Self-Amplified Research: A Sustainable Avalanche?

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Abstract

We elaborate briefly on the tacit metamorphosis of scientific research evolving from the contemplative, curiosity driven phase into the industrial, profit-driven phase. It appears that the involved positive feedback mechanisms render the current, postmodern research system an exponentially bursting complex object, persistently expanding further in a self-locked, 'confined to grow' setting. This current, highly effective research system involving millions of scientists worldwide is generally considered as a paramount success story, so there is not much internal driving force emerging towards the critical, multilateral investigation and assessment of long-term research dynamics. Here we discuss some emergent, potentially menacing consequences, including inflation-instabilities and complexity related systemic risks of the current, self-amplified research trends. Our hope is to raise attention and initiate interdisciplinary calls on these covert, yet crucial issues, in order to keep our research system genuinely sustainable, enabling science to serve the peace and well-being of humankind further.

Keywords: sustainability, self-amplified research, critical complexity, complexity meltdown, posthuman science

The metamorphosis of science

The world of science keeps expanding enormously, flooding us with the shiniest results, with the plethora of breakthroughs on a daily basis. We truly witness an unprecedented scientific boom, sustaining an exponentially inflating world [1-3], in which science got strongly intertwined with world economy, forming self-amplified, cross-profiting alliance.

In the past centuries science underwent a tacit metamorphosis. A few centuries ago, in the “artistic”, contemplative phase, the emphasis was on the individual, curiosity driven discovery of the surrounding world and scientific activity was pursued mainly by individuals. Mainly either by aristocrats, or people in courts, in service of noblemen. The question of material, financial gain did not arise that much, for the activity was mainly driven by inner interest, or by curiosity only. Furthermore, the direction of research was chosen spontaneously, so the flow of research could change like directions fluctuate in a random walk. One can call this as a curiosity-driven, artistic phase, with uncoupled, unbiased, freely meandering research directions (Fig. 1).

By today, the scenario has dramatically changed. There are several millions scientists working in a highly interwoven network of research institutes worldwide grouped up in large teams. In the framework of excellence programs billions of Euros are allocated to pursue profiting traits [4]: Mars-program, Human Genome Project, Brain-research programs, Big Data, LHC, just a few flagship calls to mention. Also, privately funded, megalithic research centers (Google, Apple, Tesla, etc.) rapidly expand and thrive these days. There is also the flaming burst of IT business and a plethora of concomitant profitable applications dramatically changing our everyday lives: the internet, smart-phones, smart-glasses, smart-watches, and an unfathomable avalanche of even supersmart-devices yet to come (augmented and virtual reality devices). There is no question that this modern, globalized research is a different phase of scientific activity. It is an industrialized phase, it became an economy/profit driven business, together with a proposal industry: just think how much time one has to spend on proposal writing to stay in the race, in order to create more implicit and/or explicit profit [5].

Modern research has indeed become inherently inseparable from world economy: they define and mutually depend on each other. Many even call our globalized system as a knowledge/science based society, but by the same token one could call it as a profit-based research, or profit-based world society. The total scientific output seems to scale with the invested amount of money, and a positive-feedback, an exponential growth sets in. Furthermore, unlike in the artistic, curiosity driven unbiased science phase, research directions are now strongly biased by profit-maximization. Definitely, this is an entirely new, industrial research phase, one could coin it as *Self-Amplified Research (SAR)*. It got strongly coupled to world economy, thus the supported research directions have become strongly biased, rectified by the involved funding aspects of profit maximization [6, 7] (Fig. 1).

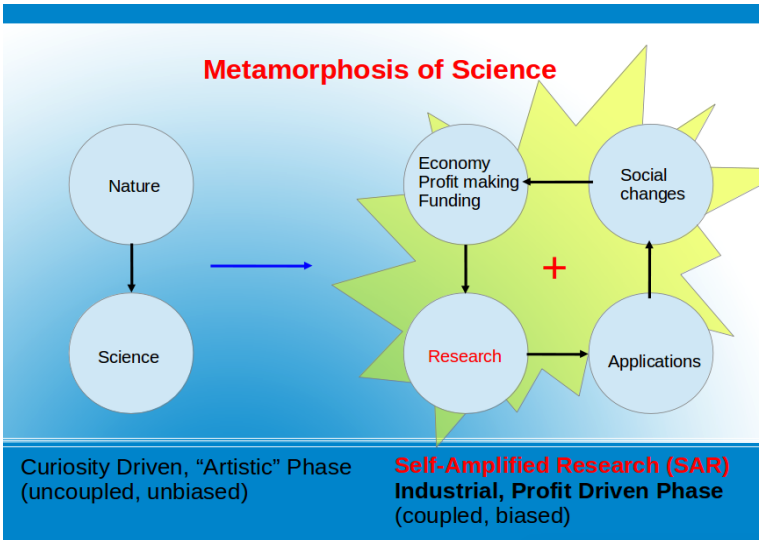

Fig. 1. The world of science has undergone a silent metamorphosis. From the curiosity driven, unbiased, uncoupled phase it tacitly transformed itself into a profit-driven, industrial, coupled and biased phase, coined as Self-Amplified-Research (SAR).

