within the area of this chemical park as well. Of course the limitations imposed by "REACH", etc., must be acknowledged.
[28] Although several laws exist in Germany to speed up approval processes in special sectors (e.g., offshore and onshore wind energy for building grids) and locations (for East Germany, to overcome the difficulties of the transition), a coherent and integrated law comprising the different legal competences of the federal government, the states (Länder) and the local level (cities and counties) is still missing.
[29] The centerpieces in this field are modern collective agreements (sector- and regional-related) with escape clauses; joint institutions like the Chemical Foundation for Social Partnership in Wiesbaden CSSA, http://www.cssa-wiesbaden.de/

- Federal Ministry of Economy and Energy
- Federal Ministry of Education and Research
- Companies
- Associations (BAH, Bio Deutschland, BPI, Pro Generika, vfa)
- Science (Fraunhofer IME, Helmholtz-Zentrum Munic)
- Trade Union (IG BCE)

This dialogue has two targets:

a) To strengthen Germany as a pharma location in the fields of R&D and production
b) To guarantee a countrywide supply of qualitative and safe drugs

The topics are:

a) Evaluation of the entire added-value chain
b) R&D for innovations
c) Regulatory framework
d) Trends and future fields in the drug sector
e) Future impacts for innovation, employment and production locations in Germany.

This national dialogue in the pharma sector is a mixture of working groups with experts and dialogue plenaries. The final conference with recommendations and expertise will be held in January 2016.

2) Beyond this dialogue at the national level, *sectoral dialogues* have already been organised at the regional level (states/Länder); for example, in Baden Württemberg (VCI Baden-Württemberg, Ministerium für Finanzen&Wirtschaft Baden-Württemberg, IG BCE 2013) and Hessen (Initiative Gesundheitswesen Hessen 2015). These dialogues are shaping regional industrial policy for the pharma sector in these regions.

3) As already mentioned, the pharma sector is very dependent on *public health policy*. The health systems in Europe are 60 to 70 per cent financed by public benefactors. As part of the consolidation of public budgets, health budgets have been shrunk as well. Parallel to this, public health policy is promoting generic and parallel imports. For the pharma sector, a positive factor is that the issues of “health” and “nutrition*” are at the top of* the agenda for public research institutions in Germany (Federal Ministry of Education and Research) as well as in the EU (Horizon 2020).

4) Furthermore, the *demographic change* in Germany has created higher demand for biopharmaceutical.

In light of the above points, the experts from the pharma sector in Germany propose that the following points be implemented into a modern industrial policy (see the previous sections, 4.2.-4.4., for more field-specific issues):

- Public health policy: Currently this policy is too oriented towards the prices for drugs instead rather than the issues of a country-wide supply of qualitative drugs. What is urgently needed is an integrated policy approach to overcome the fragmented views of the different actors in this sector. Furthermore, public health policy needs to be made more reliable. The continuation of the price moratorium beyond 2013 came as a surprise for the sector since the previous federal government had announced that the moratorium was time-limited. It has now been prolonged by the new federal government (grand coalition)
- Innovation: Only good interaction between product, process and structural innovations driven by R&D (done in companies and scientific organisations, supported by industrial policy) and accompanied by a "personal/individual drug treatment" can lead to a modern public health policy. The creation of vertical and horizontal clusters (both at local and regional levels) comprising companies (suppliers plus producers of final products) and research institutions should be given more weight through a modern industrial policy
- Promoting SMEs (e.g., through tax relief incentives for research), which currently are not able to finance R&D in such a way as to keep their products competitive – their products will increasingly be replaced by generic medicaments
- Simplification of the currently cumbersome licensing procedure for clinical drugs studies I-III
- Biotechnology: The majority of biotech companies in Germany operate in the field of biomedicine, a field in which Germany is one of the global players. It is the task of industrial policy to create social/public acceptance for biotechnology and develop a legal framework to promote R&D in this field
- As in the chemical sector, qualification of employees should be a main topic for politics as well as maintaining the framework for the satisfying/good labour relations between employers (associations) and employees (trade union)
- Important innovations in the health sector (for example, antibiotic resistances) should be promoted financially by the EU.

