

ОБЩЕСТВЕНИ КОМУНИКАЦИИ И ИНФОРМАЦИОННИ НАУКИ
PUBLIC COMMUNICATIONS AND INFORMATION SCIENCES

**MANAGEMENT OF INFORMATION AND KNOWLEDGE IN PUBLIC
R&D SPENDING AND PRIVATE INVESTMENT**

Nico Frisch

University of Library Studies and Information Technologies

<https://doi.org/10.70300/XPUJ2147>

Abstract: *This paper examines whether government spending on research and development (R&D) crowds out or stimulates private investment in Germany. While traditional economic perspectives emphasize displacement effects arising from funding competition, alternative theoretical frameworks suggest that public R&D can complement private investment by reducing uncertainty, improving efficiency, and expanding technological opportunities. In particular, state-funded basic research appears to support corporate innovation by providing foundational knowledge on which private investment can build. The analysis combines a conceptual discussion of crowding-out and crowding-in mechanisms with a descriptive examination of long-term trends in public and private R&D expenditures from 2000 to 2023. Beyond its macroeconomic perspective, the study contributes to the broader academic discourse on knowledge creation, dissemination, and utilization. By examining the role of public research funding as a catalyst for knowledge generation and innovation, the paper highlights the importance of institutional frameworks that transform scientific knowledge into economic and societal value. The findings indicate that public research investment functions as growth-enhancing capital formation rather than a substitute for private activity.*

Keywords: *Public R&D Spending; Private Investment; Crowding-In Effect; Innovation Policy; Endogenous Growth*

INTRODUCTION

A fundamental controversy in classical macroeconomic theory concerns the examination of the effect of government spending on private investment behavior. In neoclassical models, government spending acts as a primary disruptive factor for private investment, while Keynesian theory and endogenous growth theory postulate a stabilizing and stimulating effect in this context (Keynes 1936; Romer 1990). The form of government spending remains of crucial importance in this analysis, with investment in research and development (R&D) in particular having a complementary effect on private investment rather than crowding it out. This article analyzes the crowding-in effect in the context of government spending on R&D in relation to the funding structure of the Federal Republic of Germany (FRG). The central thesis of this article is that government funding in the field of basic research performs an incubation function that positively stimulates private investment. Due to the high level of uncertainty and (financial) risk, this private investment may not materialize without government start-up funding.

This topic examines the role of information, knowledge, innovation, and institutional structures in modern society. Public investment in research not only generates scientific knowledge but also facilitates its dissemination and transformation into technological and economic progress. Consequently, the interaction between public and private R&D investments can be understood as an important mechanism within knowledge-based economies.

In the classic crowding-out theory, government spending leads to rising interest rates, which in turn suppresses private investment. The assumption here is that public spending cannot generate independent productivity effects and is substitutable for private investment (Modigliani 1961; Barro 1974). In the context of the possible long-term impact of government spending on R&D, this analysis is theoretically limited.

The objective of this article is to systematically present the theoretical mechanisms of government R&D spending and to link them to empirical evidence from Germany. On a methodological

level, the article combines an analysis of the underlying theoretical framework with a descriptive evaluation of time series data on public and private R&D investment in Germany for the period from 2000 to 2023. The economic added value of the article lies in its integrated consideration of crowding-out and crowding-in effects in the area of government research funding and the derivation of policy implications for productivity-oriented fiscal measures.

RESEARCH METHODOLOGY

The research adopts a mixed conceptual–descriptive methodology, integrating a theoretical review of macroeconomic models with a descriptive analysis of official longitudinal secondary data on German public and private R&D expenditures. In order to achieve the objective of this article, it is necessary to examine the theoretical foundations of the mechanisms of government spending and private investment as a starting point for investigating crowding-out and crowding-in effects. The theoretical assessment depends to a large extent on macroeconomic model assumptions. In classical crowding-out theory, government spending leads to rising interest rates, which suppresses private investment. The assumption here is that public spending cannot generate independent productivity effects and is substitutable for private investment (Modigliani 1961; Barro 1974). This condition is met when the state invests in infrastructure that has a complementary effect on productivity, such as transport infrastructure, energy supply, research and development (R&D), and education. This is complemented by investment in innovative areas that promote technological development. Accordingly, public spending must generate non-rivalrous knowledge (basic research), as this knowledge can be used by multiple actors and is not subject to consumption, thereby increasing productivity (Barro 1990; Romer 1990). Against this backdrop, government investment in R&D plays a prominent role, as it is a key driver of innovation. The differences between these theoretical foundations are essential when analyzing crowding-out and crowding-in effects in the context of government R&D investment, as the factors of knowledge, innovation, and technical development cannot be integrated into the classical assumptions of a perfect market. In the context of the possible long-term impact of government spending on R&D, this assumption is theoretically limited.

