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RIO Country Report 2017

The R&I Observatory country report 2017 provides a brief analysis of the R&I system covering the economic context, main actors, funding trends & human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data are from Eurostat, unless otherwise referenced and are correct as at January 2018. Data used from other international sources are also correct to that date. The report provides a state-of-play and analysis of the national level R&I system and its challenges, to support the European Semester.

Summary

In European perspective, the Swedish economy is robust and public finances are healthy, which breeds confidence and a favourable international reputation. Real GDP in Sweden grew by 3.2% in 2016, which is less than the previous year but well on average in a longer time frame, and expected to remain at the same level in 2017 but decrease somewhat in 2018 (EC autumn economic forecast 2017: 126-127). Sweden is a small and export-oriented economy with strong political and economic (trade) ties to its fellow Nordic countries, to continental Europe, to North America, and several countries and regions in the Third World. Its exposure to globalisation and shifts of balances of global productivity and trade makes the Swedish economy vulnerable, but with a highly educated workforce and generally friendly business climate, Sweden also has robust means at its disposal to meet the challenges of the current geopolitical and economic world order.

Challenges for R&I policy-making in Sweden

Improving the links between research and innovation. While the general performance of the Swedish R&D system on the supply is very good, there is a long-lasting debate concerning the alleged inefficiency of turning the heavy investments in R&D into innovation-based economic growth. For several years the governmental research bills acknowledge the need for increasing the links between research and innovation. In practical terms, the dominant approach has been to launch a series of supply-side measures, most of all a variety of funding instruments to promote cross-sectoral collaboration.

Reducing the dependence of BERD on multinational companies. Swedish GERD, while very high in international comparison, is dominated by the private sector, where, in turn, most R&D expenditure takes place in a relatively small number of very large companies. Policy efforts have aimed at increasing the level of investment in R&D among SMEs, the introduction of public venture capital, programs to increase collaboration between universities and firms and also university spin-offs, and a series of funding programs targeted at start-ups and innovation in SMEs.

Sustaining the high quality of the public research base. Despite the heavy investment in both education and research, signs have abounded for a long time that the supply of competence, and also the international competitiveness of the Swedish R&D system as measured in outputs, is stagnating or falling slightly. This is a policy challenge of great magnitude but also great complexity, and while it is acknowledged in governmental research policy documents, its remedy is a controversial topic.

Main R&I developments in 2017

- [Report on governmental support of innovation and enterprises](#)
- [Swedish "Research Barometer" document](#)
- [Governmental decision to set up six national research programs](#)

Smart Specialisation

The practical work on smart specialisation at national level is delegated by the government to the Swedish Agency for Economic and Regional Growth. A detailed instruction followed this decision, where the agency was assigned by the government the role of (1) supporting regional authorities in their work with S3; (2) assisting regional authorities with knowledge and overviews of national priorities and future competitiveness; (3) supporting regional authorities in their collaboration with the EU.

The Swedish Agency for Economic and Regional Growth also manages and distributes funding from the European Regional Development Fund on assignment by the government, which means that it is in charge of supporting smart specialisation on NUTS

2 regional level, which is not coherent with the organisation of Sweden in administrative regions (the 21 counties are the primary units and correspond to NUTS 3 regions, and 10 of them are nowadays called "regions" in an ongoing trial policy of increasing regional autonomy), whereas there are eight NUTS 2 regions in Sweden, one of which corresponds to a county (Stockholm), with the other seven consisting of between two and five counties/regions. This creates some difficulty of coordination and cohesion, and a certain imbalance in the level of implementation of smart specialisation strategies.

Foreword

The R&I Observatory country report 2017 provides a brief analysis of the R&I system covering the economic context, main actors, funding trends & human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data are from Eurostat, unless otherwise referenced and are correct as at January 2018. Data used from other international sources are also correct to that date. The report provides a state-of-play and analysis of the national level R&I system and its challenges, to support the European Semester.

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1 Economic context for R&I

In European perspective, the Swedish economy is robust and public finances are healthy, which breeds confidence and a favourable international reputation. Real GDP in Sweden grew by 3.2% in 2016, which is less than the previous year but well on average in a longer time frame, and expected to remain at the same level in 2017 but decrease somewhat in 2018 (EC autumn economic forecast 2017: 126-127). The main driver of growth in 2016 was domestic demand, but exports are expected to increase slightly in the coming years due to the continued economic recovery on Sweden's primary export markets, assisting continued growth and keeping unemployment down (at slightly above 6%) in spite of an expanding labour force. Inflation remains at slightly over 1% and still does not meet the target of 2% set by the Swedish National Bank (Riksbanken). Sweden is a small and export-oriented economy with strong political and economic (trade) ties to its fellow Nordic countries, to continental Europe, to North America, and several countries and regions in the Third World. Its exposure to globalisation and shifts of balances of global productivity and trade makes the Swedish economy vulnerable, but with a highly educated workforce and generally friendly business climate, Sweden also has robust means at its disposal to meet the challenges of the current geopolitical and economic world order.

