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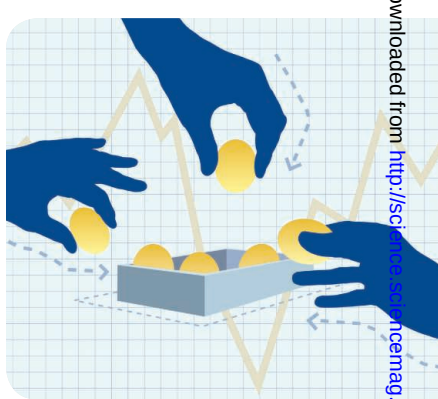
Investing in Distant Rewards

WOULD YOU SPEND MONEY TODAY TO MAKE THE WORLD A SUBSTANTIALLY BETTER PLACE FOR YOUR children and grandchildren? Most of us would. But what if the benefit would accrue only to your great-great-great-great-grandchildren, not born until the 22nd century? That's an awfully distant time horizon for most people. Many would probably spend today's resources on more immediate concerns.

Economists model this preference as a "social discount rate," a form of reverse compound interest that assesses future benefits or catastrophes as exponentially less important than immediate ones. Mathematical arguments favor this model over several alternatives. But when applied to the question "How much should we spend today on basic science research?", the model often gives the answer "Not much!" This is because the returns from basic research, although possibly large, can be quite distant. Reverse compound interest thus knocks out the returns. But, I argue here, exponential discounting is both mathematically and practically inappropriate when applied to basic science. Also, importantly, the public appears to know instinctively why it does not apply.



In its broad range, from useful incremental advances to world-changing discoveries, scientific research exhibits what statisticians call a "heavy-tailed" probability distribution. Such distributions have the property that more important events are only mildly less probable, a so-called power law. A consequence is that rare events can have truly huge magnitudes, in comparison to typical ones. The discovery of penicillin was no typical incremental advance, and the confluence of fundamental discoveries in quantum mechanics and atomic structure that led to modern electronics was surely world-changing. Yet both occurred in a single century. Science's heavy tail allows us to expect even greater future discoveries, even though we can't predict when they will occur. (Less grand but more easily quantified surrogate statistics such as research publication or patent citation frequencies are also heavy-tailed.)

How should the rational investor think about investing in a heavy-tailed opportunity? It is mathematically unlike any conventional investment with a knowable annual return on investment. Formally, the return is divergent in that the longer you make continuous investments, the greater will be your effective return. Invest long enough, and your return will eventually overtake any doubter's exponential discount, thus justifying your patient investment. The mathematical opposite of "gambler's ruin"—losing everything on a run of bad luck—heavy-tailed investments exhibit "patient investor's bounty," in which one stays in the game to reap large, rare returns.

The U.S. public appears to understand this concept intuitively, without needing the formalism of mathematical arguments. The evidence is indirect but convincing. Polls show that in the United States, the public ranks science as one of the most prestigious occupations, along with firefighters, doctors, nurses, teachers, and military officers.* Thus, science is in the company of professions whose benefit to people is immediate. Yet, when I ask nonscientists about the benefits of science, few give answers that imply the short time horizons that motivate most economic activity. They like science because, among other things, it can lead to longer, healthier lives; protect the planet and feed humanity; and channel and empower the natural idealism of young people; and it satisfies a basic human need to understand the world.

The public recognizes science as having long-term, often idealistic, goals, yet accords scientists a level of respect otherwise reserved for "immediate helper" occupations. The combination suggests an instinctive understanding of heavy-tailed distributions and the patient investor's bounty. Put differently, the public realizes that the beauty and benefits of science are inseparable as a single long-term enterprise. Elected public officials worldwide would do well to listen to this particular wisdom of crowds. **– William H. Press**

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*www.harrisinteractive.com/vault/Harris-Interactive-Poll-Research-Pres-Occupations-2009-08.pdf.

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