An Exploration on the Impacts of Public R&D Policies

Leticia Brilhante and Fernando Romero
Department of Production and Systems and Algoritmi Research Centre, University of Minho, Portugal

id9404@uminho.pt
fromero@dps.uminho.pt

Abstract: This paper explores the role of public funding and policies in supporting research, development, and innovation (RD&I) across various national contexts, including both developed and developing countries. The analysis assesses the impacts of such policies on innovation capacity, economic growth, and the generation of positive externalities via integrated innovation systems. Challenges faced by National Innovation Systems (NIS)—such as fragmentation between the public and private sectors and limited technological absorption—are critically examined. The paper presents practical examples highlighting the value of public-private partnerships and long-term strategic agendas to enhance RD&I outcomes. The study concludes that a coordinated approach, integrating academia, government, and industry, is vital for promoting sustainable innovation and global socioeconomic development.

Keywords: Innovation, Public Funding, Public Policies, R&D, Externalities.

1. Introduction

Innovation is a fundamental driver of economic and social advancement, especially when stimulated by public policies that support RD&I. These policies can foster innovation in both private firms and academic institutions, encouraging public-private partnerships and creating an ecosystem conducive to technological progress. However, the outcomes of such policies can vary widely, with externalities being a core aspect. In some instances, public subsidies induce crowding-in effects—stimulating additional private investment—whereas in other cases, they may cause crowding-out, displacing private resources and limiting policy effectiveness (Becker et al., 2023).

This article is structured into eight sections. It begins with this introduction, followed by a description of the methodology used to investigate the externalities of public RD&I policies. The conceptual framework then elaborates on the mechanisms of crowding-in and crowding-out. Section four discusses financial support and public investment in RD&I, and section five focuses on assessing and measuring the externalities of such policies. The sixth section explores the role of National Innovation Systems (NIS) and their interactions with public RD&I initiatives. Section seven presents a discussion of the challenges and barriers in policy implementation, and the final section concludes with recommendations aimed at maximizing positive impacts while mitigating negative externalities.

2. Methodology

This paper employs an exploratory literature review to examine the externalities of public policies supporting research, development, and innovation (RD&I), with particular emphasis on the effects of crowding-in and crowding-out. The aim is to provide a broad and critical overview of the current state of knowledge, highlighting trends and identifying gaps in the literature. To ensure a robust foundation, the review draws on peer-reviewed sources from Scopus, Web of Science, Emerald Insight, Google Scholar, and OECD iLibrary.

A targeted combination of keywords was used to guide the search, including terms such as “crowding-in and crowding-out,” “public funding of R&D”, “National Innovation Systems” and “externalities of R&D policies”. These terms were strategically selected to capture studies examining the impact of innovation policies across both developed and developing countries. The review also includes literature exploring the relationships between academia, industry, and government, with a focus on cooperation dynamics, funding mechanisms, and policy outcomes.

In total, 33 references were consulted, with 26 peer-reviewed journal articles forming the core of the analysis. A significant proportion of these focus on advanced economies such as the United States, United Kingdom, Sweden, South Korea, and the European Union (EU), while others address emerging markets like Brazil, Mexico, and Chile. Additional references include institutional reports and conference papers, enriching the comparative scope of the research. The article contributes to addressing the literature gap by incorporating insights from less-represented regions and offering context-sensitive interpretations.

3. Conceptual Basis

The effects of public RD&I policies are primarily examined through two core concepts: crowding-in and crowding-out. These mechanisms describe how public funding influences private investment behavior. Crowding-in occurs when public funding stimulates additional private sector investment, amplifying resources available for innovation. In contrast, crowding-out arises when public funding displaces private capital that would otherwise have been invested, potentially weakening the intended innovation incentives (De Fuentes et al., 2023; Santoleri et al., 2022).

National Innovation Systems (NIS) serve as the framework within which these effects unfold, promoting cooperation among government, industry, and academia. Their success depends on the system's capacity to absorb technology and coordinate efforts. In Canada, for example, strategic policies such as the Strategic Innovation Fund have effectively leveraged public investment to attract private contributions in key sectors like clean technologies and health (Becker et al., 2023; MIT Science Policy Review, 2024; OECD, 2024a).

