The Impact of Genomics on the U.S. Economy

Federal research investment has contributed to medical science, improved public health, created American jobs and helped generate nearly $1 trillion in economic impacts to date

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About United for Medical Research

United for Medical Research represents leading research institutions, patient and health advocates and private industry, joined together to seek steady increases in federal funding for the National Institutes of Health. The coalition groups consist of the American Association for Cancer Research, American Cancer Society Cancer Action Network, American Diabetes Association, American Heart Association, Association of American Universities, Association of Public and Land Grant Universities, BD, Biotechnology Industry Organization, Boston University, Corning, FasterCures, Harvard University, Johns Hopkins University, Life Technologies, Massachusetts Institute of Technology, Melanoma Research Alliance, Northwestern University, Pancreatic Cancer Action Network, Partners Healthcare, PhRMA, Research!America, Stanford University, The Endocrine Society, Thermo Fisher Scientific, University of Pennsylvania, University of Southern California, Vanderbilt University, and Washington University in St. Louis.

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The sequencing of the human genome represents the largest single undertaking in the history of biological science and stands as a signature scientific achievement. Scientists, clinicians, researchers and technologists are using the reference genome, the knowledge of genome structure and the data resulting from the Human Genome Project (HGP) as the foundation for advancements in medicine, science and technological development.

The HGP has had a profound positive effect, not only in human health and medicine, but also in fields as diverse as: renewable energy development, food and agriculture, veterinary medicine, industrial biotechnology, environmental protection, justice and national security.

The reference human genome is to biology what the periodic table is to chemistry: a fundamental platform for understanding and advancing science for generations.

Battelle, with the support of United for Medical Research (UMR), updated our estimate of the U.S. economic impacts still resonating from the federal investment in the HGP. This analysis updates, through 2012, some of the data originally presented in the May 2011 impact study.[1] Using input/output analysis, Battelle measured the effects that the HGP, follow-on HGP-related federal investments and the growing U.S. genomics-enabled industry have had on our nation's economy. The detailed analysis produced four overarching conclusions:

1. ***The economic impacts generated by the sequencing of the human genome are large and widespread.***

   Between 1988 and 2012, the human genome sequencing projects, associated research and industry activity—directly and indirectly—generated an economic (output) impact of $965 billion, personal income exceeding $293 billion and more than 4.3 million job-years of employment.

2. ***Federal investment in the genomic revolution has contributed to a total economic output of nearly $1 trillion.***

   The federal government invested $3.8 billion in the HGP through its completion in 2003 ($5.4 billion in 2012$) and followed that investment with an additional $8.5 billion ($9.1 billion in 2012$) in HGP-related direct research and funding support.

   Looking only at HGP funding as the initial input, these genomics activities yield a leverage ratio on the U.S. economy of 178:1. Considering all federal investment in HGP-related genomics activities through 2012 still yields a leverage ratio of 65 to 1 – every $ of federal HGP and related investment has helped contribute to the generation of an additional $65 in the U.S. economy.

   The 24-year U.S. federal investment in HGP-related genomics research amounts to $2 per year for each U.S. resident, helping to generate nearly $1 trillion in economic output as well as transformational changes in medicine.

3. ***The growth of genetics and genomics science and applications in the U.S. has been a true public-private partnership, with private sector entities supporting and benefiting from federal research and generating significant tax revenues.***

   The genomics-enabled industry sector generated and stimulated nearly $3.9 billion in federal taxes and $2.1 billion in U.S. state and local taxes in 2012. Thus in one year, revenues returned to governments equaled the entire 13-year investment in the HGP.

2012 Economic Impacts

In 2012 alone, the research, development, and commercial activities that continue to leverage the federal investment in the human genome sequencing projects directly and indirectly generated:

- ***$65 billion in U.S. economic output***
- ***$31 billion toward 2012 U.S. GDP***
- ***152,000 genomics and supplier jobs and supporting more than 125,000 additional jobs in the economy***
- ***$19 billion in total personal income***

Cumulative Economic Impacts

Between 1988 and 2012, the research, development, and commercial activities that continue to leverage the federal investment in the human genome sequencing projects directly and indirectly generated (in 2012 $):

- ***Nearly $1 trillion in total economic impacts since 1988***
- ***More than 4.3 million job-years of total supported employment***
- ***$54.8 billion in tax revenues from the genomics sector and its suppliers***

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[1] For the original study please see, "Economic Impact of the Human Genome Project", Battelle, May 2011. http://battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf.

4. ***The broad and functional impacts of the human genome sequencing are just beginning to be realized.***

   The HGP is arguably the single most influential investment to have been made in modern science and a foundation for progress in the biological sciences moving forward. Large scale benefits in human medicine and many other diverse applications are still in their early stages. Yet, examples already exist of patients seeing life altering benefits – via genomics-enabled diagnostics, targeted therapies and dosages and improved survivability and quality of life.

