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Science and Education Policy in Sweden – Some Salient Features[1]

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Abstract: While there has been a high level of consensus concerning the need of a high and sustainable level of funding for scientific exploration among policy makers in Sweden, there has been less agreement on the governance, organization and form of the research performed in the sector. The research policy debate today centers much on knowledge creation forms and governance. Most debaters agree that there is a need of pluralism in the research sector and that there is a genuine need of not only free basic and applied research but also of strategic research and needs-driven research.

The policy for the higher education system has been quite successful in both expanding the share of the population receiving university education and in broadening the recruitment base to include traditionally non-academic segments as well as students with disabilities or other disadvantages. In terms of gender balance, higher education has also made great strides towards a better gender balanced university.

Keywords: Science and education policy, research policy, higher education system

1. Science, technology and innovation policy

Research and development (R&D) has received high priority for the last several decades in Sweden. In the 2012 Research and Innovation bill, the Government proclaims that the research policy objective for Sweden is "to be a prominent research nation in which research and innovation are conducted with high quality, contributing to the development of society and the competitiveness of industry" [1][2]. These broad policy goals have benefited from a general consensus of opinion in the research policy community, resulting in a consistently high level of funding for R&D regardless of which political parties have been in power.

Sweden is actually one of the top OECD countries in the terms of R&D expenditures per capita. In 2014, Swedish R&D amounted to 3.16% of GDP, down from 3.91% in the peak year 2001 but still well above the OECD

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[1] This paper includes updated versions of previous research presented in Göransson 2017, Göransson 2013 and Brundenius, Göransson and Ågren 2011 [2-4].

[2] In November 2016, the Government presented the new research policy bill 'Collaborating for knowledge – for society's challenges and strengthened competitiveness' to the parliament (Prop. 2016/17:50) [5]

average of 2.38%. That puts Sweden among the top 5 spenders on R&D as measured as a share of GDP (Table 1). Also relative to the number of inhabitants, Sweden devotes large expenditures to R&D with 1426 PPP$ per capita, second only to South Korea with 1484 PPP$ per capita in 2014. For Vietnam the corresponding figure was 9 PPP$ in 2011 [6].

Table 1. Top 6 countries for R&D expenditure 2014 and selected countries (% of GDP)

Country	2001	2003	2005	2007	2009	2011	2013	2014
South Korea	2.34	2.35	2.63	3.00	3.29	3.74	4.15	4.29
Israel	4.19	3.90	4.04	4.41	4.12	4.01	4.09	4.11
Japan	3.07	3.14	3.31	3.46	3.36	3.38	3.47	3.58
Finland	3.20	3.30	3.33	3.35	3.75	3.64	3.29	3.17
Sweden	3.91	3.61	3.39	3.26	3.45	3.25	3.31	3.16
Denmark	2.32	2.51	2.39	2.51	3.07	2.97	3.08	3.08
…..								
Germany	2.39	2.46	2.42	2.45	2.73	2.80	2.83	2.87
USA	2.64	2.55	2.51	2.63	2.82	2.76	2.74	n.a.
….								
China	0.95	1.13	1.32	1.38	1.68	1.79	2.01	2.05
….								
Russia	1.18	1.29	1.07	1.12	1.25	1.09	1.13	1.19
….								
Vietnam	n.a.	0.18[a]	n.a.	n.a.	n.a.	0.19	n.a.	n.a.

a) 2002

Source: UIS (2016) [6]

The bulk of the expenditure for research in Sweden comes from the business sector which accounted for 69% of total expenditure for R&D in 2013, close to the OECD average of 68%. This share has declined gradually over the last decade from a high of almost 75%, partly as a result of the trend of outsourcing of corporate R&D activities to new and emerging economies. But even so, it is quite clear that Sweden has been, and continues to be, at the top end in R&D spending on a global scale. Research at the universities and other higher education institutions accounted for over 27% of the total in 2013 - a higher proportion of total expenditure on R&D than the OECD average of 17.7% - while the remaining 4% of research expenditure was accounted for by government agencies (3.68%) and the small private non-profit sector (0.23%) (see Table 2.). In monetary terms this means that of the total of 125 billion SEK spent on R&D activities in Sweden 2013 – or about USD 19 billion - the expenditure in the private sector reached over USD 11.6 billion, in the university sector USD 5.6 billion and for government agencies USD 0.5 billion [7].