In Brazil and Chile, public programs such as FINEP (Brazil's Funding Authority for Studies and Projects) have sought to stimulate private sector engagement without displacing existing investment. These policies foster complementarities between public and private efforts, mitigating potential crowding-out effects (Becker et al., 2023; MIT Science Policy Review, 2024; OECD, 2024a).

Chile's Start-Up Chile initiative exemplifies how public support can generate crowding-in effects by attracting foreign investment and enhancing local startup ecosystems (Crespi et al., 2020). Similarly, in South Korea, RD&I policies that emphasize strategic sectors and promote collaboration among universities, research institutions, and industry have successfully attracted private investment without substituting it (Hwang et al., 2019).

However, not all outcomes are positive. In China, evidence indicates that in sectors already capable of self-financing, public funding has sometimes substituted private investment rather than complementing it (Wang & Wang, 2021). Similarly, within the EU, certain subsidy programs for SMEs have failed to incentivize additional investment, leading to overreliance on public resources (Santoleri et al., 2022). These cases highlight that while crowding-in is often the policy goal, contextual factors may reverse the outcome, leading to unintended consequences.

4. Financial Support and Public Investment in Research, Development and Innovation (RD&I)

Public financial support plays a critical role in promoting innovation in both developed and developing economies. The European Union's Horizon Europe program, for example, allocates significant grants to foster research collaboration between universities and firms across Europe. In the United States, the Small Business Innovation Research (SBIR) program finances small innovative firms to stimulate technological advancement. In Brazil, FINEP supports high-tech sectors such as biotechnology and renewable energy. These programs demonstrate how well-designed public policies can enhance RD&I activities, encourage intersectoral cooperation, and drive economic growth (OECD, 2024a).

Funding models differ across countries. India's National Innovation Foundation (NIF) supports rural innovation through grassroots initiatives, while Brazil's Inova Empresa Program blends public-private partnerships with direct subsidies tailored to strategic sectors. These approaches allow governments to adapt funding mechanisms to regional needs, promoting localized innovation either through public investment, private engagement, or hybrid strategies (Janger et al., 2021).

Government support is justified by market failures that restrict knowledge diffusion and deter private investment in innovation. Knowledge, as a public good, often yields social returns exceeding private ones, prompting firms to underinvest. This is especially true for small firms and start-ups, which face financing barriers due to information asymmetry and risk. Instruments like subsidies and tax incentives help reduce these constraints and promote innovation capacity (Huergo & Moreno, 2017).

Public investment in RD&I also generates substantial spillover effects across sectors. South Korea's Science and Technology Strategic Plan, launched in the 2000s, integrated multiple sectors into a national innovation value chain, boosting productivity and competitiveness. Electronics, semiconductors, and software industries particularly benefited, exemplifying how coordinated strategies can amplify innovation outcomes (Deleidi & Mazzucato, 2021).

Recent OECD (2024) data reinforce the impact of these policies. In Germany, RD&I intensity increased by 2.7 percentage points, sales of new products rose by 3.1 percentage points, and export performance among SMEs improved by 4.2 percentage points. These gains are attributed to a combination of national and supranational subsidies, highlighting the potential of well-coordinated innovation policies to foster competitiveness and maximize positive externalities (OECD, 2024a).

Beyond market support, governments also foster their own innovation ecosystems. Silicon Valley exemplifies the synergy of public support, private investment, and academic partnership in creating a vibrant tech hub. Similarly, Porto Digital in Recife, Brazil, combines public initiatives with ICT sector development to stimulate innovation at the regional level. Such innovation clusters, often shaped by public policies, facilitate the integration of talent, infrastructure, and knowledge (Breschi & Malerba, 2021).

International cooperation further strengthens RD&I outcomes. The EUREKA Network, which spans over 45 countries, exemplifies how multinational collaboration can yield transformative innovations. Notably, Bluetooth technology emerged from joint efforts across European firms and research centers, underlining the effectiveness of cross-border cooperation in advancing technological development (Guan et al., 2016).

