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The Returns to Publicly Funded R&D: A Study of U.S. Federally Funded Research and Development Centers

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Annals of Science and Technology Policy

Published, sold and distributed by:
now Publishers Inc.
PO Box 1024
Hanover, MA 02339
United States
Tel. +1-781-985-4510
www.nowpublishers.com
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Outside North America:
now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

The preferred citation for this publication is

J. A. Cunningham and A. N. Link. *The Returns to Publicly Funded R&D: A Study of U.S. Federally Funded Research and Development Centers*. Annals of Science and Technology Policy, vol. 6, no. 3, pp. 228–314, 2022.

ISBN: 978-1-68083-945-6

Annals of Science and Technology Policy
Volume 6, Issue 3, 2022

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Annals of Science and Technology Policy, 2022, Volume 6, 4 issues. ISSN paper version 2475-1820. ISSN online version 2475-1812. Also available as a combined paper and online subscription.

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The Returns to Publicly Funded R&D: A Study of U.S. Federally Funded Research and Development Centers

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ABSTRACT

There is an ongoing policy debate across many countries about the returns to investments in publicly funded R&D. However, much of that debate is based on conjecture rather than empirical facts. Unlike the literature that focuses on the returns to investments in privately funded R&D activity, empirical estimates of the returns to publicly funded R&D are limited.

This monograph focuses on one group of public sector organizations that is not only R&D intensive but also that has the potential to enrich economic growth and development in the United States; namely, Federally Funded Research and Development Centers (FFRDCs). Herein, the limited literature on the returns to public sector returns to R&D is reviewed, this legislative history of FFRDCs is presented, and the social benefits associated with FFRDC research

James A. Cunningham and Albert N. Link (2022), "The Returns to Publicly Funded R&D: A Study of U.S. Federally Funded Research and Development Centers", Annals of Science and Technology Policy: Vol. 6, No. 3, pp 228–314. DOI: 10.1561/110.00000023.

are evaluated. The monograph concludes with policy recommendations about the direction for future research on the returns to publicly funded R&D.

1

Introduction

There is an ongoing policy debate across many countries about the rate of return of publicly funded R&D. The COVID-19 pandemic has heightened the awareness and visibility in society as to the value of investing in public research and development (R&D). Heretofore, such returns on public R&D from a societal perspective have been less visible. Furthermore, when it comes to allocating public R&D policymakers are favoring more mission-oriented public innovation policies (Kattel and Mazzucato, 2018; Janssen *et al.*, 2021).

There is a rich literature related to estimates of the returns to aggregate and private investments in R&D activity (Del Bo, 2016; Hall *et al.*, 2010; Maroto *et al.*, 2016). The genesis of the U.S-based literature traces, in part, to an academic and policy response to the so-called productivity slowdown in the United States in the early-1970s and then again in the mid-1970s and early-1980s. As Figures 1.1 and 1.2 show, aggregate economic activity in the United States slowed during these time periods. In particular, the shaded columns of periods of productivity downturn in Figure 1.1 and the periods of negative percentage changes in productivity in Figure 1.2, are most notable.

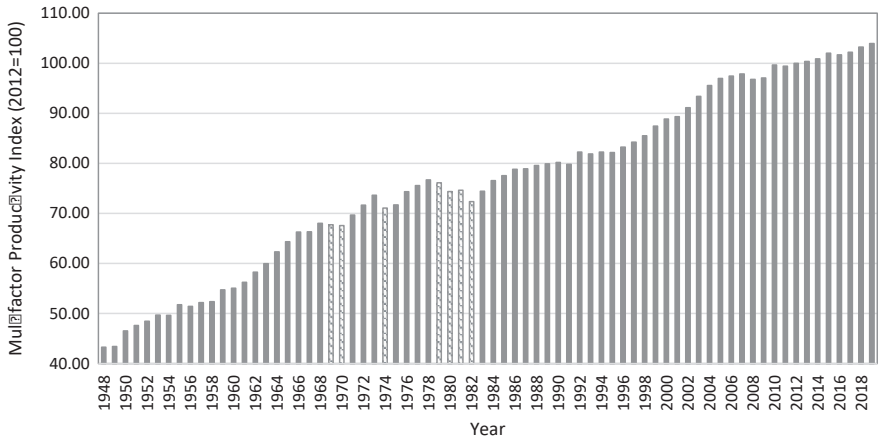

Figure 1.1: Multifactor productivity index in the private U.S. business sector (2012 = 100).

Source: http://www.bls.gov/mfp/.