Last, but not least, the following table shows selected strengths and weaknesses of industrial policy in Germany, according to the experts interviewed[30].

Table 36: Selected strengths and weaknesses of industrial policy in Germany – the experts' arguments

Strengths	Weaknesses
• There is an industrial policy in place • There is an industrial policy focused on the chemical sector, especially R&D promotion and high-tech strategy (this does not	• Neglecting the infrastructure (e.g., traffic, transport) • No consistent/integrated industrial policy related to issues such as infrastructure, R&D, ecology (at present, ecology is

[30] The argumentations of the experts are contradictory to each other, according to their different roles

apply to the pharma sector) • Dialogue orientation of the new industrial policy (comprising all stakeholders) • Market orientation of industrial policy, related to the strength of the sector/companies • Industrial policy promotes the R&D networks of companies, universities and other research institutes • Predictability of legal decisions (so-called binding decisions/no time-limited permit of operation production) • Satisfying approval process for chemical companies	overemphasised) and to competences (federal/state/city and county levels) This applies especially to education policies (governed by the 16 states), which neglect whole groups such as migrants and children from socially disadvantaged milieus. Furthermore, the policy should promote the dual (apprenticeship) system more (fear: erosion of the dual system in the future) • No trans-sectoral approach within the industrial policy (comprising different branches/sectors) • No promotion of venture capital – Germany is a risk-avoiding country (according to current EU understanding) • No legal requirements by the industrial policy to ensure developing countries comply with intellectual property rights regulations • Badly implemented “German Energiewende” with high energy costs for domestic companies and high dependency on foreign energy sources • No efforts within the industrial policy to enhance public acceptance of chemical and pharma production • Public health policy (price-cutting, cumbersome approval processes for new drugs/clinical studies) is deteriorating the global competitiveness of pharma companies • No real strategy within the industrial policy to implement pharma products more rapidly into the markets • Fragmentation of the different tools of industrial policy (promotion programmes) – exclusion especially for SMEs • No tax relief for SMEs’ R&D in the

	pharma sector

5. Comments on learnings from the study

Both Germany and Sweden are countries that have been able to maintain strong manufacturing bases by combining industrial excellence with strong R&D performance, well-developed supply chains/industrial clusters, skills policies (dual learning in Germany) and workplace democracy. The challenges for the German and Swedish chemical and pharmaceutical sectors are the same, in the light of increased global competition. Industrial manufacturing is important to both countries and they are also dependent on large volumes of export.

5.1 Similarities and differences between the two countries

First, let us look at some data describing important indicators for Sweden and Germany:

Table 37: Economy and society in Sweden and Germany, selected indicators

	Sweden	Germany
General Data and Economy		
Population (1 January, 2014), in Mio	9.6	80.8
Gross National Product, per capita, 2013 **(EU-28 = 100)-Eurostat**	127	124
Export share in % of GDP, 2012-Eurostat	49	52
Global competitiveness Index 2014 **(WEF Global Competiveness Report 2014-15, ranking 1-148)**	10	5
Global Innovation Index 2014 **(http://www.globalinnovationsinex.org, ranking 1-143)**	3	13
Debts by the private sector, in % of GDP, 2012 (Spain: 195)	210	106
Taxes and Social Contributions, in % of GDP, 2012-Eurostat	44.2	39.1
VAT/Top Income Tax Rate, both in %	25/56	19/48
Sustainability: Share of renewable energy of gross energy consumption, 2011, in %-Eurostat (EU-27: 9)	36	8
Society		
Trade Unions: **-Trade union density, in % of all**		