The private sector is the dominating actor, financing 69% of all R&D in Sweden. Apart from a small share flowing to the public sector, most of the funding goes to companies in the private sector. The level of self-financing in the private sector was 86% in 2013 and with much of the remainder coming from sources abroad. The corresponding figure for the public sector was 79% in 2013 with the lion's share of the funding flowing to universities (Fig. 1.).

The State directly (through the budget) accounts for the funding of most of the research activities in the higher education sector. In 2011, this core funding amounted to almost half of the R&D revenues of this sector. The rest was accounted for by external financing (most of which were national research councils, central government agencies and research foundations).

Table 2. R&D expenditure per sector 1997-2013 (%)

Year	Total (%)	Private sector (%)	Universities/ Colleges (%)	Government Agencies (%)	Non-profit Organisations (%)
1997	100	74.88	21.57	3.54	0.08
1999	100	74.47	22.20	3.33	0.11
2001	100	77.54	19.62	2.84	0.09
2003	100	74.53	21.82	3.26	0.39
2005	100	72.82	22.00	4.87	0.31
2007	100	72.97	21.92	4.94[a)]	0.17
2009	100	70.64	24.87	4.42[a)]	0.07
2011	100	68.83	26.51	4.34[a]	0.32
2013	100	68.95	27.14	3.68[a)]	0.23

a) includes municipalities

Source: Adapted from SCB (2015) [7] and SCB (2009) [8]

There are four main research councils responsible for financing research:

+ the Swedish Research Council (VR) – funding basic research in science, technology, medicine, the humanities and social science,

+ the Swedish Research Council for Health, Working life and Welfare – funding basic and needs-driven research,

+ the Swedish Research Council Formas – funding basic and needs-driven research in the areas of Environment, Agricultural Sciences and Spatial Planning,

+ the Swedish Governmental Agency for Innovation Systems (Vinnova) – funding needs-driven research in technology, transport, communication and working life.

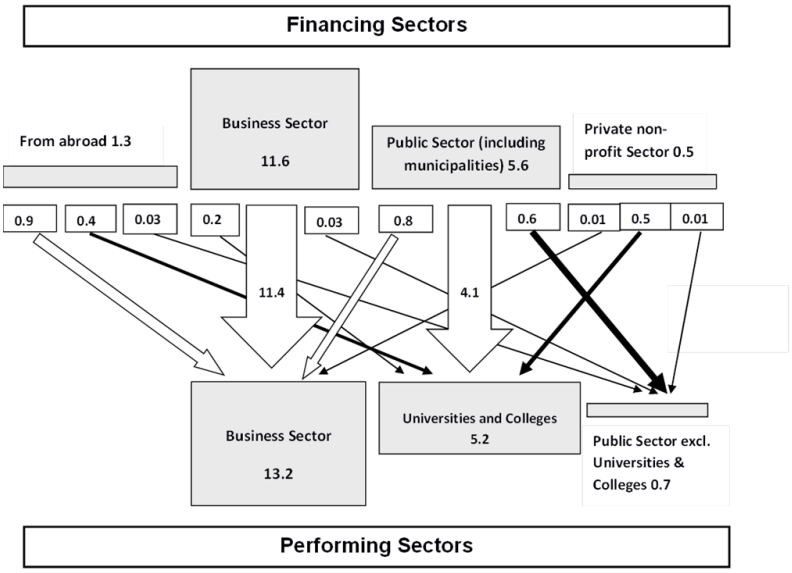

Fig.1. Research funding flows in Swedish R&D from financing sector to performing sector 2013 (billion 2013 USD).