1.1 Structure of the economy

The Swedish business sector's high performance builds on several decades of strength in high- and medium-technology sectors. In the second half of the 20th century, the Swedish business sector was dominated by a small number of large, domestically-owned industrial manufacturing companies. In the 1980s and on, deregulation, structural transformation, and globalisation enabled a gradual shift to today's internationalised market and business landscape, with many innovative and export-oriented firms active in a range of manufacturing sectors (automotive, aerospace, telecommunication equipment, pulp and paper, chemicals, pharmaceuticals, electrical goods) and a large and growing service sector. The latter nowadays accounts for roughly $\frac{3}{4}$ of the annual growth of the Swedish economy, and brandishes a significantly more dynamic structure than the manufacturing side of the economy, where a smaller number of very large companies still dominate. The longer-term trend is a shift of the economy away from traditional Swedish strengths in manufacturing (in automotive, aerospace, pulp and paper, and telecommunication) and towards service-orientation, significant diversification, and a greater presence of SMEs. While not showing any increase on short or medium term (the last decade), knowledge-intensive service sectors accounted for close to half of total employment (46.72%) in 2015, and 40.65% of the growth.

1.2 Business environment

Seen from a global and/or European perspective, the business environment in Sweden is favourable. It ranks 10th among 190 economies in the World Bank's "Ease of Doing Business" index (World Bank 2018) and 2nd among 127 countries in the Global Innovation Index (GII 2017), Sweden is way above the EU, G7 and OECD averages in both measures, with comparable countries such as Finland, Austria and the Netherlands behind. Also on the EC Digital Economy and Society Index (DESI), Sweden ranks very high with a 3rd place (among EU-28) only behind Denmark and Finland (DESI 2017).

Consequently, the business policy environment is good in international comparison and has also improved in recent years, according to some measures. The Swedish positions in "Starting a business" on the "Ease of doing business" ranking have improved considerably, from 32nd in 2014 to 15th place in 2016 (and 13th in 2017) (World Bank

2018, Dahlstrand et al 2017), and its position as 6th globally in the E-Government Development Index for 2016 marks a significant improvement from the position as 14th in 2014 (United Nations 2017). Especially in digitalisation and eGovernment, however, Sweden is only on par with, or slightly less prominent than, its Nordic neighbours and not always in the top tier of the ranking of EU member states (DESI 2017, Dahlstrand et al 2017).

2 Main R&I actors

The Swedish innovation system is characterised by a very large academic sector that is almost entirely publicly owned and that consumes more than two thirds of the governmental appropriations on R&D, and an R&D-intensive business sector dominated by a few very big companies.

Sweden's rate of investment in R&D is very high in international comparison – 3.25% of GDP (2016) – but roughly 2/3 of this is in the private sector and the remaining amount is very much concentrated to the universities. The few very large and R&D-intensive companies Volvo, Ericsson, Sandvik, SCA, Electrolux and AstraZeneca have a traditionally important position in the Swedish economy, also in terms of innovation and industrial renewal, that dates back to the Cold War era and the national security and enterprise policy doctrines of the time, that emphasised national self-sustenance by the maintenance of state monopolies on the demand side and industrial giants on the supply side. In the past few decades, the service sector has grown and dramatically increased its share of GDP (see above), and Swedish innovation capacity has also diversified significantly. Current policy efforts to reduce the dependence on large multi-national companies (MNCs) for innovation include government programs with support to startups and high-tech firms, and improving framework conditions for SMEs.

As noted, the public side of the R&I system is dominated by the universities, and there is only a marginal role for public research institutes of the type found in many other countries (Hallonsten 2017). The key governing documents for public sector research and innovation are the governmental *research bill* and *energy research bill* (both released every four years, last time in 2016), and the national innovation strategy which was issued in 2012 and provides overall guidelines for Swedish innovation policy up to 2020. In these and other governmental research and innovation policy documents, the message is often conveyed that the research and innovation system is in a relatively healthy shape but nonetheless in need of some trimming in order to secure Swedish long-term competitiveness, which is considered to depend a lot on strategic profiling and mobilisation in core areas such as materials science, life science, and climate research, and strengthening the rather weak interaction between academia and industry (see also section 4).

Historically, national Swedish public administration has been characterised by relatively small government ministries (in international comparison) and larger governmental agencies with responsibilities for specific policy areas. There are two major agencies in the R&I policy area, the Swedish Research Council (Vetenskapsrådet) and the Swedish Agency for Innovation Systems (Verket för Innovationssystem, VINNOVA), who both distribute funding for research and innovation in open calls and in specific areas and programs on instruction by the government. They are also important actors in providing policy advice to the government. The Swedish Higher Education Authority (UKÄ) is responsible for the statistics on the higher education sector alongside with Statistics Sweden (SCB).

Other important actors in the system are the Swedish Defence Research Agency, the Energy Agency, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and the Swedish Research Council for Health, Working Life and Welfare (Forte), all of which are important R&I funders and policy actors in their

respective domains. Especially Formas has received increased attention and a greater mandate after the 2016 research bill launched new initiatives in climate research.

The R&I funding landscape is complemented by a number of semi-public non-profit research foundations, most notably the Knowledge Foundation and the Foundation for Strategic Research, and a few private research foundations, among which the several Wallenberg foundations are especially noteworthy.

