

EconOmics

Far from defending government spending on genomics as an economic stimulus, we celebrate this landmark contribution to our strategic intelligence on the evolving threats to our health, well-being and life on this planet.

US federal spending on the Human Genome Project and on subsequent genomics research from 1990 to the end of 2012 totaled some \$12.3 billion (\$14.5 billion in 2012 dollars), making the Human Genome Project one of the largest scientific endeavors ever funded. It has been a success by economic criteria alone, according to the 2011 study *Economic Impact of the Human Genome Project* from the Battelle Memorial Institute Technology Partnership Practice (http://battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf), updated in June 2013 for United for Medical Research (UMR). The updated report casts the project economically as a stimulus investment that helped industry make a 65-fold return on public money and resulted in 310,000 jobs (over 4.3 million job years, each corresponding to one person employed for one year). The project even returned in taxes many times the tax dollars it cost.

Of course, we cannot repeat the experiment without federal funds, and it may well be that purely private genomics efforts could have advanced the field with comparable economic and scientific outputs in the same time. However, by setting and guaranteeing priorities for a sustained period of time, US funders secured excellent use of both public and private contributions. Casting genomic research as a government priority sent the message that the genome is a public good, that scientific findings were accountable to US taxpayers and that private investment in genomics would be accompanied by vigorous discussion of rules for participation in the new knowledge. Federal participation sanctioned international cooperation between countries as well as individual scientists and corporations.

But to see the Human Genome Project just as an investment or a public good is to underestimate its value in gathering strategic intelligence on evolving threats that actually do kill most of us (including genetic lesions and mismatches between our evolving genome and those of food sources and pathogens, as well as the environment). Generating intelligence, the total cost for the unprecedented 23-year period of the Human Genome Project compares admirably to the 2012 US national and military intelligence budget of some \$75 billion (<http://www.washingtontimes.com/news/2012/oct/30/us-intel-budget-topped-75-billion-in-2012/>), which aims to tackle largely manmade threats of known provenance, low complexity and primitive motivation. In contrast, the previously unknown territory genomics describes is of unexpected complexity and universality. The technology the Human Genome Project has already enabled offers insights into environmental sustainability and contributes to food security, public health, international security and justice.

In summary, we support analysis of the economic benefit of funding science through both public and private sources. In the history of science and medicine, the gains are all too readily absorbed, and the need for continued research is underestimated. We agree with the motivation for the US STAR METRICS initiative (<https://www.starmetrics.nih.gov/>), encouraging more scientific thinking about the benefits of science funding. Economic analysis, scientific analysis, transparency and accountability all have their places in keeping up the pressure to favor paying for knowledge over remaining ignorant. But let us not get lost in these accounting exercises and end up thinking too small. The choice is to fund science or be unprepared for the future. ■