Source: SCB 2015 [7]

Together, these research councils in 2012 provided over USD 1 billion for research within their areas of responsibility.

In addition to the research councils, a number of research foundations created with public capital finance research. Chief among these are SSF (strategic research), Mistra (strategic environmental research), KK-foundation (knowledge and competence development) and STINT (internationalization of higher education and research. In total, the foundations funded around 1.3 billion SEK in 2012.

For one performing sector, the universities, the freedom to decide *which* research to carry out has been somewhat eroded during the last decades. Governments of different political shades have instituted a shift towards marketization of knowledge production at universities [9]. This has been done through funding steering mechanisms as well as other measures to better align academic research with market forces. Increasingly, the objective of the government to achieve higher direct relevance of research for societal problems has resulted in a lowering of core funding - governed by the university researchers themselves - and an increase in external funding, often targeted or earmarked for strategic and/or needs-driven research. Thus, the relative level of core funding from government to universities has decreased from around 70 of total funding in 1995 to well below 60% in 2003 and around 50% today (fig. 2).

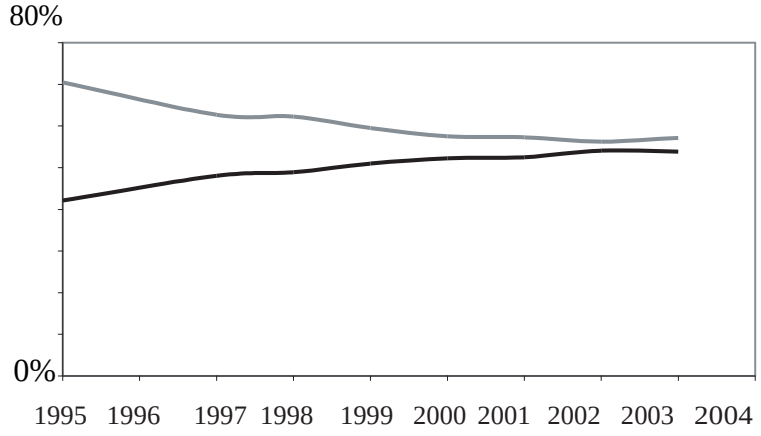

Fig. 2. Share of core funding and external funding for research at universities

Source: Sandström et. al. (2005) [10]

The balance between core funding from government and external, project-based funding from research councils and foundations influences the universities' ability to determine their research agendas. The issues of control over research resources and the decision of what research should be carried out, i.e. the research evaluation system, have consequently received much attention. In particular, the difficulties in the existing evaluation system to measure quality and excellence as well as the risks that the quest for citations lead to strategic choices away from high-risk and potentially rewarding research are pointed out.

2. Research allocation considerations

State resources have traditionally gone directly to the universities as part of the government appropriation bill. From the 1960s on, resources for research have grown impressively, as a result of a rapid expansion of the higher education system and big investments in sectoral research. In the 1970s,

the awareness rose about *the need for national research policy* where the state was to take an active role. In the 1960s and 1970s, the OECD countries had become increasingly aware of the imperative of states to have a policy on science and technology. In 1979 the Swedish Government presented its first research policy bill. The Parliament not only approved the bill but it also decided that this kind of bill should be submitted to it during each term in office, serving as "instruments for long-range planning and coordination of public sector R&D investments".

During the beginning of the 2000's, the Social Democratic Government produced a series of reports aimed at coming to grips with the challenges of globalization, and the opportunities (and threats) that the increased global competition implies for the Swedish knowledge and learning economy. In a Government report [11], it is stated that: "(T)he role of the state is to create the conditions that will enable Sweden to provide the best research and education in the world and to maintain a stable economy, a first-class business climate and efficient innovation systems"

The report stressed that in order to ensure "high-level growth and increased productivity, and thus our future welfare, we must develop conditions that are conducive to innovation and we must enhance the innovation climate". The challenge is to maintain the competitiveness of Swedish industry (in a broad sense) in an increasing competitive climate. In this endeavour the knowledge intensity in industry (products, processes and services) is vital. Hence, not only is an attractive investment climate important for industries to grow - traditional and new industries alike - but it is also as important to create the conditions for an attractive knowledge and learning economy at large.

