Samuel Neaman Institute
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Some evidence towards the path to Scientific Excellence

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SOME EVIDENCE TOWARDS THE PATH TO SCIENTIFIC EXCELLENCE

A work done at the Swedish Collegium of Advanced Study

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1. The erosion of scientific quality.

In recent years, research universities have been responding to the market and social forces too easily. University presidents and heads of leading research institutions find themselves under constant market and financial pressure to respond to "immediate temptations" in order to solve financial problems in their own institution and to some extent as a result of the general public atmosphere of the relation between money and success

Some questions about scientific excellence

The scientific society is taking for granted as an axiom that academic freedom; free competition, free publication; evaluation; peer review etc. will lead to scientific excellence. Is there any evidence for this hypothesis and, if so, what are the preconditions for it to succeed? In this paper we will try to relate to some of these issues.

For all of us who are engaged in science policy or policy for science, it has become difficult to follow all the "new" measures: science indicators; various methods of ranking by an increasing number of institutions.

I think that we should "go back to basics" to clarify the mission of our institutions, not for P.R. but for the scientific research sector and try to concentrate on the key issues from within.

Some years ago Clark Kerr, who was a distinguished scholar and President of U.C., published a book arguing that university presidents can "make a difference", 1986. In recent years the quantity and quality of information in the way science has been both measured and evaluated has been growing and comparisons have become more and more difficult to follow.

The question is: What is really important and where should we focus or concentrate? Is there a national strategy for the support of scientific research and, if so, is there any evidence that can support the use of such a strategy in small countries or states?

In my professional career, which went on for more than 45 years, I have been exposed to publications on research of higher education; official papers; conferences and meetings with Nobel Prize laureates; Wolf Prize laureates and Presidents and CEOs of national and regional institutions all over the world. All of us, I think, have been trying to learn from each other and to expose our experiences to our fellow colleagues. Israel, as a young country, had to build its institutions: establish universities and colleges on the institutional level and on the national level; The Council for Higher Education, The Planning and Grants Committee, The Israel Science Foundation, The National Council for R & D.

Personally I was privileged to take part in this process from both the practical part and the theoretical concepts that were developed and formed. There was an ongoing effort to use various measures and principles to maintain a system with high quality.

Is it possible to make a difference in a university, a state or a country? If so, what should we look for? Are we going to read official papers from governments; research councils; individual researchers, etc. etc. Hundreds of papers were published trying to define what is academic freedom; free competition; mission of university; mission of the individual researcher.

In the following paragraphs I would like to "go back to basics" and relate to the basic values and concepts of academic freedom and scholarship in the world of science. It is this value that lies at the foundation of science that has been interwoven into the system and has become the essence of its existence and growth.

Back to Basics: Academic Freedom

The Robins Report, which was published in 1963, says: (1)

(Academic Freedom – The Robins Report 1963, p. 230)

"We believe that a system that aims at the maximum of independence with the necessary degree of public control is good in itself as reflecting the ultimate values of a free society"…we do not regard such a freedom as a privilege, but rather as a necessary condition for the proper discharge of the higher education function as we conceive them.

But freedom in this context is a complex concept and in order to see exactly where it is, and is not compatible with the claims of order, it is necessary to examine (16) various components: freedom of appointment, freedom to determine curricula and standards, freedom of admissions, freedom to determine the balance between teaching and research, and the freedom to determine the shape of development. (2)

"We are convinced also that such freedom is a necessary condition of the highest efficiency and the proper progress of academic institutions, and that encroachments upon their liberty in the supposed interest of greater efficiency would in fact diminish their efficiency and stability in their development".

The basic assumption is that the freedom to pursue science for its own sake is fundamental to creation of knowledge through peer review and the scientific method. This is the first priority.

The concept that science should be instrumental to serve the needs of society is a later development in the PR of the research institutions in order not to break the long ties with society as being indifferent. The mission of the Academy with "particular responsibility for academically-based and industry-driven basic research" (3) (Royal Swedish Academy), curiosity driven research and basic research all motivated by the initiative of an individual researcher or research group. Basic research is of public concern and has to be financed by it

in order to maintain its objectivity and not by earmarked missions either by the state or by the private sector.

` For scientific research to flourish, academic freedom is fundamental. We will try to relate to a number of features and factors that make academic freedom operate. The field of economics uses the term "perfect competition", which described a market structure where in theory it reaches its highest level when a number of factors are playing a role in the world of basic research

2. Free market competition in the field of scientific research.

In the theory of economics there are three fundamental assumptions that are underlying a free market competition to operate:

(a) Full information

(b) Small competing units

(c) Mobility

I truly believe that the field of scientific research is the closest living sector in society to the economic theory of "perfect competition" far more than any other sector in the real market.

