

Supporting Entrepreneurship and Innovation in Higher Education in Sweden

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Preface

Changes in climate, technology and demography as well as the COVID-19 pandemic are transforming our societies and way of life. The EU Member States, as elsewhere, need a strong higher education sector, as an engine of innovation and entrepreneurship and driver of skills and knowledge. As the conditions in which our societies operate are changing, there is broad consensus that higher education institutions have to adapt and contribute to shaping societal transformation.

The potential of Higher Education Institutions (HEIs) has been further confirmed by the COVID-19 pandemic. Across Europe and internationally, HEIs transitioned to new forms of teaching and learning, connected their research to the needs of their communities, and they are now playing a crucial role in recovery plans.

Whilst there is no one-size-fits-all approach to innovation or entrepreneurship, HEIs, businesses and policy makers, working hand-in-hand, is a proven and effective way to succeed and thus respond to societal challenges and people's expectations. Several successful examples of innovation and entrepreneurship are built on collaborations with businesses, the public sector, HEIs and civil society, even though each HEI will have its own path of innovation and entrepreneurship, based upon its own strengths and assets.

HEInnovate, an initiative developed by the EC in collaboration with the OECD, supports HEIs in their journeys through its self-assessment tool, a series of country reviews, and a policy-learning network. It provides a framework for HEIs and policy makers to determine their next steps, and examples of best practice to build on. HEInnovate enables exchanges between HEIs and their stakeholders on how to promote entrepreneurship and innovation with a view to creating societal impacts and sustaining economic growth at local and national levels.

This HEInnovate country review of Sweden adds to this knowledge base. Over the past decade, the numerous efforts by the Swedish government to increase the innovative and collaborative capacity of HEIs have been largely successful. Swedish HEIs have a broad understanding of collaboration with wider society, which encompasses both economic and societal challenges. There is a strong emphasis on entrepreneurship and innovation education with the vast majority of HEIs offering entrepreneurship education, including as part of lifelong learning. Going into the COVID-19 pandemic, Swedish HEIs were in a strong position to move to online education, benefiting from a well-developed broadband infrastructure as well as a large proportion of students already accustomed to distance learning.

However, to maintain this strong position, Swedish HEIs should continue to innovate and deepen engagement with innovation and entrepreneurship. The complexity of the innovation system means that incentives can be confusing and even contradictory for HEIs. The opportunity to develop an entrepreneurial mind-set should be offered to a larger number of students, allowing them to pick the most relevant competences and to be exposed to both theory and practice. Sweden's HEIs should also look to push the frontier of digital transformation, for instance through the use of digital platforms to undertake knowledge exchange and collaboration, which enable the extraction of data as well as generation of new data, creating value for the participants.

The HEInnovate country review of Sweden offers insights to policy makers and HEIs on the state of play and developments related to innovation and entrepreneurship in higher education, both in Sweden and in Europe. The OECD and the European Commission are grateful to the Swedish Government, notably the Ministry of Education and Research, for their cooperation and the effective and lasting partnership created through this review.



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Acknowledgements

This review was a collaborative effort between the OECD's Centre for Entrepreneurship, SMEs, Regions and Cities (CFE) led by Lamia Kamal-Chaoui, Director, the European Commission's Directorate for Innovation, Digital Education and International Cooperation (in the Directorate-General for Education, Youth, Sport and Culture), led by Antoaneta Angelova-Krasteva, Director. It was undertaken in partnership with the Swedish Ministry of Education.

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The OECD wishes to thank the European Commission for its support, and in particular Joerg Niehoff and Maria Palladino from the Directorate-General for Education, Youth, Sport and Culture of the European Commission, who actively contributed to the delivery of the review.

The review team is also grateful to the Swedish Ministry of Education and Research for its contribution to the review. In particular, we are grateful to Robin Moberg of the Department for Higher Education.

The COVID-19 pandemic required that this report be conducted entirely through virtual meetings. The review team extends its gratitude to the co-ordinators, staff and students of Higher Education Institutions (HEIs) and Research Institutes (RIs) who provided fundamental input and support for the review.

Members of the steering group for this review also provided key insights and comments. They include Karin Åmossa (Swedish Confederation of Professional Associations or Saco), Sofia Hylander (Swedish Confederation of Professional Employees, or TCO), Emil Görnerup (Confederation of Swedish Enterprise, or SN), Johanna Adami (Swedish Association of Higher Education Institutions, or SUHF), Fredrik Hörstedt (SUHF) and Simon Edström (Swedish National Union of Students, or SFS).

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Executive summary

The HEInnovate review of Sweden sheds light on advanced practices put in place by higher education institutions (HEI) to promote entrepreneurship and innovation in their communities and networks. Sweden is characterised as an Innovation Leader in the European Innovation Scoreboard (EIS). Its HEIs are at the centre of the national innovation systems and co-operate extensively with businesses, public authorities and civil society to promote sustainability, inclusiveness and innovation.

Sweden's innovation system is strongly rooted in its HEIs, which receive a comparatively high percentage of research funding and are significantly larger than other publicly funded research bodies. All 21 Swedish regions have HEIs, with the goal being to improve accessibility to higher education and innovation all over the country. However, a relatively small group of research-focused HEIs, often located in metropolitan areas, receive the lion's share of research funding. Autonomy is an important characteristic of the Swedish HE system and individual HEIs have considerable discretion in running their operations and in how they choose to spend funding. National entities such as Vinnova, the Swedish public national innovation agency, and several other bodies, including private foundations, support research and development (R&D) in higher education and promote the creation of new interdisciplinary spaces, generating opportunities for innovation and innovative practices.

The Swedish higher education system has developed a broad understanding of collaboration between HEIs and society, including to tackle both economic and social challenges. Sweden is involved in a long-term process to integrate collaboration into higher education funding and assessment, by increasing funding for these activities, and by creating structures to support relationships between HEIs and business. The 2017 Research Bill introduced a new model for research funding, under which 20% of existing direct government funding was to be based on indicators reflecting an HEI's success in securing external funding and on scholarly production. In 2018, a third criterion was announced, namely the 'collaboration with the surrounding community'.

The quantitative assessment reveals a number of excellent examples. Nevertheless, the current report shows a gap between the skyrocketing number of publications originating from the increased support to research activities in all HEIs, and local economic and innovation performance in HEI ecosystems. Promoting academic publications in all the HEIs is not a panacea for collaboration: research does not trickle down to all innovation ecosystems. Interviews with case study HEIs show that collaboration is often initiated by firms that are looking for solutions they cannot buy on the market, or that are interested in recruiting talent.

Swedish HEIs place strong emphasis on entrepreneurship and innovation education. Virtually all HEIs have activities related to entrepreneurship education, including promoting lifelong learning. However, the HEIs interviewed whose focus is principally on teaching struggle to engage with entrepreneurial instruction and learning activities. Conversely, the HEIs most active in teaching entrepreneurship are those with dedicated academics as professors of entrepreneurship who conduct research in the field. These HEIs also offer doctoral programmes in entrepreneurship. The evidence collected from case study HEIs suggests that the creation and development of successful entrepreneurship teaching and learning activities depends on the availability of expert skills and knowledge by professors in this domain. This may require

recruiting teachers with practical experience, and teachers who adopt interdisciplinary approaches to develop entrepreneurship teaching and learning activities.

At the outbreak of the COVID-19 pandemic, Swedish HEIs were in a strong position to move to online education, as they could rely on a well-developed broadband infrastructure and a large proportion of students already accustomed to distance learning. Nonetheless, the scale of online learning during the pandemic was described as transformational for even the most advanced institutions. In Sweden, digital teaching appears to have reached a tipping point. It may become the default pedagogy for some subjects and HEIs interviewed for this review noted that maximising the potential of digital technologies would require new pedagogical approaches and high-level instructional design expertise.

The digital transformation also offers an opportunity for HEIs to move to the frontier of Knowledge Exchange and Collaboration (KEC). Globally, it is becoming increasingly difficult for HEIs to connect business and investors with researchers, as global research output accelerates and grows in volume. Digital technologies offer new ways of connecting actors and finding relevant information. Online platforms facilitate interactions between individuals and/or groups, and make it possible both to extract and to generate new data, creating value for the participants. Challenges in data management, privacy and ethics remain, but participatory platforms can increase HEIs' capacity to engage.

Sweden's efforts in the past decade to increase the innovative and collaborative capacity of its HEIs have been broadly successful. However, stakeholders noted that the system is complex, and that incentives can be confusing and even contradictory. Funding is the main policy lever for influencing behaviour, and the organisational capacity of Swedish HEIs is shaped by responding to the requirements of their different public and private funders, which may not always align with the government's objectives. In addition, despite their significant autonomy, Swedish universities are not prioritising capacity building unless they have the funding to do so.

The report includes a number of considerations for next steps, both for policy makers and for HEIs. Box 1 displays these recommendations. The main points can be summarised as follows. First, promoting innovation and entrepreneurship in higher education requires dedicated skills and institutions. The Swedish Higher Education Authority (Universitetskanslersämbetet, or UKÄ), capitalising on networks and practices established in the past decade, could complete reforms for the funding and assessment of Knowledge Exchange and Collaboration. Practices and incentives could better reflect the different roles that HEIs play, bearing in mind, for example, their relationship with their regional communities. Second, public and private funders of HEIs' activities should seek collaboration and adopt shared priorities, standards and a common measurement framework. This would help reduce complexity in the HE system and align strategic objectives. Third, Swedish HEIs can move to the global forefront in digital teaching practice, relying on a default position of digital where appropriate. In particular, HEIs should help teachers develop the necessary skills for digital teaching. Finally, considering the importance of strengthening the links between entrepreneurship research and teaching, HEIs should consider developing doctoral programmes in entrepreneurship to give breadth and depth to teaching and learning practices and support activity.

Box 1. List of considerations, organised by theme

Entrepreneurial Teaching and Learning

- Policy makers should consider how to support HEIs to leverage external collaborations in their teaching, for instance leveraging external facilitators/educators, using "Design Thinking" and engaging alumni.
- Policy makers should consider providing funding for HEIs to undertake activities in management and entrepreneurship. This includes research activity in entrepreneurship and management.

- HEIs can support entrepreneurship teaching and learning by emphasising social capital, which is key to facilitate economic activities, particularly outside metropolitan regions.
- HEIs should make efforts to provide competences and resources specifically geared towards the regional economy, while supporting graduates so they can meet the needs of the global workforce.
- HEIs should consider developing industrial doctoral programmes, which could help in particular small and medium-sized enterprises (SMEs) and other companies that find it difficult to access HEI infrastructure.
- HEIs could consider how to better target entrepreneurship teaching to the needs and characteristics of disadvantaged groups.

Digital Capacity and Transformation

- HEIs should aim to be at the global forefront of digital teaching practice, defaulting to digital wherever appropriate. In particular, HEIs should increase support for teachers to acquire the skills necessary for digital teaching.
- HEIs should consider how to use digital technology to address the data challenges of research collaboration. There will not be a single solution for every HEI, but options for HEIs to explore include:
 - Diversify services to students, researchers and stakeholders.
 - Put IT services at the centre of institutional governance, to facilitate experimentation and identify good practices.
 - Allocate specific resources to data management.
- HEIs should explore platforms and the technologies of participation, in order to be more innovative and inclusive. They should simultaneously engage in creating skills and values, to ensure that privacy and ethics are taken into account in developing these technologies.

Knowledge Exchange and Collaboration

- Policy makers could consider integrating collaboration into higher education funding and assessment.
- The Swedish Higher Education Authority should finalise reforms concerning funding and assessment of Knowledge Exchange and Collaboration. This could be a joint effort between policy makers and HEIs, to create acceptance and ownership of these indicators.
- HEIs could plan to embed a proactive culture that connects research with innovation ecosystem, without waiting for incentives or permission. Options include creating observatories to gather data and evidence on the activities that HEIs use to promote sustainability and well-being in their communities.
- HEIs could broaden their understanding of excellence research to include collaboration activities, including those with their ecosystems.
- HEIs could look to learn from one another and to leverage the expertise of regional HEIs to promote the diffusion of university research through teaching and co-operation activities.

Organisational Capacity

- The HE sector and policy makers could look to develop a shared understanding around evaluating the outputs for innovation, entrepreneurship and collaboration activities.
- Funders of HEIs' activities, both independent public agencies and private foundations, should consider how to reduce complexity in the innovation landscape, introducing clearer priorities.

This will provide HEIs with clearer incentives to invest in long-term capacity to deliver on those priorities.

- Policy makers could look to increase support for HEI networks, including those composed of national and international members. Learning from international best practice will allow Sweden to challenge itself to continue to operate at the global frontier.
- Vinnova could fund smaller regional HEIs to develop their profile and seek partnerships abroad. The art will also be to use existing instruments and resources to enable the smaller regional universities to further develop their profile and international relationships without endangering the first seedlings of exchange with the local environment or SMEs.
- HEIs have significant autonomy and freedom to develop their institutional capacity to become innovative and entrepreneurial. As in the case of knowledge exchange, they should not always wait for direct incentives from government to proceed with this agenda.
- HEIs could consider proactively instituting policies to reward and incentivise staff for initiating innovation and entrepreneurial activities, particularly in promotion or hiring decisions.
- HEIs could also undertake more peer learning, in particular sharing opportunities for learning among large research institutions and teaching-focused institutions on how to become more entrepreneurial and innovative.

1

Overview of the Swedish higher education and innovation systems

Sweden has a long-standing ambition to be one of the world's leaders in innovation, where higher education improves national competitiveness and responds to social challenges. Higher education institutions sector plays an important role as centres of research and innovation, and have strong protections for their institutional autonomy. HE Leaders reported engagement with all aspects of the HEInnovate best practice, with a majority of institutions offering support to entrepreneurs, connecting research to regional impacts and engaging in measurement of impact.

Introduction

Sweden has a long-standing ambition to be one of the world's leaders in innovation, where higher education improves national competitiveness and responds to social challenges, both domestically and globally. The obligation of higher education institutions (HEIs) to make education and research relevant to society has been embedded in legislation in Sweden since 2009.

Characteristics of Sweden's higher education system

The Swedish higher education system has experienced far-reaching changes in the last four decades. Before 1977, Sweden had only six research universities and five technical institutes. While universities like Uppsala University, founded in 1477, and Lund University, founded 1666, have long histories, overall, Sweden's higher education system is of fairly recent origin. Its third-oldest university, in Gothenburg, was established as a university in 1954.

In 1977, to spread educational resources more evenly through the country, the Swedish government reformed the country's university system by decentralising it. This reform established 11 new HEIs and the promotion of 14 university colleges to research universities. The policy aimed to improve education at the local level and increase employment in the regions, in other words, the aim was not simply improving education and research, it also had an economic purpose.

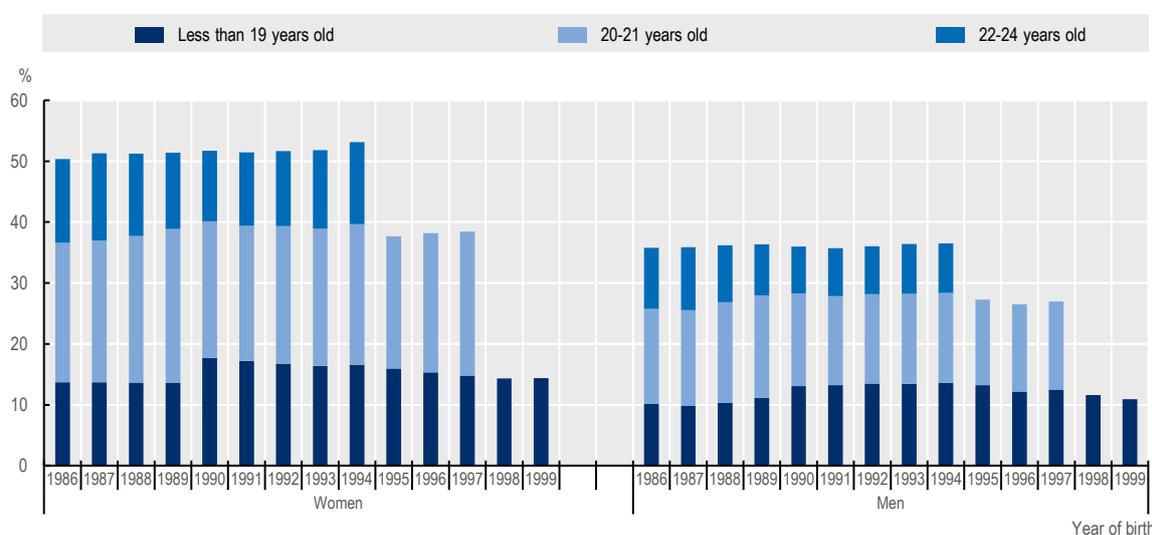
In many ways, the expansion of the university system in Sweden has delivered on that promise. After the reform, the number of students at the new HEIs more than doubled, while the number of students at the old HEIs only increased by half. Resources for research at the new HEIs, meanwhile, increased substantially. The new universities have generally been regarded as a catalyst for economic development in the areas where they are located. Between 1977 and 1999, the population in the municipalities where the new HEIs were introduced grew by 4.6%. By contrast, the cities in which the old HEIs were located grew by only 1.6% (Andersson, Quigley and Wilhelmsson, 2009^[1]). Motivated by the apparent success of the university decentralisation policy, the Swedish government has continued to expand the university system, and, in 1999, three university colleges, in Örebro, Karlstad and Växjö, were promoted to university status (Bonander et al., 2016^[2]).

Currently, the Swedish Higher Education Authority (UKÄ) recognises 48 HEIs, comprising universities, university colleges (*högskola*) and "other" types. Each of Sweden's 21 regions has a HEI. HEIs vary dramatically in size, with the largest having almost 45 000 students for the academic year 2018/19, and the smallest less than a hundred.

As of 2018, 37% of the Swedish population aged 25-64 had at least two years of tertiary education, more than the OECD average and up 8% from 2008. This trend is likely to continue, and the academic year 2018/19 was the third year in a row in which the number of new HE entrants for bachelor's and master's level education increased. (Swedish Higher Education Authority, 2020^[3]). One of the specific characteristics of the Swedish HE system is that young people are increasingly delaying their higher education after secondary school. Of 19-year-olds born in 1999, 13% had begun higher education by 2018. However, trends show that this figure is likely to grow each year, and the percentage of young people who begin higher education by age 24 has remained relatively constant, at between 43% to 45% for those born in the 1980s and 1990s (Swedish Higher Education Authority, 2020^[3]).

Sweden also has a relatively low completion rate in higher education, of 55%, below the OECD average. Employment rates of graduates are high, and of graduates with bachelor's and master's degrees in the academic year 2016/17, 86% were employed after 1 to 1.5 years. The earnings advantage was 24% higher for individuals with bachelor's and master's degrees compared with individuals who only had secondary school degrees (Swedish Higher Education Authority, 2020^[3]).

Figure 1.1. Percentage of those born in 1986-99 who began higher education in Sweden or who have student finance to study abroad



Source: Swedish Higher Education Authority (2020^[3]), *Higher Education Institutions in Sweden: 2020 Status Report*.

Higher education frameworks enjoy institutional autonomy

Autonomy is a critical part of the governance of Swedish HEIs, which are responsible for decisions regarding their organisation, internal allocation of resources, educational offerings, educational content and design, how many students are admitted and what research is conducted. This autonomy allows HEIs to define their own strategic goals and allows HEIs to develop specific profiles and make their own decisions on investment in long-term infrastructure and partnerships. It also provides HEIs a certain amount of freedom in staffing and appointing their committees, and thus in influencing strategic path dependencies.

The international comparison shows that, overall, Swedish universities have a high level of autonomy. (European University Association, 2021^[4]). However, they do have limitations relevant to innovation and entrepreneurship, since only a limited number have been granted permission to have commercial holding companies.

While HEIs have a high degree of autonomy, it is clearly recognised that they are also public institutions, answerable to society and to policy goals. The Higher Education Act states that the role of higher education institutions: “The mandate of higher education institutions shall include third-stream activities and the provision of information about their activities, as well as ensuring that benefit is derived from their research findings” (Section 2 of the HEA 1992). Furthermore, HEIs in Sweden “shall promote sustainable development to assure for present and future generations a sound and healthy environment, economic and social welfare, and justice” (Section 5 of the HEA 1992).

The Act lays out a principles-based regulatory approach that allows for flexibility. It sets out what characterises HE courses, governance, freedom of speech and provisions for student influence. Only two levels of HEI decision making are required by the Act: 1) a Board of governors with external members making up the majority, and 2) a Vice Chancellor leading the HEI as a member of the board.

Additional requirements for HEIs are specified by the independent agency of the UKÄ in the Higher Education Ordinance, which provides more details on entrance qualifications, assessment and grading, as well as the appointment of teachers and doctoral students.

HEIs are also governed by annual public service agreements (*regleringsbrev*) between the government and each HEI. The public service agreement specifies that educational offerings correspond to demand from students and the needs of the labour market, the amount of the state funding for bachelor's and master's level education, for research and PhD education, and specific assignments given to HEIs.

Ongoing quality assurance is undertaken by UKÄ, which both ensures the academic performance and provides support for continual improvement of the HEIs. The focus of the activities and assessments of the UKÄ is to ensure high-quality teaching. They also consider broader issues such as collaborative research, knowledge exchange and societal benefits.

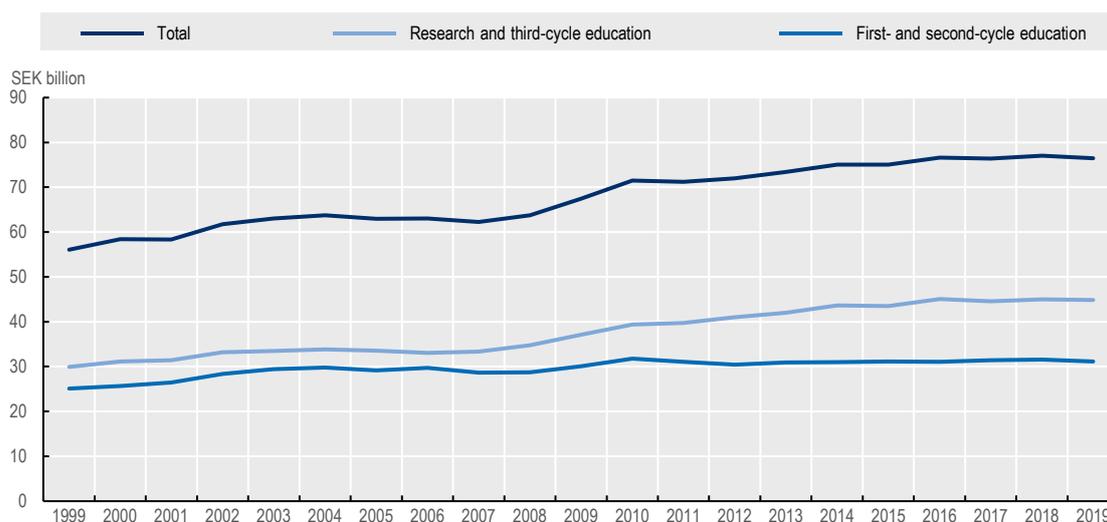
Funding is largely devoted to research

Swedish HEIs receive the majority of their funding through block grants from the Swedish government. In 2019, close to 80% of Swedish HEIs' operations were financed with government funding, 4% were funded by public organisations and 12% came from private sources of funding (Swedish Higher Education Authority, 2020^[31]). This funding is also highly concentrated, with four institutions (Lund University, Karolinska Institute, Uppsala University and Gothenburg University) comprising 40% of the total higher education funding. Tuition fees do not play a significant role in the financing of Swedish universities.

In terms of the allocation of the block grants, the Swedish government determines the allocation for each HEI, which receives separate funding for education and for research. The education block grant represents a maximum cap, and the actual amount of funding the HEI receives depends on the number of undergraduate and master's students who complete its courses. In 2019, HEIs educated fewer students than their grant allocation would have covered. From the students' perspective, higher education is free (although tuition fees for international students were introduced in 2011).

Between 2008 and 2018, research funding for HEIs increased by 29%, while education funding increased by 10% over the same period. This increase in research funding reflects Sweden's ambition to remain a world leader in research and innovation.

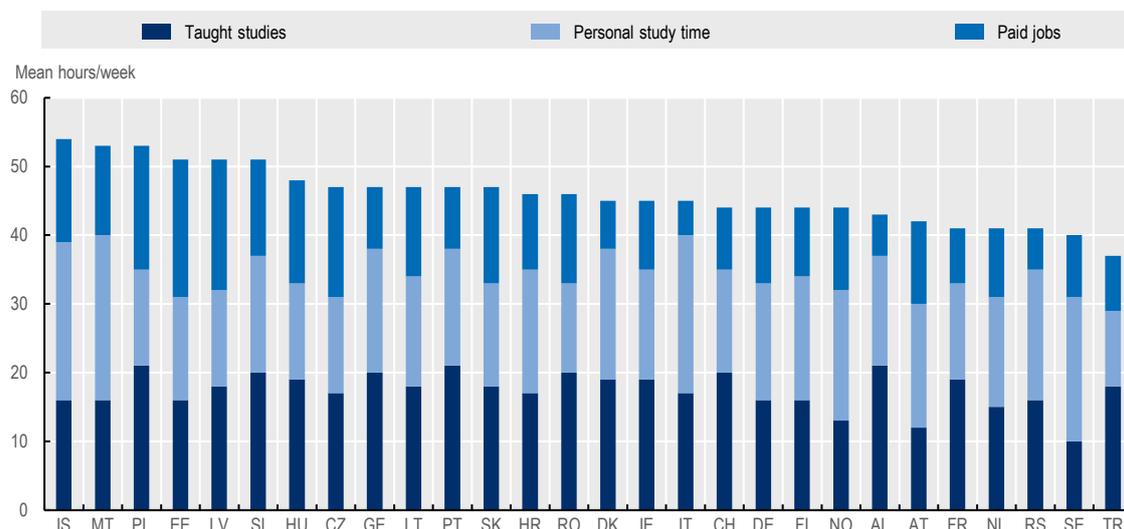
Figure 1.2. HEIs' total revenues for education and research, 1999-2019



Source: Swedish Higher Education Authority (2020^[31]), *Higher Education Institutions in Sweden: 2020 Status Report*.

The relative stability of funding for education has meant a decrease in real terms. In 2019, direct government funding was EUR 2.61 billion. As compared with 2018, this represents a EUR 39.7 million decrease at fixed prices (Swedish Higher Education Authority, 2020^[3]). Swedish students reported a number of hours of contact with their teachers that was among the lowest in Europe (Figure 1.3).

Figure 1.3. Time budget of students by type of activity



Source: DZHW (ed.) (2018^[5]), *Social and Economic Conditions of Student Life in Europe - EUROSTUDENT VI 2016-2018 Synopsis of Indicators*, German Centre for Higher Education Research and Science Studies.

The growth in research funding, and the concentration of research funding in a relatively small set of universities, means that some institutions have seen their activities shift largely towards research in the past two decades. For example, in 2019, eight HEIs had budgets where 60% of their funding was research-based, with the highest percentage being at the Karolinska Institute, which received 84% of its funding from research (Swedish Higher Education Authority, 2020^[3]). This emphasis on research activities also shapes the specialisation of HEIs. Competitive funding and external funding represent an important source of funding for Swedish HEIs. However, this funding is focused in several areas, in particular medical and health sciences, the natural sciences and engineering and technology. Correspondingly, the lion's share accrues to the large HEIs that specialise in these areas.