In June 2004, the Government launched a new innovation strategy, Innovative Sweden: A Strategy for Growth Through Renewal - a platform that would pursue the "vision of Sweden as the most competitive KBE (knowledge-based economy) in the world". This strategic plan was the result of discussions involving various ministries (most importantly the Ministry for Industry and Trade and Ministry of Education and Science) and representatives of academia, the business sector, public authorities and labour organizations. In connection with the launching of this new strategy the government also appointed an *ad hoc* Innovation Policy Council.

As part of the innovation strategy, the Government developed programmes for maintaining and strengthening Sweden's leading position in some key sectors: the metallurgy industry; the forest and wood industry; the vehicle industry, the pharmaceuticals and biotech industry; the IT and telecom industry, and finally, but not least, the aerospace industry.

With the change of government to a center-right government in 2006, public funding for research increased and took aim at stimulating quality and relevance in research. A Government Inquiry on research funding concluded that the agency structure with four research funding councils did not function as intended when it came to support to needs-driven and strategic research and recommended, among other things, increased coordination among research councils [12]. The Government has also introduced a new "quality assurance system" for the allocation and redistribution of the appropriations for university research. This system is based on bibliometric data on levels of publications and citations for each university and allocates up to 10% (proposed to increase to 20% in the 2012 Research and Innovation Bill) of government appropriations to be redistributed to high-performing universities [1].

Further measures to live up to the catch-words of quality, efficiency and effectiveness include international recruitment of top researchers, and excellence programs for up-and-coming younger researchers.

3. The research policy discourse

While there has been a high level of consensus among policy makers in Sweden concerning the need for a high and sustained level of funding for research, there has been less agreement on the governance, organization and form of the research performed in the sector. Partly this has been a reflection of the constantly evolving discourse of the nature of knowledge and the knowledge creation process. As in most countries the linear model was uncontested until more sophisticated models came to the fore. The linear model assumed knowledge to be "free" and easily transferable and emphasized basic research as the starting point automatically leading to the emergence of new, beneficial technologies to be inserted in the economy. With the emergence of new models challenging this notion (see fig. 3), the funding for free basic research has gone down relative to more needs-oriented applied research.

	Knowledge is free	**Knowledge is bound**
Linear process	Linear model V. Busch (1945) Arrow (1962)	Human capital model Mowery (1983)
Non-linear process	Chain-linked model De Solla Price (1969)	Combination model Pavitt (1998)

Figure 3. The nature of knowledge and the knowledge creation process

Source: Sandström et. al. (2005) [10]

The research policy debate today centers much on forms for knowledge creation and governance. Illustrating this with a version of Pasteur's quadrant, most would agree that there is a need for pluralism in the research sector and that there is a genuine need not only for free basic and applied research but also for strategic research and needs-driven research (fig. 4.). The contention is *how much* targeted research, *what* strategic research and how much freedom the research community should be allowed to exert in the formulation of research agendas and execution of research.

	Free research	**Targeted research**
Basic research	Free basic research	Strategic research
Applied research	Free applied research	Needs-driven (applied) research

Fig. 4. Forms for knowledge creation and governance.

Source: From Sandström et. al. (2005) [10]

Critics argue that the Research and Innovation Bill of 2012 was insufficient or ineffectual in addressing the basic problems in the sector. A review of debate articles published in response to the Bill points at the following areas:

Structural problems

- the balance between free basic research and commercial research continues to be skewed in favour of the latter

- increasing short-term external funding precludes new and bold research initiatives and leads to the emergence universities as research hotels

Organizational problems

- too many and unsynchronized research funding agencies

- organization for research performance is too broad

- many research environments are very small

Strategic problems

- prioritizing the best researchers (old, male) leads to the Mathew effect and gender imbalance

