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# RETHINK FUNDING

The way we pay for science does not  
encourage the best results

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WITH MILLIONS OF SCIENTIFIC PAPERS published every year and more than \$2 trillion invested annually in research and development, scientists make plenty of progress. But could we do better? There is increasing evidence that some of the ways we conduct, evaluate, report and disseminate research are miserably ineffective. A series of papers in 2014 in the *Lancet*, for instance, estimated that 85 percent of investment in biomedical research is wasted. Many other disciplines have similar problems. Here are some of the ways our reward and incentives systems fail and some proposals for fixing the problems.

### We Fund Too Few Scientists

Funding is largely concentrated in the hands of a few investigators. There are many talented scientists, and major success is largely the result of luck, as well as hard work. The investigators currently enjoying huge funding are not necessarily genuine superstars; they may simply be the best connected.

#### Solutions:

- Use a lottery to decide which grant applications to fund (perhaps after they pass a basic review). This scheme would eliminate the arduous effort and expenditure that now goes into reviewing proposals and would give a chance to many more investigators.
- A proposed cap to the maximum funding that any single investigator can receive was fiercely shot down by the prestigious institutions that gain the most from this overconcentration. Shifting the funds from senior people to younger researchers, perhaps even in the same laboratory, however, would not affect these institutions and would also make the cohort of principal investigators more open to innovation.

### We Do Not Reward Transparency

Many scientific protocols, analysis methods, computational processes and data are opaque. When researchers try to crack open these black boxes, they often discover that many top findings cannot be reproduced. That is the case for two out of three top psychology papers, one out of three top papers in experimental economics and more than 75 percent of top papers identifying new cancer drug targets. Most important, scientists are not rewarded for sharing their techniques. These good scientific citizenship activities take substantial effort. In competitive environments, many scientists even think, Why offer ammunition to competitors? Why share?

#### Solutions:

- Create better infrastructure for enabling transparency, openness and sharing.
- Make transparency a prerequisite for funding.
- Universities and research institutes could preferentially hire, promote or tenure those who are champions of transparency.

### We Do Not Encourage Replication

Under continuous pressure to deliver new discoveries, researchers in many fields have little incentive and plenty of counterincentives to try replicating results of previous studies. Yet replication is an indispensable centerpiece of the scientific method. Without it, we run the risk of flooding scientific journals with false information that never gets corrected.

#### Solutions:

- Funding agencies must pay for replication studies.
- Scientists' advancement should be based not only on their discoveries but also on their replication track record.

### We Do Not Fund Young Investigators

The average age of biomedical scientists receiving their first substantial grant is 46 and is increasing over time. The average age for a full professor in the U.S. is 55 and growing. Only 1.6 percent of funding in the NIH's Research Project Grant program went to principal investigators younger than 36 in 2017, but 13.2 percent went to those 66 and older. Similar aging is seen in other sciences, and it is not explained simply by life-expectancy improvement. Werner Heisenberg, Albert Einstein, Paul Dirac and Wolfgang Pauli made their top contributions in their mid-20s. Imagine telling them it would be another 25 years before they could receive funding. Some of the best minds may quit rather than wait.

#### Solutions:

- A larger proportion of funding should be earmarked for young investigators.
- Universities should try to shift the aging distribution of their faculty by hiring more young investigators.

## We Use Biased Funding Sources

Most funding for research and development in the U.S. comes not from the government but from private, for-profit sources, raising unavoidable conflicts of interest and pressure to deliver results favorable to the sponsor. Clinical trials funded by the pharmaceutical industry, for instance, have 27 percent higher odds of reaching favorable results than publicly funded trials. Some of the sponsors are improbable champions of scientific truth. For example, Philip Morris (the manufacturer of Marlboro cigarettes) recently announced it would contribute \$960 million over 12 years to establish the Foundation for a Smoke Free World, a nonprofit initiative that aims to eliminate smoking. Disclosure of conflicts of interest has improved in many fields, but in-depth detective work suggests that it is still far from complete.

### Solutions:

- Restrict or even ban funding that has overt conflicts of interest. Journals should not accept research with such conflicts.
- For less conspicuous conflicts, at a minimum ensure transparent and thorough disclosure.

## We Fund the Wrong Fields

Much like Mafia clans, some fields and families of ideas have traditionally been more powerful. Well-funded fields attract more scientists to work for them, which increases their lobbying reach, fueling a vicious circle. Some entrenched fields absorb enormous funding even though they have clearly demonstrated limited yield or uncorrectable flaws. Further investment in them is futile.

### Solutions:

- Independent, impartial assessment of output is necessary for lavishly funded fields.
- More funds should be earmarked for new fields and fields that are high risk.
- Researchers should be encouraged to switch fields, whereas currently they are incentivized to focus in one area.

## We Do Not Spend Enough

In many countries, public funding has stagnated and is under increasing threat from contesting budget items. The budget for U.S. military spending (\$886 billion) is 24 times the budget of the NIH (\$37 billion). The value of a single soccer team such as Manchester United (\$4.1 billion) is larger than the annual research budget of any university. Investment in science benefits society at large, yet attempts to convince the public often make matters worse when otherwise well-intentioned science leaders promise the impossible, such as promptly eliminating all cancer or Alzheimer's disease. When these promises do not deliver, support for science can flag.

### Solutions:

- We need to communicate how science funding is used by making the process of science clearer, including the number of scientists it takes to make major accomplishments. Universities, science museums and science journalism can help get this message out.
- We would also make a more convincing case for science if we could show that we do work hard on improving how we run it.

## We Reward Big Spenders

Hiring, promotion and tenure decisions primarily rest on a researcher's ability to secure high levels of funding. But the expense of a project does not necessarily correlate with its importance. Such reward structures select mostly for politically savvy managers who know how to absorb money.

### Solutions:

- We should reward scientists for high-quality work, reproducibility and social value rather than for securing funding.
- Excellent research can be done with little to no funding other than protected time. Institutions should provide this time and respect scientists who can do great work without wasting tons of money.

## We Do Not Fund High-Risk Ideas

Review panels, even when they are made up of excellent scientists, are allergic to risky ideas. The pressure that taxpayer money be "well spent" leads government funders to back projects most likely to pay off with a positive result, even if riskier projects might lead to more important, but less assured, advances. Industry also avoids investing in high-risk projects, waiting for start-ups to try (and often fail with) out-of-the-box ideas. As a result, nine out of the 10 largest pharmaceutical companies spend more on marketing than on R&D. Public funding agencies contend that they cherish "innovation" when they judge grant applications. This is nonsense. Innovation is extremely difficult, if not impossible, to predict in advance. Any idea that survives the scrutiny of 20 people reviewing it (the typical NIH study section) has little chance of being truly disruptive or innovative. It must be mainstream, if not plain mediocre, to be accepted by everyone.

### Solutions:

- Fund excellent scientists rather than projects and give them freedom to pursue research avenues as they see fit. Some institutions such as Howard Hughes Medical Institute already use this model with success.
- Communicate to the public and policy makers that science is a cumulative investment. Of 1,000 projects, 999 may fail, and we cannot know which one will succeed ahead of time. We must judge success on the total agenda, not a single experiment or result.

## We Lack Good Data

There is relatively limited evidence about which scientific practices work best. We need more research on research ("meta-research") to understand how to best perform, evaluate, review, disseminate and reward science.

### Solution:

- We should invest in studying how to get the best science and how to choose and reward the best scientists. We should not trust opinion (including my own) without evidence.