In European competitive funds, Sweden's performance is mixed. Sweden has successfully participated in the EU's Framework Programmes, but ranks behind a number of other small R&D-intensive countries if adjusted for size, both in terms of funds awarded as well as in terms of success rates. This might be explained by the comparatively larger amount of resources available at the national level in Sweden, which makes it less attractive to compete for European funds.

Ongoing reform programme to strengthen the system

Every four years, the Parliament lays out a Research and Innovation Bill setting out the ambitions and funding for research and innovation in Sweden. The 2017 bill included provision for a new model for research funding where 20% of existing direct government funding was to be based on two indicators: 1) the HEI's success in securing external funding; and 2) scholarly production.

This shift to performance-based funding has been controversial. In 2018, a third criterion was announced: collaboration with the surrounding community. How this will be assessed is in the process of being determined, and is currently under review at UKÄ.

In 2017-2019, the Swedish government undertook an inquiry of higher education structures, funding and incentives, known as the STRUT Review (*Styr- och resursutredningen*; A government inquiry on HE structures, problems and incentives). It concluded that the “driving energy” in Swedish HE is provided by smaller universities and advocated for more academic self-governance in larger universities. It also concluded that too much external funding was forthcoming from too many different sources, and not enough from the block grants.

In December 2020, the government presented its new Research and Innovation Bill (“Research, freedom, future – knowledge and innovation for Sweden”) to set the direction of policy for the next four years. Like its predecessors, the bill provides a detailed spending plan for various actors and programmes; including mission-oriented funding programmes. It also included the following commitments:

- a comprehensive evaluation of the funding landscape, while upholding long-term trends, including an increase in funding, although HE block funding will be reduced
- an allocation of EUR 14 million of new funding, spread evenly over four years
- an announcement of more funding for the HE teaching block grant
- a new Centre of Excellence programme, and new block-funding indicators.

In the spring of 2020, and in the context of these reviews, the Swedish Government requested that the EC and the OECD prepare an HEInnovate Review (see details of the review process in Box 1.1).

Box 1.1. HEInnovate Review of Sweden

HEInnovate is a guiding framework jointly developed by the European Commission and the OECD that aims to assist HEIs in increasing their innovative and entrepreneurial capacities. To support policy makers and HEI leaders, the OECD and the European Commission jointly collaborate on the HEInnovate Country Reviews.

HEInnovate encompasses eight dimensions:

- Governance
- Organisational Capacity: Funding, People, Incentives
- Entrepreneurial Teaching and Learning
- Preparing and Supporting Entrepreneurs
- Knowledge Exchange and Collaboration
- Digital Capacity and Transformation
- The Internationalised Institution
- Measuring Impact.

HEInnovate includes a self-reflection tool for HEIs as well as a Policy Learning Network. The third strand of work is the Country Reviews. HEIs do not operate in isolation but collaborate with their community and compete with other HEIs in the same country (and abroad) in a variety of ways. The Country Reviews were developed to capture and assess these complex interactions and dynamics.

The HEInnovate Review of Sweden is rooted in the priorities of the Swedish national authorities, focusing on four key dimensions: Entrepreneurial Teaching and Learning, Digital Transformation and Capabilities; Knowledge Exchange and Collaboration and Organisational Capacity: Funding, People, Incentives.

Eleven HEIs were interviewed as case studies for the review, namely:

- *Göteborgs universitet* (Gothenburg University)
- *Högskolan Gävle* (University of Gävle)
- *Högskolan i Borås* (University of Borås)
- *Högskolan i Jönköping* (Jönköping University)
- *Karlstads universitet* (Karlstad University)
- *Karolinska Institutet* (Karolinska Institute)
- *Kungliga tekniska högskolan, KTH* (Royal Institute of Technology)
- *Linköpings universitet* (Linköping University)
- *Luleå tekniska universitet* (Luleå University of Technology)
- *Mittuniversitet* (Mid Sweden University)
- *Umeå universitet* (Umeå University).

Due to the COVID-19 pandemic, the OECD and EC team were not able to visit Sweden after the kick-off meeting in March 2020. The rest of the assessment was conducted through video interviews with the experts, a survey of HE Leaders with input from Nordregio. The authors are grateful for the support and flexibility of their Swedish colleagues in facilitating and supporting this assessment.

Characteristics of Sweden's innovation and entrepreneurship ecosystem

Innovation has long been at the core of Swedish economic and social development. It has underpinned the strong international competitiveness of Swedish firms in manufacturing and services, and has drawn on and fed into the well-educated labour force. It has also generated revenues that have been distributed throughout society and reinvested in innovation.

Sweden is consistently characterised as an “innovation leader” and is one of the OECD’s most R&D-intensive countries, both at the system level and specifically with respect to higher education.

However, as of 2000, Sweden’s R&D intensity (gross expenditure on R&D as a percentage of GDP) started to decline. This was driven by a reduction in business expenditure on R&D, which in Sweden is highly concentrated in large multinational companies. In an analysis of the top 10% of most cited articles globally, Sweden’s percentage of highly cited publications is just over 11%, above the global average. On this measure, Sweden is ranked 13th, after Denmark, but ahead of the other Nordic countries. Switzerland, the Netherlands (NLD), Belgium (BEL) and the United Kingdom (GBR) all have higher citation impacts than Sweden, while having lower R&D expenditure in the higher education sector in relation to GDP (Hansson et al., 2019^[7]). The OECD 2016 Innovation Review of Sweden concluded that, “The general picture that emerges is 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^[8]).

One important characteristic of the Swedish innovation system is the central role of HEIs, which account for a comparatively large share of research spending and play a significant role in both basic research and applied research. In most other countries, the “other government sector” (i.e. research institutes) is considerably larger.

Thus, in Sweden, the overall performance of the system depends to a large extent on the performance of the HE sector. In recent years, expectations have increased that HEIs will not only support sector research for large multinational companies, but also for SMEs, and will support entrepreneurship more generally.

Sweden has a strong framework for entrepreneurship. The regulatory burden on new start-ups is very low relative to that of other EU Member States. SME lending has increased in Sweden since 2012, coinciding with decreasing interest rates, increasing business lending and low rate spread. Private equity funding and alternative finance are also on the rise. The government restructured the public financing for innovation and sustainable growth in 2016 and simplified the publicly funded venture capital system to rationalise public resources in the area (OECD, 2020^[9]).

Main public vehicles for delivering innovation and entrepreneurship in HEIs

The Swedish government has developed two main vehicles for HEIs to deliver innovation and entrepreneurship priorities: 1) holding companies and 2) innovation offices.

- **Holding companies:** State-owned companies managed by HEIs, these companies were first established in 1994. The holding companies contribute to commercialising research results and ideas and operate at an earlier stage of investment than other government financing. They can also provide contract education. There are currently 18 companies, varying considerably in size and available capital. While the holding companies are well-established, they face challenges including a lack of incoming capital, difficulties recruiting staff with the required skills and “mission creep”, where subsidiaries take on a whole range of activities that may not be linked to their main goals of commercialisation. Not all universities have their own holding company, and the companies may conduct similar activities at other universities. HEIs without a holding company, however, have reported that it is difficult to obtain equivalent support for their commercialisation activities, and some have applied to the government to form such companies.
- **Innovation offices:** These were introduced in the 2012 Research Bill to facilitate the use of research results by the private sector. Operations of the offices may vary, but each offers some form of general business advice to researchers, students and employees. The innovation offices receive direct funding from the government, which can be supplemented by HEIs. There are 12 innovation offices at 15 universities, with the expectation that they will assist HEIs that do not have one. Several HEIs have noted, though, that it is not always easy for them to obtain access to the services offered at the offices.

While both the holding companies and innovation offices play a critical part in how HEIs contribute to innovation and entrepreneurship, they are not the focus of this HEInnovate Review, which makes no specific recommendations on their set-up or funding. In parallel to the HEInnovate Review, however, the Swedish government commissioned an independent inquiry to focus on these structures, led by Alf Karlsson and reported in October 2020. The inquiry concluded that, “in order to maintain our pole position, therefore, we must ensure that we constantly implement change not previously implemented by any other country. We need to be more innovative than anyone else” (SOU, 2020^[10]).

A main finding of the Karlsson report was that the current innovation and entrepreneurship landscape is too fragmented and complex and that the responsibilities of the players overlap and vary greatly from region to region. It called for increased monitoring and evaluation of the institutions’ innovation spending. Major differences were found in the flow of ideas from the institutions. The holding companies at Gothenburg University, Lund University and Uppsala University, for instance, together account for approximately 70% of the investments made by holding companies in the past five years.

The report made ten recommendations:

- Monitoring of innovation spending be included in the annual monitoring programme run by the Swedish Higher Education Authority, with an evaluation every four years.
- Establish thematic innovation offices.
- Increased funding for early-stage commercialisation
- Establishment of a national centre for entrepreneurship. The centre will be financed through appropriations of EUR 1.9 million per year.
- All HEIs should have an intellectual property strategy.
- Research councils pay a more active role in commercialisation.
- Establishment of a Holding Company at each HEI.
- Holding companies take on wider roles, including representing the HEI with third parties and offer more services.
- To address governance and capacity issues the report proposes that higher education institutions with holding companies be commissioned to form a consortium, to manage a joint limited company. Joint management will be regulated by a shareholder agreement whereby the more important components will be determined by the Government.
- More varied products across the country.

At the time of writing, the Swedish Government is still considering the inquiry's recommendations.

Results of the Higher Education Leaders Survey

As part of the HEInnovate Country Reviews, an online survey was administered to the senior management of HEIs in Sweden, with questions on seven dimensions of the HEInnovate framework. (Entrepreneurial Teaching and Learning is explored in a Student Survey that will be discussed in the relevant chapter below, as it deals with practices within a classroom, as opposed to the other dimensions, which are mostly focused on institutional approaches.) The HE Leaders Survey is separate from the HEInnovate Self-Assessment tool, which guides HEIs through a process of identification, prioritisation and action planning across the eight dimensions. The HE Leader survey gathers information about current practices.

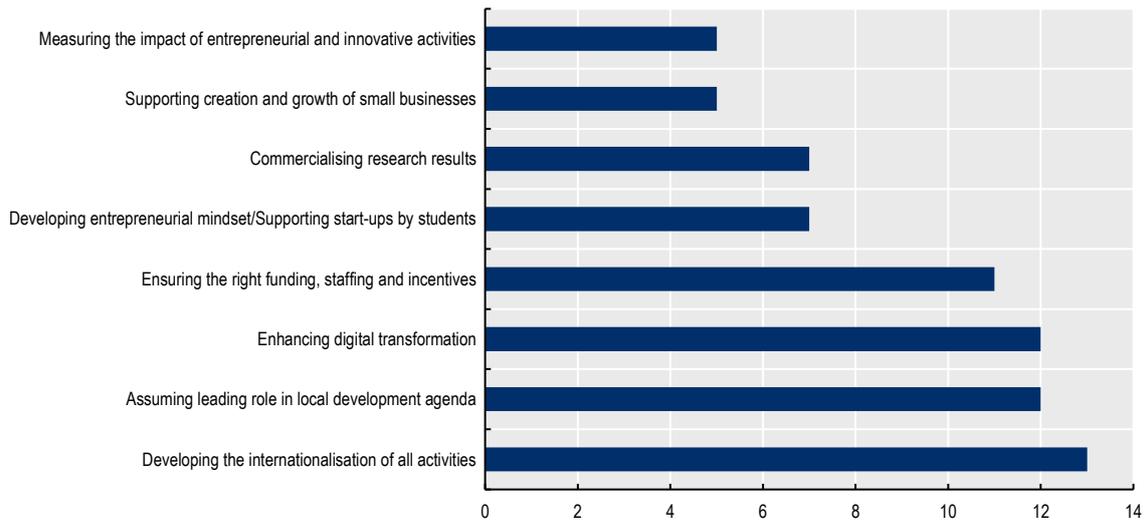
Consistent with past HEInnovate Country Reviews, the response rate was relatively low in Sweden. Of 48 recognised HEIs in Sweden, 20 participated (almost 40%). Two of the respondents had used the HEInnovate Self-Assessment Tool in the past. The survey was anonymous and did not break down responses by the different types of HEI providers.

Governance

This dimension is defined in the HEInnovate framework as strong leadership. Good governance is crucial for developing an entrepreneurial and innovative culture within an HEI.

Of the respondents, 65% confirmed that they have an institutional strategy. The elements most commonly noted were internationalisation and regional outreach. Measurement, supporting small businesses and commercialisation of results were all included less frequently.

All the respondents confirmed that external stakeholders sat on their governing bodies. They included students, other HEIs, large companies and regional/local government.

Figure 1.4. Elements included in HEI Strategies, n=14

Source: Authors' research based on OECD (2021^[11]), *HEI Leaders Survey of Sweden*, OECD, Paris.

Organisational Capacity: Funding, People, Incentives

The organisational capacity of an HEI drives its ability to deliver on its strategy. If an HEI is committed to carrying out entrepreneurial activities to support its strategic objectives, key resources, such as funding and investments, people, expertise and knowledge, and incentive systems must be in place to sustain and increase its capacity for entrepreneurship.

Of the respondents, 75% of the HEIs report that their institution employs professionals dedicated to supporting innovation and particularly entrepreneurship. However, 10% of respondents said they reward staff members for their involvement in commercialisation of research, supporting entrepreneurship or teaching entrepreneurship alongside their standard job responsibilities.

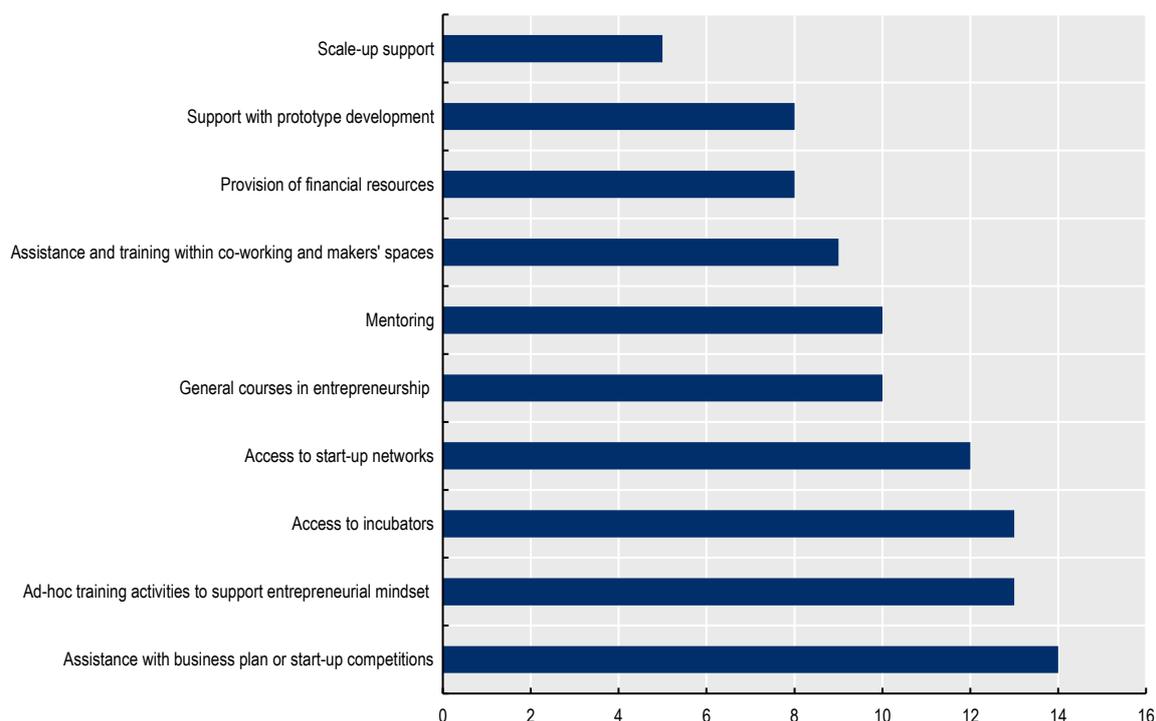
Preparing and Supporting Entrepreneurs

HEIs can help students, graduates and staff consider starting a business as a career option. For those who decide to proceed to start a business, or other type of venture, targeted assistance can then be offered in generating, evaluating and acting upon the idea, building the skills necessary for successful entrepreneurship, and importantly finding relevant team members and getting access to appropriate finance and effective networks.

70% of respondents offer concrete activities to support start-up creation and growth. Faculty (75%), undergraduate students (70%) and post-graduate students (65%) were the main targets of this entrepreneurship support, although there was sharp drop-off for support once students had graduated from the institution (15%).

The support most frequently provided by respondents focuses on the initial idea development and business plan development. Importantly, *ad hoc* training activities to support an entrepreneurial mindset are frequently offered, which is important in spreading the benefits of entrepreneurial competencies, regardless of whether the target is interested in establishing a business.

Figure 1.5. Entrepreneurship support measures offered, n=20



Source: Authors' research based on OECD (2021^[11]), *HEI Leaders Survey of Sweden*, OECD, Paris.

Knowledge Exchange and Collaboration

Knowledge exchange is an important catalyst for organisational innovation, advancing teaching and research, and local development. It is a continuous process, which includes the “third mission” of an HEI, defined as the stimulation and direct application and exploitation of knowledge for the benefit of the social, cultural and economic development of society.

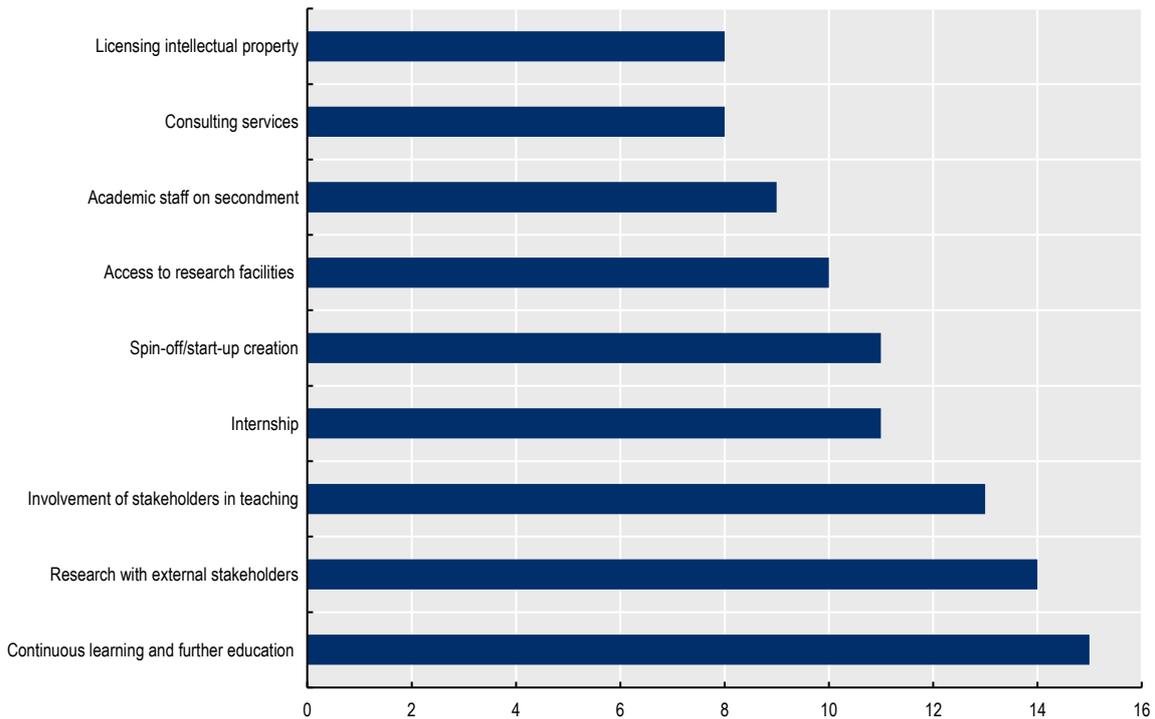
Respondents saw themselves as having an impact on the local economy; 70% of respondents rated themselves as having a significant impact on regional prosperity.

Analysing the type of knowledge and collaboration (KEC) noted in the responses, important links between KEC and education emerge. Interestingly, while research collaboration with external stakeholders is a common activity, other forms of collaboration with the private sector, such as licensing and consulting, were not.

Digital Capacity and Transformation

HEIs are already deploying digital technologies, but their uptake and integration vary among and within institutions. HEIs should make the most out of the opportunities presented by the digital transformation and consider digital technologies as a key enabler.

All respondents replied that they would be investing in their digital systems post-COVID-19, but certain areas emerged as a preferred focus for investment. The most common were the skills of staff and the development of new digital platforms, and the least common was learning analytics.

Figure 1.6. Type of KEC activities undertaken by HEIs, n=20

Source: Authors' research based on OECD (2021^[11]), *HEI Leaders Survey of Sweden*, OECD, Paris.

The Internationalised Institution

Internationalisation is the process of integrating an international or global dimension into the design and delivery of education, research and knowledge exchange. Internationalisation is not an end in itself, but a vehicle for change and improvement. It introduces alternative ways of thinking, questions traditional teaching methods and opens up governance and management to external stakeholders.

International practices are well-established in Sweden, with 70% of respondents confirming that they undertake international research collaboration both inside and outside the EU and international education programmes, and 65% participating in international staff exchange programmes. Only one respondent institution has an office or campus abroad.

Fewer institutions made the link between internationalisation and entrepreneurship, with 26% encouraging internationalisation as part of their entrepreneurial activities.

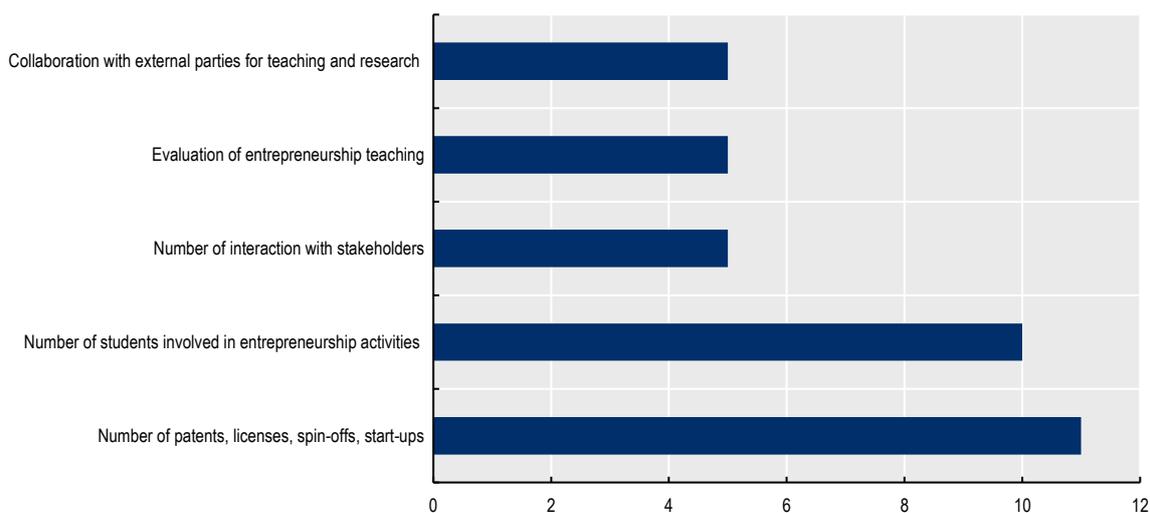
Measuring Impact

Entrepreneurial/innovative HEIs need to understand the impact of the changes they bring about in their institution. The concept of an entrepreneurial/innovative HEI combines institutional self-perception, external reflection and an evidence-based approach.

The majority of respondents confirmed that they measure some of their innovation and entrepreneurship activities, with 45% using either external or internal evaluation (25% used both).

The main indicators used to measure innovation and entrepreneurship are numbers of patents/spin-offs/start-ups or student participation in entrepreneurship activities.

Figure 1.7. Indicators used to measure innovation and entrepreneurship, n=20



Source: Authors' research based on OECD (2021^[11]), *HEI Leaders Survey of Sweden*, OECD, Paris.

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2 Entrepreneurial Teaching and Learning

The teaching of entrepreneurship is embedded in Swedish higher education institutions with formal and informal learning opportunities for students. Several universities have developed novel methodologies and pedagogies to cultivate an entrepreneurial mind-set. The practices suggest that entrepreneurship education at Swedish higher education institutions requires them to connect with their external environment, as well as organising internal capacity in terms of strategies, structures and incentives, but also on good research.

Introduction

Entrepreneurship education generates innovations that go beyond pedagogy. As this chapter shows, this is clear in the way Swedish HEIs have organised themselves and their relationships with communities and networks, after having embraced entrepreneurship in teaching.

A range of factors shape entrepreneurial teaching and learning. They operate at different levels, from the framework conditions of higher education in the country to the specific teaching decisions made by individual teachers in the classroom. This chapter will look at the factors at the following three levels:

- **Ecosystem factors:** An HEI's strategies and practices of entrepreneurship teaching and learning are influenced by external environmental characteristics and dynamics, which may be related to different institutional and policy layers (e.g. geographic: national, regional, municipal; sectoral: education, innovation, regional development, business).
- **Institutional factors:** An HEI's engagement in entrepreneurship teaching and learning is manifested in its strategies, which outline the objectives/goals for entrepreneurship at an institution, and organisational factors, which assign resources (e.g. personnel, finance) to the development of activities and structures supporting entrepreneurship.
- **Learning activities factors:** An HEI's activities of teaching and learning are developed according to different goals and audiences:
 - Education actions and practices to promote awareness of entrepreneurship and innovation through structured initiatives and actions (e.g. seminars, workshop, webinars), sometimes in collaboration with external partners. They target the entire academic community (including students of all levels, faculty and staff).
 - Educational actions and practices to develop entrepreneurship competencies for students (and PhDs) through official courses in entrepreneurship (e.g. structured courses/master's degrees, that are part of the education portfolio).
 - Ad hoc, hands-on practical training initiatives for students and faculty, with entrepreneurial ideas designed to help them develop business plans and the establishment of new companies
 - Lifelong entrepreneurial teaching and learning activities, targeting external organisations and individuals (other than students and faculty), e.g. industrial partners' employees (lifelong learning), citizens at large.

Box 2.1. Entrepreneurial Teaching and Learning in the HEInnovate Framework

The HEInnovate Framework defines entrepreneurial teaching and learning as involving exploring innovative teaching methods and finding ways to stimulate entrepreneurial mindsets. It is not just learning about entrepreneurship, it is also about being exposed to entrepreneurial experiences and acquiring the skills and competences for developing entrepreneurial mindsets.

The dimension is identified as have the following five characteristics:

1. The HEI provides diverse formal learning opportunities to develop entrepreneurial mindsets and skills.
2. The HEI provides diverse informal learning opportunities and experiences to stimulate the development of entrepreneurial mindsets and skills.
3. The HEI validates entrepreneurial learning outcomes which drives the design and execution of the entrepreneurial curriculum.