- increasing external funding for strategic and needs-driven research erodes the research platform at universities

- increasing external funding for strategic and needs-driven research leads to excessive time spent on writing research proposals

- too much strategic research leads to conformity and conceptual inbreeding

Evaluatory problems

- difficulties to measure quality and excellence

- the quest for citations/publish-or-perish leads to strategic choices away from high-risk and potentially rewarding research

4. Higher education policy and the role of universities in the Swedish National System of Innovation

The Swedish Higher Education Institution (HEI) system has a long history and traces its origin back to the medieval cathedral schools. The first university in Sweden was established in Uppsala in 1477. Today, the Swedish university system encompasses 44 universities and university colleges of which 26 can confer doctoral degrees. Most of these are public institutions or, in some cases, self-governing foundations funded by public money and following the same directives as public universities.

The strong governmental involvement in Higher Education is historically anchored in the Swedish welfare system with public sector provision of free education, health care and universal social security. The mandated tasks for universities, regulated in the University Law of 1992, are to provide science-based education as well as to carry out research and development. To these, a third task was added in 1997; to interact with the broader society and actively work for the utilization of research results. Although the wording is rather nebulous, the HEIs have generally interpreted it as providing support structures for researchers to develop and commercialize technical products [13]. This is much in line with a general trend in HEIs since the turn of the millennium of moving towards increased market orientation and collaboration between HEIs and private industry. Stressing the need for universities to better support the competitiveness of Swedish industry, a string of reports and white papers from governments of different political shades has called for universities to become more entrepreneurial and conducive to innovation. In support of that goal, universities were granted increased autonomy in 2011 (Min. of Education 2009) leading to a higher influence of the private sector on university boards.

How successful has the higher education system been in supporting social processes of inclusive development in terms of enrolment by disadvantaged groups and gender equality? In the remainder of the paper we will look more closely at that.

5. Social inclusion in the higher education system

The governing Swedish University Law of 1992 [14] is continuously amended to reflect changing policies and societal needs. The free education system has historically been regarded as a cornerstone in the building and sustaining of the welfare system and, as such, a great leveler of class and rank. In this respect, the University Law is an important tool in the bridging of societal differences by providing guidance for inclusiveness in and access to higher education. Up to the expansion of the university system beginning in the 1960's, higher education was a matter for a small and select group. From exclusive elite universities with a few thousand students, higher education has grown to today's mass-university system with over 400,000 students engaged in studies at the university system [15]. The number of students enrolled at the universities more than doubled over the 25-year period 1980 to 2005, from 184,000 to 395,000, providing access to higher education to previously excluded groups of students. Notwithstanding these accomplishments, the higher education system is still struggling with issues of equality, chief among these a persistent bias in the recruitment base for higher education and gender inequality.

6. Social bias in recruitment

The recruitment of students from low-income or marginal groups continues to be low despite many years of implementation of policies for inclusiveness at universities and despite its explicit inclusion as a goal in the amendment of the University Law in 2005. The Law mandates universities in general to work for economic and social welfare and justice and, in particular, to actively promote and broaden the recruitment to higher education. Some social segments of the population exhibit a lower likelihood of starting higher education. This is in particular the case of students whose parents have low educational attainment as well as students with a non-Swedish origin.

Parents' educational background

As an average, 44% of the cohort born in 1988 had started university studies by the age of 25. But for students who had at least one parent with a licentiate or doctoral degree, this rate was as high as 84% whereas the participation rate for students with parents with lower-secondary education was as low as 22% [16]. Moreover, there is a discernable pattern of students from differing social strata opting for different types of courses and programs; the longer and more qualified the program is, the higher is the proportion of students with highly educated parents.

Also in post graduate studies as well as among researchers and teachers at universities, we find this pattern. In 2015, the Swedish Higher Education Authority (UKÄ) for the first time reported the background of researchers and teachers in higher education [17]. Compared with the population at large, researchers and teachers at universities tend to have parents with university education. About half of all researchers and teachers at universities in the age span 30-44 years old have parents with a longer university education; the corresponding figure for the whole population is about 20%.

