Overhyped and concentrated investments in research funding are leading to unsustainable science bubbles.

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David Budtz Pedersen *examines how the scientific market exhibits bubble behaviour similar to that of financial markets. Taking as an example the overwhelming investments in neuroscience, such high expectations may actually drain the research system from resources and new ideas. In the end the permanent competition for funding and the lack of 'risk diversification', might generate a climate in which citizens and policymakers lose their confidence in science as they did with the financial sector after the 2008 crash.*

Much like the trade and traits of bubbles in financial markets, similar bubbles can appear on the scientific market. When economic bubbles burst, the drop in prices causes the crash of unsustainable investments leading to an investor confidence crisis possibly followed by a financial panic. But when bubbles appear in science, truth and reliability are the first victims.

No one with even a passing interest in science and technology has failed to notice the past decade's massive investments in a select handful of new research fields. Research in neuroscience, graphene, artificial intelligence or big data, to mention a few, have attracted massive investments as well as tremendous expectations. Universities and research laboratories have geared their research strategies towards attracting money from investment-seeking foundations and research councils. This has led to the creation of a bubble-hospitable environment in which scientists and investors drive expectations to the level of unrealistic promises instead of sound assessment and scientific judgement.

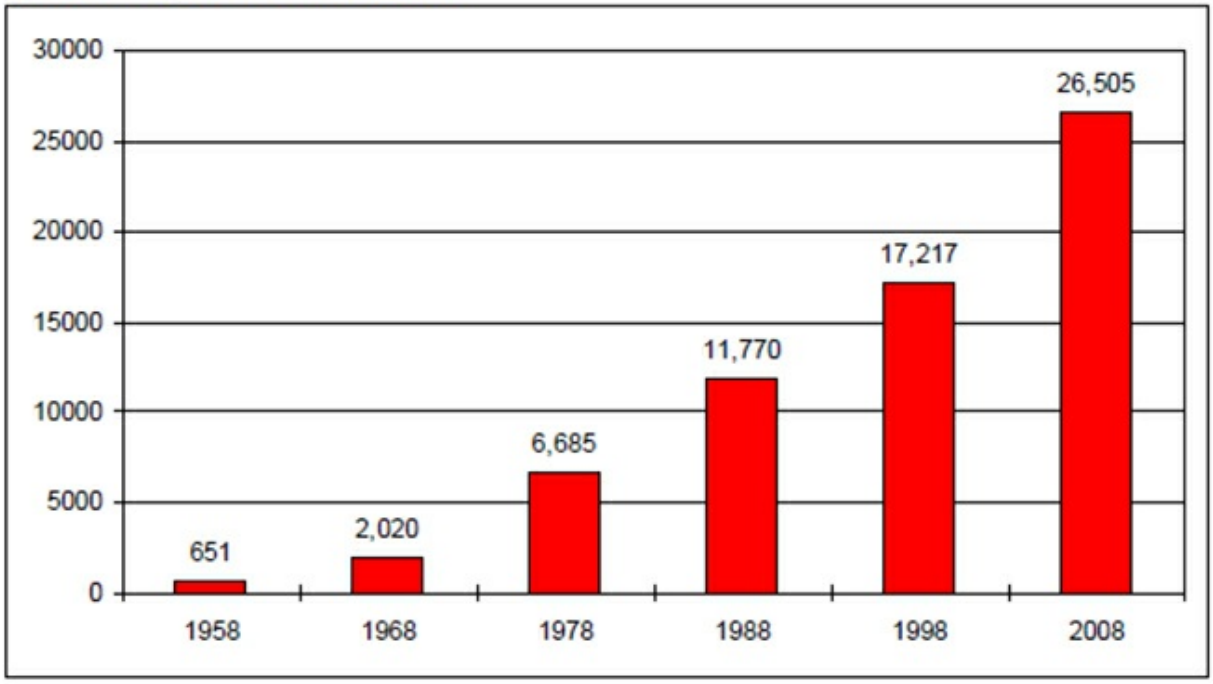
Reflection in a bubble. Image credit: Brocken Inaglory (Wikimedia, CC BY-SA 3.0)

In wake of the financial crisis, there have been many suggestions as to why bubbles occur. One seemingly paradoxical theory suggests that too much liquidity is actually poisonous rather than beneficial for a financial market. As suggested by the former president of the German Federal Bank, Axel A. Weber, "the past has shown that an

overly generous provision of liquidity in global financial markets in connection with a very low level of interest rates promotes the formation of asset-price bubbles". In a recent research paper published in Philosophy and Technology we demonstrate how bubbles are equally identifiable in research funding. If there are too many research grants chasing too few research areas, together with a socio-psychological environment in which researchers are incentivized to streamline their research, you get a cocktail where fashions and hype may damage scientific truth and explanation.