The Swedish governmental research budget is dominated by the institutional block grants to universities and colleges, which are still distributed mainly according to the historical/traditional faculty divisions. The long-term trend is, however, that such institutional block grant funding for research in the universities is in decline relative to third-party funding (Dahlstrand et al 2017; Engwall and Nybom 2007). Since at least the 1990s, there has been an ambitious reform agenda for the academic system, aiming at promoting university collaboration with other sectors, primarily business and public sector actors but also civil society, and to strengthen the competitiveness of Swedish research and make universities more active partners in the national innovation system. These ambitions to reform the system have been shared across the political spectrum and hence been implemented regardless of the political parties in power, and have turned universities away from their previous decentralised, traditional and rather rigid organisational structures towards a more entrepreneurial role in line with the fashions of innovation policy and research, although this transformation is far from completed and the universities bear strong traces of old organisational ideals. The 2016 research bill emphasised academic collaboration with society, partly in contrast to its predecessor bills whose focus rather laid on strategic specialisation and promoting excellence in research.

A parallel development to reshape the relatively small Swedish research institute sector was concluded in 2016 when three institute groups, formed during a two-decade process of mergers and reorganisations of several existing industry-specific institutes, were merged into the larger RISE – Research Institutes of Sweden, organised as a private enterprise but almost in its entirety owned by the government (Hallonsten 2017).

3 R&I policies, funding trends and human resources

Main R&I policy developments in 2017

Relevant document	Short description
Report on governmental support of innovation and enterprises - Swedish National Audit Office (01/2017)	<p>The Swedish National Audit Office delivered its report on governmental support of innovation and enterprises. It publishes the results of an appraisal of the activities of promoting innovation in the private sector through SME subsidies by three agencies: The Swedish National Agency for Innovation Systems (Vinnova), the Swedish Energy Agency, and the Swedish Agency for Economic and Regional Growth.</p> <p>The results, conclusions and recommendations of the Audit Office are of mixed character; while it states that the overarching goals of the three agencies are similar or identical, the programs studied seem to vary a lot in their specific goals and targets, which leads to a lack of coherence and overall sense of purpose of the Swedish government’s innovation support in the private</p>

	sector. It also mentions the lack of clear and concise criteria and methods for goal attainment of several of the programs.
<u>Swedish "Research Barometer" document - Swedish Research Council</u> (06/2017)	<p>The Swedish Research Council released the first version of the so-called "Swedish Research Barometer", an overall survey of Swedish research in international comparison, as measured through thirty indicators including bibliometrics and common quantitative measures such as those found in the Eurostat and OECD databases. The "barometer" report is naturally focused on the academic sector, since this dominates publicly funded R&D in Sweden.</p> <p>The conclusions in the report mirror the conclusions in this and previous RIO reports: with a comparably high level of investment in R&D and a high share of researchers, Sweden performs well in research and has an internationally-oriented research system.</p>
<u>Governmental decision to set up six national research programs</u> (05/2017)	<p>The government instructed the Swedish Research Council, the Swedish Research Council for Health, Working Life, and Social Welfare (Forte), and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) to set up the six national research programs envisaged in the 2016 governmental research bill in the areas of <i>climate, sustainable societal development, migration and integration, antibiotics resistance, applied welfare research, and working life research</i>.</p> <p>The ten-year programs are supposed to contribute to meeting societal challenges, and are complementary to the previously launched Strategic Research Areas (2018) and Strategic Innovation Programs (2012). Each program is funded with between €20 and €100 million over a ten-year period. The first two programs, in <i>antibiotics resistance</i> and <i>migration and integration</i>, were set up in June 2017.</p>

R&I funding trends

The GERD of Sweden remains very high in international perspective, and in 2016 it was the highest in the EU with 3.25% of GDP. The EU-28 average in the same year was 2.03%, and the second highest in the EU was Austria with 3.09%. The long-term development of the Swedish GERD as share of GDP is, however, decline: At the turn of the millennium, the figure was above 4%, and has dropped consistently every year since (Hallonsten 2014: 7).

As noted in a previous section, the average distribution of GERD among sectors is some 26% in the academic system, some 70% in the private sector, and the remaining 4% in the private non-profit sector and the non-academic public sector. This means that the R&D performed by universities and colleges is one of the highest in the EU, with 0.87% of GDP (2016), surpassed only by Denmark (at 0.91% of GDP) and well above the EU-28 average of 0.46%.

3.1 Public allocation of R&D and R&D expenditure

The quadrennial governmental research bills set out the direction for the most important developments in the allocation of public funds for R&D, and while they often launch new initiatives and point out new directions for research policy and funding, the broader patterns in the allocation remain largely intact, with some exceptions. This means that the dramatic increase in governmental funding for R&D in the years 2007-2014 was rather evenly distributed over the universities, the research councils, and the other funding agencies. Some of the money was earmarked for specific initiatives such as the Strategic Research Areas Grants, with a total budget of over one billion SEK, and in recent years the heavy investments in the new accelerator-based neutron scattering facility the European Spallation Source (ESS), under construction in Lund in Southern Sweden, also stand out in comparison with the overall allocation (Hallonsten 2015).

Attempts have been made to allocate parts of the institutional block grant funding to the universities through a performance-based scheme based on bibliometric analysis, and 20% of this funding stream has been redistributed with the help of this model since 2014, but the model has been subject to severe criticism.