4. The HEI co-designs and delivers the curriculum with external stakeholders.
5. Results of entrepreneurship research are integrated into the entrepreneurial education offer.

Source: HEInnovate (n.d.^[11]), *Home Page*, <https://heinnovate.eu>. Accessed 05 October 2021

Ecosystem findings

Sweden is an innovation leader

As noted in Chapter 1, Sweden has been recognised as an innovation leader by the European Innovation Scoreboard (EIS). In 2020, Sweden's strengths are in Use of information technologies, Human resources and Attractive research systems (EC, 2021^[2]).

The inventor ownership regime in place at Swedish HEIs is known as “the professor's privilege”. This has been kept in place despite growing concerns about its effects on the incentives for commercialising academic research through university structures (Pettersson, 2018^[3]). Studies have shown that this regime does not reduce engagement in academic entrepreneurship by comparison with other intellectual property regimes (e.g. the United States' Bayh-Dole intellectual property regime) (Åstebro et al., 2019^[4]).

HEIs have longer history of interactions with (large) companies, and commercialisation activities (e.g. patenting and licensing, spin-offs) at HEIs are a more recent phenomenon (Tripl, Sinozic and Lawton Smith, 2015^[5]). Commercialisation enables universities to directly support the prosperity of their surrounding region. For instance, patents and licenses involving the natural sciences present a crucial part of commercialisation, helping to deploy new ideas and reward structures. They introduce a business environment in academia and create new agencies that have a positive impact on the entrepreneurial ecosystem at the HEIs (Tripl, Sinozic and Lawton Smith, 2015^[5]).

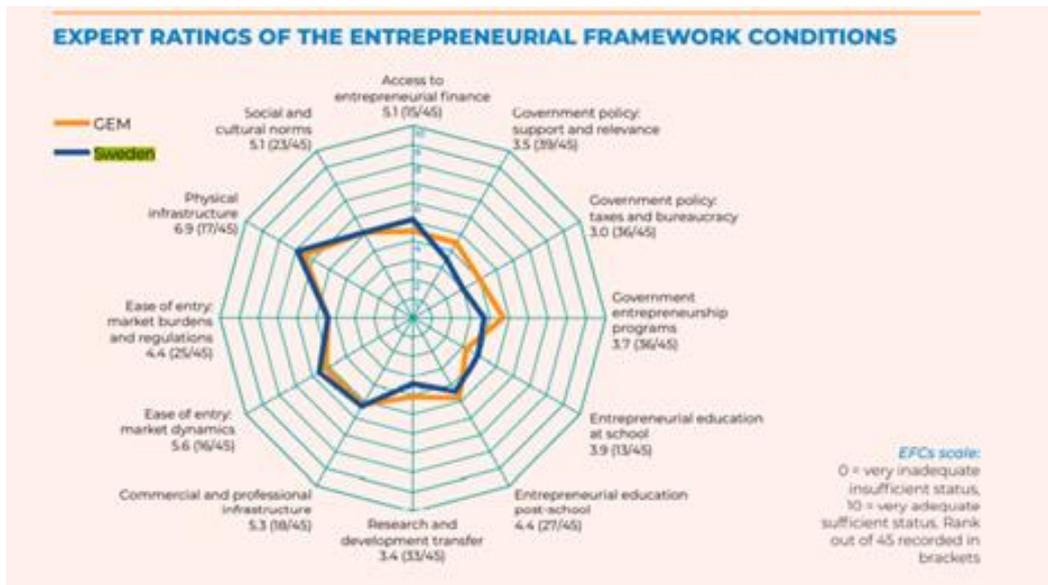
Entrepreneurship is increasingly a national trait

In Europe, Sweden (and the other Nordic countries) performs relatively better than other countries in several dimensions related to entrepreneurship, including relationships with industry (e.g. availability of venture capital, start-up rates), government (e.g. a stable bureaucracy, intellectual property protection), universities (e.g. availability of research and training facilities) and civil society (e.g. media attention to entrepreneurship) (Medeiros et al., 2020^[6]). These strengths are reflected in the Global Entrepreneurship Monitor survey results (see Figure 2.1).

Traditionally, the dominant form of public spending to sustain enterprises in Sweden has been the provision of financial tax relief, primarily to existing SMEs, rather than direct support for the creation of new enterprises (Lundström et al., 2014^[7]). However, in recent decades, entrepreneurship has increased, and young firms (less than five years old) now account for more than half of all firms in Sweden (Heyman et al., 2019^[8]). Crucial reforms were carried out during the 1990s, including introducing a tax system favourable to individuals who starting and controlling firms; deregulating several product markets and improving licensing, permit systems and communications; and implementing labour market reforms (Heyman et al., 2019^[8]).

Stockholm has emerged in the last decade as one of Europe's most dynamic start-up cities (Davidson, 2015^[9]). It is also known for its unicorns (Temperton, 2017^[10]), and in particular, for digital entrepreneurship (Ernkvist, 2015^[11]). Sharing economy start-ups and scale-ups are not typical in other cities, with the exception of Gothenburg (Geissinger et al., 2019^[12]). These large cities allow access to finance (e.g. venture capital) and skilled labour, diffusion of technologies, proximity of key actors (e.g. suppliers, regulators, politicians and institutional entrepreneurs) (Geissinger et al., 2019^[12]).

Figure 2.1. Global Entrepreneurship Monitor Survey results for Sweden



Source: GERA (2021^[13]), 2020/2021 Global Report GEM, <https://www.gemconsortium.org/file/open?fileId=50691>.

Entrepreneurship in Sweden is influenced not only by the metropolitan-rural divide, but also by the presence of remote, peripheral areas (Eriksson and Rataj, 2019^[14]). In these different types of regions, entrepreneurship is equally stimulated by human capital and entrepreneurial culture, whereas in remote rural areas, where economic conditions are less favourable and resources for entrepreneurship are scarcer, social capital plays a stronger role (Eriksson and Rataj, 2019^[14]).

Sweden's generous insurance and unemployment benefits (Hjorth, 2008^[15]) may make entrepreneurship a less desirable career option. This is especially true for those with a tertiary education. According to some authors, tertiary studies in Sweden are designed for positions in the public sector, and for employment in the private sector (Berggren and Olofsson, 2021^[16]). For instance, a study on the income return to entrepreneurship for electrical engineers in different locations in Sweden showed that the average income is lower for the self-employed than for employees in all regions (Hårsman, Mattsson and Hovsepyan, 2018^[17]). Another study showed that income returns are skewed in the top or bottom of the distribution, depending, respectively, on whether the self-employed are incorporated or not (Halvarsson, Korpi and Wennberg, 2018^[18]).

Entrepreneurship by Swedish recent graduates is influenced by good trade conditions, the availability of personal resources (e.g. finance, education, social networks), gender (men have a greater likelihood of becoming self-employed than women), education background (graduates from agriculture/forestry, fine arts, human/theology fields are more likely to become self-employed), and gained experience on the wage labour market (Berggren and Olofsson, 2021^[16]).

Swedish HEIs emphasised the association between innovation and entrepreneurship. However, some disciplines (e.g. medicine) are resistant towards using the word "entrepreneurship", and innovation is the preferred terminology.

Most interviewees stressed the importance of creating an entrepreneurial mindset and entrepreneurial competences – in line with recent European attitudes viewing entrepreneurship as a key competence (Bacigalupo et al., 2016^[19]). Earlier studies provide support for these insights, demonstrating that entrepreneurship education in Sweden favours the development of entrepreneurial skills that are "tied to life in general, rather than being only (...) skills needed in order to get a job or to start a business" (Dahlstedt

and Fejes, 2019^[20]). The selected universities try to achieve this by engaging students in practical activities with companies, as described in the section on the micro-level.

Institutional findings

Institutional autonomy is an important feature of the Swedish higher education system, and in particular, the autonomy of professors to determine what to teach in their classrooms. However, this does not mean the institution plays no role. It in fact plays an important role in planning peer learning, investment in hiring specific expertise and agreeing on a strategic direction.

Entrepreneurship as part of institutional strategy

With a few exceptions, the HEIs included in this study have no formal institutional strategy in support of entrepreneurial education. It appears professors in entrepreneurship cultivate an internal culture and strategy, and that most of the HEIs organise courses in response to external demand or opportunities from the government to join new initiatives. The proactivity of most of the universities comes more from external stimuli rather than from internal culture and strategy. This is particularly relevant for universities that do not have tenured faculty members in entrepreneurship and innovation-related activities (e.g. the University of Gävle, University of Borås).

For interviewed HEIs, the perception of new challenges emerges from the changing landscape of actors in large cities – such as start-ups and small companies in Stockholm with different institutional logic. Start-ups and unicorns have a more flexible and faster approach to the market, and consequently require a more informal and cross-functional approach to university-industry relationships. All the interviews demonstrated that large multinational companies are acknowledged as long-standing traditional partners by universities both in the larger cities (e.g. Stockholm, Gothenburg) and in more peripheral regions (e.g. the universities in Luleå or Umeå).

The interviews provided evidence that the type of organisation adopted by the internal innovation office is one of the key aspects for commercialisation of research and entrepreneurial teaching and learning. No single or “standard” organisational arrangement predominates; in some universities the innovation office is centrally managed and directly organises entrepreneurship-related activities (e.g. KTH Innovation, Mid Sweden University)

For instance, KTH Innovation is at the centre of entrepreneurship at KTH. KTH Innovation supports students, researchers and employees at KTH who want to develop an idea or create impact from their research. It works closely with regional and international partners, with the mission of enabling more technology and knowledge from KTH to create impact in society. Started in 2007, it has supported almost 3 000 ideas from students, researchers and employees at KTH, securing EUR 24.5 million in funding, and helping file more than 600 patent applications.

Entrepreneurship supported by collaboration

In other universities, entrepreneurship education is achieved by collaborating with external organisations by establishing partnerships (e.g. University of Gävle or Karlstad University with Drivhuset, Luleå University of Technology with the *Familjen Kamprads stiftelse* for Entrepreneurship, Research & Charity; or the Karolinska Institute with the Stockholm School of Entrepreneurship).

The Stockholm School of Entrepreneurship (SSES) is a joint school between Karolinska Institute, KTH, Stockholm University, Stockholm School of Economics, Royal College of Music and University of Arts, Crafts and Design, which offers education, training and inspiration in applied entrepreneurship. It offers three categories of courses: core courses (e.g. business model innovation; execution – running your own

company; growth – managing your firm; ideation – creating a business idea), context courses (e.g. entrepreneurship in developing countries; social entrepreneurship) and skills courses (e.g. Design Thinking; finance for start-ups; negotiations for start-ups; trendspotting and future thinking). The courses are provided in interdisciplinary groups with students from different backgrounds and allow students to obtain ECTS credits that can be counted towards their degree.

The collective interviews suggested that universities that are more active in offering specific activities focusing on entrepreneurial teaching/learning have professors of entrepreneurship and a successful track record of research in this field of scholarship (e.g. the Centre for Innovation and Entrepreneurship at Linköping University and the Unit for Innovation and Entrepreneurship within the School of Business, Economics and Law at Gothenburg University).

Learning Activities findings

HEIs described at least some courses/workshops/advice at the awareness-raising level for entrepreneurship education, which guarantee “quick exposure” set to stimulate an interest in entrepreneurship (Zaring, Gifford and McKelvey, 2021^[21]). The main differences across cases concern the way through HEIs concretely “mainstream” entrepreneurship across different faculties and levels of the organisation. The interviews suggest that different solutions are implemented depending on the organisational design of internal innovation offices or the use of external partnerships.

The Innovation Office at Mid Sweden University (MIUN) leads different initiatives to disseminate an entrepreneurial culture at the university, such as:

- MIUN Breakfast Lecture/Lunch Lecture: A presentation given by a noteworthy entrepreneur or celebrity, accompanied by catering (20 hours/academic year);
- Business Model Canvas: A workshop to develop an understanding of Alexander Osterwalder’s business modelling method, through lectures and student presentations (100 hours an academic year);
- Class visits: Scheduled visits to classes to present MIUN’s Innovation Office (eight hours a semester);
- Good Tech Hack: An overnight workshop dedicated to solving a real-life problem for the benefit of society and industry, through lectures and student presentations (48 hours/academic year).
- SKARPT UPPDRAG™: A whole-day workshop dedicated to solving a real-life problem for the benefit of society and industry, through lectures and student presentations (48 hours/academic year).

Another example is Drivhuset (The Greenhouse), which aims to create a positive attitude to entrepreneurship and to interest more students in realising their ideas, with a strong focus on the entrepreneur, rather than on the idea. It was founded in 1993 by two students at Karlstads University, Christer Westlund and Fredrik Langborg. They were interested in development and discussed finding new ways to live in the future, and looked for alternative ways to pursue their career at a time when Sweden was suffering from an economic crisis and a high rate of unemployment. Drivhuset has grown since then, and is active in 15 places in Sweden, including the University of Borås, University of Gävle, Gothenburg University and Karlstad University. Drivhuset supports university students intending to set up a viable enterprise through networking, coaching and dedicated training programmes.

Several universities have developed novel methodologies and pedagogies to cultivate an entrepreneurial mindset or competences, drawing on benchmarking and the evaluation of existing practices from other universities, experimentation and development of novel approaches, testing and refinement of tools.

CRE8® is a creative problem-solving method in competition form, developed at Karlstad University, which allows students taking different courses and programmes to collaborate to solve real problems. This method was originally developed in a Vinnova-funded project, “MINT” (2015-2017), which had the goal to find ways that students could help bring researchers’ innovative ideas forward. Four Swedish universities participated in MINT and tested different methods and concepts. They benchmarked and evaluated the methods and concepts together, coming up with the proposal for CRE8®. The project then expanded to another four European universities, thanks to a grant from Erasmus+ strategic partnerships (CRE8® Europe).

In a CRE8® workshop, four teams of five students are given a scenario to demonstrate their problem-solving skills, before pitching their solution to a jury. These are real-life scenarios, sourced from companies or the public sector, and the jury includes representatives from those organisations. To prepare the students, the workshop is preceded by an hourlong “pitching session”. For the workshop, the students are divided into their teams, and each team has two hours to develop a solution and prepare a five-minute pitch to the jury. The jury then has 10 minutes to question the team after each team pitches individually to the jury. Those waiting to pitch are separated from each other, to make sure the teams cannot inadvertently share solutions. After the pitches, the jury chooses a winning team. If the employer representatives wish to proceed with one or more ideas from the workshop, they pursue further contacts with the students directly.

While both “internalised” and “collaborative” solutions to raise students’ awareness of entrepreneurship at the different selected universities are interesting, they require sensitivity and cultivating entrepreneurship education at the university level. In this respect, it is interesting to compare the efforts in Norway to encourage engaged education through entrepreneurship with a national initiative to stimulate a Centre for Excellence in Education dedicated to entrepreneurship (Box 2.2).

Box 2.2. Centre for Engaged Education through Entrepreneurship (Norway)

Engage has been a Centre of Excellence in Education since 2017. The creation of the Norwegian Centres for Excellence in Education (SFU) is a national initiative that was established in 2010 to recognise and stimulate excellence in Norwegian higher education. It is funded by the Ministry of Education and Research and is administered by Diku, the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education.

Engage’s vision is to develop higher education to increase the number of students in Norway and around the world with the entrepreneurial skills and mindset to become change agents and to innovate for the better. The centre aims to engage students to discover and bring opportunities to life, whether to realise a clever invention, create a start-up company or simply to accomplish everyday tasks. By enabling students to engage by doing, learning, real world interaction and uncertainty, Engage aims to develop students’ entrepreneurial skills and mindset so they may excel.

Engage seeks to build upon, and develop experience-based teaching models that, independent of any discipline or profession, encourage students to seek out opportunities, act on them and mobilise their surroundings for effective execution. In developing higher education, Engage contributes to the generation of self-aware students who know how to use their expertise to meet the needs around them and who have the willingness to act, regardless of resistance against new methods. The centre builds new knowledge through testing, documentation and evaluations, and disseminates this insight both inside and outside Norway.

Source: Engage (n.d.^[22]), *Home Page*, <https://engage-centre.no/>. Access 05 October 2021

Formal courses in entrepreneurship

Swedish HEIs offer official courses in entrepreneurship, allow either a “classroom exposure” or a “theoretical and practical exposure” resulting in an academic degree at any level (Zaring, Gifford and McKelvey, 2021^[21]). The data revealed that, in the majority of these courses, the development of entrepreneurship competences is associated to experiential learning and active students’ engagement with companies’ real problems and needs (e.g. students’ “missions”; challenges; consulting activities). The practical implementation of these courses is different depending on whether the research units specialise in business, management, entrepreneurship or innovation (for instance the Division of Project, Innovations and Entrepreneurship at Linköping University; or the Unit for Innovation and Entrepreneurship at Gothenburg University, which can transfer their knowledge directly to students).

At Gothenburg University, entrepreneurial education is taught in the School of Business, Economics and Law’s Unit for Innovation and Entrepreneurship (UIE). The UIE carries out research and educates future leaders in co-operation with the business community, in innovation, entrepreneurship and management of intellectual assets.

The Master of Science in Knowledge-Based Entrepreneurship is one of the two masters programmes the School offers. It is a two-year master’s course (120 ECTS) cultivating personal and business development, providing students with an integrative, international and interactive approach, and adopting hands-on learning methodologies. For instance, professors collaborate with business coaches from external companies and idea providers from Gothenburg University (e.g. researchers, innovation office) to learn about entrepreneurial opportunities. Students are from different backgrounds (e.g. economics, engineering, design) and are thus exposed to learning in a diverse environment. The programme is structured to give students the chance to evaluate and recognise opportunities in the first year of study; and to practice with entrepreneurship tools (e.g. business models), networking with the external ecosystem in Gothenburg, or working with the innovation office in the second year. According to 2018 data, 63% of students of this masters degree accepted a job before graduation, and 91% had found employment two months after graduation.

Alternatively, universities where such research skills are not available, for instance in medical or technical schools, the courses are established as part of a larger programme of collaboration with external partners.

Karolinska Institute has created a Unit for Bioentrepreneurship (UBE), which develops and provides educational activities related to innovation and entrepreneurship in the life sciences. UBE offers a two-year Masters in Bioentrepreneurship (120 ECTS) for students with a background in biomedicine, pharmaceuticals, biotechnology, healthcare or medicine, with courses that address how to manage and develop life science companies. The programme is interdisciplinary with regards to the background of students and teachers, as well as the pedagogical methods. The pedagogic model at UBE is student-centred and based on “entrepreneurial learning,” to create conditions for creativity, reflection and initiative in teaching. Lectures are often held by external experts with diverse backgrounds and serve as inspiration for discussion. Theoretical knowledge is obtained through literature studies and applied through practical work, such as workshops, case exercises and projects, often in groups. Some of the courses in the Master in Bioentrepreneurship are offered with other partner schools in Stockholm. The business administration courses are offered by the Royal Institute of Technology (KTH) and the elective courses by Stockholm School of Entrepreneurship.

From the selected cases, the keywords that emerge as relevant for constructing effective entrepreneurship courses are linked to active and experiential learning; personal involvement and professional/business development; and interdisciplinarity. Interviews suggested that developing successful entrepreneurship teaching and learning depends on professors’ skills and knowledge. In addition, professors should have a sensitivity to interdisciplinarity to develop these activities, which students should be offered as a foundation so they can choose the most relevant competences and be exposed to both theory and practice.

The cases presented in this section show how different departments or business schools can create successful entrepreneurship programmes, either autonomously or through external partnerships. At the international level, the Ryerson Entrepreneur Institute in Canada shows how a university-level initiative can be supported by a university's top management team, making innovation and entrepreneurship support more accessible to all students and alumni of the university in different faculties (Box 2.3).

Box 2.3. Ryerson Entrepreneurship Institute (Canada)

The Ryerson Entrepreneur Institute (REI) leverages Canada's largest business school and entrepreneurship programme, aiming to spread a culture of entrepreneurship and empower those in need. Its goal is to support a values-driven culture of innovation, prosperity and achievement, igniting a passion for entrepreneurship. REI is a global leader in sustainable co-curricular student engagement and experiential learning in entrepreneurship. It inspires and supports students as they engage in transformative co-curricular projects. Students engage in transformative entrepreneurial projects both outside and alongside their university degree curriculum. Students design and implement their own projects and their personal development goals.

In collaboration with several partners, REI's scalable customised programmes provide inspiration, education, resources and funding to a wide range of audiences. REI avoids a one-size-fits-all process, and is attuned to the diverse values, language and approaches that different individuals and organisations bring to entrepreneurial projects. Its mission/goal is to provide students an experiential, learning experience and are empowered with a philosophy of entrepreneurial thinking that they can apply to their lives, their jobs, their communities and/or their own new ventures.

Canada's largest entrepreneurship programme offers innovative educational programmes and supports multidisciplinary experiences across campus, with local, national and global impact.

Source: Ryerson Entrepreneur Institute (n.d.^[23]), *Home Page*, <https://ryersoninstitute.org/>. Accessed 05 October 2021

Extracurricular and informal learning opportunities

The selected HEIs have provided insights on different hands-on educational initiatives that can be tied to entrepreneurship or innovation. In general, interviews with representatives of HEIs suggested that such initiatives are inspired by an understanding of the need to use novel education approaches based on practical iterations with objects and people, allowing students to test theories and ideas. Interestingly, while some of these hands-on activities are realised by setting up dedicated structures and infrastructures (e.g. the makerspace incorporated into the services of the library at Luleå University of Technology), others do not rely on physical infrastructures but have promoted novel approaches offering new interaction modalities and space).

The Co-up Lab is a novel education approach for hands-on learning and spurring innovation in the life science context. Based on co-creation, the pop-up space creates an interface for interaction on site between students and stakeholders. This approach has been used at Karolinska Institute by combining "pop-up" innovation spaces and an incubation programme focusing on early incubation. With mobile innovation spaces, students and teachers "pop up" at different locations (e.g. the entrance of a hospital), forming an interface between the classroom and the public, the learning and real context and the innovation process and the user. Students develop ideas in co-creation with stakeholders, professionals and end users. The educational offer is designed as a semester-long educational experience, with three "co-ups" that follow a user-centred approach. Each "Co-up" is open to students eager to learn more about either the theme of that co-up or to work with their idea at one event instead of the semester-long programme.

Several universities worldwide are pursuing the idea of creating an accessible space to bring together people curious about social, environmental or technological issues and interested in developing new skills for their career, for practical experiences and developmental encounters. As these cases demonstrate, accessibility and availability of dedicated resources, equipment and tools allow for students' proactive participation and engagement, which can help develop entrepreneurial ideas.

Box 2.4. Imperial Enterprise Lab (UK)

The mission of Imperial Enterprise Lab is to help students think outside the box, break boundaries and dare to be different. It provides a space for activities such as student competitions, speaker events, hackathons, skills seminars, co-working space and expert mentors. It brings together people from different disciplines, cultures, backgrounds and life experiences to look at situations from new angles and solve problems. It supports the next generation of entrepreneurs and innovators at Imperial College London, and promotes and nurtures entrepreneurial idea development from the student community through to start-up level. Students are part of an energetic and passionate team, helping to generate the growth of new entrepreneurial ideas from science, engineering, medicine and business.

Source: Imperial Enterprise Lab (n.d.^[24]), *Home Page*, <https://www.imperialenterpriselab.com/>. Accessed 05 October 2021

The case-study HEIs carry out specific hands-on activities in incubation or support services for academic start-ups, established either by students or by research staff. These activities can be organised through university internal innovation offices, such as the KTH Innovation pre-incubator programme, or by collaboration with external partners, such as Jönköping University and Jönköping Science Park (which welcomed about 300 ideas from students and researchers in 2016).

The KTH Innovation pre-incubation programme is a 12-month programme to accelerate development of promising start-up projects from KTH students, researchers or employees with tech-based start-up or research commercialisation projects. The programme, which incubates around 30 companies per year, is free of charge. KTH Innovation does not have ownership of the business idea. The overall goal of the programme is to find the first customers and to have the first product/service ready. The teams in the programme get access to KTH Innovation's co-working space, enjoy weekly lunch workshops together with the other teams, and get higher priority from staff at KTH Innovation and access to its network (e.g industry players, other incubators in the region and EU KIC's incubation activities). When the project progresses, the team can get an experienced external mentor and can make a pitch for about EUR 25 000 in investment from KTH Holding. Through this programme, the team increases the knowledge of entrepreneurship and commercialisation, and builds its own network.

One interesting option emerging from the selected cases is to promote the development of business ideas through entrepreneurs in residence or matching programmes. This can put students in a position to consult inventors, entrepreneurs or real companies to develop their business idea.

LEAD, Linköping University Entrepreneurship and Development, is owned by Linköping University, by the wholly owned subsidiary LiU Holding AB. LEAD's goal is to accelerate the development of start-ups by providing idea owners and entrepreneurs a wide range of directed resources and services for faster and more secure growth, such as innovation support, verification funding and start-up support. Among the different activities, LEAD carries out an entrepreneurs in residence initiative, a six-months trainee programme during which participants are part of a business development team with a clear mission: to transform new ideas or new technologies into start-up companies with the potential to succeed in the market. LEAD offers support through dedicated experienced business coaches. Another initiative is the "Summer Match", an entrepreneurial programme that focuses on developing ideas derived from research

at Linköping University towards market-adapted products and services. Students get the chance to work with another student, and are matched with a researcher who wants to push his or her idea into the market. The tasks vary, depending on the focus of the research idea and where in the commercialisation process the idea is. The researcher may, for example, be in need of new perspectives, prototype work, mapping, market analysis or graphic design. Students' efforts can result in new solutions, agreements with customers and hopefully new companies.

Some Swedish HEIs participating in this exercise have specifically mentioned the involvement of alumni as relevant for nurturing collaboration with industry (e.g. KTH, Gothenburg University), although their involvement is not specifically focused on exposing students to corporate entrepreneurship opportunities. This differs from international experiences that favour engagement of university alumni in entrepreneurship learning, for instance through entrepreneurship clubs and societies (Pittaway et al., 2011^[25]).

Life-long learning

Some HEIs focus on lifelong learning and propose training and education to managers and professionals in companies (e.g. KTH's online courses on innovation or digital economy; Jönköping's Executive programme in Family Business Management).

CeFEO, the Centre for Family Entrepreneurship and Ownership at Jönköping University, is one of the leading research environments in Europe and among the top three environments globally in the area of ownership and family business studies. The leading mission of CeFEO is to combine academic excellence and practical relevance. CeFEO is an internationally oriented research and learning centre with the ambition to become a natural partner for researchers and family owners/managers, as well as for advisors and other actors interested in family entrepreneurship and ownership. The mission of the centre involves 1) high-quality academic research on relevant family entrepreneurship and ownership topics; and 2) engaging in a knowledge dialogue on family entrepreneurship and ownership topics with stakeholders, through service and outreach activities (such as seminars and education) to increase awareness and skills among students, owners, managers, advisors and policy makers.

In the centre, one of the most prestigious programmes is the Executive Programme Family Business Management. The programme is certified by Jönköping International Business School, and is tailor-made for family business owners, managers and practitioners, and is based on the latest findings from the leading research conducted at the Centre for Family Entrepreneurship and Ownership (CeFEO).