In the paper, we examine a number of science bubbles. A potential science bubble is the overwhelming investments in neuroscience. Neuroimaging, for example, is one among several research areas that is driven by a strong economics of scientific promise. Regularly, research papers report that fundamental advancements in the neurosciences (including neuropsychology, neurolinguistics, and computational psychology) will provide a better foundation for important disciplines of the social sciences (such as sociology, anthropology, economics, political science, and ethics) as well as some fields of the humanities, including history, literary studies, communication, legal studies, and religious studies.

Figure 2. The growth of neuroscience



Numbers of papers published annually in the neurosciences 1958 – 2008 (source: Web of Science).

This narrative – one of highlighting the explanatory priority of neuroscience within domains originally studied by other disciplines – has been around for at least a decade, but is now getting serious. The European Commission, for example, has decided to invest almost 1 billion Euros in the Human Brain Project to build a "supercomputer replica of the human brain". In the United States, President Obama has endorsed the $1-billion Brain Activity Map Project.

Supplying policymakers and funding agencies with extraordinary promises and expectations has become an effective strategy when attracting funding and resources. However, very few tools are available for actually determining how these megaprojects will turn out. It is like an investor predicting the market. Whether or not the expectations will be realized, research funding is framed with expectations that new scientific projects will lead to greater explanatory power and eventually translate into jobs and growth.

The generous provision of funding for a select group of research areas creates the first condition for a science bubble to propagate. Add to this the second condition for bubbles to come into existence: the presence of speculators. Both researchers and managers of research laboratories hedge their bets by supporting research strategies that follow the current fashions, publication channels, and funding streams.

This situation resembles a number of well-documented phenomena in social psychology and behavioural economics called “pluralistic ignorance” and “bystander effects” which have been shown to have significant impact on information processing and bubble behaviour. Pluralistic ignorance essentially means subscribing collectively to a norm that one privately rejects. It is a collective state of mind, which does not necessarily mirror the stance of any singular agent, but every agent wrongly believes that everybody else believes – exactly like the case of The Emperor’s New Clothes. Pluralistic ignorance occurs when no one asks what the real epistemic merits are. Every scientist and policymaker may individually doubt the merits or promises of a certain research programme but simultaneously wrongly believe that everybody else are convinced of its robustness so they collectively subscribe to the research promises (for instance, by providing research grants or rewarding citation performance).

Overly optimistic investments and concentration of too much liquidity on too few research paradigms may eventually risk creating science bubbles – that will drain the research system from resources and new ideas. This problem is not confined to epistemological quandaries. In the end the lack of incentives to produce negative results and the permanent competition for funding and resources, might eventually generate a climate in which citizens and policymakers lose their confidence in science as they did with the financial sector after the 2008 crash.

For example, concerns have recently been raised about the lack of reproducibility studies in science. Various researchers have uttered criticism that some of the most widely cited experiments within their field cannot be systematically replicated. For instance, in 2012 researchers at an American pharmaceutical company tried to replicate 53 studies that they considered landmarks in cancer research, in many instances cooperating with the original researchers to ensure consistency. According to a paper published in Nature, the researchers were able to reproduce the original results in only six out of 53 instances (the study was later cited by The Economist). Similarly, a study reported in Nature Reviews Drug Discovery showed that researchers could only reproduce published results in a quarter of 67 studies.

In neuroscience, a growing number of scientists, psychologists and philosophers have begun to raise concerns about the explanatory ambitions and research designs. A recent study adds to these woes, suggesting that a wide range of neuroscience studies lack statistical power to back their findings. In a paper published in Nature Reviews Neuroscience, Kate Button and her colleagues reviewed the statistical power of studies – defined as the function of sample size, significance of effects, and positive predictive value – published in renowned neuroscience journals. The investigators found that, on average, studies detect a genuine effect only about 20 per cent of the time. The review concluded that many of the published findings might not be reliable in several important respects, leading to overestimating effect size and explanatory significance.

None of these surveys support the general conclusion that neuroscience has particularly grubby motives. But science policy in general and funding instruments in particular need to be very well designed in order to attain the desirable outcome. In order to promote scientific progress, scientists should not all be doing the same thing or working on the same set of theories or research programmes. Borrowing a term from finance, “risk diversification” in science implies that different researchers and different research teams are given incentives to pursue different theories. The situation of a scientist is not unlike the one of a financial investor trying to invest money in different asserts. Finding a true, adequate or correct hypothesis involves some degree of risk, i.e. the risk of failure and being wrong.

Conversely, when scientists are competing for resources at ever more diverse levels they are incentivized – intentionally or unintentionally – to pursue the same research questions and inflate the explanatory merits of their research programmes. In such situations, a strategic game is being played in which being first is more important than going in the right direction. Science is normally taken to be a highly rationalized practice. However, with the

regulatory principles that are currently being installed in scientific institutions, science may begin to exhibit bubble behaviour identifiable from the same principles that are governing the financial markets.

This piece is a shorter version of the research paper Science Bubbles published in Philosophy & Technology (November 2013) by David Budtz Pedersen, Vincent F. Hendricks. Read the full paper here: http://link.springer.com/article/10.1007/s13347-013-0142-7

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