In recent years, OECD countries have increased public RD&I support, often combining direct funding and tax incentives. Countries like Belgium, Canada, and France have shifted towards tax-based instruments, with annual growth in corporate R&D tax incentives averaging 3.5%. Meanwhile, Switzerland and Sweden maintain a preference for direct public grants. In 2023, 62% of Sweden's public RD&I support came from direct funding, reflecting a centralized strategy tailored to national priorities (Dumont, 2017; OECD, 2024b).

Firm size and RD&I maturity also influence access to support. In South Korea, the coordination of 17 RD&I agencies across ministries and institutions facilitates efficient resource allocation, improving intersectoral collaboration and national competitiveness (Hwang et al., 2019).

In the United States, technology transfer from federal labs to private firms is complex but effective, relying on patents, licensing, and cooperative agreements. These tools ensure that public research outcomes are commercially leveraged, boosting innovation and international competitiveness (Link et al., 2019).

The effects of subsidies often extend beyond direct recipients. Studies show that public support generates patents and new innovations even among non-funded firms through spillovers. This multiplier effect underscores how public RD&I investment benefits entire ecosystems, not just individual enterprises (Becker et al., 2023).

Combining policy instruments such as grants and tax credits enhances long-term RD&I impact. Evidence from Ireland shows that sequenced support—first grants, followed by tax incentives—stimulates additional private investment, a phenomenon known as "additionality." This mix strengthens firms' innovation capacity and fosters sustainable development (Lenihan et al., 2024).

5. Assessment and Measurement of Externalities in Public Policies to Support RD&I

Evaluating the externalities of RD&I policies is essential for policymakers to understand the real outcomes of their interventions. Key externalities include knowledge spillovers, the creation of new markets, and environmental and social effects. Though difficult to quantify, methods such as input-output analysis, econometric modelling, and case studies are commonly used to assess the broader impacts of RD&I initiatives (OECD, 2019).

In Sweden, government subsidies have been vital in fostering innovation in high-growth sectors like artificial intelligence and biotechnology. Public funding facilitated partnerships between private firms and research institutions, resulting in new technologies and regional economic development. However, the effectiveness of such programs depends on optimized resource allocation to high-potential projects and sustained policy continuity (OECD, 2024b).

In OECD countries, evidence shows that firms receiving RD&I incentives improve not only their productivity but also generate spillovers that benefit neighboring firms. For instance, in Germany and South Korea, collaborations between businesses and academic institutions have led to measurable gains in patent output and export growth, demonstrating the importance of regional policy design in enhancing competitiveness (OECD, 2024a).

Externalities can be classified into three types of additionalities: input additionality, such as increased private RD&I investment and employment; output additionality, including new revenues from innovative products and

patent growth; and behavioral additionality, such as greater innovation propensity and reduced project abandonment. Identifying these is crucial to distinguish between crowding-in and crowding-out effects (Méndez-Morales & Muñoz, 2019).

Crowding-out occurs when public subsidies displace private investment, reducing total RD&I activity. While some studies report that subsidies may deter private funding, others show that in environments with high financial risk or limited capital, public support can increase private investment. Thus, the policy context and firm characteristics are key determinants of subsidy effectiveness (Wang & Wang, 2021).

Poorly targeted subsidies, particularly to firms with limited innovation potential, increase the risk of crowding-out. In contrast, when directed towards firms with constrained access to capital, subsidies often catalyze investments in fixed assets and technological upgrading, especially in developing countries. For example, in Chile, Start-Up Chile enabled early-stage technology firms to acquire essential infrastructure, accelerating innovations in fintech and software (Crespi et al., 2020).

Although innovation externalities are typically positive—boosting productivity, job creation, and competitiveness—some may be negative. Examples include environmental degradation or biodiversity loss. Comprehensive evaluation of these externalities is necessary to balance the benefits and mitigate potential adverse impacts of innovation policy (European Commission, 2014).

Traditional metrics, such as patent counts, university spin-offs, and return on investment (ROI), remain central in measuring innovation outcomes. However, ROI depends not only on absorptive capacity but also on how effectively public policies foster an enabling innovation environment. Furthermore, these quantitative indicators often fail to capture qualitative benefits like improved living conditions or social impact (Grossman & Helpman, 2021).