We will try to relate to each factor separately and "borrow" the factors from the economic theory into the field of scientific research.

(a) Full information.

"Full information" and open science, when scientific research and its data and sources are open to all inquiring individuals and institution. It includes publishing in books, journals and lectures in public. The form of publishing can differ in different fields of inquiry. We would like to borrow some of the assumptions of perfect competition to the world of basic research. There are partial similarities in a number of key features in the theoretical framework of the theory of perfect competition. The concept of research competition means different things to individual researchers, departments, institution and provinces of countries. Individuals can excel in their research in a low quality environment, department, institution and state.

Increased competition in research funds appears to be encouraging potentially valuable and needed differentiation of the university system, in which certain universities focus on performing nationally relevant basic research and other universities focus on research critical to welfare of their societies. The efforts of comparing and measuring the research activities are being done through basically two paths:

The first one – the measurement of the expenditure on R research and D development between units, universities and states. The second path – through citation indexes, quantity and impact and all its variations. This should be followed by three basic questions:

1) How much is being allocated;
2) To whom it is being allocated?
3) How is it allocated?

To me the most important question among the three in the field of research is How. I will turn to this issue later in my paper.

(b) Small units – the individual investigated.

A central ambiguity that is underlying in the discussion in the context is what is the unit of analysis. Is the purpose of the state to improve research competitiveness of the individual investigator or team, or of individual research universities, or of an individual area.

There are a number of key participants in the competition in the field of research: The individual researcher; the team; the department; the field; the institution. The most important among them is the individual researcher. The most commonly mentioned reason for pursuing research was the creation of new knowledge. When asked what they looked for in grant proposals, federal research administrators were virtually unanimous in agreement that creative ideas are number one. (4) Another important factor is the university:

"…the academic research system may be described as follows: Universities are multiproduct firms that offer a mix of outputs – undergraduate education, graduate education, and research. In addition to their own internally generated resources, universities compete for externally supplied research inputs by offering differentiated research proposals and complementary goods (e.g., facilities, equipment, reputation). Universities compete for recognition, prestige, and current resources based on the quantity and quality of their outputs which are not easily

measured, leading at times to the use of input measures (e.g., R&D expenditures) as a proxy for both. The production function for academic outputs – that is, the relationship between the quantity and quality of inputs and the quantity and quality of outputs – is not well specified.

(5) Schumpeter's theory of creative destruction offers an alternative perspective within which to view these possible scenarios. Research – the search for new knowledge or applications – is a continuous process of creative destruction that constantly redefines the value of existing theories, data, techniques, and equipment. The ability of established institutions to maintain their positions over long periods of time does not imply that they possess the most creative researchers, or distinct quantities or combinations of critical factors at a point in time. Rather, they have internalized the capacities to identify emerging research areas, to attract a continuing flow of resources, and to use these resources in ways that contribute to continued intellectual leadership over time.

Competition in R&D is the driving force of research and the individual researchers are the fundamental determinants of the advancement and transfer of scientific knowledge – they are the ones who generate the ideas, write the grant proposals and conduct the research. Individual researchers devote years to their training, often tolerating relatively meager salaries during the first years of their careers and considerable tension in the pursuit of their career to get tenure and be well established in their field. The most important issue is, in my view, the competition for ideas and discoveries based on their merit. Trying to get the best results that will stand up against peer review and criticism. Full information is also called open science. In the past scientists wanted to profit from their discoveries and had to prove ownership when they were prepared to make a claim on it. Newton and Leibniz had both claims of priority in discovering the calculus. Today, with the introduction of all the modern methods and techniques of dissemination of information, the term "publish and parish" has become more visible. Many researchers are engaged in collaboration with researchers close to their area in other countries and institutions. Cooperation has increased significantly.

(c) Mobility.

Mobility: Allowing free mobility of ideas, researchers and groups, allowing short term adjustments and long ones to charging of research discoveries and findings at the forefront of research. The number of researchers is large enough and with their scientific findings are incapable of monopolizing as the only truth. There are enough scientists who will be on the watch to reexamine the findings. So no single researcher has the power to set the rules of the hypothesis and its results. There is no gathering of an interest group as a professional trade union on the pure basis of scientific research. There are no legal regulations preventing flow of ideas, exchange of views and there are no boundaries as a result of state intervention. The atmosphere is of fruitful collaboration in search for understanding the world around us, past, present and future.