In general, the insights gained from interviews in this research suggested that companies are looking for collaborations with universities to help solve problems or business needs. This can be achieved either by requiring education or training, engaging in continuous work with students, or employing doctoral students or postdoctoral fellows. As noted both in interviews and prior studies (e.g. (Klofsten and Jones-Evans, 2013^[26]), these programmes require engaged leadership, openness and willingness to share ideas among participating entrepreneurs, high levels of company engagement, informality and flexibility. Swedish universities are key actors in regional research and innovation strategies (e.g. Karlstad University's strategic partnership with Region Värmland to create the Academy for Smart Specialisation). The role of universities as key actors in providing specialised human capital is particularly emphasised by universities in remote areas (e.g. Umeå University and Luleå University of Technology).

NorrlandsNavet is a business development centre at Luleå University of Technology, which was founded in 2020 by the Kamprad Family Foundation for Entrepreneurship, Research & Charity (*Familjen Kamprads stiftelse*). The initiative is funded by EUR 9.9 million over eight years. Luleå University of Technology has long experience of working closely with companies and has the highest proportion of corporate-funded applied research of any Swedish universities.

NorrlandsNavet aims to strengthen and develop small and medium-sized enterprises (SMEs) in northern Sweden, by supporting, stimulating and rewarding education and scientific research to promote entrepreneurship, the environment, competence, health and social improvement. The centre will identify knowledge needs from both larger companies (50 to 250 employees) and smaller companies (five to 10 employees), in areas that are important for business development and competitiveness (e.g. digitalisation of business models; international marketing). When the needs are identified, Luleå University of Technology will develop educational initiatives to benefit the companies. In some cases, companies' needs may be more challenging and may require longer research efforts or collaboration with students in the form of degree projects. The knowledge gained will be disseminated in the region, nationally and internationally.

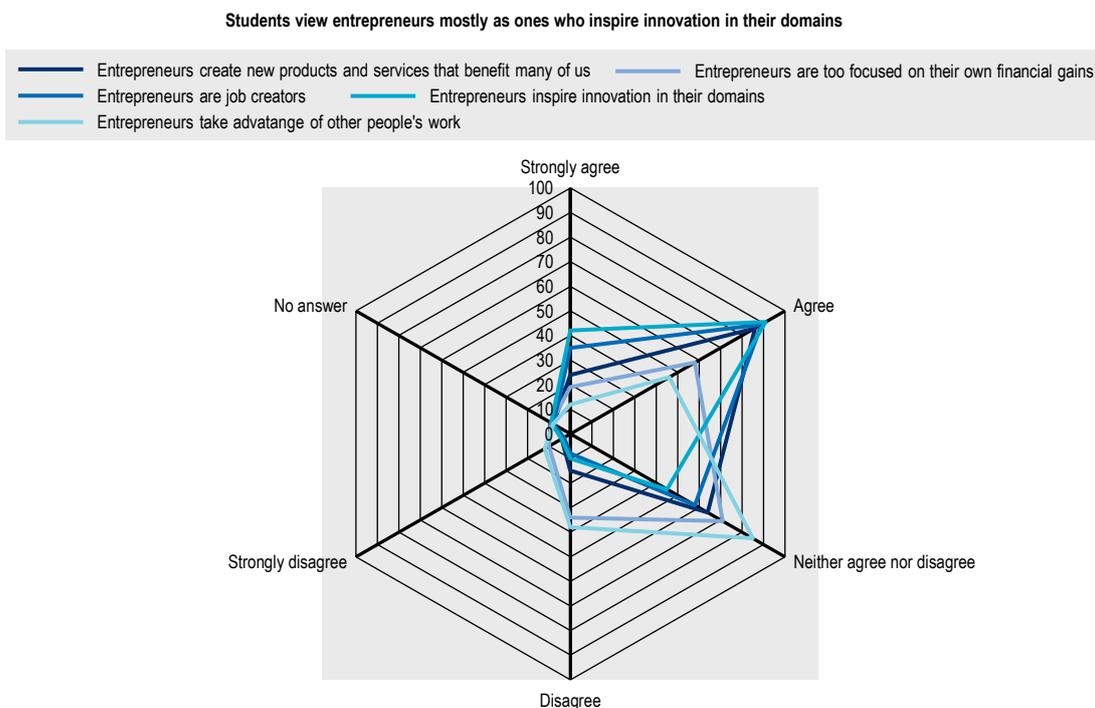
PhD students play an important role in NorrlandsNavet. They work in close collaboration with SMEs in the region to identify problems and challenges in the companies. The PhD students do most of the fieldwork and thus spend considerable time with the companies. The SMEs involved gain access to collaborative PhD students and researchers from different scientific disciplines, who can help them develop their business.

Results of the Entrepreneurial Student Survey

One of the innovations for the HEInnovate Review of Sweden was a survey of students taking entrepreneurial courses, which gave them an opportunity to contribute directly to the analysis of the report. Responses were provided by 201 students.

The views of entrepreneurs were mixed. Students had both positive and negative statements about entrepreneurs. A high degree of neutral responses indicated the ambivalent view students had of entrepreneurs.

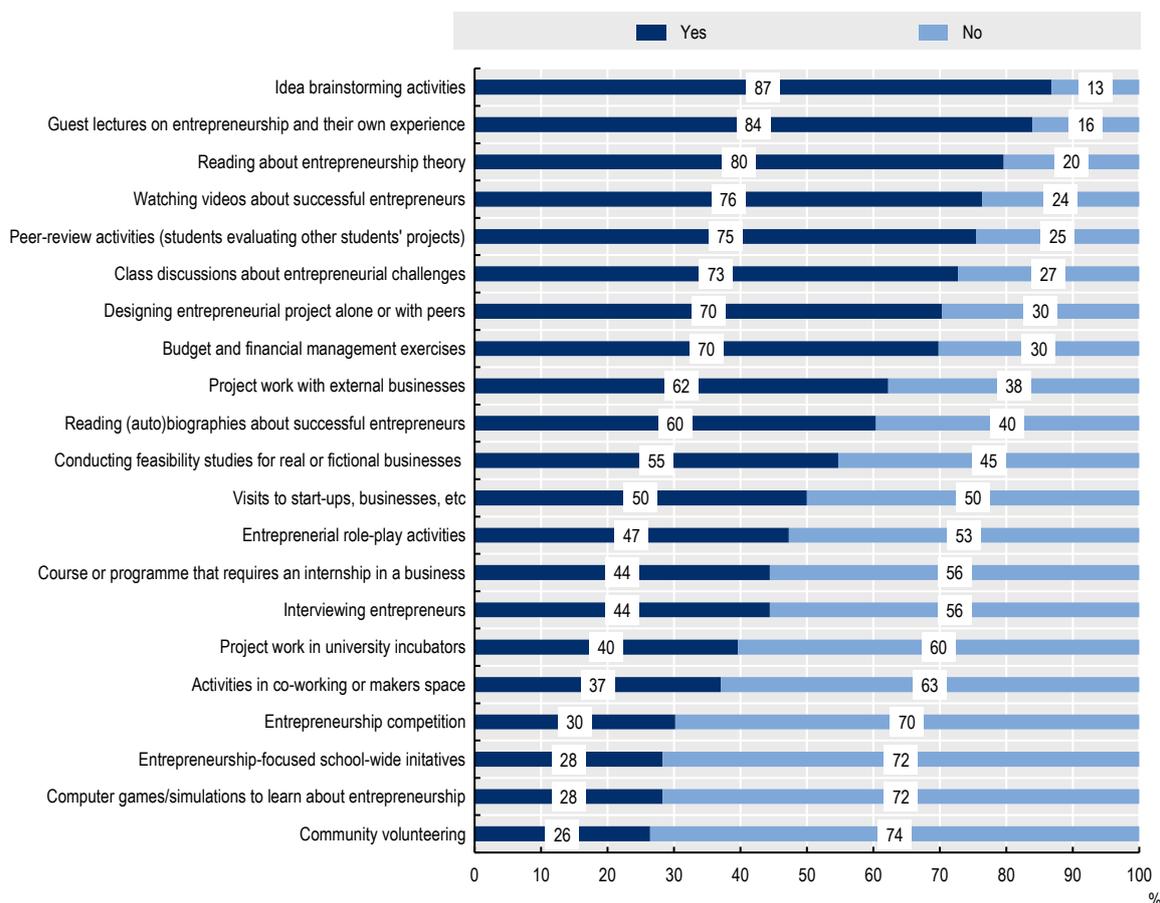
Figure 2.2. Students had ambivalent views of entrepreneurs



Source: Authors' research, based on OECD (2021_[27]), *Entrepreneurship Education Students' Survey*, OECD, Paris.

Students reported being exposed to entrepreneurship through a wide range of teaching methods, but mainly focused on traditional pedagogy, such as reading about entrepreneurship theory, guest lectures or class discussions. Swedish entrepreneurship educators may consider widening access to hands-on experiences, such as interviewing entrepreneurs, activities incubators and entrepreneurship competitions.

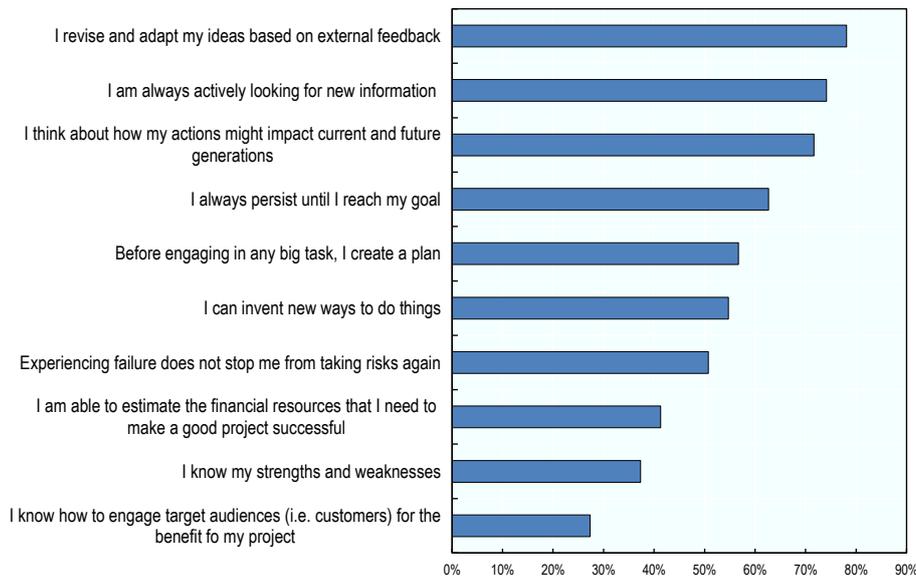
Figure 2.3. Entrepreneurship education activities focus on in-classroom teaching



Source: Authors' research, based on OECD (2021^[27]), *Entrepreneurship Education Students' Survey*, OECD, Paris.

Students gave extremely positive reports of hands-on activities as influencing their views on entrepreneurship. Lectures and guest events with entrepreneurs, a teaching approach that was most frequently mentioned, was reported as having some of the lowest impacts on their engagement with entrepreneurship. Real-world activities, including simulations with fellow-students, were assessed very highly.

The students also self-assess their entrepreneurial skills and draw from existing and validated instruments whenever possible, looking at 1) the extent to which students report feeling they are capable of identifying and creating ideas and opportunities, 2) whether they can mobilise internal resources (such as self-awareness and perseverance) and external resources (such as using feedback, collaborating with others and networking), and 3) whether they can combine ideas and resources to launch and nurture projects.

Figure 2.4. Students' self-assessment of entrepreneurial skills

Source: Authors' research, based on OECD (2021^[27]), *Entrepreneurship Education Students' Survey*, OECD, Paris.

Building on success

Entrepreneurship as a career is influenced not only by individuals' characteristics, but by the context and historical influences. HEIs can implement programmes that inspire students through entrepreneurship education, but societal norms and the expectations of family and friends should also allow for a shift towards widespread acceptance of entrepreneurship and self-employment as a desirable and feasible opportunity, with respect to available alternatives (Berggren and Olofsson, 2021^[16]). It is important to note here that the discourse of entrepreneurship education in Sweden has evolved within a wider neo-liberal rationality, which tries to shape citizens who are responsible for themselves and their life trajectories, who constantly will and desire to learn and are thus able to adapt to the changing future (Dahlstedt and Fejes, 2019^[20]; Hägg and Schölin, 2018^[28]).

Incentives for entrepreneurial teaching and learning

The Swedish HEIs system is largely subsidised by the Swedish government, to promote its key role in regional development, with substantial autonomy (e.g. (Lindqvist, Olsen and Baltzopoulos, 2021^[29])). However, not all the HEIs follow the same strategy and organisation. Older, traditional universities employ research-oriented activities, and new HEIs have a strong focus on education to serve the regional needs for competences in the public or private sector (Tripl, Sinozic and Lawton Smith, 2015^[5]). Not all universities have the same performance in innovation and entrepreneurship activities. For instance, not all HEIs have been equally successful in applying for the establishment of VINN excellence centres (Tripl, Sinozic and Lawton Smith, 2015^[5]). VINN centres are research and development centres in industry areas relevant to high technology research (e.g. biotechnology, informatics and ICT, product development and new materials, transport and working life) (Hellström, 2014^[30]). Similarly, cases covered in this exercise display a varying degree of attention to entrepreneurship outcomes and education.

Box 2.5. European support for higher education institutions

To support HEIs' role in the post-pandemic recovery and the twin transition to a greener and more digital Europe, HEIs can draw from a number of EU opportunities:

- NextGenerationEU and the Recovery and Resilience Facility supports the recovery and provides unprecedented investment in skills, higher education, research and digitalisation.
- The European Green Deal aims to transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use and no person and no place left behind. The European Green Deal is also the lifeline out of the COVID-19 pandemic. One-third of the EUR 1.8 trillion investments from the NextGenerationEU Recovery Plan, and the EU's seven-year budget will finance the European Green Deal.
- The EU's digital strategy aims to make sure that the digital transformation works for people and businesses, while helping to achieve its target of a climate-neutral Europe by 2050. It will strengthen its digital sovereignty and set standards, rather than following others' – with a clear focus on data, technology and infrastructure.

In 2020, the Commission adopted a number of communications to give political orientations to Member States that are also highly relevant for HEIs: communications on the European Education Area (EEA), the revitalised European Research Area and the new Digital Education Action Plan.

Purpose of Entrepreneurial Teaching and Learning

In Sweden, tertiary education is still understood and designed for employment within large institutions, either in the public or in the private sector. For instance, graduates “in technological fields find employment within Swedish multinational companies, graduates from social science and law fields are directed towards positions in governmental institutions, and graduates from the fields of health care and education are directed towards positions in the public sector which correspond precisely or well with their degree” (Berggren and Olofsson, 2021^[16]). A reflection on the changing opportunities in the environment is important. For instance, medical schools (e.g. KTH and the Karolinska Institute) could be continuously considering potential entrepreneurship opportunities (both through start-ups, corporate or university spin-offs), building new connections and the potential in licensing out inventions.

HEIs also demonstrated an understanding of entrepreneurship beyond the formation of businesses. Managers and professors frame entrepreneurship as focusing on the entrepreneurial mindset and transversal competences. This approach can enhance the students' entrepreneurial mindset, and that of their local communities and companies in the local context. However, the lack of formalised strategies, incentives and structures can undermine development of entrepreneurship teaching and learning, especially if other priorities emerge and drain resources (e.g. the COVID-19 pandemic).

It is not clear to which extent innovation support should be reorganised on the national level to strengthen the capacity of innovation offices, since the landscape observed for this study was differentiated and based on selected HEIs. The key factors seem to be located externally (e.g. depending on whether the HEI is located in a metropolitan area), but also internally to single HEIs (e.g. organisation of the innovation office, presence of a business school, presence of professors in entrepreneurship).

The location of HEIs matters, especially considering their capacity to manage development relationships in cities in remote locations. The Stockholm ecosystem is very active, even if it mainly attracts “local” universities and allows HEIs to partner with other key actors in the entrepreneurial ecosystem. The changes in the composition of the population of companies in the country, e.g. the increasing presence of

start-ups and small businesses, represents a challenge for HEIs traditionally able to deal only with resourceful large multinational companies or public sector bodies.

Few programmes at the doctoral level have been found in the selected universities for exposure to entrepreneurship. A review of the literature seems to confirm this. A study of Swedish doctoral programmes in economics indicates that neglect of the role of the entrepreneur “partly explains the strong emphasis on research and development as a primary determinant of growth in growth modelling” (Johansson and Malm, 2017^[31]).

Considerations for Next Steps

The present review illuminates the paradox of strong government encouragement for research and innovation, but different degrees of internal capacity and organisational structures at different HEIs. The practices presented in this chapter suggest that entrepreneurship learning and education at HEIs requires them to pay attention to harvesting and stimulating resources in the external environment, as well as organising internal capacity in terms of strategies, structures and incentives, but also on good research.

Considerations for policy makers

For entrepreneurship education, the findings from this exercise suggest that strong entrepreneurship education comes as a consequence of HEIs’ emphasis on internal values (entrepreneurial culture or culture of collaboration with companies), internal incentives to become engaged and to generate impact for faculty members, and “openness” to the outside. However, these may be necessary, but not sufficient, starting conditions. Swedish HEIs enjoy the autonomy to take on many of these measures without government action, but public policy can help incentivise priorities. Policy makers can play a part in providing the framework conditions for HEIs to create internal capacity to generate innovation and entrepreneurship, as well as to create research capacity in entrepreneurship. Options for policy makers include:

- Support HEIs to leverage external collaborations in their teaching, for instance leveraging external facilitators/educators, using "Design Thinking" and engaging alumni.
- Funding for HEIs to undertake activities in management and entrepreneurship. This includes research activity in entrepreneurship and management.

Considerations for higher education institutions

HEIs can provide support for entrepreneurship teaching and learning by emphasising social capital, which is an important way of facilitating economic activity, particularly in peripheral regions. HEIs in municipal centres in relatively peripheral areas could become sources of growth in regions with mature industries or that are in decline. Valorising interdisciplinary research and commercialisation of research results can be helpful, taking into account the idiosyncrasies of the local context (urban vs. rural) and of the prevailing industries (e.g. mining, fishing, textiles, fashion, design, etc.).

Swedish HEIs are key actors in regional innovation and development strategies, for instance through industry-university collaborations in training, education and transfer of research knowledge. They could make efforts to provide competences and resources specifically geared towards the regional economy, while supporting graduates so they can meet the needs of the global workforce.

Considering the importance of strengthening the links between research into entrepreneurship and the teaching of entrepreneurship, HEIs could consider developing industrial doctoral programmes, which could help in particular small and medium-sized enterprises (SMEs) and other companies that find it difficult to access HEI infrastructure. A variety of approaches to entrepreneurship education are valid, and some can be considered best practices and a source of inspiration for other players, even outside Sweden. Options include:

- HEIs regularly participate in international networks and associations (e.g. the European University Business Forum, ASTP Proton, UIIN, etc.) in order to socialise their best practices, and to learn from different successful or unsuccessful experiences and from different innovation ecosystems.
- Develop joint programmes with other partners in Scandinavia or on the international level. Some already exist (e.g. Linköping University participates in the European Consortium of Innovative Universities, a consortium of 12 European universities offering, among other things, innovation and entrepreneurship courses). Further efforts of this kind could be desirable.

In closing, none of the interviews raised the issue of diversity in entrepreneurship education. Entrepreneurs' backgrounds determine their position in the labour market and influence their likelihood of engaging in entrepreneurship. Closer consideration could be given to addressing the needs and characteristics of disadvantaged groups.

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3 Digital Capability and Transformation

Prior to the Covid-19 pandemic Swedish higher education institutions already undertook a significant amount of digital teaching, expertise they were able to leverage during the pandemic. Digital transformation also has potential to support higher education institutions activities' outside of the classroom, and may play a critical role in addressing some of the biggest challenges in knowledge exchange activitiesm, including big data and platform management.

Introduction: Digital transformation in Sweden

Sweden demonstrates the importance of the “digital transformation and capability” dimension in supporting entrepreneurship and innovation in higher education. It is recognised as a European and global leader on digital transformation. Among OECD countries, Sweden’s economy has the highest share of value added produced by the information and communication technologies (ICTs) sector and is among the top ten exporters of ICT services worldwide (OECD, 2019^[1]). Spotify is one successful example of this leadership, and became the biggest online streaming service in 2016. Internet use is widespread in Sweden, among both individuals and businesses, and the digital divides along the lines of age, education, income and firm size are among the narrowest in the OECD. What is more, 60% of Swedes actively use the Swedish eGovernment Services, and 40% of Sweden’s governmental agencies are engaged with working with data, offering many entrepreneurial opportunities for academia as well as local business.

Sweden has consistently striven to have digital strategies that are amongst the world’s most ambitious. In 2009, the national government set the ambition for 2020 to have 90% coverage of households and business with 100 megabits per second (Mbps). The national government has already extended its target, now aiming by 2025 to provide access of 1 gigabit per second to 98% of households and firms (OECD, 2019^[1]).

Risks remain, however, that Sweden will need to monitor. For instance, while only a very small percentage of the population has low broadband speeds, remote and regions without high-speed infrastructure are at significant risk of being excluded from services and economic opportunities.

Swedish policy also needs to take full advantage of this infrastructure. As an earlier report noted (OECD, 2019^[1]), “Current policies do not address the demand for complementary skills to thrive in a digital economy, e.g. problem solving, self-direction, interaction, co-operation, management and leadership skills. Education reforms should include such skills more firmly in curricula and syllabuses. Sweden has the possibility to ‘jump’ beyond the technology frontier and become a global leader in digital education/skills/infrastructure”.

Alongside this robust and extensive infrastructure Sweden has made a commitment to ensure that citizens acquire digital skills. In October 2017, the Ministry of Education and Research (*Utbildningsdepartementet*) launched a National Digitalisation Strategy for the School System with the goal of providing all children, students and young adults with the skills they need for their life and work. In 2019, the Swedish Government has tasked the UKÄ, Sweden’s Higher Education Authority, and the Swedish Agency for Economic and Regional Growth (*Tillväxtverket*) to collaborate in analysing and proposing how access to cutting-edge digital expertise can be ensured both in the short and long term. The report detailed a set of recommendations on how to improve digital skills and competencies in Sweden. These included clarity about who is responsible in the educational system for the validation and certification of digital excellence; conducting an overview of the lifelong learning offerings by higher education institutions (HEIs) and establishing a “Council for the Supply of Digital Excellence” to identify a clear supply and demand profile of digital workforce needs (Gulliksen et al., 2020^[2]).

As a global leader in digital transformation, Sweden nevertheless faces pressure to continue at the frontier of innovation. This dilemma has been critical in shaping the digital transformation and capability of Swedish higher education. The expectations of government, students and society at large are high, both in terms of how higher education is digitally-enabled, as well as in how it contributes to building capacity in society at large to continue its digital transformation. This digital transformation and capacity, as Box 3.1 demonstrates, will be a core part of the innovation and entrepreneurship journey of Swedish HEIs in the coming years.

Box 3.1. Digital capability and transformation in the HEInnovate Framework

The OECD and the European Commission added Digital Transformation to the HEInnovate Framework in 2018, reflecting the growing role of digital technologies in underpinning the objectives of the framework. This dimension reflects the intertwined nature of the HEInnovate framework, where an entrepreneurial mind-set is necessary to achieving digital transformation and equally digital transformation is critical to delivering entrepreneurial outcomes.

The dimension was reviewed and updated in March 2021 and it was that new framework that was used to inform this analysis.

The dimensions were updated to have the following characteristics:

1. The HEI fosters a digital culture and implements and monitors a digital strategy supporting innovation and entrepreneurship.
2. The HEI invests in, manages and continuously improves a fit-for purpose digital infrastructure.
3. The HEI actively supports the use of digital technologies to enhance quality and equity in teaching, learning and assessment.
4. The HEI actively uses open educational resources, open science and open data practices to improve the performance of the institution and increase its impact on its ecosystem.
5. The HEI makes full use of its digital capacity to promote sustainable and inclusive innovation and entrepreneurship.

While the HEInnovate review of Sweden commenced before this update was published, the new characteristics are the basis for the analysis below.

Source: HEInnovate (n.d.^[31]), *Home Page*, <https://heinnovate.eu>. Accessed 05 October 2021

The next sections discuss “digital transformation and capability” in relation to teaching and learning, knowledge exchange and collaboration, and sustainability. There are other areas, however, in which digital transformation has been particularly evident in the Swedish system. For instance, the way in which leadership, governance and organisational capacity have reacted to the sudden digitalisation of processes and management activities is quite relevant. The presence of formal “digitalisation strategies” helped several Swedish HEIs weather the pandemic quite successfully. IT services have become central in institutional governance arrangements, and this has allowed for the experimentation of innovative digital solutions in all HEIs’ activities and processes.

Digital Teaching and Learning

Due to COVID-19, 2020 marked a great acceleration in digital teaching and learning in Sweden, as it did for HEIs globally. The Swedish government imposed restrictions on how HEIs could teach, as did its peers across Europe, and HEIs in Sweden moved to teaching and assessment online.

Swedish HEIs were in a strong position to move to online education, with dedicated strategies and resources in place. For instance, KTH already had a designated Object Owner for E-learning, who is responsible for supporting online education across the institution. The position is held by a lecturer from the Education Department who lectures and researches on the subject of digital education.

Swedish HEIs also benefited from the fact that they could assume that both staff and students would have access to high-quality fibre connections, allowing for cutting-edge digital teaching tools, including multiple two-way video. Equipped with an infrastructure where everything was possible, teachers could design courses around pedagogical needs, rather than the speeds that students had access to.

A significant percentage of students are distance learners. Taking into account percentages before the COVID-19 pandemic, 45% of the students at the University of Gävle were already distance learners. Likewise, at Mid-Sweden University, over 50% of the students were already engaged in a form of online learning before the pandemic hit. Online learning was used by both institutions and others to support lifelong learning, and before the pandemic were collaborating with businesses to develop micro-credentials to meet the needs of the labour market.

Both Karlstad University and the University of Gävle used digital tools to develop compact, flexible courses to support the up-skilling of those already in work. At Karlstad University, students only need to pay for these courses if they wish to receive a formal certification. Unlike Massive Open Online Courses (MOOCs), these sessions are integrated into the HEIs' main course offerings, and in Gävle, a student may attend teaching on campus. Both institutions reflected that they consider online teaching to be fundamental in meeting the demands of learning in modern working life.

This is not to say that the COVID-19 pandemic represented a pure continuation of teaching and learning in Sweden. Before the pandemic, KTH, the Royal Institute of Technology, had 50 Zoom calls a day on average, which jumped to 2 500 per day less than a month after the move to online learning. KTH also needed to introduce new digital tools, in the form of pre-recorded lectures and online discussion forums. It was also found that moving assessment online presented challenges for courses that were developed for face-to-face presentation, and which, for instance, required a practical lab experiment as part of the final assessment. KTH were able to move 80% of examinations online in May/June 2020, and for the remaining 20%, adapted the examination format. They worked to learn from international best practice, for instance studying how Hong Kong universities had adapted when their exams were disrupted by strikes in 2019.