It has been argued that evaluating research performance requires going beyond publication metrics to include broader social outcomes (de Pinho & da Rosa, 2017). RD&I policies should be assessed not only for economic impact but also for their contribution to well-being, inclusion, and sustainability. Addressing social and environmental challenges through innovation demands a more holistic evaluation framework (de Pinho & da Rosa, 2017).

Complementary indicators such as process efficiency should also be considered. These help organizations assess how effectively innovation is integrated into operations, particularly in long-term projects. This is vital for firms that rely on incremental improvements to maintain competitiveness (Adams & Hardwick, 2020).

Different national contexts present specific challenges to maximizing innovation benefits. Germany's innovation system, for example, has generated strong spillovers by fostering university-industry collaboration, which increased patent registration and exports. In contrast, countries like Mexico have struggled with misaligned subsidy strategies, often resulting in crowding-out effects that limit private RD&I (Becker et al., 2023; Crespi et al., 2020; OECD, 2024a).

To address this, integrated approaches that combine tax incentives with direct subsidies have shown better results. Canada's public-private financing strategies in clean technologies demonstrate how targeted interventions can stimulate additional private investment while ensuring strategic alignment (Lenihan et al., 2024).

Performance also varies across OECD countries. Sweden, Japan, and Germany have achieved stronger outcomes, while Italy and Spain lag due to inefficient coordination. Larger economies with diversified sectors often benefit more from RD&I policies, while smaller countries such as Portugal and Norway face challenges related to scale and fragmentation. For these countries, better coordination and strategic sector focus are essential (Ziesemer, 2024).

6. National Innovation Systems and the Implementation of Public Policies for Research, Development and Innovation (RD&I)

National Innovation Systems (NIS) are critical frameworks involving networks of companies, universities, research institutes, and government bodies working together to generate, disseminate, and apply knowledge. The success of these systems depends on effective coordination among actors and the development of mechanisms that support collaboration and knowledge transfer (Godin & Gingras, 2017).

In the United States, programs like Small Business Innovation Research (SBIR) and the Advanced Technology Program (ATP) illustrate how federal initiatives promote innovation in small and medium-sized enterprises (SMEs). These initiatives strengthen university-business partnerships and enable the creation of new technologies. The Silicon Valley ecosystem exemplifies the benefits of aligning public policy, private investment, and world-class academic institutions such as Stanford University (Garcia & Calantone, 2018).

The European Union (EU) also supports a robust NIS through initiatives like Horizon Europe, which funds cross-border collaboration in RD&I. Despite progress, challenges remain in aligning funding mechanisms among member states and ensuring equitable access to resources for startups and SMEs, which can hinder the full realization of the region's innovative potential (Tödtling & Trippl, 2020).

South Korea has successfully implemented coordinated RD&I policies, investing heavily in strategic sectors like electronics and biotechnology. Strong linkages among government, universities, and industry are supported by innovation hubs, tax incentives, and intellectual property protections. However, gaps persist in supporting startups and ensuring that resources are not overly concentrated in large conglomerates (Kim & Lee, 2017).

Latin American countries such as Argentina, Chile, Colombia, Mexico, and Peru face structural constraints in their NIS, including weak infrastructure, limited funding, and insufficient coordination among stakeholders. While technology clusters and innovation networks show promise, SMEs often struggle to absorb and implement new technologies. These challenges highlight the need for capacity building, strategic investment, and stronger stakeholder engagement (O'Connor et al., 2017).

Brazil's NIS has benefitted from agencies like FINEP, which finance RD&I projects in companies and research institutions. Nonetheless, structural weaknesses remain, such as the disconnect between research and production systems, low innovation propensity among firms, and inefficiencies in resource allocation. The lack of a long-term innovation strategy further limits Brazil's potential to scale innovation outcomes (Mazzucato & Penna, 2023).