3. Some evidence: the relation between scientific excellence and "free market" in research

Scientific systems that maintain characteristics of "full information" of publications as well as small units mostly individually investigated motivated by his curiosity and complete mobility of researchers and ideas is, in the long run, bound to perform far better than scientific systems which are lacking one of those features. Is there any evidence for this claim? Yes, there is. I will bring two central examples.

The first one from small leading western countries who have been at the forefront of the scientific research for decades: Sweden, Denmark, Finland and Switzerland.

The second is in the USA – the most prominent scientific country. Here we have an excellent case where a top down decision for creating a proper scientific infrastructure can impose states within the USA who have been lacking the preconditions for high quality research.

This was an act of the National Science Foundation (N.S.F.) as a result of congressional pressure.

(6) The Swedish case study

The report published by the Royal Swedish Academy of Sciences, which examined various national efforts in the number of small countries: "Akademirapport" Fostering breakthrough research: A comparative study", Gunnar Öquist och Matto Benner, Dec. 2012. Later some highlights from The Royal Swedish Academy of Sciences published a position paper named "Research Policy Platform", 2012, which relates to the issue of national research policy. The Academy's effort in this publication was to deal with its modern concept of promoting science on the one hand strengthening its influence on society on the other hand. Some extracts from the report:

(6) "1. Primary message

The Royal Swedish Academy of Science's aim is that Sweden's research policies will promote scientific research's overarching need for

- objectivity and expertise
- long-term thinking
- freedom in the choice of issues, methods and forms of communication
- cooperation and mobility in accordance with the needs of research and without regard for national borders, ethnic origin, gender, or other circumstances of no relevance to science
- guaranteed and substantial space for basic research

The position of the Academy research policy rests on the two mainstays that form the Academy's mission statement: *to promote the sciences and strengthen their influence in society.* On the one hand, this means that scientific research must be assured of the time, resources and autonomy necessary for achieving reliable and useful results. On the other hand, it must actively seek out channels for both the societal dissemination of its results and for the mutual exchange of scientific results and information with interested, and potentially interested, parties outside academia. The Academy plays an active role as an independent actor in promoting the balanced development of both these aspects of the scientific task. The Academy works to encourage decision-makers to respect the need for this balance and to ensure it has a solid empirical basis for its research policy measures."

The Royal Swedish Academy of Sciences (KVA) decided to carry out a comparative analysis of research systems in Sweden, Denmark, Finland and Switzerland "to identify differences as that may explain why **this country is performing less well at quality level**"

(7). "This makes it extremely worrying if Sweden's competitiveness weakens in terms of breakthrough research" (8). **The report argues very clearly that the research institution should redefine its mission and focus on the research function.** "It must be taken seriously if **Sweden is to remain a research nation in the top division**. Reorienting Swedish research in a **more pioneering direction must build on a strong emphasis on academic excellence, with corrective measures at various levels" (9)**.

The corrective measures should be the focus of the universities on research first. There should be **a shift from internal funding by the universities to external funding for supporting individual researchers**. All the measures that were recommended by the report (10) stress the following points:

"strengthening the quality of Swedish research"

"reinforcing national funding of individuals"

"leaders with strong academic identities"

"funding that permits long-term research"

"peer review for regulated quality control" and it goes on…

In contrast "The international impact of Danish research has clearly grown…it is evident that policy changes have contributed to this positive development" (11)

(12) Until the 1980s, Danish research was loosely organized and on a small scale. While some areas and environments (such as theoretical physics and biophysics) were internationally renowned and operated in well-organised structures, quality was arguably more variable elsewhere. The institutional structure of Danish research, too, was modes in scale and this has changed over the last 20 years. The Swedish report even uses the term "Danish Miracle". This was a result of a long term adoption of formal and informal support and the creation of a better atmosphere by: research funding; setting policy priorities; reforming universities to strengthen academic leadership. All these measures have brought Denmark to perform better than

Sweden. "Today, Sweden exceeds the world average for the most highly cited publication…by 15%, while the figures for Denmark and the Netherlands are 35% (12).

The Swedish practice in the last twenty years, as it appears from this report has responded to market forces and relations to industry and social needs for more funds from external sources has gradually become part of the research in universities. It had also increased the amount of funding from internal sources and thus the quality of the academic research has gradually receded to the extent that the Royal Swedish Academy of Sciences decided to publish this report. However, in Denmark science has become more competitive and the state has increased the level of funding for pure scientific research based on full information, small units, i.e., individual researchers and mobility of researchers and ideas. This has ended up in the long run to turn Denmark into a "**Danish miracle**"! as the reports claim.