Mid Sweden University was able to continue the bulk of its entrepreneurship teaching, including moving its annual summer bootcamp fully online. It also adapted the content of the course to reflect the entrepreneurial skills that students would need during the pandemic, for instance, dedicated sessions on remaining motivated while working physically isolated from colleagues.

It was clear that Swedish HEIs have hit a tipping point in digital transformation, and that digital tools are the norm for some teaching activities. In the webinar that brought all the case-study institutions together, it was noted that the distinction between distance and campus learning is becoming increasingly blurred, with distant learners coming to campus for focused sessions, and teaching for campus-based students relying increasingly on digital tools.

In Sweden, digitally enabled teaching is becoming a key part of the pedagogical for enabling entrepreneurial and innovative teaching practices. For instance, by moving some material online, teachers have more time to focus on mentoring and coaching.

Opportunities for improvement

The HEIs interviewed for this review also identified areas where they believe they need to continue to improve. HEIs consistently highlight the importance of supporting teachers. This had two elements, first, providing teachers with the digital skills to maximise the use of digital tools they have access to, and second, engaging them in a broader pedagogical conversation about the use of digital tools. One of the challenges post-pandemic will be to help teachers design their courses with digital in mind (as opposed to adapting in a crisis).

University of Gävle has built a Digital Learning Lab for testing different forms of blended learning. This lab is used both for the training of the university's staff and undertaking academic research on blended learning. It is open for other partners to use. This is an excellent example of an HEI that actively supports the use of digital technologies to enhance quality and equity in teaching, learning and assessment.

Available technology that the Digital Learning Lab includes:

- robots and programming
- augmented and virtual reality
- recording and e-meetings
- digital media production
- game-based learning (gamification).

The lab also had equipment to support the creation of digital educational productions. It is open to partners outside the university to create productions for courses.

Another challenge is balancing digital learning with the important role of an HEI in the wider regional ecosystem. Regions that host HEIs, especially if they are rural, consider student communities as important assets, for a range of socio-economic reasons. Attracting a large student community can be considered the most visible “impact” of a HEI in its own ecosystem. Blended learning may reduce the need for students to spend long periods living close to the HEIs and challenges the sustainability of the current model. In the webinars with case-study HEIs, losing the in-person student community was noted as a major cause for concern.

HEIs as digital hubs for Knowledge Exchange

As will be discussed in detail in the Chapter 5 on Knowledge Exchange and Collaboration, Swedish HEIs have strong knowledge exchange practices, supported by innovation centres that are directly funded by government (for details on the structure and operation of the KEC system in Sweden, see Chapters 5). These offices leverage a number of “off the shelf” digital tools for customer management and project planning, to support commercialisation and knowledge exchange. At the most basic level, many of the initial contacts between industry and research are the results of internet searches for the answer to a research question generated by a process within a given business. KTH is trying to go a step further and has built a portal that students and staff can access to search for perspective thesis projects with outside stakeholders. The hope is that this tool can be refined so that it can better match business needs and skills and knowledge in their academic community.

Just as with teaching, the innovation centres and technology transfer offices moved their operations online during the pandemic. They found that they are well-positioned to continue their work, as they had already been using a number of digital tools for knowledge activities within their communities.

However, COVID-19 has intensified their digital activities. Luleå University of Technology moved its 2020 summer pre-incubator programme from in-person to online delivery. This included introducing new content, such as more training on self-empowerment, to adapt to working in a virtual environment. An approach of experimentation digital tools was adopted, testing a wide range of different digital options as the programme was delivered.

A number of HEIs noted that COVID-19 exposed the limitations of the degree to which knowledge exchange and collaboration work can be digitally transformed using their current off-the-shelf tools. Kick-starting commercialisation of new technologies, especially at the PhD and research level, is difficult without face-to-face interaction. A number of the case-study institutions interviewed flagged the concern that the full impact of COVID-19 will only be felt in the years to come, when fewer projects are in the pipeline for commercialisation.

Innovation centres are becoming increasingly sophisticated in their use of digital tools, including adapting them to the audience they are working with. The support they offer students developing an app is very different from the support needed by a researcher working on deep-abstract tech. This approach that form follows function is key to fully unleashing the potential of the digital transformation.

Opportunities for improvement

As part of this discussion, HEIs identified digital tools as key to more effective targeting of the resources of the innovation centres. This has already started to develop at Luleå University of Technology, which is considering how to digitally transform the services it offers to potential businesses, in particular in the area of customised self-service support, allowing them to support more entrepreneurs, so that their in-person consultancy can be targeted to where it will have the most impact.

In other countries, HEIs are cited as role models in digitalisation for their wider entrepreneurial ecosystem. The consensus view of the case-study institutions was that in Sweden, HEIs have less of a need to be role models, but that they do play an important role in supporting the digital capacity of their communities by collaborating with the large number of other actors in the space. The Stockholm IT Region, for example, aims to create new collaborations between the public sector, academia and business to increase knowledge about the possibilities of digitalisation and accelerate the pace of digitalisation. KTH and Stockholm University are both members, alongside Microsoft, IMB and the city and regional governments. In this area, Sweden should look to continue these strong practices, rather than to force HEIs into a leadership role in a crowded landscape.

Digital transformation also offers an opportunity for HEIs to move to the frontier of knowledge exchange and collaboration. In particular, digital transformation may play a critical role in helping innovation centres address some of their biggest challenges: big data and platform management, and the way in which it is possible to secure users' privacy and the ethical behaviour of all users (and of algorithms).

Knowledge exchange and collaboration is becoming a problem of big data. Much of the core KEC activities of an HEI revolve around knowledge brokering, such as connecting the right researcher with the right funder, helping a company find the right patents to support its work, or connecting a problem with the people who are working on similar issues. . However, such work is becoming increasingly challenging as innovation becomes more complex, and global research output grows in volume.

Developing brokering relationships

Swedish HEIs, based on their level of digitalisation, could contribute to developing digital brokering systems and other technologies of participation. As global research becomes more complex, the Swedish HEIs should also focus on collaboration with different stakeholders, as well as international organisations and researchers. For instance, co-operation with local tech-based start-ups could help accelerate the development of the new digital brokering system.

In this context, digital technology offers a potentially transformative way of developing new ways of connecting and finding the most productive connections. The phenomenon of “digital innovation brokerage” aims to connect ideas, people, organisations and communities through digital technologies. As NESTA's recent report on Enabling Collaborations through Emerging Digital Technology notes:

“...innovation rarely happens through the actions of a single person or organisation. More often, it is the result of collaboration and the exchange of ideas. Yet the role of intermediaries that bring innovators together is frequently overlooked, despite digital technologies offering new ways of connecting. The phenomenon of ‘digital innovation brokerage’ aims to connect ideas, people, organisations, and communities through digital technologies.” (NESTA, 2020^[4])

To ensure that novel ideas benefit people more quickly, NESTA recommends that policy makers do more to recognise the importance of digital innovation brokerage and to support the field.

As NESTA emphasises, a challenge lies at the heart of digital innovation brokerage: how best to combine human and machine capabilities. Innovation brokerage involves human skills – building relationships, evaluating fit between potential collaborators, and making judgements about strategy – but it can also involve tasks suited to machines, such as analysing large amounts of data to find a match. Solving this collective intelligence problem could significantly reshape how we innovate (NESTA, 2020^[4]).

Quoting again from NESTA's report on innovation brokerage, several trends make it particularly timely to think about emerging digital innovation brokerage:

“The increasing complexity of innovation: As innovation becomes more complex, the potential for recombination and collaboration expands, which makes opportunities harder to navigate.

Emerging technologies: New technologies such as blockchain, machine learning, virtual reality (VR), and augmented reality (AR) are currently starting to aid brokers in search, analysis, coordination, and communication.

The growth of brokerage in other sectors: Brokerage more generally has become a powerful force within industries like online dating, e-commerce and the sharing economy (e.g. community car-sharing schemes), much of it using digital platforms. Many of today's most successful companies (including Amazon, eBay, Uber and Airbnb) are brokers of some kind, partly since such ‘marketplace’ approaches are more readily scalable than other business models. If we compare how brokerage has reshaped various industries, we can gain insights into how it might reshape innovation itself.

Increased attention on digital filtering: “Information overload” problems have become commonplace in numerous areas, creating the need to filter and prioritise relevant and meaningful digital content and connections. However, we are becoming increasingly aware that filtering information is not the same as filtering data against a noisy background, and brings new risks such as “filter bubbles”, monopolistic content, and bias.” (NESTA, 2020^[4])

Swedish HEIs have the potential to leverage digital technology to tackle some of these brokering challenges. Platforms represent one opportunity to consider, but it is also important to manage potential risks related to this approach, as discussed above.

Box 3.2. Use of platforms in Knowledge Exchange

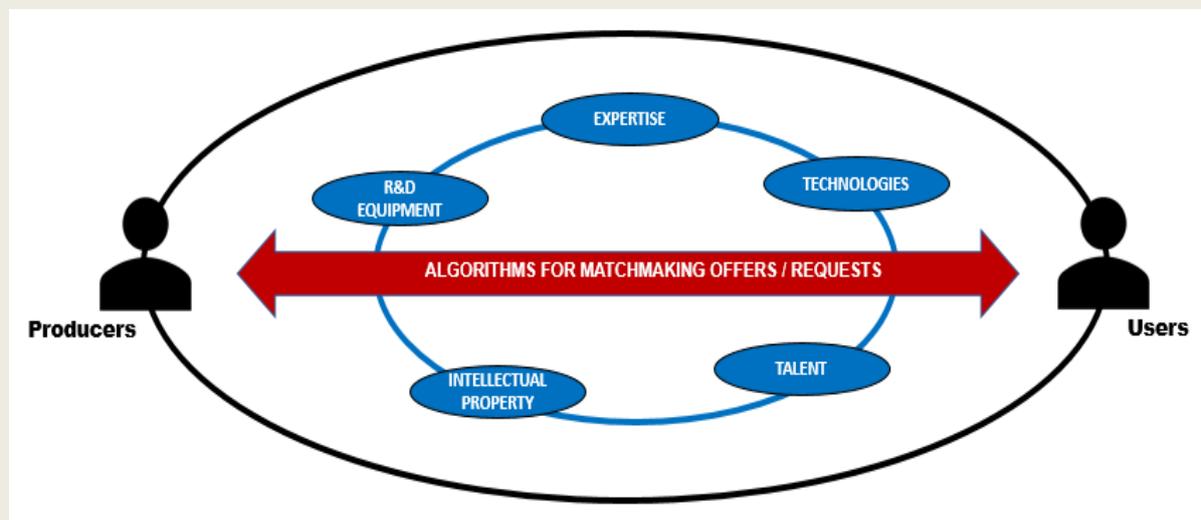
The purpose of a platform is to provide tools and services to facilitate exchanges and consummate matches between individuals and organisations that share common interests. The design of a platform should start with the definition of the core interaction that is meant to connect, and enable exchanges between producers and users seeking to pursue common interests.

From the perspective of HEIs, participants in the platform will include its own producers of research and development (R&D) (i.e. faculty, undergraduate and graduate students), as well as industry stakeholders as users (i.e. corporations that include start-ups, SMEs and mid- and large-size caps). However, they could also include other public research centres, since scientists from different organisations are potential R&D collaborators. The industry users and academic producers as defined above are its predominant actors, but the HE platform can be multisided and also involve other participants, such as investors (i.e. angel investors, venture capitalist firms and corporate venture capital), patrons (e.g. private sponsors, public agencies and alumni), and partners (e.g. incubators/accelerators, engineering and business schools).

The value units in the HE platform are defined by the information elements that can be traded between, and can generate value for, producers and users. This information can include scientific and technological expertise, technologies developed from R&D projects, intellectual property derived from such R&D projects, state-of-the-art research equipment and infrastructure in university and industry laboratories, as well as the human capital and talent that is developed in those laboratories and that could serve as the expert personnel sought by industry and university.

The filter is the algorithmic software-based tool a platform uses to enable the exchanges of value units between producers and users. The filter is the process that enhances the dynamics of the platform along predefined lines of affinity (e.g. through specific orders or requests made by the producers and by the users), and by which the platform initiates matchmaking between the producers and the users.

Figure 3.1. Exchange of Information on Technological Developments on Platform



The benefits of a platform established to promote knowledge exchange in HE are threefold. First, the platform generates data on the state of technology fields. Such data is critical for academics to orient their R&D and prioritise initiatives to pursue with industry. Second, the network effects captured on a platform generate a greater number, and increase the utility, of complements, i.e. common technological building blocks that can be shared and assembled to create new complementary products and services that have additional functionality. A platform creates a community that is amenable to combinatorial innovation by means of crowdsourcing discrete tasks or R&D modules to better equipped or more experienced parties. Third, the platform is essentially a marketplace that is likely to create new revenue opportunities for the university, either as a result of licensing deals or R&D contracts with industry, or through the creation of spin-offs by the university and its entrepreneurs.

The HE platform's aim should be to create a community that can share concerns on technological developments, discover new ones and collectively explore benefits of the commercial applications of public R&D.

A platform provides the basic software, acting as an intermediary to create, facilitate and animate interactions and matchmaking between individuals and/or groups. The key benefit is that the architecture of the platform allows for the extraction of data as well as the generation of new data, which will result in value creation for participants on the platform. HEIs developing platforms and technologies of participation, in general, will have to take into account the challenges represented by privacy protection and by the need

to secure ethical standards for all users (and algorithms). Swedish HEIs are well placed to promote a holistic, multidisciplinary, approach to digital technology, connecting STEM, humanities and the arts.

Sustainability and digital transformation

Sweden has developed an ambitious policy agenda to become a global leader in sustainability in the next decade. HEIs have an important role in this agenda, as developers of solutions to sustainability challenges, but also as organisations that need to consider how to become more sustainable. Case-study institutions affirmed that sustainability is fully embedded in their work and strategies. They share an understanding of sustainability as a multidimensional objective that encompasses the ecological and social (inclusiveness) issues. The objectives of the UN's Agenda 2030 play a key role. The Swedish government requires sustainability to be one of four higher education learning goals and is considered in all funding applications to the national councils.

Sustainability and digital capability are increasingly being seen as closely linked. As these capabilities gather data about diverse phenomenon happening in a society, they can be analysed and used to offer solutions. The most effective sustainability policies are a result of a quick response to the current environment, which is achieved through intense data gathering and analysis. Sustainable efforts require a huge amount of information to be able to offer valid conclusions that can be implemented as policies. In addition, diverse digital tools should be used to update the sources of information continuously and to assist policy makers in decision making. Creating sustainable policies can be seen as a data-intensive activity, which requires digital tools to be efficiently managed.

Digital tools play an important role in developing ways for HEIs to support sustainability

Emblematic of the Swedish approach to sustainability is the approach of Umeå University, which applies digital solutions to improve the environmental sustainability of its four campuses and reduce their carbon footprint. It leveraged its expertise in data analysis to create a tailored solution to help connect digital and physical spaces and reduce its emissions. Umeå University district is part of the European Smart City initiative, and ideas that it is developing with the regions for their community will be tested across Europe.

Digitally enabled real estate and smart cleaning projects are also being carried out at Umeå, to consider how it can continue to innovate and also to reduce its carbon footprint.

Digital tools are also a key part of Openlab in Stockholm, which focuses on innovation for the public sector, through design methods and digital innovation platforms. It focuses on four challenges of the Stockholm area: sustainable urban development, future healthcare, education and the ageing population. The Openlab also leverages the infrastructure of Sweden's capital as a test bed to develop new digital solutions. The founding partners are the City of Stockholm, Region Stockholm, KTH, Stockholm University, Södertörn University and the Karolinska Institute.

The fluid governance of these activities support their innovation character. However, HEIs should make sure that there is sufficient co-ordination between these activities to have a material impact.

Considerations for next steps

There is the capacity for Sweden to become a world leader in the digital transformation of higher education. The following suggestions provide options for Swedish HEIs and policy makers to continue to evolve and operate at the cutting edge of digital transformation of education.

Considerations for policy makers

Policy makers should look to continue to prioritise and promote digital transformation of Swedish HEIs. One option would be to provide additional specific funding to teachers, to incorporate digital practices into their pedagogy.

Consideration for HEIs

HEIs should aim to be at the global forefront of digital teaching practice, defaulting to digital wherever appropriate. In particular, HEIs could increase support for teachers to acquire the skills necessary for digital teaching. Options include:

- HEIs with less experience in online learning should learn from peers with deeper expertise.
- Leverage system resources like national testbeds for educational technology or research centres like the University of Gävle's Digital Learning Lab.

Secondly, HEIs could consider how to use digital technology to address the data challenges of research collaboration. There will not be a single solution for every HEI, but options for HEIs to explore include:

- Diversify services to students, researchers and stakeholders.
- Put IT services at the centre of institutional governance, to facilitate experimentation and identify good practices.
- Allocate specific resources to data management.

HEIs could explore platforms and the technologies of participation, in order to be more innovative and inclusive. They should simultaneously engage in creating skills and values, to ensure that privacy and ethics are taken into account in developing these technologies.

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4 Knowledge Exchange and Collaboration

Collaboration with wider society is a prominent feature of Swedish national frameworks and in individual institutional strategies. The Swedish higher education system has developed a broad definition of co-operation, based on well-being and sustainability. However, quantitative evidence that academic research trickles down to local stakeholders is limited. Supporting local linkages by experimenting with innovative solutions can unleash additional potential for innovation in all regions.

Introduction

Collaboration with wider society is a prominent feature of Swedish national frameworks and in individual institutional strategies. Promoting knowledge exchange and collaboration (KEC) in higher education was recognised in Sweden as an essential tool for increasing its competitiveness several decades ago. However, the last decade has seen some important improvements. The Swedish higher education (HE) system has developed a broad definition of co-operation, based on well-being and sustainability. Individual higher education institutions (HEIs) have reinforced efforts to bring KEC down to earth, from formulating strategic policy goals to focusing on implementation.

This evolution was based on a systematic effort to put HEIs at the centre of innovation systems, both at the national and regional level. The national government has increasingly invested in academic research to boost the international excellence of Swedish HEIs (including some global champions) and to strengthen the linkages between research and innovation. In the same vein, several regional stakeholders have leveraged HEIs to strengthen regional innovation ecosystems, reflecting local needs and opportunities for development.

National and regional efforts generated several good practices based on successful collaboration between HEIs and their stakeholders. Examples can be found both in metropolitan areas, where HEIs contribute to world-class innovation ecosystems, for example in Stockholm and Gothenburg, and also in non-metropolitan areas, where smaller HEIs co-operate with regional stakeholders on tailored innovation.

The link between research and collaboration activities does not come naturally, however. In considering the impact of Swedish HEIs on local development and local innovation, quantitative evidence that academic research trickles down to local stakeholders is limited. This finding is supported by the evidence collected in interviews with Swedish actors, who discussed the *ad hoc* institutions and personal networks that are necessary to connect HEIs with their stakeholders in regional ecosystems.

Supporting local linkages by experimenting with innovative solutions can unleash additional potential for innovation in all regions. A focus on KEC would also make it possible to experiment with new interdisciplinary approaches to research and innovation, which – as the COVID-19 crisis has illustrated – will be of paramount importance in the near future in promoting inclusive and sustainable research.

Defining Knowledge Exchange and Collaboration

In recent decades, the missions of higher education institutions have expanded. The direct contribution of HEIs to research and development (R&D) investments has tripled over the past 40 years. HEIs have also acquired increasing autonomy in many OECD countries. This transformation has gone hand in hand with some major trends, such as an ageing population, digitalisation and globalisation, which are challenging the HEIs' traditional functions, teaching and learning. Fast-paced technological change and automation require HEIs to teach such new skills as adaptability, “learning to learn” and digital skills (sometimes described as “twenty-first century skills”). Technological progress has also made information more accessible, which has put more pressure on HEIs to facilitate access to research, and to produce research that adds value to society. HEIs can tackle these challenges by teaching new skills to students and by engaging with business and civil society to produce research that adds social and economic value.

In this framework, “knowledge exchange and collaboration” is a diverse, multifaceted dimension that encompasses different activities and roles that HEIs can play in their ecosystems and networks. What was once called the “third mission” of HEIs has become a broader concept that requires HEIs to connect proactively with their ecosystems and networks (Table 4.1). Knowledge exchange takes different forms – academic engagement such as collaborative research, contract research, consultancy and academic entrepreneurship, including the income generation derived from intellectual property (IP) and the formation

of spin-off and start-up firms. Other types of knowledge exchange include public engagement, community engagement, and cultural and social forms of exchanges. These different channels involve individual academics and groups of academics, as well as the departments, faculties and the university as a whole.

Table 4.1. Key definitions for Knowledge Exchange and Collaboration

Term	Processes, participants and implications
Knowledge generation or knowledge production	Implies that new knowledge is produced as an outcome of some form of process, but does not indicate the nature of the process. It does not explain whether the new knowledge is discrete from or a product of past knowledge and experience. Research knowledge is likely to be a key component in the process, but the desirable balance between disciplinary input, fusion of disciplines and lay knowledge and expertise is open-ended.
Co-production of knowledge	Implies a process where knowledge is or can be produced through interaction with others, possibly with people with different perspectives and backgrounds, through co-operative endeavours and mutual learning.
Knowledge utilisation	Implies a key focus on the intent and purpose behind a particular use of knowledge. It does not limit itself to what the use of knowledge is but seeks to reveal intent, purpose and agency within the process.
Knowledge transfer	Implies that knowledge is portable, has a linear direction, and that delivery and reception is a one-way process from A (usually a researcher) to B (usually a user).
Brokerage of knowledge	Implies negotiated knowledge, deliberation between different parties A and B (and C, etc.), and possibly mediation through a third party towards a mutually acceptable set of goals, working methods and more effective interactions and knowledge processes.
Storage of knowledge	Implies that knowledge is portable and can be held in a form that can be accessed when needed.
Knowledge exchange	Implies a two- or multiple-path process, with reciprocity and mutual benefits, possibly with multiple learning, but not necessarily recognition of the equitable value of the different forms of knowledge being exchanged.
Knowledge sharing	Implies a process similar to knowledge exchange, but with greater recognition of the knowledge that all partners have equal value.
Knowledge dissemination	Implies strategies being employed to get knowledge from A to B, usually instigated by A.
Transformation of knowledge	Implies changing the knowing or knowers towards a different state or condition in the process.
Knowledge mobilisation	Implies eliciting or spreading knowledge to a wider range of recipients, possibly with the intent of increased application of knowledge. In the process, knowledge from A can be made useful to B's interests or otherwise have societal impacts.
Knowledge translation	Implies communication using a mediated language modified for recipients.

Note: Some of the many terms used to describe processes of KE and the implied meanings of these terms.

Source: Adapted from Fazey, I. et al. (2013^[1]), "Knowledge exchange: A review and research agenda for environmental management", <http://dx.doi.org/10.1017/S037689291200029X> and Richards-Kennedy, S. (2018^[2]), "Caribbean researcher experiences with societal impact: A case study of the Research and Development Impact Fund", University of Sheffield., Sheffield.

Within HEInnovate, KEC is one of the eight dimensions around which a given HEI can evolve to promote entrepreneurship and innovation (Box 4.1). The capacity to connect and co-operate with other actors is a distinctive trait of innovative and entrepreneurial HEIs that are strongly connected to other actors. These include firms of all size and maturity, other public and private research organisations, national and subnational government agencies, such as regional development agencies or metropolitan authorities, cluster associations, incubators or accelerators, technology and science parks, etc.

Box 4.1. KEC as a dimension of HEInnovate

The OECD and the European Commission have developed the HEInnovate guiding framework in order to help higher education institutions develop third mission activities to become drivers of socioeconomic development. Based on economic theory, field research and experts survey, the OECD and the European Commission have identified eight areas in which HEIs should take action. The HEInnovate guiding framework thus comprises key eight dimensions reflecting a multidimensional approach to the “engagement agenda”. These dimensions are leadership and governance, organizational capacity (funding, people and incentives), entrepreneurial teaching and learning, preparing and supporting entrepreneurs, digital transformation and capability, knowledge exchange and collaboration, the internationalised institution, measuring impact.

Knowledge exchange is an important catalyst for organisational innovation, the advancement of teaching and research, and local development. It is a continuous process, which includes the ‘third mission’ of an HEI, defined as the stimulation and direct application and exploitation of knowledge for the benefit of the social, cultural and economic development of society. The motivation for increased collaboration and knowledge exchange is to create value for the HEI and society.

1. The HEI is committed to collaboration and knowledge exchange with industry, the public sector and society.
2. The HEI demonstrates active involvement in partnerships and relationships with a wide range of stakeholders.
3. The HEI has strong links with incubators, science parks and other external initiatives.
4. The HEI provides opportunities for staff and students to take part in innovative activities with business / the external environment.
5. The HEI integrates research, education and industry (wider community) activities to exploit new knowledge.

Source: HEInnovate (n.d.^[3]), *Home Page*, <https://heinnovate.eu>. Accessed 05 October 2021

Incentives for Knowledge Exchange in Sweden

Role of competitive funding in supporting KEC activities

The Swedish HE system has evolved to promote collaboration and engagement. The Swedish research promotion and funding system is highly developed and well-endowed with public research infrastructures, as well as several foundations that provide support and funding for research and innovation. While Vinnova, the Swedish public national innovation agency, is well known at the international level, other entities that play a role in funding universities (Figure 4.1). For instance, the more visible institutions include the Knowledge Foundation, the Swedish Research Council, the Swedish Foundation for Strategic Research, the Swedish Foundation for Strategic Environmental Research (Mistra) and the Swedish National Space Board). These entities offer conditional competitive funding promoting high-quality research based on co-operation or on attempts to promote knowledge exchange.

The Swedish approach illustrates how competitive funding and dedicated funding programmes can be an important stimulus for enhancing collaboration and knowledge transfer within a research system. In theory, competitive funding should incentivise the thematically open or directed generation of new research ideas (for additional resources), quality control (supported by peer review) and output orientation. Both the

application-oriented bottom-up funding and the topic-focused and mission-oriented programme funding in Sweden consistently presuppose co-operation with external partners as a funding condition. This is a powerful incentive, which orients academics in the early stages of their research to improve their chances of receiving competitive funding. It also incentivises more complex, multi-actor programmes. Finally, embedding collaboration in competitive funding facilitates the creation of long-term relationships between HEIs and their stakeholders.

The presence of many different funding actors generates complexity

The number of different actors that provide competitive funding for “collaborative research” generates both complexity and reliance on funding as the main lever for incentivising KEC activity. Case studies reported that this can hamper the coherence of assessment of collaboration and of the way it is conducted. Incentives in the system can also be confusing and contradictory, because there are so many sources of funding at the regional, national and European level, all of which have different requirements.

The system of incentives actually creates a strong motivation for collaboration with industry to secure research funding (since even public grants require in-kind funding). As also mentioned in some case studies (by KTH, in particular), regardless of whether it is funded or contract research, in terms of identifying collaboration partners, HEIs seek value for both sides, so the collaboration is not just for show.

However, in this context, it may prove difficult to assess whether the government’s objectives are being realised. As noted in a recent discussion of third-party funding in Sweden (Stampfer, 2019^[4]), it is difficult to control and reform a rich and at the same time multilayered funding system like Sweden’s, “as neither the semipublic nor the private foundations can be influenced by the state.”