Portugal has implemented public RD&I initiatives such as UPTEC (Science and Technology Park of the University of Porto) and programs like Portugal 2020 and SIFIDE (System of Tax Incentives for Business RD&I). These have boosted business competitiveness and internationalization. However, knowledge transfer between academia and the private sector remains a persistent bottleneck in the Portuguese NIS (Carvalho et al., 2021).

A well-functioning NIS requires more than funding—it demands coordination, shared vision, and policy alignment. Governments must ensure synergy among stakeholders and deploy instruments that reinforce collaboration. Where well structured, public policies can support integrated systems that amplify innovation, economic growth, and social progress (OECD, 2024a).

In conclusion, despite their diversity, NIS across countries share common needs: strong intersectoral collaboration, targeted public policy instruments, and context-sensitive approaches. The experiences of the United States, EU, South Korea, Brazil, Portugal, and Latin American countries underline the importance of tailoring public RD&I policies to local capabilities while fostering global connectivity and resilience (Carvalho et al., 2021; Garcia & Calantone, 2018; Kim & Lee, 2017; Mazzucato & Penna, 2023; O'Connor et al., 2017; Tödtling & Trippl, 2020).

7. Challenges and Barriers in the Implementation of Public RD&I Policies in National Innovation Systems

National Innovation Systems (NIS) face distinct challenges depending on countries' development levels and socioeconomic conditions. In developed economies such as the United States, South Korea, and EU member states, coordination among government, academia, and industry remains a central challenge. The integration of emerging technologies like artificial intelligence and biotechnology into industrial processes demands not only infrastructure investment but also enhanced public-private collaboration. Regional disparities further exacerbate the issue, as less-developed areas often lack the resources and institutions to support innovation, concentrating activities in already advanced regions (Garcia & Calantone, 2018; Tödtling & Trippl, 2020).

In developing countries such as Brazil, Mexico, and Chile, barriers are more structural. Limited funding, weak infrastructure, excessive bureaucracy, and fragmented innovation ecosystems hinder progress. The low absorption capacity for new technologies among small firms and the absence of a robust innovation culture among companies further restrict development. However, targeted programs such as FINEP in Brazil and Start-Up Chile demonstrate that well-coordinated public interventions can help overcome some of these barriers.

International cooperation networks and locally adapted tax incentives have also shown promise in enhancing technological capability and promoting sustainable development (Mazzucato & Penna, 2023; O'Connor et al., 2017).

A recurring challenge in many developing contexts is partial crowding-out, where public subsidies replace private RD&I investments. While this substitution is often viewed negatively, it can be beneficial when financially constrained firms use public support to invest in capital goods and improve their technological infrastructure. For instance, Start-Up Chile enabled several early-stage firms to acquire equipment they could not have financed otherwise, accelerating innovation in key sectors (Crespi et al., 2020).

To address these challenges, countries must tailor public policies to their local contexts while promoting coordination and inclusiveness. In developed economies, improving the integration of new technologies and reducing regional disparities is key. In developing countries, capacity building, infrastructure enhancement, and the promotion of innovation-oriented business cultures are essential. Only through context-sensitive, collaborative, and forward-looking policies will it be possible to strengthen NIS and ensure long-term, sustainable innovation (Mazzucato & Penna, 2023; OECD, 2024a).

8. Conclusion

This study examined components of National Innovation Systems (NIS) in varying socioeconomic contexts, highlighting the relationship between public RD&I policies and the performance of these systems in both developed and developing countries. The aim was to understand the interactions, challenges, and barriers influencing policy implementation and how they affect innovation capacity, economic growth, and competitiveness.

Findings show that while advanced economies such as the United States, South Korea, and the European Union face issues related to coordination and integration of emerging technologies, developing countries like Brazil and Chile encounter structural constraints including insufficient funding and weak technological absorption. However, when public RD&I policies are effectively designed and adapted to national contexts, they can foster cooperation between academia, government, and industry, enhancing the collective innovation ecosystem.

The results underscore the importance of flexible policy frameworks that account for local specificities while encouraging global connectivity and collaboration. Effective policy design must go beyond isolated instruments and instead foster systemic integration, aligning fiscal tools, direct subsidies, and strategic agendas to maximize both national and international innovation outcomes. International networks, targeted incentives, and coordinated infrastructure development emerge as powerful mechanisms to overcome persistent innovation barriers.