Thus although the 2016 research bill had a slightly different focus than its predecessors (in part due to the 2014 shift in government), funding allocation remains largely intact. The largest share of public R&D expenditure (the institutional block grants to the universities) may be subject to internal redistribution but remains the largest overall budget item and is without exception subject to increases every year. In addition, the funding channelled through governmental agencies (research councils, VINNOVA, etc.) is also largely tied up in already determined programs and categories of support, such as the open calls of the research councils and the heavy investment in research infrastructure, with significant path-dependence. Moreover, with the period of 2007-2014 seeing the largest increases of governmental spending on R&D in a long time, with allocations to universities and public research-funding agencies increasing nearly 50% in this seven-year period (Hallonsten 2015: 419), quite naturally growth curves are now levelling off and the current trend is rather a consolidation of previous changes in priorities and funding distribution.

3.2 Private R&D expenditure

Also Swedish BERD as share of GDP stands out as very high in international comparison. It is the highest in the EU, 2.26% in 2016, and only Austria comes close, with 2.2%. The EU-28 average is 1.32% (2016). The business sector hence still stands for more than 2/3 of the total GERD in Sweden, in spite of the fact that BERD as share of GDP has been in decline in the past decade, from 2.74% in 2008 and 2.45% in 2009 (Hallonsten 2014: 7; Dahlstrand et al 2017). In real terms, however, there has been an increase of BERD in the past few years, and the decline as share of GDP is explained most of all by the high growth of the latter.

As noted in a previous section, although the scenery is under long-term change, the Swedish R&D-intensive industry is still dominated by large manufacturing firms in electronics, pharmaceuticals, automotive, aerospace and utilities. The telecommunications equipment company Ericsson, headquartered in Stockholm, stands out as the Swedish company with the heaviest investment in R&D, earning the 28th position among the most R&D-intensive companies in the world measured in real terms, although its position in this ranking has slipped 11 places since 2004 (JRC 2015a: 39). The automotive company Volvo ranks 61 on the same global list, whereas Sweden's third most R&D intensive company, Sandvik, is only on position 281. In the EU, Ericsson and Volvo ranks 9th and 19th among the most R&D-intensive companies across the board (JRC

2015b). The Swedish knowledge-intensive service-sector makes up a fairly large share of the economy, with 46.72% of the total employment and 40.65% of the GDP growth (2015), but shows a slight decline in both measures in the past two to three years.

A long-term incremental restructuring of the industrial sector in Sweden has been on the political agenda for at least two decades, shared across the political spectrum and more or less intact through shifts of government. It aims at reducing dependence on a small number of very large companies by supporting growth of SMEs in high-tech sectors and promoting the appearance of new, service- and knowledge-intensive companies.

A 2014 reform by the previous (centre-right) government launched a limited tax incentive scheme for small businesses hiring R&D staff, but Swedish governments (regardless of the party in power) continue to avoid broader tax credit schemes (Swedish Government 2015a). Recent efforts by the government to improve the financial conditions for start-ups and SMEs, in 2016, have been followed by an assignment by the government to the Swedish Agency for Economic and Regional Growth to make a concerted and targeted effort to promote new enterprises among immigrants (in January of 2017). A similar assignment to the same agency was to develop a model for shorter and more efficient procedures for the administration of enterprises (in July of 2017) (Swedish Government 2017a, 2017b).

3.3 Supply of R&I human resources

Although a small country highly dependent on exports, Sweden has a strong position internationally in terms of human resources for an innovative economy.

The number of new doctorates awarded per 1000 population aged 25-34 was 1.67 in 2015, which means that Sweden is surpassed by several European countries (Germany, Denmark, Switzerland, Slovenia, Norway, the UK, the Netherlands, and Ireland) but still above the EU-28 average of 1.07 (in 2013). The number of new graduates in science, maths, computing, engineering, manufacturing, construction per 1000 population is 2.09 (2015), slightly lower than the EU-28 average of 2.32, and consequently with 15 European countries ahead (including the UK, Finland, France, Austria, Denmark, and Germany), some far ahead, like Ireland with 3.62 and the UK with 2.98 (see also section 4.3 below).

The Swedish performance in these indicators has remained stable in the past decade. A high performance in education, from pre-school and all the way to tertiary education, has been a high political priority in Sweden and will continue to be an important issue not least given the challenges in this regard brought by immigration.

After having fallen dramatically in mathematics, science and reading in the OECD Programme for International Student Assessment (PISA) since its first appraisal in 2000, Sweden improved its position significantly in the 2015 PISA in all three categories (OECD 2017).

A recent policy initiative by the current government has produced a legislative reform that aims to link the primary and secondary education levels better to tertiary education, by a time-limited (5 years) program to give university teachers the possibility and incentives to obtain qualifications, through pedagogic training in order to work as specialist teachers at secondary school level (Swedish Government 2016c).

4 Policies to address innovation challenges

4.1 Challenge 1: Improving the links between research and innovation

Description

While the general performance of the Swedish R&D system on the supply side is very good, as shown by the indicators analysed in previous sections, there is a long-lasting debate over the alleged inefficiency of turning the heavy investments in R&D into innovation-based economic growth. This phenomenon reached a high level of attention in the 1990s when scholars coined the term the “Swedish Paradox” (Edquist and McKelvey 1998) to describe it, analogous to a similar identification at European level to turn R&D investments into innovation and growth (e.g. Andreassen 1995).