employees, 2010 or 2011-www.stats.oecd.org (OECD: 17) **-Collective bargaining coverage - ICTWSS-2007-9 (UK: 33)** **European Participation Index, ETUI: www.worker-participation.eu (UK: 0.10)**	68 91 0.95	18 62 0.81
Equity and social justice: **-Gini-Coefficient, 2013-Eurostat (EU-28: 30.5)** **-EU Equity Index, Bertelsmann-Foundation (Greece: 3.57)**	24.9 7.48	29.7 6.55
Gender policy, ranking 1-142, Gender Gap Report, 2014 (UK: 26)	4	12
Global Age Watch Index, 2014	2	5
Trust in political and social institutions: - **Trust in the national parliament, EU-Eurobarometer 81, June 2014, in % (EU-28: 28)** - **Corruption Perception Index, www.transparancy.org, ranking 1-177** - **Governance Indicator, World Bank, govindicators.org, Highest +1.67 (Norway), lowest: -2.20 (North Korea)**	6 3 1.65	51 12 1.37
Well-Being, Happiness, OECD Better Life Index, ranking 1-36	3	14

Quoted in: MAASS 2015

A similarity for both countries is the integration of their economies in the world market and their export orientations. A difference between the countries is, first of all, the size of both sectors in the two countries; consequently, questions of competitiveness vary for each of the companies. To address these points, industrial policy in Sweden and Germany should be pinpointed to the specific conditions in both countries and not copied one by one. Another interesting difference highlighted during the desk studies and the expert interviews was the importance of the approval processes in both countries, related to the chemical and pharma sectors: apart from the approval processes for introducing a new medicine or chemical product (both are highly regulated by EU rules), the approval process for real investments does not appear to

be a big issue now for German industry (which was different 15 years ago), whereas for Sweden this kind of approval process is a big issue now.

5.2 What Germany can learn[31]

The Nordic countries are renowned for their well-developed social welfare states, well-organised labour markets, high level of social equality, good innovation systems (despite high incomes and high income/low corporate taxes), social partnership and high acceptance of the common good of societies.

But this Nordic model seems to be eroding, for reasons such as:

- Globalisation, technological change and climate change; e.g., Volvo Cars in Sweden and Nokia in Finland no longer exist as independent company brand names for their countries
- The fair distribution of income and wealth is eroding slightly as well. Though the Nordic countries have maintained their position internationally as the most fair countries (see the Gini-indices[32]), in Sweden in particular the wealth coming from manufacturing and finance is concentrated on a few families
- The increasing migration, with it challenges vis-à-vis integration not only into the labour market but into society in general

But even taking into account these erosions, there are still some crucial points that Germany and its industrial policy can learn from Sweden:

According to the Innovation Indicator in 2014 (see chapter 4.3), Sweden and Germany ranked as numbers five and six respectively.

Innovation ability = innovation policy

But the Index for Innovative *Ability* shows some differences between Sweden and Germany. In three out of four fields, Sweden does better than Germany:

- human resources (qualification of employees)
- structural capital (ability to implement knowledge into organisations) and
- relationship capital (ability to organise the transfer of knowledge beyond organisational boundaries) (Fagerberg, Fosaas 2014)

These three fields are important for the functioning of democracy and the development of innovations (e.g., social networks, trust in fellow human beings, acceptance of diversity, trust in organisations, a fair idea of social justice, good understanding of the common good of society).

[31] See also Fagerberg, Fosaas 2014, Buhr 2014, Maass 2015,
[32] In 2013 the Gini-coefficient was 24.9 for Sweden and 29.7 for Germany (EU-28 average 30.5) (Eurostat)

Social cohesion = social policy

In general, social cohesion in Sweden is higher than that in Germany. The single indices of the general Social Cohesion Index correspond positively with the amount of GDP and level of knowledge in a society (World Bank 2012). To conclude: The most innovative societies are characterised by a strong social cohesion.

Education policy

Firstly, Sweden's education policy, which forms part of the industrial policy, is not as much fragmented as that in Germany with the competences of the 16 states (= Länder). This more integrated education policy gives young people a much better chance on the labour market (national and international), and also addresses employers' demands for standardisation of education.

Secondly, pupils in Sweden are much better prepared for the schooling system as the pre-schooling systems are much better developed than those in Germany.

