Measuring Short- and Long-Term Impacts of S&E Activity

Many of the indicators included in this thematic report represent S&E activities that cannot be measured monetarily. This sidebar provides an overview of the kinds of analyses that are used to assess economic impact across a variety of metrics, including their strengths and limitations. Overall, patenting in aggregate has great economic value, but an individual patent may go unused and thus have its value unrealized. Open-source software is a substitute for purchased software, but its value cannot be captured neatly by looking at total revenues from sales or licensing. The value of a trademark depends on the revenue its use can generate. The economic value of each of these activities may not be realized until long after they are created, adding to the difficulty in assessing their impact. Short-term impacts are those that can be estimated at the time spending takes place, whereas long-term impacts take time for their impact to manifest.

Some S&E indicators, like the number of employed S&E professionals and their levels of income, intrinsically measure the economic impact of S&E activity. Other indicators, such as R&D expenditures, can be used as inputs to estimate economic impacts. There are ways to estimate short- and long-term economic impacts. Economic impact analysis with multipliers, as described below, is the most common way to estimate short-term economic impacts. Econometric methods, which use model-based statistical analysis of large data sets, are most frequently used for long-term analysis.

Economic impact analysis using multipliers is a well-established approach to measuring short-term impacts on economic activity. *Multipliers* are economic ratios that show an average historical relationship between spending and related economic activity. In the United States, industry- and location-level input-output data from the Bureau of Economic Analysis are used to develop ratios that estimate a *multiplier effect*, which considers subsequent rounds of spending that take place when purchases are made. For example, the purchase of consulting services leads to further rounds of spending as the consulting firm hires workers, rents offices, and purchases goods and services. When consumer spending associated with the wages paid is added to the estimated effect, the multiplier increases further. If the multiplier for an activity is estimated to be 1.2, then $100 of spending would generate $120 of activity.

Economic impact analyses using payroll data from research universities or other organizations can show the number of workers employed and wages directly supported by grants or other funding sources. These analyses can show (1) the direct effect of spending and associated jobs, (2) the supply chain effect from consuming the output of other industries, and (3) the effect of employee spending in the economy.

A 2023 economic impact study for the National Aeronautics and Space Administration (NASA) used this approach to estimate economic impacts of NASA activities for 50 states and the District of Columbia (PCI Productions 2024). Using industry-level multipliers, the report estimated that NASA paid $3.5 billion in wages in 2023 and generated an additional $23.3 billion in purchases (procurement). NASA's Moon to Mars program is estimated to account for 33% of these total impacts. Using industry-level employment multipliers, the report estimates that each full-time equivalent job at a NASA facility supports 16 additional jobs (PCI Productions 2024).

A limitation of this kind of model is that it estimates impacts of public investment with the same ratios as it does for impacts of private investment. For some types of economic activity, this may not be appropriate. Counterfactual analysis is a further step in evaluating whether public expenditure is more efficient than private investment in generating the relevant technology. This method compares with a baseline of what activity would exist without the public investment and is particularly useful when investment is intended to produce outcomes that the private sector cannot entirely appropriate (Link and Scott 2012).

When private returns to an investor are different from returns to the public at large, these differences can be measured as *spillovers*, which can be positive (beneficial) or negative (costly). The creation of new and sharable knowledge can be the source of positive spillovers as firms take advantage of knowledge created by other firms or by other institutions (Griliches 1991). Over the long run, knowledge creation increases the quantity of output that can be created through increased productivity, which in turn leads to growth in average living standards (Solow 1956). *Multifactor productivity*—aggregate economic benefits in excess of cost after removing the effects of capital and labor—is an indicator calculated with economic data that can be used to estimate these long-run effects. Long-term multifactor productivity effects can be calculated in two ways: (1) an econometric method that attributes all excess returns as due to innovation, and (2) assuming a rate of return to innovation similar to that of other investments (Hall 2011).

The proximate cause of these long-term effects can be hard to pin down. The framework used by the Congressional Budget Office accounts for five factors that influence the timing and size of impact. These are the timing of outlays, how outlays are financed, how much they affect productivity, how quickly they affect productivity, and how state and local governments respond (Gullo et al. 2025). Based on the results of decades of productivity analysis and reasonable assumptions, Gullo and coauthors (2025) conclude that federal R&D increases the benefit of private R&D.

Just how big is this benefit? A broadly applicable method by Jones and Summers (2020) estimates the average economic return from different types of innovation investments, finding that $1 in R&D investment creates between approximately $5 and $10 in economy-wide benefits, with a likely delay of 3–6 years. The exact amount of these benefits depends on the type of investment and the amount of time for impact to take place, with the impact of basic research taking longer to realize returns and having greater uncertainty than experimental development.