There are several available explanations to this “paradox” in the academic literature, that are more or less acknowledged by policymakers: First of all, the dominance of the academic sector in GBAORD complicates comparisons (based on GERD as percentage of GDP) with other countries (Jacobsson and Rickne 2004: 1361). Second, and related, it appears that the volume of GBAORD might be too generously estimated and does not take into account neither the general cost levels for labour and necessary goods and services in Sweden, nor the organisational and systemic peculiarities of the Swedish academic system, whose governance and steering is complex and does not necessarily lend itself to easy statistical classification (Granberg and Jacobsson 2006: 334).

But leaving such methodological issues aside, it is clear that the links between research and innovation are insufficient and constitute a dire challenge for the Swedish innovation system as a whole, and especially its innovation policymakers. Several structural reasons can be found in the previous sections and in other recent work: the deep division between the public and private R&D sectors has been identified by some analysts, who even call the system “bipolar” (Arnold et al 2007: 22) and describe it as “two giant mountains on the edges, and a wide and sparsely covered lowland there between” (Sörlin 2004: 4). This divide might inhibit dynamic exchanges between academic and private R&D. The somewhat unclear role of the universities in the innovation system, the absence of a strong institute sector, and an allegedly insufficient entrepreneurial climate stemming from a lack of adequate incentive structures for business start-ups in comparison with regular employment are among the other often-mentioned reasons for the “Swedish Paradox” (Hallonsten 2014). All of these are, to varying degrees, highlighted in the three most recent governmental research bills (2008, 2012, 2016), in the 2012 National Innovation Strategy and in the OECD innovation policy reviews for 2008, 2012 and 2016. Signs abound that the problem is becoming gradually less severe with time, but the challenge clearly remains.

Policy response

As noted above, for several years the governmental research bills acknowledge the need for increasing the links between research and innovation. In practical terms, the dominant approach has been to launch a series of supply-side measures, most of all a variety of funding instruments to promote cross-sectoral collaboration.

The creation of the Swedish Agency for Innovation Systems (VINNOVA) in 2000 inaugurated a period of strong emphasis on academy-industry collaboration and Triple Helix (knowledge triangle) collaboration, with a variety of programs for academic research environments, start-ups, and innovation in established firms. The Strategic Innovation Programmes, launched by the 2012 research bill and reinforced in the 2016 research bill with the launch of “strategic cooperation programmes” in five fields (next generation travel and transport, smart cities, circular bio-based economy, life science,

and connected industry and new materials) can be seen as a continuation of these supply-side measures (Swedish Government 2016d: 108-109).

In 2016, a government investigation suggested that the so called "third mission" activities at universities (i.e. outreach and collaboration with society) should be given more attention (Swedish Government 2016b), and the focus of the 2016 research bill is on "collaboration". This might eventually produce other policy measures besides the supply-side policies of Vinnova and others. This type of measures, especially the programs for governmental support of innovation and enterprises, were the subject of an investigation by the Swedish National Audit Office that was published in January of 2017 and that criticised several of the previous and existing programs for lack of clear criteria for measuring goal attainment, and on aggregate level, it also included some criticism towards the governmental policy in the area for lack of coherence and overall sense of purpose (see also section 3 above) (Swedish Government 2017d).

Assessment

The response to this challenge appears in part accurate, since the long term development is favourable. But given that the policy responses to the challenges of linking innovation and research have been skewed towards supply-side measures, the critique voiced by the National Audit Office must be considered a liability for the governmental policy-making doctrine in the area.

With regard to the need for improving the entrepreneurial climate, there have been some attempts at reducing red tape but also a clear unwillingness to launch the far-reaching tax reforms that some regard as potentially very useful.

4.2 Challenge 2: Reducing the dependence of BERD on multinational companies

Description

Swedish GERD, while very high in international comparison, is dominated by the private sector (about 2/3), where, in turn, most R&D expenditure takes place in a relatively small number of very large companies. The Swedish Agency for Growth Policy Analysis analyses the distribution of R&D expenditure among Swedish firms on a biannual basis, and shows that 20 of the largest Swedish multinational companies accounted for approximately 40% of the total Swedish BERD in 2015 (Tillväxtanalys 2017: 11). According to the same report, as much as 80% of all Swedish BERD is spent by and within companies with more than 200 employees (Ibid.: 24).

These major industrial firms, most notably Volvo, Ericsson, ABB, Sandvik, and AstraZeneca, often have Swedish origin and remained completely Swedish-owned and located in Sweden until the great wave of structural transformation and geopolitical change began in the mid- to late-1980s. Today, several of these have a diminished Swedish ownership and control, and in many cases both production and R&D resources have been relocated outside Swedish borders. Much capacity remains in Sweden, but the dependence of the Swedish economy on these giants also comes with significant vulnerability, since decisions on the up- and downscaling of particular productive and R&D assets within multinational companies are taken on basis of a whole other set of considerations than the well-being of the Swedish economy and labour market. In the recent decade, this has had some dramatic consequences: AstraZeneca closed two of three Swedish sites (in Lund and Södertälje) in 2010 and 2012; SonyEricsson closed its site in Lund in 2012, and Saab Automobile was let to go bankrupt by its owners in 2011.