The academic and policy response to the slowdown was intended, at least in part, to identify culprits associated with the productivity slowdown. As Figure 1.3 shows, aggregate investments in R&D slowed

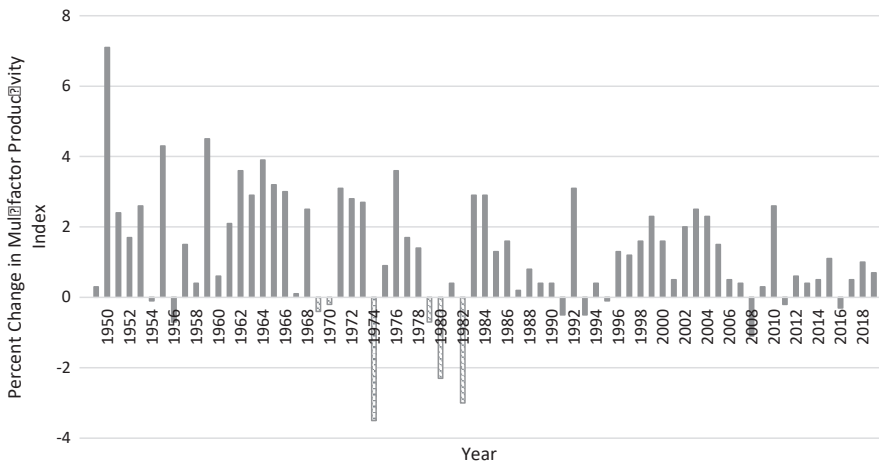

Figure 1.2: Percent change in multifactor productivity index in the private U.S. business sector.

Source: http://www.bls.gov/mfp/.

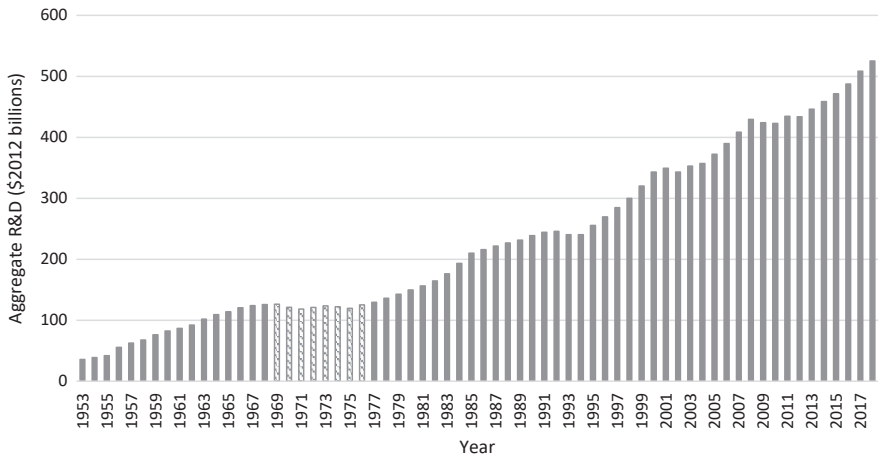

Figure 1.3: Aggregate U.S. R&D expenditures ($2012 billion).

Source: https://ncses.nsf.gov/pubs/nsf20307/#&.

prior [emphasis added] to the first period of slowdown, and thus it was logical at the time that it became one target variable for policy consideration.[1]

In addition to looking at the slowdown in aggregate investments in R&D as a possible culprit for the U.S. productivity slowdown, many academics at the time reflected on the seminal finding from Nobel Laureate Robert Solow (1957). Solow concluded from his statistical analysis of aggregate U.S. data over the period 1909 through 1949 that 87.5% of the increase in gross output per man-hour could *not* [emphasis added] be attributed to inputs to production, and it was inferred from this finding that the increase in gross output per man-hour might be due to advances in technological change. It was in the 1960s and 1970s, as it is to some extent today, not a large leap for many academic scholars and policy leaders to suggest that increases in technological change follow from increases in investments in R&D. In fact, early scholarship related to the economic impacts associated with R&D investments was pioneered through the research of Minasian (1962) and Mansfield (1965).

[1]Link and Siegel (2003) discussed other economic events that were at the time viewed as culprit antecedents to the productivity slowdowns.

Arguably, it was the research of Terleckyj (1974) and Griliches (1979) that provided a policy framework and policy emphasis on investments in R&D as a target variable. Subsequent research thus investigated R&D in association with the productivity slowdown not only in the United States but also in various other industrial countries in which there had also been a productivity slowdown, and that research focused on estimates of the overall returns to investments in R&D.