Last, but not least, the financial investment in higher education is greater in Sweden than in Germany.

Energy Policy

Although Sweden does not have an equivalent to Germany's "Energiewende", its energy policy is much more coherent and has long maintained the same long-term strategy – i.e., it is not abrupt, as it is the case in Germany. This policy provides for cheaper energy prices for the manufacturing industries and in particular for chemical and pharma companies, to enable them to maintain their (global) competitiveness.

5.3 What Sweden can learn

Industry in Germany, with its substantial share of the contribution to GDP, is seen as an important sector. The political interest for industry is higher in Germany than in Sweden. Ongoing dialogues with industry as well as the development and implementation of strategies are important to create good conditions for the chemical and pharmaceutical sectors.

An education system with close collaboration with the industry

The dual system and higher education are the best ways to secure a job in Germany. According to Eurostat, Germany has the lowest youth unemployment rate in the EU at 7.1 %, while Sweden has 21.6 % (Jan 2015). The German educational system eases the "school-to-work-transition" for young people. It provides not only a high level of vocational qualifications, but creates an intrinsic motivation (identity) amongst young people to perform work to the best of their ability and qualifications.

The education system in Germany is tailored to industrial needs. This has reduced youth employment and provided the industry with skilled labour. In the Duales *Ausbildungssystem*, young Germans can learn one of 356 (year 2005) apprenticeship occupations. A dual-education system combines training in a company and vocational education at a vocational school in one course. As part of

the dual-education courses, students are trained in a company for three out of five days a week. The company is responsible for ensuring that students receive the standard quantity and quality of training outlined in the training descriptions for each trade.

Because of the prospect of a future shortage of qualified workforce in Germany, many companies have added to the apprenticeship system a so-called “Duales Studium”. This means that young people, once they have completed their apprenticeship, are granted a scholarship by companies to go into higher education. During the universities’ vacation periods, the students work in the respective companies. Once they have graduated, students are required to work for these companies for at least five years. This has turned out well and the majority of these young people remain with the company after this compulsory period.

The interest for vocational education needs to increase in Sweden. Sweden can learn from the dual system of education and the well-developed collaboration between the industry and the schools.

Collaborative research in clusters

One of the strengths of R&D in Germany is the wide choice of possibilities for conducting collaborative research. Companies, universities, hospitals and research institutes (Fraunhofer, Max-Planck, Helmholtz, Leibnitz) cooperate in projects and networks, and within regional clusters (e.g., excellence cluster M4Munic, Rhein-Neckar, Berlin).

In Sweden, the tradition over the past 50 years has been to focus on universities as the main R&D operators besides the business sector. As such, the breadth and extent of the German institute sector far outweighs that in Sweden. There are almost no “Max Planck”-type basic research institutes in Sweden (61 in Germany with 13 000 in staff), few “Leibnitz” types (87 in Germany with 16 000 in staff), only a handful “Frauenhofer” types (59 in Germany with 18 000 in staff) and some “Helmholtz” types (17 in Germany with 31 000 in staff).

To summarise, the 20 or so research institutes in Sweden employ about 4 000, while the 240 in the four German networks employ close to 80 000. Moreover, and in sharp contrast to the situation in Sweden, the four German institute networks cover the whole range from very basic to very applied and niched research. Another contrast is that each of the German networks is equipped with considerable central professional resources for moving research results to innovation and results in the marketplace, in new as well as established firms of various sizes. Due to ownership and financial restrictions, such resources and results are very rare in the Swedish system. Finally, the German institutes are distributed between 30 cities with universities and roles as regional hubs. In Sweden, the vast majority operate from the Stockholm and – to a lesser extent – Gothenburg regions.

Policies focusing on "Mittelstand" in the manufacturing sector

Swedish manufacturing has for many years been dominated by large firms with a strong international orientation and largely Swedish ownership. During the last 20 years there has also been a healthy influx of new knowledge – based on innovating firms, especially in the ICT sector, that are demonstrating success on the international markets. As a result, Sweden has moved to some of the top positions in various rankings for innovativeness and achievements in innovation-related product, service and capital markets.