Thus, despite the great achievements in expanding the access to higher education in Sweden and considerably increasing the educational level of the population as a whole, the background of the students still matters and the bias against lower-educated families still lingers. Since all education in Sweden is provided for free, it is not an economic issue

per se, but rather an intractable phenomenon of perceptions and attitudes.

Migrants, refugees and asylum seekers

For the last couple decades Sweden has granted asylum to an increasing number of migrants from Europe and Africa, and more recently the Middle East, culminating in the 2015 arrival of 160 000 refugees and asylum seekers. Data on how the more recently arrived migrants have been accommodated by the higher education system obviously cannot be obtained yet, but studies on the inclusion of earlier emigration indicate that the university system in general has not been biased against recruitment of students with foreign backgrounds. Of the students born in 1988 with a Swedish background (at least one parent born in Sweden), 44% began studies in higher education before the age of 25, or 2013. For two categories of students with foreign background – born in Sweden with both parents born abroad, as well as born abroad but arriving in Sweden before the age of 7 – the enrolment rate is even higher at 45% in 2013 (figure 3).

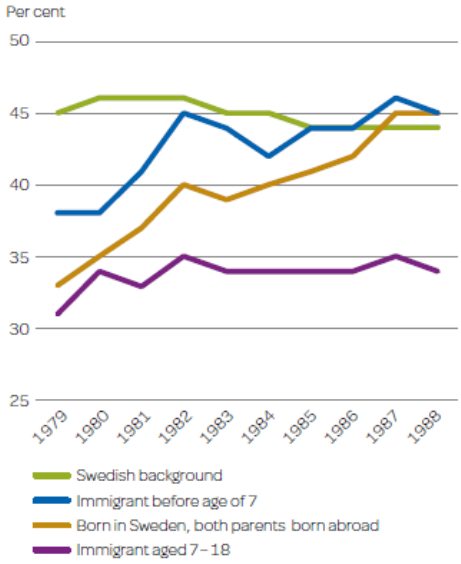

Figure 5. Proportions who have begun higher education in Sweden by the age of 25 of individuals born 1979-1988 with Swedish or international backgrounds

Source: UKÄ 2015a, figure 9 [17].

The bias in recruitment of students from non-Swedish background can instead be observed in students arriving in Sweden at an age between 7 and 18. Here the participation rate is only 34%. Thus, over time all categories of migrants but one fare equally well in attaining higher education.

7. Gender balance

In the pursuit of the three missions of the universities, equality between women and men is a prerequisite in all activities. The University Law stipulates that gender equality should always be promoted and mainstreamed at all instances. The results have generally been substantial. Table 2 summarizes main gender characteristics of the Swedish higher education system in 2001 and 2014. As can be seen from the table, women constitute a majority of the students at universities, and have done so ever since 1977. In 2014, 60 % of the 403 881 registered students in first and second cycle higher education were women. At doctoral level, this rate decreases to 47%. The lower rates of participation for women at advanced levels can be observed also in the number of degrees awarded. Although women account for as much as two thirds of all Bachelor degrees awarded in 2014, their share of degrees falls to 42 % and 49 % at Master and Doctoral levels (table 2). This in spite of the fact that performance indicators (measured as attainment of the credits for which they have been registered in a specific academic year) are generally higher for women (82%) than for men (76%) [18].

If we look at the gender balance in employment at institutes of higher education, women account for a steadily increasing proportion. In 2001, women researchers and teachers constituted 37 % of all personnel in this category; a number that has increased to 44 % in 2014. Also the proportion of women lecturers has increased – from 29 % to 46 % in that period. The last male stronghold in

academia would appear to be the position of professor. At professor's level, only around 25% are women although that number has increased considerable since 2001 when 14 % of professors were women.