Hall *et al.* (2010) have expertly reviewed the body of literature related to the returns to investments in R&D. The majority of the econometric-based studies they reviewed focused on the returns to privately funded investments in R&D relevant to both the United States and to other industrialized countries. The focus of their review was quite appropriate because the lion's share of academic and policy studies had emphasized the economic growth enhancing role of private sector investments in R&D.

The point of departure for this paper is that the Hall *et al.* (2010) review devoted one paragraph, and some tabled references, to the literature that focused on estimating the returns to *publicly funded* [emphasis added] investments in R&D. This relatively limited coverage by Hall *et al.* should *not* [emphasis added] be interpreted to mean that an understanding of the returns to publicly funded investments in R&D is less important from an economic and policy perspective than an understanding of the returns to privately funded investments in R&D. On the contrary, their limited coverage probably reflected the paucity of econometric-based attention that had been given by researchers to the study of publicly funded R&D prior to their literature review.[2]

One possible explanation for the paucity of econometric-based attention to the returns to publicly funded R&D before the Hall *et al.* (2010) review might relate to the limited accessibility that researchers had to R&D investment data relevant to public-sector research organizations. Such data limitations appear to be common across many industrial countries, and the United States is no exception.

[2]Since the publication of the Hall *et al.* (2010) review, there have been a number of econometric-based studies of the returns to publicly funded R&D. The more recent publications that are relevant to the United States are discussed below.

The focus of this monograph is on the returns to U.S. public-sector investments in R&D, and the accompanying new empirical analysis relates specifically to the returns to public-sector R&D expenditures in U.S. Federally Funded Research and Development Centers (FFRDCs). The resulting output from such public-sector R&D that is often considered is peer-reviewed science and engineering (S&E) publications, or hereafter simply scientific publications. This so-focused empirical research facilitates the calculation of a public-sector R&D elasticity of scientific publications, and it is posited in this monograph that these elasticities are both a measure of the knowledge transfer associated with public-sector R&D as well as a measure of a dimension of the rate of return to public-sector R&D.

More detailed motivations for this monograph are discussed in the following Section 2. As noted above, one motivation for studying the rates of return to public-sector R&D is the paucity of existing literature on the topic. Thus, the empirical findings presented below do contribute to the larger and more recent body of literature. However, there are two other important motivations for studying the rates of returns to public-sector R&D: a public accountability motivation and a mandated public policy motivation.

Much of the literature on the rates of returns to R&D that was reviewed by Hall *et al.* (2010) focused on econometric-based analyses, and that focus was appropriate given the scope and audience for their review. Although the analysis of investments in R&D in FFRDCs presented herein is econometrics based, there is however a frequently overlooked program evaluation literature that also offers insight into the rates of returns to public-sector R&D. Examples of the program evaluation literature presented in Section 3 for completeness as well as to illustrate a broader rate of return concept than that presented in the econometrics-based literature.

The R&D funding in U.S. federal laboratories, in general, and FFRDC laboratories, in particular, is a direct legislative action and one that might have policy resonance if the measured rates of returns to publicly funded R&D are shown to be sufficiently low or even sufficiently high (given an appropriate definition of the word *sufficiently*). If the measured marginal returns are sufficiently low, one might question the

allocation of taxpayer dollars to public-sector R&D. If the measured marginal returns are sufficiently high, one might question why an even larger amount of taxpayer dollars has not being allocated to public-sector R&D. U.S. legislative actions to increase publicly funded R&D in support of private-sector R&D are discussed in Section 4.

For the purpose of providing context, a brief history of FFRDCs in the United States is presented in Section 5. FFRDCs have surprisingly been an overlooked element of the public-sector ecosystem that supports public-sector research. As emphasized in MITRE (2015, p. 1):

> For nearly 70 years, federally funded research and development centers, or FFRDCs, have been vital to our nation's growth and security. They have supported the government by developing transformational capabilities in defense, transportation, energy, civil agency administration, homeland security, atmospheric sciences, science policy, and other areas. Yet their existence remains largely *unknown* [emphasis added] to the average person. Even those familiar with FFRDCs may be hard-pressed to explain their history, purpose, and operation.

As also explained by MITRE (2015, p. 1):

> FFRDCs are part of a "three-legged stool" that supports government research, technology development, systems acquisition, and policy guidance. The three "legs" are commercial industry, academic and related not-for-profit organizations (including FFRDCs), and government employees. Each of these institutional players approaches problems from a somewhat different angle, and each has an important role in driving innovation and solving problems.

An empirical analysis of U.S. public-sector R&D expenditures in FFRDCs, and the associated scientific publications, is presented and discussed in Section 6.

Concluding observations about the themes discussed throughout this monograph are offered in Section 7.

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