The study suggests that innovation clusters, such as Silicon Valley and Medicon Valley, offer important lessons for building dynamic ecosystems. Their success stems from a combination of concentrated talent, public and private investment, and university-industry collaboration—all reinforced by consistent policy support. Adapting these strategies to regional needs can foster competitiveness and entrepreneurship in both high-income and emerging economies.

By examining the diversity of NIS configurations and their interactions with public RD&I policies, this study proposes a set of guiding principles that can be adapted to various national contexts. A key factor in success is sustained coordination between stakeholders, backed by a shared commitment to long-term innovation goals. Building capacity for such coordination requires not only financial investment but also institutional alignment and cultural change (Mazzucato & Penna, 2023; OECD, 2024a).

Future research and policy efforts should focus on refining mechanisms for effective integration of innovation subsystems, reducing redundancies, and closing institutional gaps. Open questions remain: How can flexible policies be designed to suit both high-capacity systems and resource-constrained environments? What tools best promote long-term collaboration between government, academia, and industry? How can innovation be harnessed to address not only economic growth but also social equity and environmental sustainability?

A possible answer lies in the deployment of scalable policy tools tailored to local realities. These may include innovation clusters, tax incentives, training programs, and instruments that value regional specificity, such as geographical indication labels and local quality standards. In less industrialized regions, such tools can add value, integrate local products into global markets, and support inclusive development.

Additionally, the digital transformation offers new avenues for innovation in marginalized areas. Promoting access to technologies such as artificial intelligence and the Internet of Things can help integrate these regions into global innovation systems, ensuring balanced and sustainable development. International cooperation and participation in global innovation platforms can further expand the reach and impact of national RD&I policies (OECD, 2024a; WIPO, 2017).

Finally, the success of public RD&I policies depends on the continuous evaluation of their impacts. Systematic monitoring using clear performance indicators—such as innovation rates, patents, exports, and university-industry collaboration—is essential. As societal needs evolve, policies must remain adaptable and responsive. Feedback mechanisms and regular impact assessments will help identify bottlenecks and opportunities for improvement, enabling innovation policy to serve as a cornerstone of sustainable and inclusive growth (OECD, 2024a; WIPO, 2017).

Acknowledgements

This work has been supported by FCT – Fundação para a Ciência e Tecnologia within the R&D Units Project Scope: UID/00319/2023.

Ethics Declaration

Ethical clearance was not required for the research.

AI Declaration

AI tools were not used in the creation of this paper.

References

Adams, R., & Hardwick, P. (2020). Measuring innovation performance: Can we do better? Journal of Business Research, 109, 33-45.

Becker, B., Roper, S., & Vanino, E. (2023). Assessing innovation spillovers from publicly funded R&D and innovation support: Evidence from the UK. Technovation, 128, 102860.

Breschi, S., & Malerba, F. (2021). Clusters, innovation, and growth: A survey of the literature. Journal of Economic Surveys, 35(3), 753-772.

Carvalho, AF, Costa, EF, Pimentel, MS, & Varum, CA (2021). The National Innovation System of Portugal: An Analysis of Its Strengths and Challenges. International Journal of Innovation, 9(2), 97-111.

Crespi, G., Garone, L. F., Maffioli, A., & Stein, E. (2020). Public support for R&D, productivity, and spillover effects: Firm-level evidence from Chile. World Development, 130, 104948.

De Fuentes, C., Milla, J., Lu, L., & Ahmadi, S. (2023). Crowding-in or crowding-out? Analysis of innovation government support for firms in Canada. Treasury Board of Canada Secretariat.

de Pinho, MIG, & da Rosa, MJMP (2017). Research Evaluation: the need to include processes and impact.

Deleidi, M., & Mazzucato, M. (2021). Directed innovation policies and the supermultiplier: An empirical assessment of mission-oriented policies in the US economy. Research Policy, 50(2), 104151.

Dumont, M. (2017). Assessing the policy mix of public support for business R&D. Research Policy, 46(10), 1851-1862.