In summary, women representation in higher education – both as students as well as researchers and teachers – has made considerable progress the last couple of decades. At most levels, women account for a substantial share and even a majority in terms of university students. The low level of representation at the highest of the academic positions, the professor, is still a major concern but the proportion of women is steadily increasing over time. Replacing male professors involves a time lag before the influx of women professors will take serious effect. A positive development is that 35% of newly appointed professors were women in 2013 as opposed to the 23% already appointed [19]. On the other hand, from a gender perspective it can also be argued that it is worrisome that the proportion of newly appointed women professors is not closer to 50% as the rate of women representation at the level of lecturers would suggest.

Table 3. Indicators on gender balance at HEIs 2001 and 2014

	2001			2014		
	Women	Men	Total	Women	Men	Total
Students	61%	39%	354 490	60%	40%	403 881
Doctoral students	45%	55%	18 968	47%	53%	18 971
Degrees awarded	64%	36%	48 800	64%	36%	69 800
Of which BA[a]	n.a.	n.a.	n.a.	66%	34%	22 975
Of which Master[a]	n.a.	n.a.	n.a.	42%	58%	7 308
Of which PhD	45%	55%	2 758[b]	49%	51%	2 843
Researchers and teachers (FTEs)						
All categories	37%	63%	21 865	44%	56%	28 937
Of which lecturers	29%	71%	5 715	46%	54%	8 378
Of which professors	14%	86%	3 269	25%	75%	5 075

[a] 2002/03 and 2011/12

[b] 2005

Source: compiled from SCB UF20 SM 1301, UF21 SM1501 and UF23 SM 1501

8. Concluding remarks

Science policy and education policy are recognized by policy makers of differing political shades as important tools for maintaining and developing the Swedish welfare state. There is and continues to be a high level of consensus among policy makers in Sweden concerning the need for a high and sustained level of funding for research, but there has been less agreement on the governance, organization and form of the research performed in the sector. Regardless, research and development (R&D) has received high priority for the last several decades in

Sweden with a consequent high level of funding and experimentation with new forms for knowledge creation and governance.

In education policy, free access to education at primary, secondary and tertiary levels has been and continues to be a pillar in the quest for an egalitarian society in Sweden. The higher education system has been quite successful both in expanding the share of the population receiving education at universities and in broadening the recruitment base to include traditionally non-academic segments as well as students with disabilities or other disadvantages. Also in terms of gender balance, higher education has made great strides towards a better gender balanced university, although the proportion of women professors still lags behind many other countries.

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Tóm tắt: Trong khi đã và đang có một mức đồng thuận nhất trí cao giữa các nhà hoạch định chính sách ở Thụy Điển quan tâm đến về sự cần thiết của việc gây quỹ ở mức độ cao và ổn định để phục vụ mục đích nghiên cứu khoa học, lại có ít những đồng thuận về quản lý, tổ chức và hình thức của các nghiên cứu được thực hiện trong lĩnh vực này. Hiện nay, các cuộc tranh luận về chính sách nghiên cứu tập trung nhiều về các hình thức của sáng tạo tri thức và quản trị. Hầu hết những người tham gia thảo luận đồng ý rằng có một nhu cầu về chủ nghĩa đa nguyên trong lĩnh vực nghiên cứu và rằng có một nhu cầu thực chất không chỉ về nghiên cứu cơ bản và nghiên cứu ứng dụng tự do mà còn về nghiên cứu chiến lược và nghiên cứu được định hướng bởi nhu cầu.

Chính sách về hệ thống giáo dục bậc cao đã khá thành công trong việc tăng tỉ lệ dân số được tiếp cận giáo dục ở bậc đại học cũng như trong việc mở rộng các cơ sở tuyển dụng để bao quát các phân khúc truyền thống phi học thuật và các sinh viên khuyết tật hay gặp các bất lợi khác. Bên cạnh đó, về vấn đề cân bằng giới tính, giáo dục bậc cao đã có những bước tiến lớn hướng tới một môi trường đại học với sự bình đẳng giới tốt hơn.

Từ khóa: Chính sách khoa học và giáo dục, chính sách nghiên cứu, hệ thống giáo dục đại học.