CIMR Research Working Paper Series

Briefing Paper

Working paper No. 64

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March 29 2023

ISSN 2052-062X

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The macroeconomic effects of public expenditure in research and development

Giovanna Ciaffi[3], Matteo Deleidi[4] and Enrico Sergio Levrero[5]

Abstract

This paper investigates the impact of public R&D on economic growth and the R&D investment carried out by the private sector. By applying an econometric technique based on the Local-Projection to a dataset of 15 OECD countries considered for the 1981-2017 period, our findings show that public spending in R&D is associated with higher fiscal multipliers than those obtained for other classes of public expenditure. In addition, our results show that this specific class of public expenditure can generate spillover effects within the economic system by producing a crowding-in effect on private investment in R&D.

1. Introduction

The COVID-19 pandemic crisis and the recent energy crisis have sparked a renewed interest among academics and international institutions in a resurgence of industrial policy, conceived as direct interventions aimed at creating new markets and providing direction to economic growth (see, among others, Mazzucato, 2013; Chang and Andreoni, 2020; Pianta et al., 2020). The emphasis is mainly on the need for public investment in innovations, leading to the creation of new products and production processes, creating new firms, new industries, and new jobs and types of work (Archibugi et al., 2018). This comes after years characterised by a substantial abandonment of industrial policies and processes of market liberalisation and privatisation of many national public enterprises, combined with a drastic reduction in public investment in research and development (Pianta et al., 2020; Van Reenen, 2021). As pointed out by the International Monetary Fund (IMF), there is a need to allocate public resources to R&D activities to promote productivity and economic growth, especially as a result of the contraction of these types of investments in the last decades (IMF, 2021).

Public investments in research and development and a "mission-oriented" approach to innovation can create *ex-novo* new industrial scenarios that satisfied existing needs in a different way or new needs that did not exist before. According to this approach, the public sector acts as an investor

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of first resort, absorbing the high degree of uncertainty during the early stages of innovation and stimulating additional private R&D investment (Mowery, 2010; Foray et al., 2012). Such public policies are interdisciplinary, systemic, and characterised by an important involvement of public and private R&D activities. Their aim is to solve concrete problems and challenges within a defined time horizon (Mazzucato, 2018). In recent decades, some examples of these policies have been: i) the Apollo Programme (European Commission, 2018a); ii) the Energiewende Programme (European Commission, 2018b); iii) the Human Genome Programme (European Commission, 2018c). These public programmes were based on a high content of R&D investment, focused on the creation of new markets and systemic interactions and transformations of different sectors and actors in the economic system.

This study aims to extend the work carried out by Deleidi and Mazzucato (2021) for the United States, by estimating the macroeconomic impact of public investment in innovation, considering a dataset of 15 OECD countries considered for the 1981-2017 period. To do so, the study aims to enter a twofold literature: one on fiscal multipliers, which evaluates the impact of public spending on GDP; and one on innovation, which sees the role of the state and public investment in R&D as factors that stimulate economic growth and private R&D investment. In particular, we apply an econometric technique based on the Local-Projection (LP) approach to quantify the macroeconomic impact of public R&D expenditure on GDP and private R&D investment to assess whether public intervention can stimulate private investment in innovation. Our results show that public R&D expenditure: (i) is associated with higher fiscal multipliers than other components of public expenditure; (ii) produces a crowding-in effect on private R&D.

2. Data and Methods

To detect the effect of targeted R&D public spending on GDP and private R&D investment, we make use of yearly data provided by the OECD, using the MSTI, Economic Outlook, and National Accounts databases. Our analysis is based on a sample of fifteen OECD countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Portugal, Spain, the UK and the US. The analysis is conducted by using yearly macroeconomic data for the period 1981-2017. We consider the following variables: GDP (Y), private R&D expenditures performed and financed by the private sector ($R\&D$), and public R&D expenditures (G_I). The variables are expressed in real terms using the GDP deflator and are converted to USD dollars using the Purchasing Power Parities (PPP) index.

Following the empirical literature on fiscal multipliers (Jordà, 2005; Auerbach and Gorodnichenko, 2017; Deleidi et al. 2020, 2021), we employ the Local-Projections approach, to

detect the effect of G_I on $R\&D$ and Y. The LP estimates single regressions in which the effect of an exogenous shock on the variables of interest is analysed from time t to $t+h$. Formally, in the case of a panel model, the estimation is obtained through the following equation (1):

$$y_{i,t+h} = \alpha_i + \delta_\tau + \beta^h x_{i,t} + \psi^h(L)\, z_{i,t-1} + \varepsilon_{i,t+h};\ h = 0,1,2,\dots,H \quad (1)$$

Where subscripts i and t denote countries and time respectively; α_i e δ_τ represent country and time fixed effects; $y_{i,t+h}$ is the variable of interest considered at each horizon $h = 0,\ 1, 2$; $x_{i,t}$ is the government R&D expenditure shock at time t; $z_{i,t-1}$ represents a vector of control variables at time $t-1$[6]; $\psi^h(L)$ is a polynomial in the lag operator; β^h represents the response of GDP at time $t+h$ to the government R&D expenditure shock at time t. From the estimates for each horizon h it is possible to construct the impulse response functions (IRFs) as a sequence of β^h, and then obtain fiscal multipliers.