A sustainable avalanche?

As the direct footprint of the unfolding enormous scientific expansion, we witness a bursting multitude of scientific journals, the number of which exceeding 10.000, with several millions of published papers yearly therein. The doubling time in the number of publications is estimated to be 15-20 years [3, 8, 9]. Besides, new publishing styles emerge dynamically (e. g. Open Access Publishing), and also radically new, time effective forms of publications are on the horizon (e. g. nanopublications [10]). In this proliferating maze of research journals, there seems to be an interesting, rather robust, hierarchal scaling relation among the journal impact factors, indicating that scientific journals might form an interacting and co-evolving, self-organized superstructure [3, 11].

In the process of SAR, science became inherently inseparable of the economic, financial aspects, constituting a techno-capitalistic world alliance. As one has to justify the allocated financial resources in terms of scientific impact, scientometry has also undergone a tremendous development [12]. The excessive use of impact factors and indexes leads to an unrelenting *citation rush* and also to a further industrialization of science, stifling some of the healthy fluctuations by the prevailing publish or perish effect, i. e. by the compulsive publication and *compulsive research* habits [6, 13]. Furthermore, in such an intensive race for success driven funding, negative research results are found to be negatively biased or unpublished [14]. Along these profit-driven, compulsive research traits, together with the gradually increasing number of standardized, business type regulations the scientific freedom might get remarkably reduced [6, 7]. Based on these, it seems that such overdriven scientometric indexing systems might become counter-productive in an overall sense, many papers are discussing recently the related ambiguous trends [7,15-20].

There are numerous studies and papers pointing out that this current SAR dynamics makes the "rich richer" and the "poor poorer" (Matthew-effect [21, 22]), inducing inherent segregation trends. The

much celebrated excellence programs and flagship calls [4] actually serve as effective, mediating measures to make the hot fields hotter, and the cool cooler, contributing to an overall a Red Queen effect [23]. The emergence of such giga-projects and related “flash-fundings” leads to the appearance of star scientists and at the same time produces extensive masses of scientific shadow workers living in uncertainty and fighting for their daily survival [6, 13, 24]. On the exhibited industrial scales, the public justification of the scientific results might as well get apparently aided by the public relations (PR) activity of the respective projects and project leaders [6]. This way, above certain grant sizes, it seems that no real failure is possible, as “too big to fail” effects might come into play, closing the positive-feedback loop of SAR. Having recognized the potential inertial ineffectiveness of these over-scaled top-bottom approaches, Ref. [25] suggests the breaking of this research paradigm by introducing bottom-top approaches.

The short term, individual-hedonistic excitement (of solving problems), together with some related, “intoxication of scientific power” effects seem to override/hinder the thoughtful consideration of some possibly long term, collective and non-local discontents/instabilities [26-29]. Thus, one can indeed observe a *symmetry breaking effect* taking place between the short and long term research dynamics, in which the short term “wins and decides”, but only for the short run [30]. The concomitant deliric, self-amplified search for the hottest topics is very similar to pouring oil onto a burning house to make it even hotter, for its own sake of a bigger excitement, then to locate and study the hottest possible spot, only to make it even hotter: *“Science pour la science”*. Based on this, SAR, being inseparably intertwined with world economy seems to create an *excitable social world medium* in which perturbations/activities would not get attenuated, but rather, get amplified for the sake of short term excitement. Ulrich Beck and his coworkers elaborate on similar effects operating in world society in their concept of *reflexive modernization* in which “modernity has begun to modernize its own foundations...It has become directed at itself” [31].

As of dramatic social consequences, one can think of the pervasive internet, augmented and virtual reality (VR) devices, ranging from everyday smart phones, google-glass, oculus rift, VR-playstations, etc. Furthermore, it is not any more a too far fetching idea to think of brain prostheses, or brain chips, which could connect most humans into a fully synchronized, profit making super-organism. Such an advance might as well forecast the possibility of brain hacking, or global digital dependence. In a related study, “Einstein's nightmare”, Featherstone analyzes the severe or even devastating psychosocial consequences of such smart, VR devices [32]. Besides digital dependence, another potentially menacing, pervasive feature of the global techno-capitalistic endeavor can be the rise of robots, which can replace human jobs, creating a potential source of massive, worldwide unemployment [24, 33-35].

Besides its apparent, glamorous successes, the GDP-based inflational growth of world economy poses some potentially very severe problems as well. As a complex system, there are inherent, systemic risks encoded in the growth, expansion process itself [26, 27, 29]. We can allude to it by the following line of analogies: A stone is stable while lying on the ground, corresponding to the state of static stability. An airplane can fly stable with a constant speed, manifesting a case of dynamic stability. However, the techno-capitalistic world economy seems to be stable only at a constant acceleration/growth rate, which we can coin as the case of *inflational stability*. If the inflation rate drops, a tough, pervasive crises might set in. There are now several institutes, research centers and foundations worldwide to raise awareness of the emergent, anthropogenic global problems, posing even systemic, existential risks: Centre for the Study of Existential Risk – Cambridge; Future of Humanity Institute – Oxford; Financial Crisis Observatory – Zürich, just to mention a few. Beyond raising global awareness, through their own research projects and think tanks, these centers also try to find solutions towards global sustainability,

by increasing the world society's resilience.