The critical role of public bodies that fund KEC

The strong support and funding that public bodies provide to KEC, including when HEIs collaborate with the private sector, is one of the most important features of the Swedish system. The annual budget of Vinnova alone is about EUR 300 million. Case-study HEIs reported that KEC activities were commonly supported by public funding – quite separate from the funding provided by the university – including when one of the main beneficiaries of the project was a business. The private sector thus finds it advantageous to co-operate with HEIs, because this can generate funds to support innovation. A radical approach that not only supports innovation, it also generates more opportunities for innovation.

Vinnova is responsible for a large share of the public funds supporting KEC. The agency operates under the aegis of the Ministry of Enterprise and Innovation and also functions as the national contact authority for the EU framework programme for research and innovation. The mandate of the agency is to promote Sweden’s overall innovation capacity, which is why it closely co-operates with local business communities and offers funding opportunities for research and development to HEIs as well as to the private sector. The agency also plays an important role in engaging with the key innovation stakeholders and designing the strategic innovation areas, which connect researchers, businesses and other relevant areas. In other words, Vinnova not only supports innovation but generates new spaces for innovation opportunities.

Sustainable development as a pillar of KEC

All HEIs contribute to sustainable development, by providing educational programmes, conducting research and by interacting with stakeholders and with their surrounding communities. Swedish HEIs have adopted SDGs in their institutional strategies, and this is helping create interdisciplinary research platforms, which are essential for generating responses to environmental and social challenges, as discussed below.

HEIs’ collaboration in promoting SDGs can also have a spatial dimension. For instance, the Stockholm-based HEIs collaborate with the local municipality to pilot innovative solutions promoting sustainability and

inclusion. The co-operation with the city of Stockholm, which is internationally recognised as a best practice in terms of urban sustainability, allows the HEIs to pilot innovations that can resonate at the international level, opening new opportunities for research, innovation and academic entrepreneurship.

Local drivers for KEC

Opportunities for collaboration with local governments go beyond SDGs. The local dimension for collaboration is an important feature of the system of incentives and institutions promoting KEC in Sweden. Regardless of whether they are the large research flagships of the Swedish higher education landscape or dynamic smaller universities, Swedish HEIs are very much oriented towards their local environment and maintain corresponding contact with local administrations. This also reflects the multilevel governance of the country, and the importance of local governments in fields such as healthcare, energy and education.

The relevance of the local dimension is even more important in the case of smaller regional universities. This connection between HEIs and local and regional authorities has turned out to be a particularly important driver for the exchange of knowledge. Local authorities have helped link education and research activities to regional needs and profiles over the past decade.

There are several examples, discussed in this chapter, in which municipalities and regional governments provide local universities with grants linked with the co-ordination and implementation of specific missions. Local governments play an important role in both metropolitan areas and in Swedish regions. HEIs in rural Sweden can co-ordinate with local government to access opportunities provided by the European Regional Development Fund (ERDF), supporting investments in infrastructure and applied research.

Diverse forms of KEC activities

The diversity of approaches and forms of knowledge exchange reflect the heterogeneity of Swedish HEIs. HEIs specialised in scientific fields typically have strong linkages with the private sector, but a number of collaborations are also emerging in areas such as arts and humanities. The diversity of collaboration opportunities and practices – including humanities and arts – was one of the key points that emerged in the discussion with KLOSS, a Swedish network of nine HEIs supporting KEC, at a stakeholder workshop held during the review process (Box 4.2).

Box 4.2. KLOSS – Knowledge Exchange and Learning about strategic collaboration

KLOSS (Knowledge Exchange and Learning platform for Strategic Collaboration) aims to create an arena for HEIs to support each other in designing and implementing new working methods, tools and models for long-term collaboration that strengthens research, education and development. KLOSS is the Swedish word for “block”, a symbol of how collaborations continue to grow and reinforce one another. Vinnova, the Swedish innovation agency, supports the KLOSS project.

The KLOSS project was initiated by KTH, in 2013. The university took the first step and began to attract other Swedish universities to join in. The network now has nine members and several collaborations with other Swedish HEIs. The work of KLOSS has evolved into two main directions – identifying obstacles to collaboration and creating arenas for collaboration.

Source: Information gathered in interviews and online (UIIN (n.d.^[5]), *Swedish Universities Work as Building “Blocks”: Societal Challenges Tackled by Strategic Collaboration*, <https://uiin.org/2018/12/13/swedish-universities-work-building-blocks-societal-challenges-tackled-strategic-collaboration/>).

Additional factors besides the field of research, however, shape KEC activities in Sweden. These include the geographic location of a given HEI, the extent of its resources, and the age of the institution. The next section outlines the range of forms and practices Swedish HEIs demonstrate in engaging with their communities and networks.

Innovation leaders in metropolitan areas

Swedish HEIs in metropolitan areas are part of innovation systems populated by a large number of different actors, supported by national, regional and local policies. Their location generates opportunities for collaboration among different HEIs, which identify with their innovation ecosystem. The Karolinska Institute and KTH, for instance, often referred to a “Stockholm system” in the interviews. Likewise, Gothenburg University, and in particular its school of medicine, is embedded in an articulated innovation platform based on a mix of public and private stakeholders, which contribute to the KEC activities of the HEI. These metropolitan HEIs benefit from local innovation strategies – established by local governments – which are quite effective generating a framework for co-operation and innovation (Box 4.3).

Box 4.3. Local innovation strategies in Stockholm

Local governments in Sweden actively support and fund collaboration among the HEIs, the healthcare industry and businesses. In Stockholm, the region aims to be a strategic partner for the local universities by offering funding and opportunities to connect local business with academia. In 2012, Stockholm proposed a 2025 Innovation Strategy to promote digital capacity and improve life in the Stockholm area. It has five pillars that define how the city can achieve its specific goals, starting with improving the research and innovation infrastructure. Innovation procurement, the second pillar, involves opportunities for the public and private sector to grow and innovate. Next, the supply of capital, which focuses on strengthening the HEIs funding and global appeal by helping attract international companies and talents to Stockholm. Lastly, the cross-sector approach needs to be introduced to share interdisciplinary knowledge exchange for collaboration among the public, research and private sectors.

Digital Demo Stockholm is a project based on this innovation strategy. The initiative was established in 2016 and offers opportunities to representatives of three universities, KTH, Stockholm University and the Karolinska Institute, to collaborate with the private sector and government to enhance the life of Stockholm's citizens. The HEIs in this project act as facilitators of knowledge and research innovation, for both the private and public sectors.

Source: Digital Demo Stockholm (n.d.^[6]), Home Page, <https://www.digitaldemostockholm.com/en>. Access 01 June 2021

Collaboration among Stockholm-based HEIs has evolved, generating practices, institutions and trust among the actors. Some examples, like the Digital Demo Stockholm or the Innovation Centre at the Karolinska Institute Hospital, illustrate a capacity to institutionalise and co-ordinate the relationship with the private sector to capitalise on research opportunities. Digital Demo Stockholm (DDS), established in 2016, is a public-private partnership that aims to improve and facilitate life for residents in the Stockholm region through digital solutions. The DDS mobilises the capacity of its partners, helping them work together to generate smart digital functions that contribute to solving societal challenges.¹ The Innovation Centre at the Karolinska Institute Hospital – the second-largest in the country, with 1.5 million patient visits per year and a budget of EUR 1.5 billion – connects the hospital with research and innovation opportunities in a co-ordinated way, offering external stakeholders a point of entry into the hospital's activities.

Collaboration among HEIs evolved even further in 2019, when the three most research-intensive universities in Stockholm: Karolinska Institute, KTH and Stockholm University, established the University Alliance Stockholm Trio, with the support of the local and regional authorities in the Stockholm region. A first result of the University Alliance Stockholm Trio is to generate “mass” – by joining forces and their research capabilities, the three HEIs have become more visible and more competitive internationally. This has made them more attractive for leading researchers, attracting more international students.² Importantly, the alliance strengthens HEIs' capacity to engage with decision makers, authorities, businesses and industry on regional strategies and visions.³

Being located in the Capital Region also gives better access to strategic research networks supported by the government and to public procurement in general. This is the case for the KTH Cluster for Underwater Technology (CUTe). CUTe was established by KTH in collaboration with an industrial partner (SAAB) and the Swedish Defence Materiel Administration (FMV), a government agency under the aegis of the Ministry of Defence. This collaboration capitalises on KTH's capacity to engage with stakeholders in complex research projects, through its competence centres and research programmes. Half of its doctoral candidates are working on industrial PhDs, demonstrating the strong collaboration between the HEI and the private sector (which finances these researchers).

Other metropolitan areas in Sweden also have research platforms. Gothenburg is home to the Sahlgrenska University Hospital, a system of hospitals associated with the Sahlgrenska Academy at the University of Gothenburg. The hospital, with 17,000 employees, is the largest in Sweden, and the second-largest hospital in Europe. The size and the specialisations of the university hospital created the conditions for large-scale collaborations with the private sector. For example, the university is home to one of the national Wallenberg Centers for Molecular and Translational Medicine, which conduct basic and clinical research in the fields of metabolism, neuroscience, cancer, inflammation, degenerative diseases, genomics and life science chemistry (Box 4.4). The centre, based in Gothenburg, was built in co-operation with the surrounding area of Region Västra Götaland and AstraZeneca, the Swedish/British pharmaceutical company that produced one of the first coronavirus vaccines. The centre provides a platform in which researchers from basic research disciplines meet with clinically oriented researchers for a truly translational focus. The centre attracted a total investment of about EUR 60 million over a ten-year period.

Box 4.4. The Wallenberg Centres for Molecular Medicine

The Wallenberg Centres for Molecular Medicine are a key part of a national effort to position Sweden as a global leader in the life sciences. The initiative, by the Knut and Alice Wallenberg Foundation, is a joint venture with the Universities and University Hospitals of Gothenburg, Lund, Umeå and Linköping. SciLifeLab, based in Stockholm and Uppsala, serves as a research partner and unique core facility for the four centres.

Through repeated funding calls in the upcoming years with tenure-track research positions – Wallenberg Molecular Medicine Fellows – they will recruit translationally oriented research groups. The groups will be centred on internationally recruited young scientists of outstanding potential and funded at a globally competitive level through generous starting packages, with the possibility of promotion to senior lecturer within four years. Each of the groups will synergise with pre-existing excellent research environments as well as strong clinical collaborators, promoting groundbreaking research in molecular and translational medicine.

Source: Wallenberg Centres for Molecular Medicine (n.d.^[7]), Home Page, <https://wcmm.se/>. Accessed 05 October 2021

The regional universities support the development of their communities

The interviews with HEIs provided a rich set of examples of the dynamic ways regionally focused HEIs are providing skills, business services and support to regional development and decarbonisation, in non-metropolitan and rural Sweden. These non-metropolitan HEIs tend to co-operate specifically with partners in their surrounding communities. Some of them have developed specific institutions, while others count on the personal relationships of their faculty to generate linkages with stakeholders.

Karlstad University (KAU), in the Region Värmland, is a good example of a HEI that has created *ad hoc* institutions and practices to connect with regional stakeholders. KAU, capitalising on the long-lasting collaboration with the regional government, has established the Academy for Smart Specialisation. The aim of the academy is to better connect research activities with innovation needs and potential in the region, as identified by Region Värmland's Smart Specialisation Strategy (Box 4.5). The Academy for Smart Specialisation supports multidisciplinary research centres, including a centre of gender studies co-managed by the university and the regional government.⁴ These centres support sustainable development of the regional productive sector and, at the same time, improve the capacity of regional authorities to identify transformative innovation opportunities for the regional productive sector (OECD, 2020^[8]).

Box 4.5. Smart Specialisation Strategy to promote knowledge-driven growth

Smart Specialisation Strategies, a pillar of the current European Commission's Cohesion Policy, aims to find strategic areas where regions or countries have a competitive advantage or have the "potential to generate knowledge-driven growth". Smart Specialisation Strategies stimulate regional development by gathering key stakeholders (public sector, business and HEIs) to pursue opportunities to upgrade key sectors or to identify new areas. A Smart Specialisation Strategy (S3) consists of identifying sectors with potential for growth, based on local resources and comparative advantages, and then prioritising development of these sectors through innovative activities or technologies. In line with the inclusive governance model of cohesion policy, local and regional authorities, as well as all local stakeholders, are involved at a very early stage and should play a key role in shaping and implementing S3.

Source: (OECD, 2020^[8])

While the Academy of Smart Specialisation represents the most advanced case of collaboration between a HEI and regional public authorities, all Swedish regions embed universities in their development strategies, funded by the research grants from the HEI (including Vinnova and Horizon2020), the region and the private sector. In the regional development strategy for Region Norrbotten, Luleå University of Technology is described as the county's knowledge engine for both public and private sector but also for attracting young people to the county and to secure the competence for the municipalities. The university's website says it has the highest proportion of co-operation with external actors of any university in Sweden. Research is conducted in co-operation with companies such as Bosch, Ericsson, Scania, LKAB, SKF and other international universities.

Luleå University of Technology, in the north of the country, operates in an industrial ecosystem, home to a mix of capital-intensive large companies and small and medium-size enterprises (SMEs). The county is the home of several major Swedish industries, including the public mining company LKAB, which has produced the world's first iron ore pellets using fossil-free fuels. In the same vein, other companies operating in the steel supply chain and energy sector are developing production processes based on the use of hydrogen to offset fossil fuels.

In the past decade, the university has developed industrial PhD programmes specifically designed to promote innovation in SMEs. These group SMEs together based on their innovation needs, to facilitate interactions with the HEI and research opportunities for doctoral candidates. The university also has an innovation office. As a leader in collaboration, the focus of the university is on systematising its collaboration efforts and not relying too heavily on individual contacts.

Similarly, Mid Sweden University (MIUN) shares many characteristics with the previous two examples in its focus on working with regional sectors, both in terms of educating graduates and supporting research. The university is spread over two campuses, in the cities of Östersund and Sundsvall, and covers a significant geographic area (the two campuses are three hours' drive apart). The HEIs play an important role in supporting skills and innovation in the region. MIUN is responsible for half of all new graduates in Jämtland and Västernorrland counties, and 49% of the students still live in the counties two years after they graduate. The S3 priorities for Västernorrland reflect the strengths of Mid Sweden University: forestry, industrial IT and digital services, health, sports and sports technology, and tourism.

MIUN also engages with small municipalities. For example, the HEI has a collaboration agreement with the Örnsköldsvik municipality. This focuses on research areas relevant for the municipality, including sustainability, healthcare and specific projects such as the use of drones to identify buildings that need renovations. MIUN and the municipality are each contributing about EUR 300 000 to co-finance the

research activities for a four-year period. Representatives from both the municipality and the university provided extremely positive feedback about this collaboration in the interview. Municipal officials mentioned that the high quality of the university research provides them with a global perspective and new ideas for improving the municipality's ability to provide high-quality services to its citizens. Collaboration with the HEI also secures skills in the county, by informing students of the possibilities for working in the municipality. Representatives of MIUN, in turn, consider the municipality a testing ground for research ideas, which can then be scaled up and offered to other cities in Jämtland/Härjedalen and Västernorrland.

These are all examples of collaboration that is dynamic and rooted in the needs of the HEIs' local ecosystems. Interviews with HEIs and their stakeholders, however, suggest that the demand for the regional universities, and the perception of their added value for the economy and society, is primarily explained by the presence of professionally qualified specialists, and only secondarily by expertise and approaches to technical solutions or innovation. Strategic partnerships, whether with industry or local administrations, are usually dedicated to knowledge exchange and co-operation concerning both education (sometimes-vocational training) and research. While the focus on talent is typical of many collaborations between HEIs and their stakeholders, in OECD countries, Sweden shows it is possible to go beyond a narrative that identifies HEIs as productive units of education, and to develop a general understanding about the unique role an HEI can play in regional innovation ecosystems and networks.

Collaboration involves interdisciplinary approaches and new functions

In the past decade, KEC activities in Sweden have become more diverse and granular. Collaboration has significantly evolved in this period, and now includes a variety of (even smaller) activities, such as working with voluntary organisations. Moving on from the individual flagships to the targeted building of an ecosystem supported by stronger co-operation, KEC is becoming more sensitive to helping society respond to social and sustainability challenges. All the case-study HEIs have helped local governments decarbonise their own communities, for example.

Jönköping University offers one example of interdisciplinary collaboration, in its Department of Education, which has an innovative collaboration with Sound Lily, a digital platform for teaching music in schools. Sweden has made a consistent effort in recent years to implement digital tools in schools and has set up a test bed for educational technology. However, technology companies have had difficulties interpreting the feedback pedagogically. In undertaking a joint project with Jönköping University, Sound Lily is able to better understand the tools that will have learning impacts. The two sides have carefully designed the project to support their commercialisation and research objectives, and the Jönköping researchers consider it a best-practice example, where researchers are treated as equal partners and their academic interests are built into the project.

Another example of this type of interdisciplinary collaboration is Väst University's child and youth studies centre.⁵ Its research has strong connections with the surrounding community and reflects the HEI's focus on work-integrated learning. Several of the centre's projects are carried out jointly with schools, social services, not-for-profit organisations and other external actors. The research questions are identified in close collaboration with external partners. Many collaborative research projects focus on early intervention for children, adolescents and their families, aimed to promote psychological health as well as inclusion of children and youth, and thus social sustainability, in the long term. As part of the collaboration, researchers and external partners must agree on project outputs before the project begins. The overall funding model is designed so that each project corresponds to 30% of a full-time position.

Collaboration promoting sustainability and inclusion requires interdisciplinary approaches. The University of Gothenburg has developed the UGOT Challenges research initiative, investing about EUR 30 million in six multidisciplinary research centres. UGOT Challenges is a six-year initiative started in 2016. The six centres cover many research disciplines, all with significant multidisciplinary elements. Some initiatives are new, and others come from earlier research structures that have been broadened as a result of the

global challenges perspective. In the same vein, the Forum for Social Innovation Sweden is a national collaboration platform that brings together five HEIs (Malmö, Luleå, Jönköping, Umeå and Örebro). Funded by Vinnova and the Swedish government, the platform builds capacity innovation in collaboration between academia, business, public and “idea-driven actors” to address complex societal challenges/Agenda 2030. The forum experiments with new models and methods aimed at developing social innovations. Some examples include co-labs, science shops and test beds.

Some HEIs have created new functions and entities to be able to link their interdisciplinary research to firms and in particular, SMEs. This is the case with the University of Gävle, which, in collaboration with UK HEIs, has developed its own Knowledge Transfer Partnership (KTP) office (Box 4.6). The KTP office is a one-stop shop that businesses can use to benefit from the research capacity of the HEIs. Through KTP, small businesses can host a young researcher (a newly graduated academic) for a fixed-term contract. The HEI contributes to the salary of the researcher, who can work on product development, market development, process development and energy efficiency. In the case of the University of Gävle, the entrepreneur can also benefit from coaching and training provided by the KTP team. The KTP centre promotes both research capacity and entrepreneurial skills in the region. As observed in other case-study HEIs and in other reports (OECD, 2020^[8]), the presence of specific professional figures specifically dealing with KEC activities has a positive impact on the capacity and effectiveness of collaboration practices.

Box 4.6. The Knowledge Transfer Partnership (KTP) at the University of Gävle

Collaboration is an essential part of the curriculum at the University of Gävle, helping the university achieve both international and local recognition. The Knowledge Transfer Partnership Project, focusing on improving energy efficiency among small and medium-size companies, enables universities to offer a practical experience to their recent graduates and to connect the university with the business environment. Participating universities offer their staff expertise for consulting, providing local SMEs support for resolving critical issues. The project started in 2016, and positive results from the collaboration were observed after the first three years. More specifically, links between academia and business were strengthened.

Thanks to its success, the initiative received additional funding from Swedish government agencies and other universities. Luleå University of Technology, Mid Sweden University, Mälardalen University, Södertörn University and Kristianstad University became a part of this project.

Its efforts were recognised by the Swedish Agency for Economic and Regional Growth and the Swedish Energy Agency, which nominated the co-operation between the University of Gävle and Dalarna University for the EU European Enterprise Promotion Awards.

Source: University of Gävle (2019^[9]), “University of Gävle best in Sweden in collaborating with enterprises”, https://www.mynewsdesk.com/hogskolan_i_gavle/pressreleases/university-of-gaevle-best-in-sweden-in-collaborating-with-enterprises-2884460.

More could be done to link academic research and local development

While there is no doubt that Swedish HEIs generate economic and societal value, the increasing focus on peer-reviewed research typical of the HE system may not be the best way to promote KEC throughout the country. This section presents the results of a quantitative analysis of the economic and innovation impact of HEIs in their own communities. The lack of a clear connection between research and local development/local innovation, despite the policy efforts and the level of public investment, suggests that

the focus on research is not a panacea, and that it does not generate the right incentives to connect HEIs with business in Swedish regions.

Sweden has been promoting academic research to boost local development...

In recent decades, Sweden has invested heavily in R&D and put HEIs at the centre of its national innovation system (see Chapter 6 on Organisational Capacity). On the one hand, the government has supported peer-reviewed (published) research. This has produced a steep increase in academic publications and in citations of Swedish HEIs, boosting their international visibility (Annex 4.A).⁶ On the other hand, the government has also expanded the network of HEIs in the country to promote accessibility and local development in connection with research activities.⁷

The expectation of the Swedish government was that this strong research showing would trickle down to the economic fabric of the country. Academic research was expected to trigger greater innovation at the local level, along the lines proposed by the linear model of innovation (Bush, 1945^[10]; Maclaurin, 1953^[11]) (Figure 4.1). The new knowledge generated by these leading research institutions is expected to increase of university-industry co-operation in the given region. Successful companies can benefit from the knowledge spill-overs generated by research conducted in local HEIs, especially as knowledge is sticky and suffers from considerable distance decay effects (Moreno, Paci and Usai, 2005^[12]) (Box 4.7).

Figure 4.1. The possible economic mechanism of HEIs



Source: Based on Bush, V. (1945^[10]), "Science: The endless frontier", <http://dx.doi.org/10.2307/3625196>; Maclaurin, W. (1953^[11]), "The sequence from invention to innovation and its relation to economic growth", <http://dx.doi.org/10.2307/1884150>.

Box 4.7. Assessing the relationship between HEIs, knowledge spill-overs and local development

A large body of academic research concentrates on the relationship between HEIs, knowledge spill-overs and local development (Carlino et al., 2012^[13]). Leading HEIs, such as Stanford University and the Massachusetts Institute of Technology (MIT), have played a central role in the economic success of the Silicon Valley in Northern California and of Route 128 around Boston (Jaffe, 1989^[14]). Based on these examples, it is frequently assumed that investment in HEIs' research will provide an important fillip for innovation and the creation of new economic activity at the local level. It has also been considered that dynamic research-led HEIs can attract private-sector activity to an area and improve local productivity (Neumark and Simpson, 2015^[15]). HEIs are seen as a fundamental source of change in local economies, and policies to promote research in local HEIs have become increasingly important in development strategies (Power and Malmberg, 2008^[16]).

Empirical results of such strategies, however, are mixed and often contradictory. Using cross-sectional data for the US, (Anselin, Varga and Acs, 1997^[17]) first discovered a positive association between HEIs and local innovation. Similar results have been obtained by (Woodward, Figueiredo and Guimarães, 2006^[18]) although the size of the coefficient, and of the link between HEI research and innovation, is considerably smaller when adopting a panel data structure. It has also been found that the positive relationship between HEIs and local growth depends on the period chosen (Goldstein and Renault, 2004^[19]). They reported that for the period 1969-1998, the influence of research conducted by US HEIs on regional development was particularly weak. Similarly, (Drucker, 2016^[20]) found a fragile relationship university research and regional growth in the US for the period 2001-2011.

A more recent study focusing on the land-grant programme in the US (Liu, 2015^[21]) reported that US universities had negligible effects on local output over the short and medium term (up to a maximum of 10 years), but highly positive effects in the long run (over periods of 80 years).

Source: Carlino, G. et al. (2012^[13]), "The agglomeration of R&D labs", <http://dx.doi.org/10.2139/ssrn.2149008>; Jaffe, A. (1989^[14]), "Real effects of academic research", <http://dx.doi.org/10.2307/1831431>; Neumark, D. and H. Simpson (2015^[15]), "Place-based policies", <http://dx.doi.org/10.1016/B978-0-444-59531-7.00018-1>; Power, D. and A. Malmberg (2008^[16]), "The contribution of universities to innovation and economic development: In what sense a regional problem", <http://dx.doi.org/10.1093/cjres/rsn006>; Anselin, L., A. Varga and Z. Acs (1997^[17]), "Local geographic spillovers between university research and high technology innovations", <http://dx.doi.org/10.1006/juec.1997.2032>; Woodward, D., O. Figueiredo and P. Guimarães (2006^[18]), "Beyond the Silicon Valley: University R&D and high-technology location", <http://dx.doi.org/10.1016/j.jue.2006.01.002>; Goldstein, H. and C. Renault (2004^[19]), "Contributions of universities to regional economic development: A quasi-experimental approach", <http://dx.doi.org/10.1080/0034340042000265232>; Drucker, J. (2016^[20]), "Reconsidering the regional economic development impacts of higher education institutions in the United States", <http://dx.doi.org/10.1080/00343404.2014.986083>.

...but empirical evidence is lacking

Despite the many good practices observed in Sweden, and the importance of KEC in national and institutional agendas, there is no clear evidence that academic research has a positive impact on local development and on local innovation in Swedish regions. In other words, controlling for human capital, employment level and urban population, the academic research of an HEI in a given region, measured in publication and citations (Scopus),⁸ seems to have no relevant impact on local development (on income and wage levels at the municipal level) and on innovation (in patents granted). For a detailed discussion of the econometric analysis, see Annex I.

HEIs' impact on local growth

As already noted, there is no quantitative evidence that academic research by a given Swedish HEI positively affects the economic performance of the surrounding community. As compared with the research mission of HEIs, it may be that the HEIs' teaching mission is more important to the local economy. The training of a skilled workforce feeds into local human capital, which is a driver of income growth.

The disconnect between new HEI knowledge and local economies depends on two factors, which may also combine: first, a big gap between the kind of knowledge generated and the needs of local firms; and second, a faulty system of university-industry collaboration. On the one hand, the pursuit of published research by HEIs in recent years, with the aim of securing more public funding and improving placement in world rankings, may have pushed researchers at the institutions towards a greater research productivity, increasingly disconnected from the reality of the local economy. On the other hand, and despite the dominant narrative about productive university-industry collaboration, the mechanisms that facilitate a connection between researchers and industry may be less efficient than expected.