Today this is changing. The large firms are mainly parts of global concerns headquartered outside Sweden. Most of the successful newcomers have – often for good reasons – been acquired by foreign interests and capital. One result of these processes can be seen in the size and development of the "Mittelstand" of the Swedish manufacturing sector. For many years, Swedish industrial policy has aimed to focus on growth challenges in the Swedish "Mittelstand". However, results are historically meagre and there are few signs of improvement. Here, Sweden might learn from the German policy scene with its fundamental roots in well-established, resource-equipped local firm networks for "Mittelstand" that have power to collaborate with regional and national R&D and other resources in universities and research institutes. For the pharma and chemical sectors, where the general Swedish changes are very obvious, such learning seems to have great potential.

Learning from Germany might also influence how policy can meet challenges that are tied to possible consequences from changes in ownership. The German ownership culture seems, like in Denmark, much more supportive when it comes to keeping key ownerships under national control than the Swedish. Keeping more growing, or potentially growing, firms in "Mittelstand" under control of Swedish ownership for a business-relevant but prolonged period might fundamentally influence the job growth perspectives in many SMEs in "Mittelstand".

Approval process and environmental issues

Sweden has a well-elaborated system for handling environmental issues. There are 16 environmental quality targets outlining goals to be achieved in the near, or more distant, future. Each target has milestones and timetables. 25 governmental agencies have responsibilities in the system, separate or in collaboration. There is a parliamentary council supporting and monitoring the work, with the special task of focusing on questions where there are or could be conflicts of interest between societal, environmental and industrial views and goals. The 16 national goals are reflected into the regional and local arenas through various political and financial mechanisms. Among the 16 quality targets, there are a few that directly refer to production and use of chemicals and possible negative effects for humans and the environment.

The Inspection for Chemical Issues (Kemikalieinspektionen) is the central agency that grants approval and permission for the production, import and use of chemicals. The agency, which employs about 260 staff, is 80 per cent publically financed. There has been some discussion about the costs imposed on businesses by the agency's various activities but calculations show that the total cost represents less than 0.2 per cent of the sales in the Swedish chemical industry (not including the Pharma sector).

A more serious and current discussion is looking at the agency's lengthy processes for handling applications. Delays in the range of 3-4 years have been registered lately. The agency's explanation is that it had been seriously understaffed for years in terms of meeting the requirements of the new EU legislation with the conscious approach and quality that the agency's processes were set up to guarantee.

Recently, the agency has introduced new administrative processes that aim to significantly reduce the timeframes for handling applications; nevertheless, the government is not fully satisfied and has outlined the issue in recent annual regulations.

As for time delays and other issues related to environmental permits for industrial plants, these do not seem to be an issue in Germany. What can Sweden and the 25 involved agencies learn from Germany – without losing the key quality-creating parts in the process?

Ongoing work with industrial policy

In general, it appears to be difficult for the Swedish Government to realise overall polices that involve many ministries and really put actions into force. Sweden has no general industrial policy, but there are some strategies for some areas. Innovation is an important part of an industrial policy. When the OECD evaluated Swedish innovation policy, they pointed out the problems due to inertia in decision-making and that Sweden's innovation policy is a weak area compared with certain other policy areas such as education and taxes.

The German Government has a holistic approach toward strategies and works with the industry to create a good environment for companies. The High-Tech Strategy, the Alliance "Future of the Industry" and different sectoral dialogues (e.g., the sectoral dialogue for the pharma sector) are just some of the incentives through which the government works with different stakeholders to develop industry in Germany. There are also regional programmes for industrial policies in the federal states and numerous local programmes.

The Swedish Government has just launched an innovation council with the prime minister as chairman, and members from industry, universities and SMEs. It will be interesting to see whether the council really can influence the government and agencies as well as business actors to engage and take action – both separately as well as in collaboration – to further enhance global competiveness in Sweden.

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