These are all relevant and important efforts, but one can ask the following question. How long can this exponential inflation be maintained, while its complexity is rapidly increasing? One might think that the prevailing exponential growth forms actually an avalanche which we wish to sustain further: *a sustainable avalanche*. Due to the *inflational stability*, it seems that SAR got dynamically locked, confined into an exponential growth process [3].

Beside the genuine, curiosity driven scientific interest, which was born together with the scientific thinking and still remained one of the main driving forces of science, financial interest in the profit-driven research phase (SAR) became as well a determining, trend-setting factor operating behind scientific growth. And finally, as science grew large and acquired an enormous concentration of socio-economic might via SAR effects, *a dreadful intoxication of power, and a self-assuring illusion of control* also appear as emergent, inertial motifs driving SAR further.

Critical complexity, complexity meltdown?

It seems that the prevailing epistemology of scientific research renders an inherent branching structure to its perpetual growth: from one scientific problem which gets solved, by hook or crook, science usually creates two or even more problems. This indeed leads to the prolific growth of new branches of science, together with the aforementioned, bursting explosion of new scientific journals, flooded by a plethora papers, leading to a perverted scientific hyper-competition [36] and enormous publication pressures [13, 24].

The accumulative, bifurcation nature of science inherently leads to an enormous, self-amplifying complexity production, one calls it even a *"complexity time bomb"* [29]. Just consider the exponentially growing number of scientific papers/journals dumped by the publication industry. These trends, implicitly and explicitly make our everyday life more complex as well. It is enough to think of the plethora of smart gadgets, leading to a potential global digital dependency, as many people are getting hooked on them unnoticed. Concomitantly, our urban lifestyles got remarkably accelerated [37] and now we witness a machine based dehumanization and alienation on a massive scale as well [29, 38, 39]. We can certainly say that with such a globally pervasive progress of self-amplified research (SAR), the coherent, overall simplicity of everyday life got irreversibly lost. Unwillingly, the over-civilized Western world society pushed itself to the brinks of coherence, potentially even approaching a globally coupled, self-organized critical state, which might function basically at the edge of chaos and order, exhibiting enormous fluctuations and related crises.

Modern science produces not only an enormous dose of complexity, but at the same time, by surpassing a threshold of *critical complexity*, further, emerging (hyper)structures might come alive as well. Superintelligence is knocking at our doors, or rather, slipping in under, unnoticed? Leading scientists have formulated serious concerns regarding the emergence and controllability of superintelligence [40, 41], yet it seems that raising awareness alone does not change the prevailing traits towards realizing it. Some scientists talk even about a technological singularity [42], which is not surprising at all in the light of the above sketched complexity producing self-amplifying research (SAR) scenario.

But one ponders where such an enormous complexity factory can lead us to? Can it be, just like the supporting frame of a burning house that it melts down at some point? This would constitute a *complexity meltdown*. We have already witnessed the menacing signs of similar processes in world economy, during the global economic crises, including the latest one which began in 2007.

In line with the unfathomable science-economic development, we witness a dramatic transformation of the psychosocial norms as well. Almost 70 years ago the famous psycho-sociologist, Erich Fromm discussed the automated, conform lifestyles and the related alienation and dehumanization trends in the developed capitalistic countries [38]. And by today these trends got amplified so much [29] that even awareness is almost being lost about such tacit, elusive psychosocial problems. In her recent book "Alone together", in a highly elaborate, analytic approach Sherry Turkle discusses the role of technology in the process of human alienation and in the concomitant formation of the lonely crowd [39].

Throughout human history, there has never occurred such an unprecedented density of humans interconnected so effectively in a global sense with such technologically advanced networks as manifesting these days. Our world society today constitute a highly organized, very complex social phase, exhibiting sometimes large fluctuations, crises, but also very high levels of coherence. Due to the encoded, inherent segregation effects, one can think that many people will perform very simple, fully automated tasks, while some will have very individualized, complex duties [29]. Such social structure, which might emerge in a strongly connected, globally synchronized complex society, resembles a Bose-Einstein condensate in quantum mechanical systems and also in complex networks [43, 44].

Posthuman science?

In the light of the above, it is no science fiction any more to think of an emergent, microscopically conform, micromanaged and globally synchronized, profit-knowledge-based (digital?) world society [29, 44]. Then, only a few questions would remain regarding some small, non-scientific details. Can such a society be considered as human? Does it matter at all? And actually. Can science itself be pursued *without* fallible, inaccurate humans? Is *posthuman science* possible at all? And if so, what would that mean? And to whom?

But anyhow, the most important trait of SAR seems to be the further development of the *sustainable avalanche* itself, i. e. the construction of a faultless, *postmodern pyramid of science*, which might prevail long after humans. Maybe in this grandiose pursuit one should not waste valuable proposal and publication writing time on thinking of such "marginal", ambiguous questions regarding the human aspects [45].

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