Following the standard identification strategies used in the fiscal policy literature (Auerbach and Gorodnichenko, 2017; Ramey and Zubairy, 2018; Deleidi et al. 2021), the shocks associated with public R&D investment are obtained through a structural model by applying a recursive strategy. Specifically, we assume that public R&D expenditure (G_I) is the most exogenous variable, private R&D expenditure ($R\&D$) is the second-ordered variable, and GDP (Y) depends on both expenditures in the contemporaneous relationship. This identification strategy derives from the idea that public R&D investments represent strategic investments that reflect political and industrial priorities, and can therefore be considered independent of macroeconomic conditions (Mowery, 2010; Moretti et al., 2019; Deleidi and Mazzucato, 2021). Furthermore, the shocks ($w_{i,t}$) are scaled to be measured as a percentage of GDP, by multiplying $w_{i,t}$ by the ratio of public R&D expenditure to GDP in each period. In this way, the β^h coefficients in equation 1 represents the multipliers. Once government spending shocks are identified, they are substituted in the LP equation to estimate the IRFs and multipliers.

In our analysis we estimate the effects of public R&D expenditure on GDP as measured by IRFs, considering a timespan from the year in which the shock occurs to the two following years, and we also calculate an average effect over the three periods. Furthermore, we evaluate whether public R&D expenditure can exert a positive impact on private R&D expenditure (*crowding-in* effect). Additionally, to consider feasible heterogeneities, the analysis is conducted on the G7 countries[7] and three countries considered separately, namely Italy, Germany and the United States.

[6] The control variables are public and private R&D expenditures and GDP.
[7] Canada, Italy, France, the United Kingdom, the United States, Japan, and Germany.

3. Findings

Table 1 shows the values of the cumulative multipliers (Ramey and Zubairy, 2018), namely the response of GDP and private R&D per unit of government spending in R&D. The value of the estimated multipliers over the period considered (at the impact, and after one and two years) indicates the increase of GDP and private R&D investment after an additional $1 of public R&D expenditure realised in the same period.

	Impact	*Year 1*	*Year 2*	*Average*
Y				
15 OECD Countries	**4.92**	**6.73**	**7.40**	6.35
G7 Countries	**5.96**	**9.13**	**9.71**	8.27
Italy	7.48	**12.88**	**16.45**	12.27
Germany	**13.20**	**14.27**	8.49	11.99
US	**13.66**	12.03	**11.84**	12.51
R&D				
15 OECD Countries	**0.06**	**0.09**	**0.10**	0.08
G7 Countries	**0.12**	**0.19**	**0.24**	0.19
Italy	0.09	**0.10**	**0.33**	0.17
Germany	**0.84**	**0.82**	0.63	0.76
US	0.00	**0.18**	**0.17**	0.12

Table 1. Cumulative and average public R&D multipliers. Response of GDP and R&D. Significant estimates (68%) are in bold.

For the panel of 15 OECD countries, our results show that public spending on R&D has a positive effect on the GDP level. In particular, an increase in public R&D expenditure generates a multiplier of 6.35 on average. Similar values are obtained in the case of the G7 panel, with an average multiplier of 8.27. Focusing the analysis on individual countries, the average value of the multiplier is 12.27 for Italy, 12 for Germany and 12.51 for the United States. Concerning the possibility that public spending on R&D generates spillover effects within the economic system, the analysis shows that there is a positive effect on the innovative activity of the private sector. The average impact is 0.08 for the panel of 15 OECD countries, 0.19 for the panel of G7 countries, 0.17 when considering the Italian context, 0.76 for Germany, and 0.12 for the United States.[8]

Our results suggest that relying on a public system investing in innovation produces significant positive effects on GDP. Moreover, the multiplicative effects are greater than those highlighted in the economic literature focused on the different components of public expenditure (Gechert, 2015; Deleidi et al. 2020, 2021). Additionally, our results confirm that public R&D investments stimulate

[8] Regarding the different responses of GDP and private R&D investment across countries, they could also reflect institutional factors and different degrees of technological development, but further analysis should be carried out in this field.

private R&D investment, which would not have been realised without public intervention (Van Reenen, 2021; Deleidi and Mazzucato, 2019; 2021).

4. Conclusions

The COVID-19 crisis and the recent energy crisis have accelerated the debate on the need for a new industrial policy to enable economies to make a structural change towards a greener and more digital economic system. It is precisely in this direction that the European Commission has financed 800 billion euros through the Next Generation EU, to relaunch investments in sectors and areas that are considered strategic. In this paper, we wanted to emphasise the role that the public sector can play in influencing and directing economic growth and innovation by estimating the macroeconomic effects of public R&D investments on GDP and private R&D investments.

Our results show that public R&D expenditure can generate positive effects on both GDP and private R&D investment. These effects are stronger than those found in the fiscal policy literature both when considering total public expenditure and when disaggregating total expenditure into public consumption and investment. These greater effects arise from the fact that public R&D expenditure is not only a demand stimulus but tends to lead to structural transformations within the economic system. Then, having a public sector that invests public resources in research and development activities determines additionalities within the economic system and provides direction towards new techno-economic paradigms that do not emerge spontaneously from market forces. Indeed, public R&D investments generate high spillover effects and mobilise R&D investments realised by the private sector that is only activated when public institutions undertake the riskiest activities (Mazzucato, 2018; Van Reenen, 2021).

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