- EPSCoR – National Science Foundation Established Program to Stimulate Competitite Research.

The National Science foundation Act of 1950 states that "it shall be an objective of the Foundation to strengthen science and engineering research potential - - - and avoid undue concentration of such research and education, respectively". Over time, however, the nation's S & E efforts became concentrated geographically, focusing primarily on a limited number of major research universities.

In response to congressional concerns the NSF initiated this program in order "to stimulate competitive research in regions of the country that were less able to compete successfully for research funds". The regions were states such as Alaska, Nevada, Kentucky, etc. This was established in 1978 and has been going on since then. In 2015 three states "graduated" from the program after becoming scientifically strong. Over the years the NSF has evaluated this program and found that when you employ a scientific atmosphere with proper infrastructure where competition and resources is based on full information, individual

researchers and mobility, you then have states that become strong scientifically and "graduate" from this program.

The changing orientation of the states toward support for research universities is reflected in the evolution of the strategies employed by the EPSCoR program to achieve its principal objective: "stimulation of sustainable improvements in the quality of the academic science and technology (S&T) infrastructure of eligible states to improve their ability to participate in competitive research programs."

Based on reports from this initiative the "research suggests that the EPSCoR states are making progress in terms of traditional measures of individual-researcher success (proposals, awards, articles, etc.). Individuals have graduated from EPSCoR and remained in the EPSCoR states. In absolute terms, the EPSCoR state can show progress at the individual-investigator level.

Those involved with state EPSCoR programs believe that there has been progress on these institutional improvement and government policy fonts also". 11p---158 (13)

4. Back to basics: The mission of the research university in modern society

It has certainly become very difficult to operate when on the one hand there are market and social forces calling the universities to be relevant to the need of society and, on the other hand, to maintain its prime mission for teaching and research. This is also accompanied with sometimes a hostile atmosphere towards the sector of higher education, as we see.

The discussion as to the role of science in society is an ongoing one. In a proceeding of a workshop held in June 2017 published in the NAS:

(p. 1) The keynote address on February 28 was given by **Shawn Otto**, co-founder and producer of the U.S. Presidential Science Debates and author of The War on Science. "There seems to be an erosion of the standing and understanding of science and engineering among the public," Otto said. "People seem much more inclined to reject facts and evidence today than in the recent past. Why could that be?" Otto began exploring that question after the candidates in the 2008 presidential election declined an invitation to debate science–driven policy issues and instead chose to debate faith and values.

"Wherever the people are well-informed, they can be trusted with their own government", wrote Thomas Jefferson. Now, some 240 years later, science is so complex that it is difficult even for scientists and engineers to understand the science outside of their particular fields. Otto argued, "The question is, are people still well-enough informed to be trusted with their own government? Of the 535 members of Congress, only 11 – less than 2 percent – have a professional background in science or engineering. By contrast, 218 – 41 percent – are lawyers. And lawyers approach a problem in a fundamentally different way than a scientist or engineer. An attorney will research both sides of a question, but only so that he or she can argue against the position that they do not support. A scientist will approach the question differently, not starting with a foregone conclusion and arguing towards it, but

examining both sides of the evidence and trying to make a fair assessment." (14) According to Otto, anti-science positions are now acceptable in public discourse, in Congress, state legislatures and city councils, in popular culture, and in presidential politics. Discounting factually incorrect statements does not necessarily reshape public opinion in the way some trust it to. What is driving this change?

This is also connected to the changes in the funding of higher education. The pace of technology development has also changed dramatically. The share in the U.S. for federal support for R & D came from public sources. Now, two thirds of the funding comes from the private sector.

The role of the modern university.

The concept of the role of the modern research university has changed. The universities are expected to be sensitive to the needs of society in terms of students' access and market needs for qualified people. Universities are evaluated and assessed not on research quality alone, but rather on what the knowledge that they generate can contribute to economic and educational processes.

Patenting by universities themselves, however, has continued to expand in importance. Another spur to the economically oriented developments of the 1980s was the Bayh-Dole Act of 1981, which gave universities the right to patent inventions made under federal grants, and thus opened a new avenue for collaboration with industry, as well as paving the way for faculty to spin off their own businesses. Technology transfer offices became commonplace on university campuses, and the patent and ethics issues that seemed acutely painful in the early 1980s had, by the end the decade, been smoothed over with standard procedures.

(15) It is, however, abundantly clear that such a one-dimensional concept of performance for a research-active university is a thing of the past. New performance concepts are being

developed. A key element of the emerging consensus is that there is no one set of performance specifications that applies to institutions of higher education. For those institutions, the essential message of the 1990s is: Define your mission in a distinctive way.