Policy response

The Swedish innovation system is undergoing a long-term transformation away from the private sector R&D being mostly undertaken by a small number of very large companies,

and towards a more varied landscape with stronger presence of R&D-intensive SMEs. Part of this transformation is due to a policy response to the challenge described in the previous paragraphs, which has received considerable attention from the government since at least the mid-1990s. Policy efforts aimed at increasing the level of investment in R&D among SMEs, the introduction of public venture capital, programs to increase collaboration between universities and firms and also university spin-offs, and a series of funding programs administered by VINNOVA and targeted at start-ups and innovation in SMEs, are among the most important measures taken. In the most recent years, some intensification of these efforts is noticeable.

2017 has so far seen little concrete new policymaking in this area, but rather a continuation of existing programs. The 2016 research bill laid limited emphasis on enhancing innovation among SMEs and was rather focused on structural stimulation of innovation in the system at large through the strengthening of the research institutes, innovation test beds, the Strategic Innovation Areas, and a general focus on collaboration between universities and surrounding society (Swedish Government 2016d).

Similarly, the most notable policy measure introduced in 2017 was an assignment to VINNOVA to investigate how governmental agencies can coordinate their innovation activities and their support to innovation in regulated business areas (Swedish Government 2017c).

An effort to reduce red tape and other bureaucratic obstacles to entrepreneurship and the forming of new businesses might be underway, since a report on the effects of taxation on corporate use of incentive programmes for employees was delivered to the government in late 2016 (Swedish Government 2016a).

Assessment

Although the long-term development of the business sector side of the innovation system is on the right track and has been so for at least two decades, the challenge remains. The Swedish government has made considerable efforts to promote more R&D investment by SMEs, although these have so far consistently avoided fiscal incentives, which make them differ from policies in other EU and Nordic countries, and thus might limit the effects. The lack of experience of tax-based incentives and the general difficulty of assessing their results may inhibit the change of policy direction. The results of the report by the National Audit Office on governmental support of innovation and enterprises (see section 3) will be of importance for the continued efforts to stimulate innovation in SMEs.

4.3 Challenge 3: Sustaining the high quality of the public research base

Description

In today's globalised economy, all countries experience some challenges to their retained international competitiveness. Sweden is no exception but perhaps rather an especially critical case, having left its Cold War era self-sufficiency doctrine with state monopolies and strong regulation and sought to transform into a service-oriented and knowledge-based economy, albeit with retained dependence on exports and healthy trade relations. The "Swedish Paradox" was discussed in a previous section and is probably becoming less severe, but it is coupled with a decrease in Swedish investment in R&D as share of GDP.

The Swedish education system, from pre-school over primary and secondary school over to tertiary education and also doctoral training, has been a political priority for at least half a century and the government has invested heavily in both education and research. Nonetheless, signs have abounded for a long time that the supply of competence, and also the international competitiveness of the Swedish R&D system as measured in

outputs, is stagnating or falling slightly. This is a policy challenge of great magnitude but also great complexity, and while it is acknowledged in governmental research policy documents (see below), its remedy is a controversial topic.

As for the evidence for this development, it was noted in a previous section that Sweden was falling dramatically in the OECD Programme for International Student Assessment (PISA) between 2000 and 2012, in all three categories (science, mathematics, and reading), but that a slight surge is visible between the 2012 and 2015 assessments (OECD 2017). On the academic side, the percentage of scientific publications among the top 10% most cited publications worldwide as % of total Swedish scientific publications is in a slow but steady decline, in comparison with growth or saturation in this figure in countries comparable to Sweden such as Austria, Denmark, Finland, Norway, Switzerland, and also the EU-28 average and larger countries like France, Germany and the United Kingdom. Likewise, Sweden's share of the world's collected patent applications has been in steady decline in the past few years, although the same is true for most comparable European countries and also the EU-28 average. The share of the population having completed tertiary education, in all age groups and also including the specific measure of scientists and engineers, all show increases in the past 7 years.

These measures do, however, say little about the quality levels of the education system, and there is a current debate on this topic where experts voice great anxiety over long-term developments (see e.g. Henrekson et al 2017; Björnsson et al 2015; Ahlbäck Öberg et al 2016; Rider et al 2013). The 2016 OECD review of innovation policy concludes that "Sweden has maintained a high level of performance, but has done less well in recent years than a number of comparator countries" (OECD 2016: 22).

Policy response

In the preambles and overview analyses of the Swedish research and innovation system in all the four latest governmental research bills (2005, 2008, 2012, 2016), the Swedish government has indirectly shown that it subscribes to the description of this challenge as communicated in the previous paragraph. Sweden is in need of reform and significant strengthening of its national research and innovation base in order to remain competitive and increase its performance in the globalised knowledge economy, and thus secure the long-term wellbeing of the country and its population.

The 2008 and 2012 research bills put this rhetoric into practice by launching an unprecedented increase of the GBAORD, focused on a general increase in institutional block-grant funding to the universities and the Strategic Research Area programme, along with investments in research infrastructure (the European Spallation Source and MAX IV synchrotron radiation facilities in Lund, the Science for Life Laboratory in Stockholm/Uppsala, and continued or increased participation in international collaborations), and a general resource increase across the board that raised the level of the annual governmental outlay on R&D with 50% over seven years (Hallonsten 2015: 419).