The impact of HEIs on local innovation

The results are somewhat more promising in terms of local innovation. Interviews with case studies and stakeholders provided many examples of useful collaboration between HEIs and their communities. Researchers in Swedish HEIs in all regions engage with firms in their communities to support innovation. However, such examples appear to depend more on individual initiative and networks than on institutional research. In particular, as emerged in interviews, senior researchers, who do not need to publish to advance in their career, are more likely to collaborate with business and external stakeholders. The data available suggests that the bulk of research activities, measured as "publications", has no impact on local innovation, measured in patents granted (Annex 4.A).⁹

Only research-intensive HEIs that generate excellent academic research, as proxied by the citations to publications, positively affect the number of patents granted in a given region. The pursuit of excellence in research may thus help improve innovation in the local area. In particular, the correlation between academic citations and patents granted is evident in distances of between five and 50 kilometres and are greatest for both HEIs' publications and citations for both 5-kilometre and 10-kilometre radii (Annex 4.A). This indicates that there is no automatic linkage between academic research (publication) and innovation dynamics at the local level. Research does not trickle down to local innovation systems. In addition, while citations seem to have a positive impact on innovation, it may prove difficult to align excellent research (measured as citations) and the local needs for innovation.

KEC needs to be supported by all HEI missions

In Sweden, KEC and in particular, university-industry partnerships, are being promoted as a necessary approach to ensure that new knowledge is infused into the economy. Based on the efforts to expand the network of HEIs throughout the country, it appears that this approach focuses on the local level.

However, the dominant pursuit of (peer-reviewed) research by many HEIs may create a gap with the local economic fabric; a mismatch between the knowledge that is being produced and that can be absorbed by the local ecosystem. This may also make university-industry relationships elusive, in particular in the case of SMEs, which tend to operate at lower levels of knowledge intensity.

Analysis at the local level sheds light on the challenge of improving university/industry linkages. This may depend on the fact that either HEIs or firms (or both) are not proactive enough. This suggests that the existing system of incentives needs to be reviewed, as it does not provide enough enticements for firms to engage with universities, and vice versa.

Translating knowledge into innovation through collaboration

Finally, there seem to be problems in translating knowledge generation and innovation into economic activity. Firms are more likely to co-operate with HEIs in fields and projects closely related to their actual market needs (D'Este and Iammarino, 2010^[22]; Johnston and Huggins, 2017^[23]; Laursen, Reichstein and Salter, 2011^[24]). Without close collaboration from the beginning of the project, it is unlikely that collaboration will happen once projects are under way. Swedish HEIs may not be active enough in setting up links and communication channels with local firms, adopting, more often than not, a relatively passive stance. As observed in other countries (OECD/European Union, 2019^[25]), the career progression and financial incentives for researchers of collaborating with local firms are neglected. Considering KEC activities as ancillary to research inhibits the potential for university-industry collaboration and leads to problems in translating knowledge generation and innovation into economic activity.

The Swedish higher education system treats all HEIs in an egalitarian way. Consequently, they have all emphasised research and seek to pursue research excellence, as defined by international publication citations. However, not all Swedish HEIs are equal. HEIs have very different characteristics. The emphasis on the research mission of all HEIs may disadvantage the two other missions: education and contribution to society. There may be a need to introduce greater discernment in the Swedish HE system. Different HEIs, belonging to different ecosystems and networks, may need to pursue different objectives.

The egalitarian financing model of Swedish HEIs has helped elevate several Swedish universities in the world research rankings, but the impact of the research (i.e. publications) from many of these HEIs on local economic dynamism has been weaker than expected. HEI strategies that pursue a combination of increases in research quality and intensity do not seem to be delivering in terms of improvements in income and wages. This may reflect local economic actors' limited capacity to absorb the research. Without adequate absorptive capacity, knowledge diffusion cannot really occur (Drucker and Goldstein, 2007^[26]).

Swedish HEIs have to generate specific approaches and institutions to connect to the productive sector in their communities and networks. Practices like the Academy for Smart Specialisation in KAU demonstrate these efforts to facilitate the diffusion of knowledge in local productive sectors, filling the gap between research and innovation. To reduce “entropy”, the Swedish HE system may need to diversify its approach, recognising the role different HEIs play in their own ecosystem and supporting teaching and KEC activities, besides research.

Policy lessons and next steps

All Swedish HEIs recognise the importance of KEC and can rely on the support of national and sub-national authorities. HEIs are at the centre of the national innovation system, and the government promotes research activities in collaboration with external stakeholders. The Swedish HE system has a broad understanding of “collaboration” and puts equal effort into promoting economic, societal and environmental goals. HEIs play an important role helping local governments reduce their own ecological footprint.

Swedish HEIs and policy makers are looking at what it means to be at the cutting-edge of the innovative and entrepreneurial practices. However, given the emphasis placed on Sweden's becoming a global innovation leader, the ambitions of both HEIs and government must remain high. The HE system should welcome innovation and promote collaboration in different policy areas, such as regional development.

It is important to acknowledge that, as far as KEC is concerned, large research universities in central locations and the smaller peripheral institutions face different challenges. Some existing examples of inter-university and cross-location co-operation have potential for meaningful further development, both in terms of orienting the larger universities to societal and regional needs and of profile building and equipping smaller peripheral universities.

Large research universities could learn from the practices of HEIs in non-metropolitan areas for promoting innovation and well-being in their own communities. The Academy of Smart Specialisation illustrates the potential of co-operation between HEIs and local/regional governments to generate holistic services that help their own communities innovate in inclusive and sustainable ways.

Considerations for policy makers:

Sweden could consider integrating collaboration into higher education funding and assessment. This would be important to compensate for the attitude that considers academic research a panacea and sees teaching and collaboration as a lower priority. Reforms can make collaboration more effective, and this review offers a systematisation of the possible policies that could help it achieve its objective to strengthen the capacity of HEIs to generate societal and economic value. Current efforts go in the right direction and should be continued. The Swedish Higher Education Authority should finalise reforms of KEC funding and assessment. KEC indicators should be captured in the Swedish quality assurance system as planned. A collaborative effort by policy makers and HEIs could create joint acceptance and ownership of these indicators.

Considerations for higher education institutions:

Autonomy is a critical part of the Swedish higher education system, and it permits HEIs with significant space to innovate and experiment. Many of the most successful examples cited above originated when HEIs took advantage of this freedom. HEIs could plan to embed a proactive culture that connects research with innovation ecosystem, without waiting for incentives or permission. Options include:

- *Create institutional KEC “observatories”*: These observatories could gather data and evidence on activities HEIs have used to promote sustainability and well-being in their communities. The data/evidence should be used by the system to generate new narratives and a new understanding of the potential role of HEIs in their ecosystems and networks.

Sweden is an innovation and research leader, but HEIs could broaden their understanding of excellence research to include collaboration activities, including those with their ecosystems. Progress in this area will be an important way for Sweden to ensure that both education and research have a positive impact. HEIs could:

- develop professional figures and institutions that can proactively connect HEIs with stakeholders and help diffuse knowledge in HEIs’ ecosystems and networks.

HEIs could look to learn from one another and to leverage the expertise of regional HEIs to promote the diffusion of university research through teaching and co-operation activities. Options include:

- *Consideration of new types of collaboration agreements*: One approach HEIs cited as being particularly important for creating productive collaborations that supported the whole institution were umbrella agreements connecting multiple projects.

Annex 4.A. Measuring the local impact on development and innovation of Swedish HEIs

This annex presents the analysis of the interactions between Swedish HEIs' research capacity, local innovation, and economic growth across Swedish municipalities, done to inform the KEC chapter of this review.¹⁰

The data

Research capacity is calculated using Scopus data to measure, both the research publication outputs of different Swedish HEIs (Annex Figure 4.A.1) and, the citations worldwide to the outputs (Source: Authors' elaboration, Scopus and Statistics Sweden

Annex Figure 4.A.2). Publications and citations are measured between 2000 and 2015.

The analysis is based on Scopus as it is one of the most prominent abstracting and indexing databases. It was developed by Elsevier in 2004 and contains 75 million documents sourced from over 24,000 active journal titles and 5,000 publishers. Scopus covers content from journals, conference proceedings, book series and trade publications in all scientific fields. Additionally, it offers enhanced sorting and searching features enabling researchers to access over one billion citations going back to the 1970s. Perhaps the key strength of Scopus is the system of unique identifiers (profiles) that assist users to track research outputs of individual authors and organisations. Using the profiles of authors or institutions, one can compute the number of publications and citations for HEIs within a particular period (Aldieri, Kotsemir and Vinci, 2018^[27]).

The local growth and local innovation levels, based on this data, are subsequently introduced as the dependent variables in a series of fixed-effects panel regressions investigating the link between HEI research capacity and local growth. The model controls for time-invariant regional characteristics and other potential explanatory variables, such as human capital, employment levels, and urban population in the panel data regression. All of the socio-economic variables are collected from Statistics Sweden.

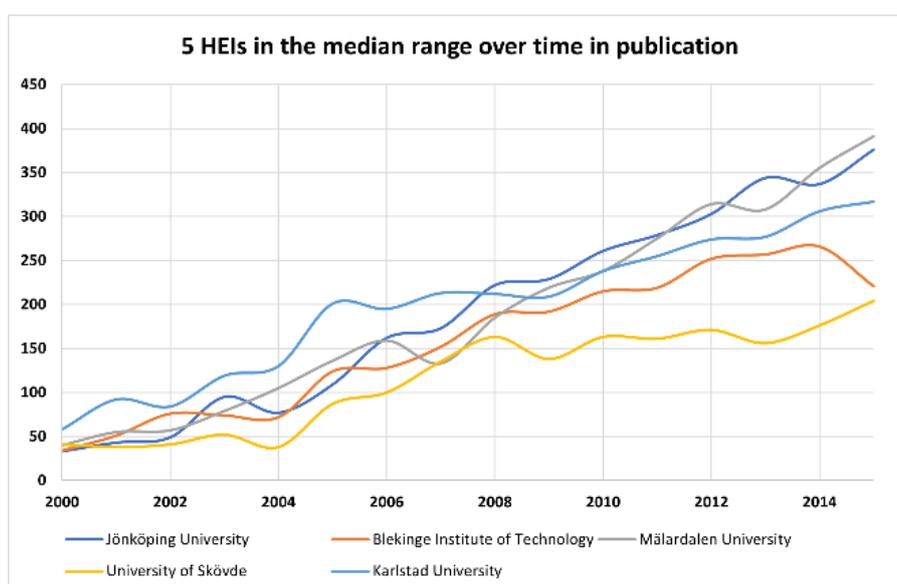
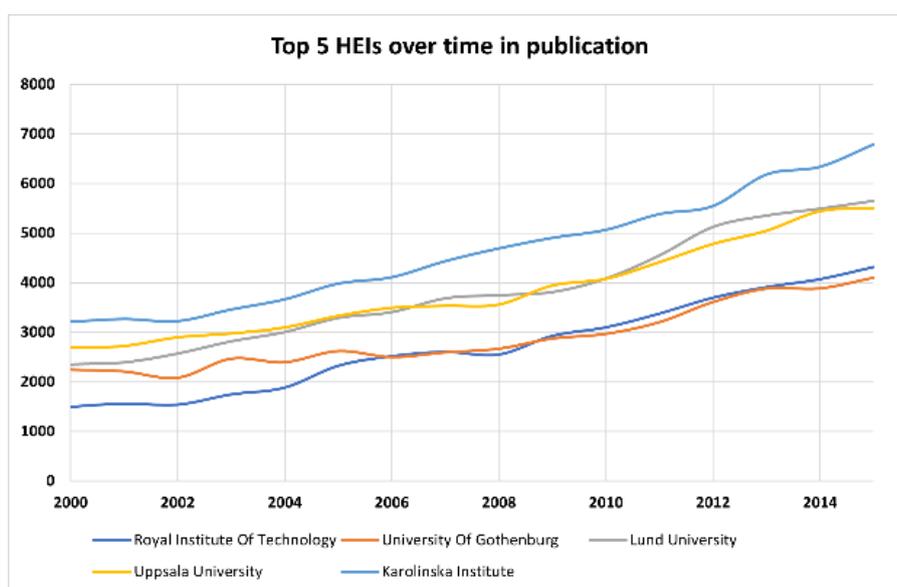
The names of the variables included in the analysis, their definition and their sources are presented in Annex Table 4.A.1.

Annex Table 4.A.1. Descriptive statistics

Variable	Description	Source	mean	std.dev.
Dependent variable				
Income	Income per capita, logged	Statistics Sweden	5.010041	0.198533
Wage	Wage per capita, logged	Statistics Sweden	5.23571	0.16434
Patent application	Patent application per capita, logged	PATSTAT	1.315324	1.349854
Patent granted	Patent granted per capita, logged	PATSTAT	1.728546	1.432874
Independent variable				
publication	research publication per capita, logged	Scopus	0.000706	0.004981
spatially lagged publication	average publication in neighbouring	Scopus	0.00013	0.001099

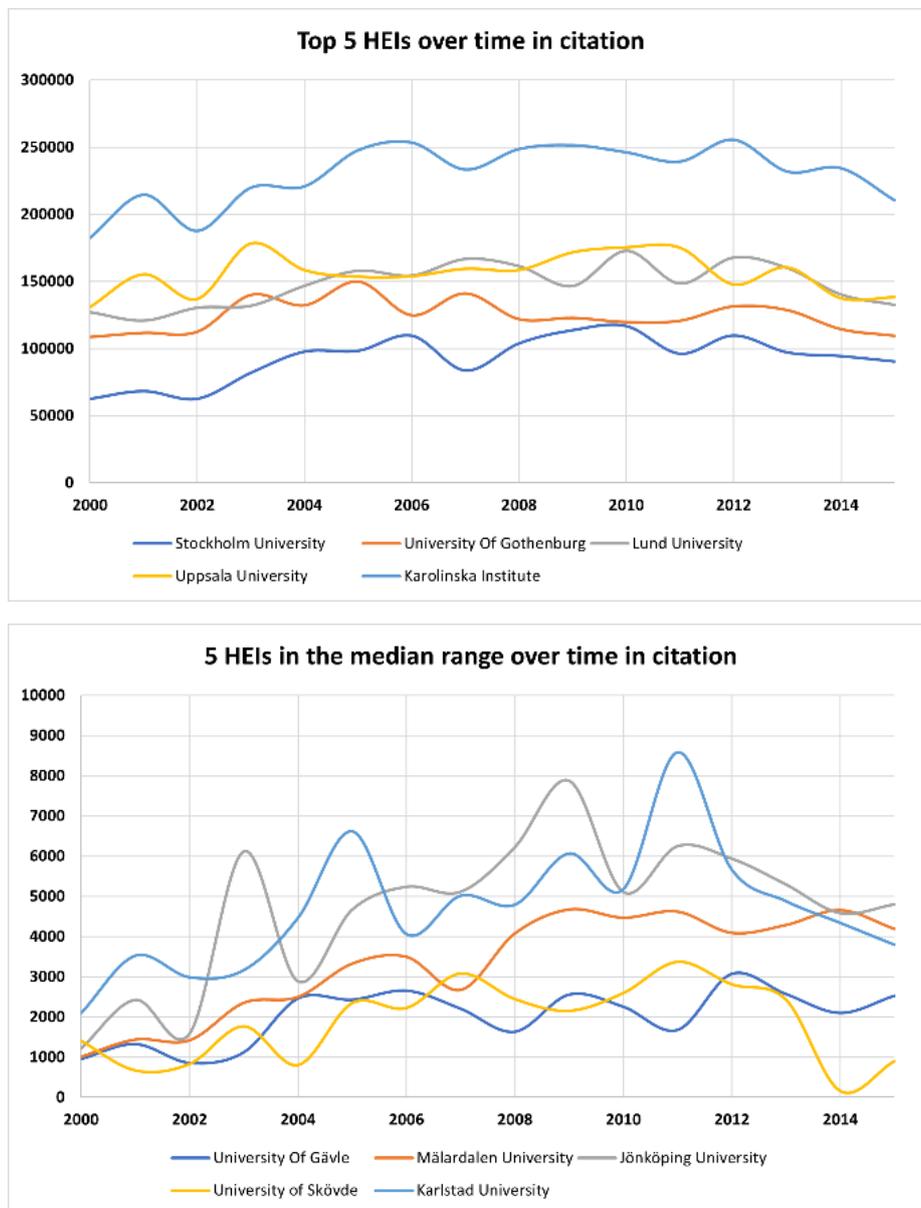
Variable	Description	Source	mean	std.dev.
	municipality, logged			
citation	research citation per capita, logged	Scopus	0.017556	0.117342
spatially lagged citation	average citation in neighbouring municipality, logged	Scopus	0.003164	0.025021
human capital	Percentage with a HEI degree	Statistics Sweden	0.085661	0.039067
employment	Percentage with employment	Statistics Sweden	0.817585	0.023353
population	urban population, logged	Statistics Sweden	9.823125	0.928007

Annex Figure 4.A.1. Research intensity of HEIs from 2000 to 2015



Source: Authors' elaboration, Scopus and Statistics Sweden

Annex Figure 4.A.2. Research quality of HEIs from 2000 to 2015



Source: Authors' elaboration, Scopus and Statistics Sweden

The model

A spatial lagged model examines the extent to which HEIs' research capacity has affected local development and local innovation in Sweden. Municipal research capacity is a function of regional investment in knowledge generation, the research activities occurring in neighbouring regions, and a vector of socioeconomic factors.

The basic model is specified as follows:

$$y_{i,t} = \beta \text{research capacity}_{i,t} + \theta W \text{research capacity}_{i,t} + X_{i,t} + \epsilon_{i,t} \quad (1)$$

$$W \text{research capacity}_i = \sum_j \text{research capacity}_j \left(\frac{\text{contig}_{ij}}{\sum_j \text{contig}_{ij}} \right) \quad \forall i \neq j \quad (2)$$

Where i represents a given municipality and t a given year. The outcome variable $y_{i,t}$ reflects local development measured by income, wage, and innovation per inhabitant. $research\ capacity_{i,t}$ measured by publications and citations at the municipal level. $Wresearch\ capacity_i$ represents average research capacity in the surrounding municipalities. More specifically, $research\ capacity_i$ denotes the level of publication or citation of neighbouring regions j and $contig_{ij}$ is indicative of whether region j is contiguous to region of interest i . $contig_{ij}$ assumes a value of one, if this is true, and zero, if false. Furthermore, we control for a set of covariates, including human capital, employment, and urban population.

To estimate the effect of HEI on the innovative activities at the local level precisely, the following model is adopted:

$$y_{h,i,t} = \beta research\ capacity_{h,i,t} + X_{h,i,t} + \epsilon_{h,i,t} \quad (3)$$

Where h denotes the HEI, i represents a given municipality, and t a given year. The dependent variable $y_{h,i,t}$ reflects innovation diffusion. The advantage of this model is that it allows to check the influence of knowledge spillovers emanating from HEIs at different distances. Realizing that the effects of HEIs' knowledge spillovers may fade with distance, we consider a range of distances —1, 5, 10, 25, 50, and 100 km— from the HEI where the knowledge is generated.

The results

Measuring the impact on local development

Annex Table 4.A.2 gives the results of how the research capacity of different HEIs affects income growth at the local level —with the local level equated to municipalities in Sweden. The raw regressions involving research capacity and income growth —and without any controls— are presented in columns (1) and (3). Of these, only the research citation, the closest indicator to the quality of research conducted by a HEI, is significantly and positively related to local income growth. The coefficients of the spatially lagged citation variables, in comparison, are negatively related to the growth of income. This implies that Swedish municipalities located in the vicinity of a HEI may not have benefited from the HEI in terms of income growth.

When the control variables are included in the model, the full model (shown in columns (2) and (4)) suggests that the association between the research conducted by Swedish HEIs and income growth is, at best, tenuous. While growth in income takes place in areas with a better endowment of human capital and more employment (but not necessarily in urban areas), the link between publications and citations to those publications, on the one hand, and income growth, on the other, is non-existent. Both human capital and employment ratio are positive and significant at 1%. The coefficient for the number of publications and citations are, by contrast, non-significant. The same applies for income growth in neighbouring areas. Here the coefficients are either negative and significant at the 10% level (Annex Table 4.A.2, Regression 2), or insignificant (Annex Table 4.A.2, Regression 4).

Annex Table 4.A.2. HEI research capacity and income growth in Sweden, 2000–2015

Variables	(1)	(2)	(3)	(4)
publication	2.259 (1.597)	1.503 (1.547)		
spatially lagged publication	-8.925 (7.100)	-16.14* (8.425)		
citation			0.314** (0.132)	-0.00674 (0.135)

Variables	(1)	(2)	(3)	(4)
spatially lagged citation			-1.392** (0.580)	0.413 (0.744)
human capital		2.195*** (0.300)		2.062*** (0.306)
employment		0.943*** (0.239)		0.970*** (0.240)
urban population		-0.0281 (0.0532)		-0.0247 (0.0535)
Constant	4.701*** (0.00231)	4.151*** (0.657)	4.701*** (0.00235)	4.103*** (0.661)
Controls	No	Yes	No	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	4,621	4,333	4,621	4,333
R-squared	0.973	0.972	0.973	0.972
Number of id	289	289	289	289

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

To further verify the results in Annex Table 4.A.2, income growth was replaced by growth in wages in Annex Table 4.A.3. Because the wage data at the municipal level is only available from 2011, the period of the panel is shortened to five years, providing a robustness test with a different timeframe. In any case, Annex Table 4.A.3 tells a similar story. Regardless of whether or not control variables are considered in the regressions, both academic publications and citations are not connected with the wage growth of residents. Similarly, the coefficients of the spatially lagged variables suggest that exposure to regional research flows is also not relevant to the wage growth in Sweden.

In the model, the only factor with a positive impact on regional wage growth is human capital. This could be led by the fact that HEI may raise regional wages through education, but the research capacity of HEI does not directly stimulate the local economy.

Annex Table 4.A.3. HEI research capacity and wage growth in Sweden, 2011–2015

Variables	(1)	(2)	(3)	(4)
publication	2.471 (5.776)	1.720 (4.514)		
spatially lagged publication	3.541 (23.22)	-1.157 (18.00)		
citation			0.111 (0.143)	0.0317 (0.101)
spatially lagged citation			-1.010 (0.695)	-0.348 (0.473)
human capital		2.218*** (0.300)		2.289*** (0.296)
employment		0.261 (0.183)		0.257 (0.183)

Variables	(1)	(2)	(3)	(4)
urban population		-0.183*** (0.0569)		-0.182*** (0.0565)
Constant	5.197*** (0.00148)	6.567*** (0.620)	5.201*** (0.00109)	6.551*** (0.617)
Controls	No	Yes	No	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,445	1,445	1,445	1,445
R-squared	0.903	0.912	0.902	0.911
Number of id	289	289	289	289

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Measuring the impact on local innovation

To measure innovation precisely, patent data —used as a proxy for innovation— were divided into patent applications and patents granted. The results for considering patent applications and patents granted are presented in Annex Tables 4.4 and 4.5, respectively.

Annex Table 4.A.4 provides evidence of interactions between publication and the growth of patent applications. However, this result goes against expectations. In columns (1) and (2), more publications by local HEIs are associated with lower, rather than higher, levels of patent applications. In contrast, having a research intensive HEI in a neighbouring area is connected to higher innovation. This means that the research emanating from HEIs may not have the expected impact on innovation in the immediate neighbourhood of the research institution. It may, however, act as a catalyst for innovation in neighbouring areas. These associations disappear when the measure of research quality, i.e. citations, is considered. In this case the coefficients for the link between the citations to the research conducted in in a particular Swedish HEI and innovation vanishes, as the coefficients are non-significant.

Annex Table 4.A.4. HEI research capacity and patent application growth in Sweden, 2000–2014

Variables	(1)	(2)	(3)	(4)
publication	-0.108*** (0.0290)	-0.137*** (0.0526)		
spatially lagged publication	0.378*** (0.116)	0.477** (0.205)		
citation			0.0120 (0.0104)	0.0149 (0.0105)
spatially lagged citation			-0.0419 (0.0420)	-0.0557 (0.0428)
Constant	0.000328*** (2.61e-05)	0.00490 (0.00429)	0.000244*** (5.53e-05)	0.00339 (0.00426)
Controls	No	Yes	No	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Variables	(1)	(2)	(3)	(4)
Observations	4,622	4,334	4,622	4,334
R-squared	0.057	0.072	0.061	0.075
Number of id	289	289	289	289

Note: Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Annex Table 4.A.5, the attention is on the patents that have been granted. When considering publications —Columns (1) and (2)— the coefficients mostly reproduce those already described in the case of patent applications: academic publications from local HEIs are connected to innovation, not necessarily in the place where the HEIs located but fundamentally in neighbouring municipalities. The coefficients for citations are different. More citations to publications by local HEIs are connected to a higher number of patents granted, although that is not the case in neighbouring areas (Annex Table 4.A.5, Columns (3) and (4)). It seems that the quality of academic research —proxied by the citations to publications— is essential for obtaining patents. In other words, it implies that the pursuit of excellence in research may contribute to improving innovation in the local area.

Annex Table 4.A.5. HEI research capacity and patent granted growth in Sweden, 2000–2014

Variables	(1)	(2)	(3)	(4)
publication	-0.130*** (0.0216)	-0.117*** (0.0233)		
spatially lagged publication	0.595*** -0.0925	0.564*** (0.0940)		
citation			0.00568*** (0.00145)	0.00834*** (0.00142)
spatially lagged citation			-0.0235*** (0.00650)	-0.0362*** (0.00651)
Constant	0.000461*** (1.53e-05)	0.00851*** (0.00307)	0.000432*** (1.58e-05)	0.00834*** (0.00314)
Controls	No	Yes	No	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	4,622	4,334	4,622	4,334
R-squared	0.147	0.155	0.137	0.152
Number of id	289	289	289	289

Note: Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To further study the innovative effect of HEI research, the focus is onto HEI to examine its effects on innovation in a set of different geographical distances in Annex Tables 4.6 and 4.7. The distances range from 1km from the HEI to 100km. The advantage of these specifications is that they allow to check the knowledge spillover effects of HEIs in a list of different ranges at the micro level. Annex Table 4.A.6 illustrates similar results at the micro level to those reported at the municipal level (Annex Table 4.A.4). Overall (and regardless of the distance), there is no clear evidence that the research capacity of Swedish HEIs is related to patent application diffusion. In almost all ranges of influence, the number of patent

applications is completely disconnected with the level of HEIs' publications and citations. This may be because filling a patent application only represents a willingness to innovate, but it does not necessarily represent true innovation.

Nevertheless, when considering patents granted instead of patent applications (Annex Table 4.A.7), it is possible to see that both the HEIs' publications and citations have a clear positive impact on the diffusion of innovation. This association is in evidence in distances between five and 50 km and greatest for both HEIs' publications and citations for both 5km and 10km radii.