Update Analysis – Impact Assessment Data Tables

Economic Impact of Human Genome Sequencing, 2012 (Dollars in Millions, 2012)

Impact	Employment	Personal Income	Value Added	Output	State/Local Tax Revenue	Federal Tax Revenue
Direct Effect	53,594	$5,885.6	$9,246.2	$24,538.0	$321.3	$1,180.9
Indirect Impacts	98,720	$7,089.3	$11,005.4	$21,649.6	$758.8	$1,419.7
Induced Impacts	125,047	$5,881.3	$10,441.4	$18,717.2	$1,042.6	$1,272.6
Total Impact	277,361	$18,856.2	$30,692.9	$64,904.8	$2,122.7	$3,873.1
Impact Multiplier	5.18	3.20	3.32	2.65		

Source: Battelle data analysis and estimations; IMPLAN U.S. Economic Impact Model

Cumulative Economic Impact of Human Genome Sequencing, 1988–2012 (Dollars in Millions, 2012)

Impact	Employment (Job Years)	Personal Income	Value Added	Output	State/Local Tax Revenue	Federal Tax Revenue
Direct Effect	780,665	$86,656.6	$116,738.6	$333,401.8	$4,259.7	$16,100.9
Indirect Impacts	1,504,671	$107,760.5	$170,397.3	$320,525.8	$12,742.5	$21,682.9
Induced Impacts	2,066,137	$98,310.0	$174,552.3	$311,696.1	$17,805.3	$21,146.0
Total Impact	4,351,472	$292,727.1	$461,688.2	$965,623.6	$34,807.6	$58,929.7
Impact Multiplier	5.57	3.38	3.95	2.90		

Source: Battelle data analysis and estimations; IMPLAN U.S. Economic Impact Models

Recent Private Sector Employment in the Genomics-Enabled U.S. Industry

Genomics Sector	Estimated Genomics "Sector" Employment				
	2008	2009	2010	2011	2012
Bioinformatics	1,120	1,102	1,175	1,084	1,142
Genetic, Genomic & Related Testing	4,087	6,095	6,349	6,083	6,230
Genomic Biologics & Diagnostic Substances	6,879	6,837	6,865	6,144	6,331
Genomic Instruments & Equipment	16,017	14,851	16,274	15,930	15,662
Genomics R&D/Biotech	11,433	11,305	9,352	8,669	9,324
Drugs & Pharmaceutical Genomics R&D*	7,009	6,825	8,712	8,486	8,611
Total Impact	46,545	47,015	48,727	46,396	47,300

Source: Battelle data estimations; Note: overall drug & pharmaceutical genomics-related R&D and employment were conservatively estimated.

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Update Analysis – Methodology Notes

The overall approach and methodology for this update are essentially the same as the original study released in May 2011. However, due to improvements in data availability and data quality from some sources, methodology adjustments were made. These adjustments are briefly described below. Please see the original study for a complete understanding of the underlying methodology.

Due to the intense interest in these data, as part of our update process we reexamined the full analytical approach to assess areas of potential improvement. Given the nature of the expanding impacts from the initial HGP efforts, we focused attention on the last five years (2008-2012) which account for 35% of the cumulative 24-year impacts. This period was also important given the impacts of the Great Recession—many of which did not present themselves in the data and economic impact models until after 2010.

With this reexamination and data update certain data series were updated, enhanced and in the case of the CPI data used for inflation adjustment of the federal HGP investment, revised.

- **Updated, enhanced, and corrected corporate employment data.** Due to the intense merger and acquisition (M&A) activities in this sector in recent years the decision was made to attempt to improve the corporate employment data for the last five years as it was being updated for the last two. This caused overall data changes. First, it became apparent that there were certain lags in the M&A-based employment changes stemming from the Dun & Bradstreet establishment-level data. To the best of our ability these lags were corrected in this update. Second, some changes in an establishment's "genomics sector" occurred as M&A activities took place, and in a number of cases establishments were moved out of the genomics sector if warranted. Third, extra attention was paid to the larger firms to better understand both M&A activities, as well as overall growth in the U.S. and abroad with data enhanced through examinations of 10-K filings. We conservatively estimated U.S. employment when required.
- **Updated and more specific NIH "genomics" R&D data.** The NIH's funding activities data tool, RePORT, has undergone continued updating and improvements both in ease of use and more importantly in data granularity and ability to summarize by institute and funding mechanism since the original HGP Impact report. To better describe the total NIH "post-HGP" investment in genomics and, importantly, to specifically designate "research" funds flowing to non-corporate entities these RePORT enhancements were used to update and specify the NIH R&D funding for the 2004 – 2012 period. In some instances this decreased the amount of NIH "genomics" R&D funding, in others it increased. As in the previous report, R&D funds flowing to corporate entities were not included in the "research" modeling as those impacts are captured in the corporate employment data.
- **Updated pharmaceutical R&D data.** The base data used to represent and estimate pharmaceutical R&D, and ultimately the genomics share of pharmaceutical R&D, comes from the National Science Foundation (NSF). Over the past few years, NSF has updated and improved its industrial R&D survey now called the Business R&D and Innovation Survey (BRDIS). With this new instrument the figures for overall pharmaceutical R&D (NAICS 3254) have been re-estimated using these new data.
- **Modeling cumulative impacts.** It was apparent in the process of developing this update that the methodology for calculating cumulative impacts by the three modeling components – federal "genomics" R&D, non-drugs & pharmaceuticals corporate "genomics" employment, and pharmaceutical "genomics" R&D (as a proxy for the biopharmaceutical industry involvement in genomics research, and hence employment) was potentially leading to a less than conservative assessment of the indirect and induced effects. For this update these components were modeled simultaneously, and hence are more conservative in nature.
- **CPI Data.** The series used to convert the federal HGP investments into 2010 dollars was revised and includes adjustments from the U.S. Bureau of Labor Statistics to convert the federal HGP investments into 2012 dollars. This process reduced the "current" value of the 1988-2003 federal HGP investments used in the original report.
- **Updated IMPLAN models.** The original study used the 2009 U.S. IMPLAN model for all years analyzed (1988 – 2010) as it was both the most recent available, and was developed differently than prior years' IMPLAN models (2009 was developed using Version 3.0 of the IMPLAN model and software). The updated approach used the same 2009 model (adjusted for inflation) for the historical values stemming from the years 1988 to 2009. The 2010 IMPLAN model was now used for the 2010 data. The 2011 model (the most current available) was used for the 2011 and 2012 data.