European Commission (2014). Innovation Union Scoreboard 2014: Innovation Union Commitment and Progress. Publications Office of the European Union.

Garcia, R., & Calantone, R.J. (2018). A critical review of innovation research in the United States. Journal of Business Research, 91, 151-160.

Godin, B., & Gingras, Y. (2017). The emergence and development of national innovation systems: The case of Canada. In The Emergence of Systems of Innovation in South(ern) Africa: Long Histories and Contemporary Debates (pp. 79-106). Palgrave Macmillan, Cham.

Grossman, G. M., & Helpman, E. (2021). The Productivity of Investment in R&D: Review and Evidence. Annual Review of Economics, 13, 371-392.

Guan, J., Zuo, K., Chen, K., & Yam, R. C. (2016). Does country-level R&D efficiency benefit from the collaboration network structure? Research Policy, 45(4), 770-784.

Huergo, E., & Moreno, L. (2017). Subsidies or loans? Evaluating the impact of R&D support programs. Research Policy, 46(7), 1198-1214.

Hwang, BY, Bae, ES, Hong, HD, & Kim, DC (2019). Operational-efficiency improvement of public R and D management agencies in South Korea. Journal of Open Innovation: Technology, Market, and Complexity, 5(1), 13.

Janger, J., Schubert, T., Andries, P., & Rammer, C. (2021). How to design effective R&D support schemes: Lessons learned from the global crisis. Research Policy, 50(1), 104125.

Kim, S., & Lee, J. (2017). The National Innovation Systems of Asian Countries: Challenges and Opportunities. Asian Journal of Technology Innovation, 25(1), 1-16.

Lenihan, H., Mulligan, K., Perez-Alaniz, M., & Rammer, C. (2024). R&D policy instrument mix sequencing: evaluating the impact of receiving R&D grants and R&D tax credits over time on firm-level R&D. Industry and Innovation, 1-34.

Link, A.N., Oliver, Z.T., Jordan, G.B., & Hayter, C. (2019). Overview and Analysis of Technology Transfer from Federal Agencies and Laboratories.

Mazzucato, M., & Penna, C. (2023). The Brazilian innovation system: A mission-oriented policy proposal. Center for Management and Strategic Studies (CGEE).

MIT Science Policy Review. (2024). Federal R&D funding: The bedrock of national innovation. MIT Science Policy Review.

Méndez-Morales, EA, & Muñoz, D. (2019). Input, Output, and Behavioral Additionality of Innovation Subsidies. Journal of technology management & innovation, 14(4), 158-172.

O'Connor, J. T., Galán-Muros, V., & Castro-Martínez, E. (2017). Comparing innovation systems in Latin America: A conceptual framework and evidence from Chile, Mexico, Colombia, and Peru. Science and Public Policy, 44(4), 464-476.

OECD. (2019). OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption. OECD Publishing.

OECD. (2024a). Global Innovation Systems Report 2024. OECD Publishing.

OECD. (2024b). Public research funding in Sweden: Optimizing the system in response to multiple demands. OECD iLibrary.

Rochina Barrachina, ME, & Rodríguez Moreno, JA (2024). A possible mechanism for partial crowding-out of R&D subsidies in developing countries. Review of Development Economics, 28 (1), 71-96.

Santoleri, P., Russo, M., & Iori, C. (2022). The impact of business R&D subsidies on firm-level innovation: Evidence from the EU SME Instrument. Research Policy, 51(2), 104569.

Tödtling, F., & Trippl, M. (2020). The EU's national innovation systems: strengths and weaknesses. European Planning Studies, 28(11), 2178-2199.

Wang, Y., & Wang, Y. (2021). The crowding-out effect of government subsidies on private R&D: Evidence from China. Sustainability, 13(1), 287.

World Intellectual Property Organization (WIPO). (2017). Geographical Indications: A Practical Handbook. World Intellectual Property Organization. https://www.wipo.int/edocs/pubdocs/en/geographical/guide-wipo-geographical-indications.pdf.

Ziesemer, T. H. W. (2024). Estimating the effects of public R&D subsidies for firms in OECD countries. Economies, 12(2), 216.