This general resource increase was paralleled by a reform agenda on the side of the governance and organisation of universities. The so called "Autonomy Reform" of 2010 deregulated the academic sector and gave the universities greater mandate to (re)structure their organizations themselves (Swedish Government 2009), but it is difficult to yet fully assess the effects of this reform. Several public inquiries have been undertaken in the aftermath of the reform, including the academic career system, university governance and management, and academic entrepreneurship. Legislation and reform are pending. When it comes to the elementary school system, its challenges and their possible remedies, there has also been limited policy action.

Assessment

The policy response to the challenge described has been focused on increases in the funding of research in universities, which is an effort whose effects cannot be measured on short- to medium-term.

There are however, signs that the Swedish research, education and innovation systems are in need of other improvement reform besides resources increases (OECD 2016) The government has taken limited action based on the public inquiries that have been launched. In the end of 2018 the government awaits the report from an inquiry on the governance and resource allocation system to the universities.

5 Focus on R&I in National and Regional Smart Specialisation Strategies

In Sweden, responsibility for the national and regional smart specialisation strategies (S3) is shared between, at national level, the Swedish Agency for Economic and Regional Growth which acts on instruction by the government and regional authorities, who are in charge of their geographical/administrative area.

At national level, the research bill and the national innovation strategy of 2012 are among the key framework documents, along with the strategy for regional development launched at national level in 2015 (*National Strategy for Sustainable Regional Growth and Attractiveness - En Nationell Strategi för Hållbar Regional Tillväxt och Attraktionskraft*). It is planned to be in effect until 2020, and it focuses on four societal challenges, namely demographic development; globalisation; climate, environment and energy; and social cohesion. The efforts within these areas are concentrated in innovation and business development; attractive environments and accessibility; competence supply; and international cooperation (Swedish Government 2015b).

In 2014, the government also appointed a National Innovation Council with experts from academia and the private and public sectors. Its work is an important reference body for all things concerning national strategies for innovation, including S3, and it has indicated three important areas to target in this work: digitalisation, life sciences and environment, and climate technology.

New policy developments

The practical work on smart specialisation at national level is delegated by the government to the Swedish Agency for Economic and Regional Growth. A detailed instruction followed this decision, where the agency was assigned by the government the role of (1) supporting regional authorities in their work with S3; (2) assisting regional authorities with knowledge and overviews of national priorities and future competitiveness; (3) supporting regional authorities in their collaboration with the EU. The agency itself emphasises the crucial role of good communications (Tillväxtverket 2017c).

The Swedish Agency for Economic and Regional Growth also manages and distributes funding from the European Regional Development Fund on assignment by the government, which means that it is in charge of supporting smart specialisation on NUTS 2 regional level, which is not coherent with the organisation of Sweden in administrative regions (there 21 counties are the primary units and correspond to NUTS 3 regions, and 10 of them are nowadays called "regions" in an ongoing trial policy of increasing regional autonomy), whereas there are eight NUTS 2 regions in Sweden, one of which corresponds to a county (Stockholm), with the other seven consisting of between two and five counties/regions. This creates some difficulty of coordination and cohesion, and a certain imbalance in the level of implementation of smart specialisation strategies.

Progress on implementation

First of all, it has to be noted that there is no obligation for the regional authorities to develop smart specialisation strategies. The work at national level has so far been focused on information, support and encouragement. Second, the 21 counties/regions

have implemented smart specialisation strategies to a very varied degree. Some regions (Dalarna, Värmland and Östergötland) have launched ambitious smart specialisation strategies in accordance with the model proposed by the European Commission, and in two Swedish NUTS2 regions, namely North Middle Sweden (NMS) and East Middle Sweden (EMS), the regional authorities (Värmland, Dalarna and Gävleborg in NMS; Östergötland, Sörmland, Örebro, Västmanland and Uppland in EMS) are developing joint strategies to explore common strengths and synergies. Third, the heterogeneity of the regions on NUTS2 level, which stems from their rather large geographical reach, creates further fragmentation (Tillväxtverket 2017b)

A 2017 evaluation is generally positive but notes some difficulties with implementing the S3 in Sweden, stating that the Swedish approach to smart specialisation is “fragmented” and there is a lack of a central actor that drives the development forward at national level. Instead of such national initiative, the work is characterised by a compromise between national programs and regional ambitions. Among the specific challenges noted in this evaluation is the tendency of the regions to work too broadly in this area, and hence not engaging in smart *specialisation* to a desirable degree (Tillväxtverket 2017b).

Among the most successful regions in Sweden in terms of S3 implementation is Värmland, where the regional authority already in 2015 developed a comprehensive strategy. The strategy was developed in collaboration with the business community, academia (Karlstad University) and other actors in the public sector, and its whole structure and direction is characterised by collaboration and synergetic mobilisation of the capacities within the region.

In line with recommendations of the Swedish government, the Swedish Agency for Economic and Regional Growth, and the European Union, the S3 is not merely treated as a tool for implementing the European structural and investment funds (ESIF) programmes but a strategy that runs through the whole collection of regional efforts to renew and strengthen innovative capacity on short and long term.