The vague and to some extent new missions expected from universities as we see, is scarce. However,

(16) "Perceptions of the appropriate objectives have become politically contentious, especially for publicly funded programs. As a result of these pressures, "we get very mixed – if not totally divergent – signals," another university administrator reported. Legislators "tell us that we need to quit doing so much research and spend more time in the classroom, [but when they] want to brag, they point to specific research accomplishments or a distinguished faculty. They don't really recognize that advising graduate students is teaching, and that you cannot have research faculty teaching for undergraduate courses and expect them to bring in a lot of research dollars."

It will be impossible to go back in history and expect the research universities to commit themselves solely for the conduct of research. There should be a differentiation among the various institutions in relation to their focus on their mission. As we see from the Swedish experiments the fact that there was a change of focus and of the way staff and students have been recruited toward a more teaching and social oriented from a research oriented has resulted in loss of quality to a worrying degree.

There are two paths of competition: the first is an intellectual one and the second is financial. As to the first one – the search for knowledge and its integrity that emerges from research is based on individual and collective adherence to core values of objectivity, honesty, openness, fairness, accountability and stewardship. The research enterprise is a complex system that includes universities and other institutions that educate, employ and train researchers: the federal, foundation, and industrial sponsors of research science and

engineering. In a report published by the NAS "optimizing the nation investment in academic research: regulatory framework for the 21st century", 2017, the committee's view was that:

(17) Continuing expansion of the federal regulatory system and its ever-growing requirements are diminishing the effectiveness of the nation's research investment by directing investigators' time away from research and training toward overlapping and incongruent administrative matters that do not take into consideration the environment under which research is conducted at academic institutions today.

(18) "If there is a single factor that stands foremost in the enhancement of research competitiveness, it would be institutional commitment. External programs for aiding research competitiveness bring little permanent improvement unless the institution itself is consciously dedicated to this goal. The era has also passed when a university might grow into greater research competitiveness simply by hiring research-active faculty: Such a commitment should be manifested in administrative leadership, planning documents, and research administration".

Increased research competition is better provided in institutions where flexibility within departments' teams, equipment and scientific staff are more common. From the point of view of the individual researcher the bottom up approach is the heart of the academic activities. His research has to be motivated by his will and not by top down decision of interest groups, government, etc.

The individual investigator who competes for external funding in a fully mobile and fully informed environment is the heart of the process. The Swedish evaluation paper and the NSF case studies show that there should be a focus on the main goal and that it cannot be achieved instantly. For research to show signals of quality changes takes years. Politicians and sometimes heads of higher education systems have short periods in their appointments to see the changes. The question is what is the share of the goal of research, teaching, market forces, needs of society, etc. within an institution. One focus in this paper was mainly to evaluate the

relation between research and quality. Thus, institutions that gradually dilute the research effort tend also gradually to lose its mission as a research institute.

The closer a scientific research entity is operating within the characteristics of the free market theory, the better are the chances to reach better scientific and high quality research.

The next stage will be to form a quantitative index for the evaluation of scientific quality that will be based on the principles that were discussed in this paper.

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תקציר

המושג הצטיינות מדעית נעשה מקובל יותר ויותר בשנים האחרונות. הקמתם של מרכזי הצטיינות, מוקדי מחקר, פיתוח כלים למדידה, השוואות בין תחומים ובין מוסדות, הם היום עניין שבשגרה.

הנחות היסוד המקובלות בקהילה המדעית של חופש אקדמי, פרסום, ניידות, תחרות חופשית על משאבים, הם מרכיבים חשובים בקידומה של הצטיינות זו.

האם ניתן למצוא קשר בין קיומם של הנחות אלה והצטיינות מדעית ואם כן האם ניתן להראות ולו באופן חלקי דוגמאות מעשיות. מאמר זה דן בשאלות אלו בצד המדעי.

במהלך תקופה ארוכה של למעלה מארבעה עשורים התרכזה עבודתי במערכת ההשכלה הגבוהה והמחקר המדעי בבניית כלים למטרה זו. דוגמאות בולטות למשל: החל במודל התיקצוב בות"ת, הקרן הלאומית למדע, קרן ביכורה, מלגאי אדמס קאוולי, האקדמיה הצעירה, כולם ביחד פעלו על בסיס ההנחות והעקרונות שציינתי.

העבודה נעשתה בסיועו של המכון ללימודים מתקדמים באופסאללה שבדיה,

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