Annex Table 4.A.6. HEI research capacity and patent application diffusion in Sweden, 2000–2014

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	<=1km	<=5km	<=10km	<=25km	<=50km	<=100km
Panel A						
publication	0.0421 (0.0580)	-0.0136 (0.0375)	0.0218 (0.0337)	0.0353 (0.0316)	0.0421* (0.0241)	-0.0246 (0.0235)
Constant	-17.24 (39.50)	-4.057 (35.60)	15.21 (30.84)	-4.482 (23.39)	0.217 (12.14)	-37.79*** (7.790)
R-squared	0.080	0.141	0.128	0.193	0.202	0.314
	(7)	(8)	(9)	(10)	(11)	(12)
	<=1km	<=5km	<=10km	<=25km	<=50km	<=100km
Panel B						
citation	0.0181 (0.0327)	-0.0302 (0.0204)	-0.00819 (0.0128)	0.00438 (0.0194)	0.00909 (0.0157)	-0.0155 (0.0139)
Constant	-17.24 (39.50)	-4.057 (35.60)	15.21 (30.84)	-4.482 (23.39)	0.217 (12.14)	-37.43*** (8.075)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
University FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	448	448	448	448	448	448
R-squared	0.080	0.141	0.128	0.193	0.202	0.314
Number of id	32	32	32	32	32	32

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Annex Table 4.A.7. HEI research capacity and patent granted diffusion in Sweden, 2000–2014

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	<=1km	<=5km	<=10km	<=25km	<=50km	<=100km
Panel A						
publication	0.0410 (0.0468)	0.112*** (0.0269)	0.111*** (0.0233)	0.0733*** (0.0250)	0.0551*** (0.0166)	-0.0133 (0.0191)
Constant	-10.79 (39.28)	-14.01 (22.17)	3.356 (17.21)	-9.134 (17.14)	-8.635 (13.01)	-24.68** (9.799)
R-squared	0.062	0.159	0.146	0.168	0.142	0.243

	(7)	(8)	(9)	(10)	(11)	(12)
	<=1km	<=5km	<=10km	<=25km	<=50km	<=100km
Panel B						
citation	0.0277 (0.0284)	0.0376* (0.0192)	0.0419** (0.0159)	0.0356** (0.0147)	0.0343** (0.0142)	-0.00440 (0.0112)
Constant	-10.79 (39.28)	-14.01 (22.17)	3.356 (17.21)	-9.134 (17.14)	-8.635 (13.01)	-24.79** (9.839)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
University FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	448	448	448	448	448	448
R-squared	0.062	0.159	0.146	0.168	0.142	0.242
Number of id	32	32	32	32	32	32

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

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Notes

¹ For more information, visit <https://www.digitaldemostockholm.com/en/>.

² The issue of scale was noted as a challenge by representatives of the Karolinska Universities, who mentioned that they had lost an important collaboration with a large international pharmaceutical company, which considered that the flow of graduates (talent) it generated yearly was insufficient.

³ The agreement has three general objectives: first, create new conditions for developing university-wide research and education by taking advantage of a complete academic environment; second, clarify the excellence and internationally outstanding academic environment that the parties represent together and strengthen the universities' capacity to act jointly, regionally, nationally and internationally, based on the alliance co-operation; third, co-ordinate and build common functions for administrative support to promote long-term conditions, professionalisation and development capacity. Information on the University Alliance Stockholm Trio is available at <https://ki.se/en/collaboration/stockholm-trio-university-alliance>.

⁴ While many of the practices of the Academy for Smart Specialisation are common in other Swedish HEIs, what is unique in Karlstad is the institutionalised, large-scale co-operation Karlstad University has created. The strategic partnership between the university and Region Värmland is a multihelix co-operation including actors from all sectors in the region. Both parties especially highlight trust at different levels as critical in creating and maintaining this kind of partnership. Karlstad still has areas of its collaboration activities it wants to review. While there are many incentives for collaboration, mainly through funding, which often requires collaboration partners, internally, classic academic metrics of success such as publications have more prestige. The challenge of agreeing upon a definition of success and measuring outputs remains to be resolved.

⁵ While it is not one of the case studies, Väst University participated in a stakeholder session on knowledge exchange and volunteered this example.

⁶ By 2018, Swedish HEIs accounted for 0.84% of GDP in R&D. This share is far higher than in the majority of OECD and emerging economies, and second only to Denmark among members of the OECD (Swedish Higher Education Authority, 2020^[29]). This effort to enhance HEI research has paid dividends in terms of the positioning of the Swedish system in world university rankings. According to the Quacquarelli Symonds (QS) World University Rankings, Sweden's higher education system ranks 14th in the world. This is considerably higher than its rank in terms of GDP (24th). Overall, eight Swedish HEIs are ranked in the top 500 in the world in the QS 2021 ranking. The Academic Ranking of World Universities (ARWU) popularly known as the Shanghai ranking, a ranking more based on research performance, rates it at about the same level. Swedish governments have also gradually increased funding for HEIs. By 2018, Swedish HEIs attracted 0.84% of GDP in R&D. This share is far higher than in the majority of OECD and emerging economies, and second only to Denmark in the OECD (Swedish Higher Education Authority, 2020^[29]).

⁷ Since 1977, Sweden has implemented a spatial decentralisation of its higher education system by establishing 11 new HEIs and increasing the status of 14 previously established university colleges (Andersson, Quigley and Wilhelmsson, 2009^[28]).

⁸ Scopus is one of the most prominent abstracting and indexing databases. It was developed by Elsevier in 2004, and contains 75 million documents, sourced from over 24,000 active journal titles and 5,000 publishers. Scopus covers content from journals, conference proceedings, book series and trade publications in all scientific fields. Additionally, it offers enhanced sorting and searching features enabling researchers to access over one billion citations, going back to the 1970s. Perhaps the key strength of Scopus is the system of unique identifiers (profiles) that assist users to track research output of individual

authors and organisations. Using the profiles of authors or institutions, one can compute the number of publications and citations for HEIs in a particular period (Aldieri, Kotsemir and Vinci, 2018^[27]).

⁹ Conversely, the number of patent applications has no relation to the level of an HEI's publications and citations. This may be because filing a patent application represents a willingness to innovate, but does not necessarily represent true innovation.

¹⁰ Similar approaches have been done in (Aldieri, Kotsemir and Vinci, 2018^[27]) and (Atta-Owusu, Fitjar and Rodríguez-Pose, 2021^[30]).

5 Organisational Capacity: Funding, People and Incentives

Swedish higher education institutions are responding to growing political impetus to increase knowledge exchange and collaboration with third parties. While the organisational and steering capacities of HEIs have developed in the right direction in the last couple of years, a number of institutions seem to lack strategic capacity for directing research towards goals that benefit business or society. There are opportunities for introducing clearer priorities and incentives for innovation and entrepreneurship, both at the system and at the institutional level.

Introduction

In Sweden, higher education policy features high on the national policy agenda, reflecting the efforts to increase the quality of research and to use research to address societal challenges. The potential of HEIs to deliver these objectives is closely tied to their innovation and entrepreneurial capacity.

Swedish HEIs' organisational capacity is extremely varied, given their history and geographic location. As noted in other chapters, Sweden could be said to have a twofold higher education system, including:

- long-established, well-equipped, research-intensive universities;
- younger institutions that developed out of a mission to educate.

This chapter focuses on the organisational capacity of institutions to formulate strategies and related goals, and to develop governance models and incentive schemes to facilitate an innovation strategy.

The principles of the HEInnovate Organisational Capacity dimension were extended specifically to address relevant issues in Sweden, including innovative governance and incentive models, promotion and awareness measures, networking with local/regional partners, authorities, enterprises and several social initiatives.

Swedish universities are responding to growing political impetus to increase knowledge exchange and collaboration with third parties. This chapter focuses on regulatory frameworks and institutional arrangements that promote collaboration and generate linkages with stakeholders.

Box 5.1. Organisational Capacity: Funding, People and Incentives in the HEInnovate Framework

The HEInnovate Framework defines organisational capacity as the ability of an HEI to deliver on its strategy. If an HEI is committed to carrying out entrepreneurial activities to support its strategic objectives, then key resources such as funding and investments, people, expertise and knowledge, and incentive systems need to be in place to sustain and grow its capacity for entrepreneurship.

Characteristics of this dimension include:

1. Entrepreneurial objectives are supported by a wide range of sustainable funding and investment sources.
2. The HEI has the capacity and culture to build new relationships and synergies across the institution.
3. The HEI is open to engaging and recruiting individuals with entrepreneurial attitudes, behaviour and experience.
4. The HEI invests in staff development to support its entrepreneurial agenda.
5. Incentives and rewards are given to staff who actively support the entrepreneurial agenda.

Source: HEInnovate (n.d.^[1]), *Home Page*, <https://heinnovate.eu>. Accessed 05 October 2021

Swedish HEIs have a strong culture and a capacity to build relationships

Sweden HEIs are increasingly and proactively taking ownership of collaboration. If the conditions (i.e. the regional environment and disciplines) were challenging, strong examples exist where an important impulse for a strategically co-ordinated approach had to come from the HEI management.

Anchoring entrepreneurial activities and engagement in higher education institutions is also reflected in the fact that the conceptual co-ordination took place in a participatory way and has been supported from the bottom up over the years, as reported in individual case studies. The constant interaction of top-down and bottom-up initiatives observed in Swedish case-study HEIs show the importance of new forms of management in generating safe, regulated spaces for autonomy, innovation and trying out new ideas.

Swedish HEIs offer several examples of multidimensional, inclusive organisational arrangements. The University of Borås' collaboration strategy for 2021-25, for example, was a top-down process, organised by the top management in small working groups. However, the previous strategy was based on bottom-up participation involving researchers. The process was adapted based on the needs of the university at the time and on the wider context. Irrespective of the origin, all of the case studies had at least some top-down support for researchers to collaborate.

Considerable diversity was seen in the level of development of the HEIs and their organisational capacity for collaboration. As a rule, technical faculties are the pioneers in such collaborations and in the development of an institutional entrepreneurial mindset. As the study proceeded, a pattern seemed to emerge that HEIs that have started to deal with collaboration more recently have done so in a more structured way and have tended to adopt a uniform approach.

Holding companies and innovation offices are key factors in Swedish HEIs' organisational capacity

In the Swedish higher education landscape, a number of institutional approaches to support collaboration have been pursued in recent years, partly driven and funded by the national administration and partly by HEIs from the bottom up. The state-owned holding companies and innovation offices have been important in developing the organisational capacity for innovation and entrepreneurship in HEIs. While they are focused on commercialisation, the activities of these institutions are often much broader, spanning education, practical research and a broad range of community engagement.

Not all HEIs have a holding company or an innovation office, but joint offices operate across multiple institutions. For the most part, the innovation offices are assigned to individual universities, but they can also be established as joint intermediaries of two universities. Mid Sweden University (which itself has two main locations) and Karlstad University have a joint innovation office. Feedback in interviews from the two universities suggested that this results in a regular exchange between the two institutions on best practices. The respective experts on site (in the field of patent exploitation or venture capital) exchange information on a weekly basis. The state-funded innovation offices provide structures and support but do not necessarily lead to a full centralisation of innovation support at the respective universities. These collaborative structures can support the entrepreneurial capacity of HEIs, as is the case in the Science Fit regional university collaboration (Box 5.2).

However, the expectations of both these organisations were extremely high, and have not been fully realised, as a number of evaluations (including those by the National Audit Office) in the past decade confirmed. Despite many successful examples, Sweden's holding companies are criticised for being too dependent on public subsidies and for having achieved too little economic success. A particular challenge is their hybrid position both of motivating start-ups that exploit research results and investing in these start-up projects or young companies, while managing the risk and profit, as a private investor would.

Box 5.2. ScienceFit: Regional University collaboration in Styria, Austria

In Styria, the Science Fit project, set up two decades ago, involves the technological transfer offices (TTOs) of Graz University of Technology, Karl Franzens University Graz, the University of Leoben, Joanneum Research and the Campus 02 University of Applied Sciences. The project takes an approach of active knowledge transfer and the different research institutions or universities offer a joint service in the interest of the target group, especially in SMEs, irrespective of their individual interests. The mixed project team actively approaches companies, identifies relevant problems on site and subsequently acts as a neutral intermediary to experts in the participating universities and research institutions, under the obligation of strict confidentiality. The project is permanently financed by the Styrian Government, the Styrian Chamber of Commerce and the City of Graz.

Source: SCIENCE FIT (n.d.^[2]), *Steirische Forschung für steirische KMU*, <http://www.sciencefit.at>. Access 22 April 2021

Incubators and support schemes for entrepreneurship

A support system for entrepreneurship has developed at different levels in Sweden, which, with a relatively lively investor scene by comparison with Central European countries, provides a good basis for knowledge-intensive and academic start-ups. As in other European countries, the National Incubator Programme (NIP), run by the national innovation agency, Vinnova (discussed in detail in the preceding chapter), was created at the beginning of the millennium to support a network of well-equipped incubators that offer their services, to exacting standards.

Some Swedish HEIs have created their own incentives and qualification requirements for entrepreneurship and incubators, in addition to or in co-ordination with other local partners and existing national or regional support structures. The incubator structures hosted by or accessible to Swedish HEIs vary greatly and do not follow a uniform model or a nationally uniform funding and financing scheme. At some HEIs, founders receive not only access to infrastructure and advisory support but a financial start-up package. A number of university incubators have also succeeded in building a profile that offers an advantage in terms of positioning in the ecosystem or towards potential investors. One example is the Arctic Incubator at the Luleå University of Technology, which also operates in other locations in the University of the Arctic consortium and is particularly involved in the area of sustainability and Agenda 2030. Another example is the biotech incubator OBI, located near Umeå University and other regional research institutions. Drivhuset at Karlstad University helps students launch their ideas by mentoring and networking. This allows students and academic staff to become directly involved within an entrepreneurial ecosystem.

These initiatives often exist alongside other structures. At KTH, for instance, individual professors have innovation teams because their needs exceed what the innovation office can provide.

Research centres, a common virtual structure for innovation

Many Swedish HEIs have organisational structures explicitly dedicated to co-operation with external partners and knowledge transfer. Establishing research centres supports co-ordination and the acquisition of third-party funding. For instance, Gothenburg University has established the Six Centre project, which focuses on societal challenges and links different disciplines, such as antibiotics and cultural heritage. These centres do not qualify for funding if they cannot demonstrate that they are interdisciplinary. As a result of this co-operation, these centres are able to receive funds, support other sciences and collaborate to tackle social challenges.

These strategic research centres are more focused and provide a longer, more stable basis of funding. In many cases, an interdisciplinary, flexible and thus cross-institutional or cross-departmental approach is deliberately chosen. Much of their collaboration and research works as a matrix, with centralised administration around flexible centres that can easily be set up and dismantled. In this way, defined collaborative research centres often function as virtual units that fit into the organisations in the form of a matrix and are rarely tied to their own infrastructure. Mid Sweden University, for instance, is currently involved in research centres that were developed in the regional context.

The members of HEIs interviewed noted the motivations for and advantages of a flexible virtual structure, as well as the challenges associated with it, in particular their sustainability over the long term. Three institutions (Borås, Umeå and Gävle) had flexible multidisciplinary centres (e.g. Sami culture at Umeå), but leveraged traditional organisational forms (e.g. the centres were tied to existing faculties). The research centres for collaborative and interdisciplinary research are organised differently. However, the research centres are directly linked to a faculty, as is the case in Umeå. Both Borås and Gävle were in the middle of strategic reviews, and in Gävle, the leadership was pushing for new ways to be organised, with collaboration as a central organising principle.

University alliances as a vehicle for strengthening capacity

The strong position of individual faculties, and the low institutional density in peripheral areas, has meant that Swedish higher education institutions have more often emerged as multicampus institutions or holdings than is typical in other countries. In recognition of this situation, even before COVID-19, the Swedish government deliberately encouraged improvements in distance learning and virtual collaboration.

In addition, HEIs based on cross-university alliances have also been able to develop. An example of this is the Arctic Five, a partnership between the Umeå University (Sweden), the University of Tromsø-Arctic University of Norway (Norway), Luleå University of Technology (Sweden), the University of Lapland (Finland) and the University of Oulu (Finland). In addition to stimulating cross-institutional and cross-disciplinary research and education, the aim of the Arctic Five is to co-ordinate and share their research systems and facilities and jointly develop state-of-the-art innovation systems to support business development. Close dialogue and outreach actions with stakeholders from local, regional and national agencies and authorities and communities including the Sámi/indigenous people ensure relevance and impact. They have an extensive collaboration with the municipalities of Luleå, Rovaniemi, Oulu, Tromsø and Umeå, all engaged members of the Arctic Mayors' Forum. The Arctic Five collaboration is developing in the key areas of mining, renewable energy, health and well-being, education, regional development and issues relating to Sámi/indigenous people where the universities' expertise and research systems and facilities are both comprehensive and complementary.

The aim of their work is to use cross-border co-operation as a tool for achieving ground-breaking research benefitting not only the Arctic but also people all over the globe who are impacted by change in the high North. Building long-term institutional capacity and strengthening international competitiveness will facilitate the development of a world-class Arctic research hub.

In addition to formal alliances, numerous bilateral collaborations have emerged between universities in the local environment. A good example of this is an ongoing informal co-ordination of the universities Karolinska Institute and KTH. Presidents of both HEIs meet monthly to share ideas for collaboration and best practices. An example of the potential of collaboration between HEIs to have an impact on the region can be found in Berlin and the University Alliance (Box 5.3).

Box 5.3. The Berlin University Alliance

The Berlin University Alliance was set up by four institutions (Freie Universität Berlin, Humboldt-Universität, Technische Universität Berlin and Charité), which concluded a co-operation agreement in 2018. At the same time, a successful application was made in the framework of the Excellence Strategy of the German Federal Government (formerly the Excellence Initiative). The Berlin University Alliance covers a broad spectrum of co-ordination and co-operation: research co-operation, joint and shared infrastructure, joint teaching courses, digitalisation, co-operation in the area of equality and promotion of young researchers, knowledge and technology transfer, as well as international collaborative research. The members of the Alliance have committed to common goals (sustainability, equal opportunity, etc.), pursued with the joint use of resources and reducing distinctions between the participating institutions in the interest of the entire local ecosystem (the Berlin knowledge region).

Source: Berlin University Alliance (2021^[3]), *Home Page*, <https://www.berlin-university-alliance.de>. Accessed 22 April 2021

International co-operation

Most Swedish HEIs have bilateral co-operation agreements with institutions in other countries. Some Swedish HEIs, like Jönköping, despite, or perhaps because of, its non-metropolitan location, see opportunities for future positioning internationally. This is also reflected in the conspicuously international composition of its teaching staff. Individual universities, like KTH, occupy key positions in flagship projects or infrastructure. Overall, though, the proportion of international researchers at Swedish universities and the international mobility of Swedish researchers is comparatively low. International outreach offers a significant opportunity to increase their capacity for innovation and entrepreneurship.

The Swedish HEIs can access a dense, interlocking network of institutions that strive to enhance co-operation in the international environment. The responsibilities of the respective organisations are primarily geared to geographical and political regions. The Swedish Council for Higher Education, the Swedish Foundation for International Co-operation in Research and Higher Education, the Swedish South Asian Studies Network, Nordplus, the Baltic Sea Project and also the Swedish Institute support international co-operation between Swedish universities, primarily in the field of education, and the mobility of students, teachers and researchers. The Swedish International Development Co-operation Agency (Sida) seeks to support global development co-operation, particularly in the field of education and researcher/student mobility, through bilateral agreements.

International research co-operation is also supported by the established research funding institutions (e.g. Vinnova or the Swedish Research Council Formas). National contact points are also located here, involved in mediation in connection with the European Framework Programmes for Research, Nordic or global co-operation in the context of development co-operation, as well as in interfaces with international key research institutions or strategic large-scale research infrastructures. Implicitly, this perpetuates the fragmented nature of Swedish funding and support structures in the context of international co-operation.

Staffing and Incentives

Professor's privilege is not perceived as a barrier for innovation

Sweden is the most frequently cited example of the importance of professor's privilege for knowledge transfer, knowledge exploitation and entrepreneurship. Sweden enshrined this principle in law as early as

the middle of the last century and has not moved away from it, despite recurring discussions. The professor's privilege is anchored in Swedish patent regulation.

While structures have been created at Swedish HEIs to support knowledge exploitation and transfer, the participation of Swedish academics in patent applications is not significantly higher than in other countries with the same regulatory approach.

Box 5.4. Professor's Privilege in Italy

In Italy, by law, universities have to give inventors a minimum of 50% of the revenues generated by university-owned patents. The inventor is required to use these revenues for research or other academic activities. In some institutions, the share of revenues allocated to the inventor is higher.

The University of Cagliari, for example, gives inventors 65% of the revenue generated by patents owned by the institution. In other cases, the additional revenue is allocated to departments that can use it to incentivise patenting activity at the university or to increase the university's share in the ownership of a given patent.

Due to the so-called professor's privilege, patents owned by universities represent only 36% of all academic patents. The patenting activity, however, is concentrated in a few institutions, about half of the patents in 12 universities, while in the case of university-owned patents, the same share is concentrated in nine institutions.

One of the recommendations of the HEInnovate review of Italy was to assess the impact of the professor's privilege on incentives. Based on international good practices that handle this issue, Italy could start an evaluation of the professor's privilege to assess the need to modify this policy.

Source: OECD/European Union (2019^[41]), *Supporting Entrepreneurship and Innovation in Higher Education in Italy*, <http://dx.doi.org/10.1787/43e88f48-en>.

In the context of the interviews conducted with Swedish HEIs, it appears that the professor's privilege is not perceived as a barrier to innovation, entrepreneurship or collaboration. However, HEIs did not consider it a relevant incentive, either. Similarly, HEIs are not very interested in promoting commercialisation on behalf of professors.

Different disciplines have different traditions of collaboration, which impacts how motivated individual professors are to engage in innovation and entrepreneurship. In the course of the discussions, particular challenges were noted that appear to offer greater incentive at the level of the overall institutions than at the level of the individual researcher. A good example of this is hospitals or clinical research in translational medicine.

Despite the importance of Knowledge Transfer and collaboration it is not a formal criterion in recruitment

HEIs report that experiences of co-operation with third parties, third-party funding and social impact are increasingly discussed in connection with recruitment. However, the interviews also showed that direct incentives for individual researchers and teachers to be innovative and entrepreneurial are lacking, and that collaboration is rarely directly invoked in hiring and promotion decisions. The recruitment processes for leading managerial and academic positions can be vital in promoting diversity and the development of new ideas and new forms of collaboration. One positive example includes the University of Borås, which has a significant project for focusing more attention on recruitment. It also decided to introduce changes

in recruitment practices and career development opportunities, rather than limit its focus to researchers' publications.

As innovation and entrepreneurship are considered as part of career development, they cannot be thought of as standing alone, but must be integrated into teaching and research. However, no specific incentives for collaboration have been established. This is particularly important for the development of the next generation of academics. Programme funding, the main vehicle for supporting capacity building in HEIs, is separate from the individual grant and PhD funding that young academics rely on.

One example of how doctoral programmes can build capacity is Linköping's PhD course Entrepreneurship in Theory and Practice (ETP). This 7.5 ECTS course, started in 2006, is organised by the Department of Management and Engineering. It primarily targets research students at the Institution for Economic and Industrial Development, but PhD students in other fields at Linköping and from other universities may also apply. ETP has enrolled over 200 PhD students in the 15 years of its existence. The course is an elective and has relied on "market pull" to meet enrolment requirements each year.

The objective is that by the end of the course, participants shall be able to:

- discuss and reflect on the meaning of entrepreneurship in various settings and situations;
- formulate, develop and present a business idea for a new firm, organisation, process, or project;
- co-operate with colleagues in other disciplines and fields of research during idea development;
- understand how an entrepreneurial approach can contribute to the development of the student as a researcher and teacher.

Evaluations of ETP courses in the last 15 years suggest four key components of good practice in entrepreneurship education: entrepreneurial teaching must 1) offer inspiration, 2) provide learning tools, 3) assemble boundary-spanning networks and 4) take advantage of interdisciplinary activities. Experience has shown the importance of balancing theory and practice in attracting students from a wide range of scientific and technological fields.

One positive opportunity is the research centres (mentioned by Mid Sweden University), although they cannot offer their own career models (no tenure-track offers are available). The development of young researchers thus ultimately depends on the participating seniors and the associated faculties.

HEIs should consider how they are developing the skills of the next generation. Young researchers, for example, can be integrated into externally funded projects, or students can be placed directly as co-workers in regional companies or public institutions.

As for gender, HEIs reported that in female-dominated fields, like teaching, collaboration is taken as a given. The institutions interviewed note that women are particularly active in research areas with a high level of activity in industrial co-operation or academic entrepreneurship.

Evaluation and Measurement

The HEIs surveyed adequately include KEC in quality assurance systems, given that the different constellations and framework conditions and purpose of KEC in research units are difficult to capture in a uniform indicator system. The next development steps should nevertheless be taken here, which can be supported by grassroots research.

Jönköping University offers an example of how measuring performance can support capacity building. It has launched an internal programme to measure performance (Spark), following a strong internal push to increase its performance in international rankings. This approach to measuring is part of a wider culture that celebrates personal initiative among its staff.

Considerations for next steps

Discussions with Swedish HEIs show that numerous efforts in recent years have been successful in proactively increasing the innovative and entrepreneurial capacity of Swedish HEIs. At the same time, the Swedish HE system has the potential to increase its capacity for innovation and entrepreneurship.

While the organisational and steering capacities of HEIs have developed in the right direction in the last couple of years, a number of institutions seem to lack strategic capacity for directing research towards goals that benefit business or society.

Considerations for policy makers

Building organisational capacity in the Swedish HE system requires an understanding of what constitutes success in delivering innovation and entrepreneurship. The HE system and policy makers could try to develop a shared understanding for evaluating the outputs of innovation, entrepreneurship and collaboration. Given the sophistication of the Swedish innovation system, policy makers and HEI are encouraged to be ambitious. Measuring innovation and entrepreneurship activities is not straightforward, but the process of agreeing an approach could have a transformative impact on innovation capacity.

Funders of HEIs' activities, both independent public agencies and private foundations, should consider how to reduce complexity in the innovation landscape, introducing clearer priorities. This will provide HEIs with clearer incentives to invest in long-term capacity to deliver on those priorities. Options include:

- formalising co-ordination efforts and adopting shared priorities and standards;
- ideally, these priorities should be based on the measurement discussion flagged in the Knowledge Exchange and Collaboration chapter.

Policy makers could look to increase support for HEI networks, including those composed of national and international members. Learning from international best practice will allow Sweden to challenge itself to continue to operate at the global frontier. Options include:

- capitalising on the existing networks, such as the Arctic University;
- leveraging the research hub in Stockholm.

Vinnova could fund smaller regional HEIs to further refine their profile and international anchoring. Positive work with the local environment and SMEs should be continued. One challenge will be to open up limited accessible tools in a modified form to a broader front of HEIs. A delicate part of the exercise will be to use existing instruments to allow the smaller regional universities to enhance their profile and international anchoring without endangering the first seedlings of exchange with the local environment or SMEs.

Considerations for HEIs

Swedish HEIs have significant autonomy and freedom to develop their institutional capacity to be innovative and entrepreneurial. As with knowledge exchange, they should not always wait for direct incentives from government to proceed with this agenda.

HEIs could consider proactively instituting policies to reward and incentivise staff for initiating innovation and entrepreneurial activities, particularly in promotion or hiring decisions. HEIs have the autonomy to make their own staffing decisions, and do not need to wait for guidance from government or a regulator to introduce innovative hiring practices.

HEIs could also undertake more peer learning, in particular sharing opportunities for learning among large research institutions and teaching-focused institutions on how to become more entrepreneurial and innovative. Many instances of strong organisational capacity exist, but they are not always shared throughout the country. Options include:

- leveraging strong cross-sector bodies to collectively build the sector's organisation capacity;
- undertaking international collaboration activities to learn more about practices outside Sweden.

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