The Värmland interpretation of “smart specialisation” that forms the basis of the strategy is that “smart specialisation means smart ways to organise and develop existing regional assets in order to create value for users and society.” The regional authorities of Värmland have implemented this interpretation through a six-step process: (1) Analysis of the region’s strengths; (2) Anchoring and participation; (3) Formulating an overall vision for the region; (4) Identifying those areas which are to be prioritised; (5) Plans for implementation; and (6) Plans for learning and follow up (Region Värmland 2015: 9). Five priority areas have been identified: Forest-based bioeconomy; Digitalisation of Welfare Services; Advanced Manufacturing and Complex Systems; Nature, Culture and Place Based Digitalised Experiences; and System Solutions with Photovoltaics. Each area involves a multitude of actors in the private and public sectors (Region Värmland 2015: 17-19). A platform for smart specialisation was set up in 2016 at Karlstad University. It is in charge of the long-term renewal work and anchoring in current research and innovation in an academic context (Region Värmland 2016).

In contrast, the southernmost region Scania (Skåne) adopted an international innovation strategy in 2011, which is centred on the slogan and ambition that Scania shall be “the most innovative region in Europe in 2020” (Region Skåne 2011). In 2017, mid-term, a study was made on the progress of the strategy implementation. Several accomplishments are listed, among them a broadening of the view on innovation to include social innovation; several more innovation support actors and a better collaboration between them, and a better ability for the regional authorities to coordinate and support activities (Region Skåne 2017).

Meanwhile, the concept of smart specialisation is completely absent from the strategy. There are several projects with support from the ESIF funds in Scania, and many projects that are implemented as a means to fulfil the goals of the innovation strategy. The regional authority also participates as a partner in several projects with focus on implementing smart specialisation, but appears to have a limited direct interest in S3 and

stands in sharp contrast to the example of Värmland discussed above. An overall assessment yields that Scania has taken other measures, beyond, above or besides S3, in its work to enhance innovation and achieve a renewal in core sectors of strength.

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Abbreviations

ABB	Asea Brown Boveri
BERD	Business Expenditures for Research and Development
DESI	European Commission's Digital Economy and Society Index
ESS	European Spallation Source (ESS)
EU	European Union
Formas	<i>Forskningsrådet för Miljö, Areella Näringar och Samhällsbyggande</i> , Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
Forte	<i>Forskningsrådet för Hälsa, Arbetsliv och Välfärd</i> , Swedish Research Council for Health, Working Life and Welfare
G7	Group of Seven
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
MNCs	Multi-National Companies
OECD	Organization for Economic Cooperation and Development
PISA	OECD Programme for International Student Assessment
RISE	Research Institutes of Sweden
S3	smart specialisation strategies
SME	Small- and Medium-sized Enterprise
VINNOVA	<i>Verket för Innovationssystem</i> , Swedish Agency for Innovation Systems

Factsheet

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GDP per capita (euro per capita)	34500	35400	37000	37800	38200	39000	39900	40400		
Value added of services as share of the total value added (% of total)	69.77	69.92	69.87	69.68	69.95	70.23	70.7	71.02		
Value added of manufacturing as share of the total value added (%)	18.36	18.5	18.62	18.77	18.51	18.57	18.56	18.2		
Employment in manufacturing as share of total employment (%)	15.27	14.93	14.92	14.91	14.82	14.67	14.64	14.56		
Employment in services as share of total employment (%)	71.65	72.13	72.3	72.62	72.87	72.91	73.32	73.56		
Share of Foreign controlled enterprises in the total nb of enterprises (%)	3.02	3.04	3.16	3.2	3.12	3.16	3.25			
Labour productivity (Index, 2010=100)	98.5	100	101	102.1	102.7	103.3	105.3	104.8		
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	1.55	1.62	1.58	1.62	1.46	1.46	1.39	1.39		
Summary Innovation Index (rank)	6	9	9	8	8	9	9	7		
Innovative enterprises as a share of total number of enterprises (CIS data) (%)				54.4		59.5				
Innovation output indicator (Rank, Intra-EU Comparison)			11	11	10	11				
Turnover from innovation as % of total turnover (Eurostat)		11.9		9.8						
Country position in Doing Business (Ease of doing business index WB)(1=most business-friendly regulations)						20	21	19	19	22
Ease of getting credit (WB GII) (Rank)						48	53	55		
Venture capital investment as % of GDP (seed, start-up and later stage)	0.012	0.01	0.008	0.008	0.008	0.008	0.008			
EC Digital Economy & Society Index (DESI) (Rank)						13	9	10	10	
E-Government Development Index Rank		24		21		20		16		
Online availability of public services – Percentage of individuals having interactions with public authorities via Internet (last 12 months)	49	51	51	53	54	59	57	60	62	
GERD (as % of GDP)	2.6	2.73	2.67	2.91	2.95	3.07	3.05	3.09		
GBAORD (as % of GDP)	0.75	0.77	0.78	0.77	0.8	0.79	0.8	0.81		
R&D funded by GOV (% of GDP)	0.91	1.04	0.95	1.1	0.99	1.1	0.99	0.95		
BERD (% of GDP)	1.77	1.87	1.84	2.05	2.09	2.19	2.18	2.2		
Research excellence composite indicator (Rank)	6	7	6	7	7	7				
Percentage of scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country		11.33	11.09	10.8	11.8	11.49				
Public-private co-publications per million population	59.39	64.66	66.86	62.44	60.46	67.59	57.6			
World Share of PCT applications	0.78	0.79	0.81	0.76	0.69	0.71	0.81			
Global Innovation Index				23	20	18	20	20		

Data sources: various, including Eurostat, European Commission and International scoreboard data.

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