RESULTS

At the heart of neoclassical theory is the assumption of limited capital supply. In this view, government investment increases the demand for savings, resulting in rising interest rates, which crowd out private investment. This assumption presupposes the logic of efficient financial markets in which capital can be transferred with complete mobility (without regulations, information asymmetries, and transaction costs) and the factors of production (labor, capital, land) are utilized optimally (Barro 1989; Mankiw 2019). In this view, the state and the private sector compete for the same limited resources, with an asymmetric distribution of these resources leading to a decline in investment by the other side. Taking modern economic relationships into account, this theoretical construct is only of limited significance. Demand-centered Keynesian theory also addresses market imperfections caused by uncertainties and the expectations of market participants (Keynes 1936). This view assumes that government spending (in productive areas) stabilizes demand in times of crisis and, at the same time, can stimulate private investment behavior by expanding production capacities through technological development (e.g., through R&D investments) and capital utilization. In addition, rising demand cultivates expectations in the private sector regarding the profitability of investment projects, which can lead to a crowding-in effect (DeLong & Summers 2012). Furthermore, this assumption is extended in the models of endogenous growth theory in the form of a long-term supply mechanism. Furthermore, technological development is not exogenous, but rather the result of targeted promotion through investment in knowledge, research, and human capital. In this context, government spending has an incubating effect on private investment by reducing uncertainty and shortening learning processes (e.g., in resource-intensive basic research) (Romer 1990; Bloom et al. 2019). It can therefore be concluded that government spending in productive areas such as R&D goes beyond short-term demand impulses and can generate long-term productivity gains.

Figure 1 illustrates the relationship between government spending (G1 and G2) and private investment (P1 and P2) in the context of the crowding-out and crowding-in effects.

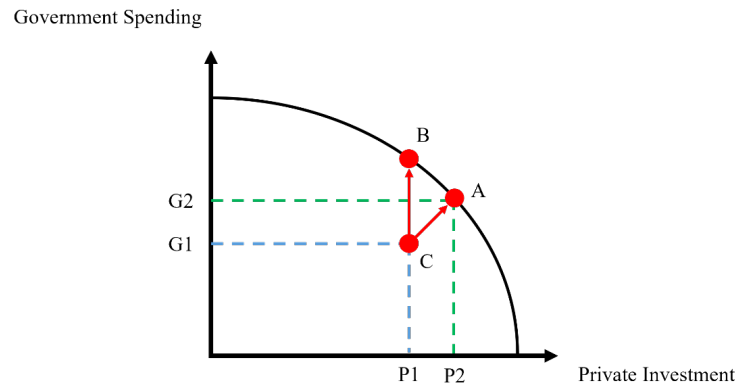


Fig. 1. Crowding-out versus crowding-in effects of government spending.
Source: Own illustration according to Keynes (1936) and Blanchard (2019).

Point C in the figure represents underutilization of production capacity, with government spending activating unused resources and thus not causing any crowding out. This situation corresponds to the description in Keynesian theory. The falling curve in the figure represents the analytical framework assuming a competitive relationship between government and private investment (crowding out). Point A describes the situation of targeted government investment that complements the private sector. This investment, particularly in infrastructure, knowledge, and human capital, generates an expansion of production capacity to the outer curve (crowding-in). Based on the summary representation of the relationship between government and private investment, it can be concluded that budgetary discipline in modern economies should not be set statically by regulatory authorities but should be dynamically geared towards long-term productivity gains.

Reducing uncertainty is a key feature of crowding-in effects. Uncertainty and information asymmetry are particularly pronounced in basic research, as this area involves significantly high costs. Furthermore, this is accompanied by constant uncertainty about the commercial use of the corresponding research results, as the focus of this orientation is not primarily application oriented. In this context, there is a significant risk for private investment in financing basic research (Dixit & Pindyck 1994). Government spending on R&D and infrastructure projects can be interpreted as providing impetus through political support in these areas. This impetus can reduce uncertainty for the private sector and create planning security with regard to investment strategies. (Rodrik 2008; Bloom et al. 2019). At the same time, government activity expands the technological possibilities within which private actors can identify profitable projects.

The prominent role of public R&D funding in this article stems from the economic characteristics of knowledge and expertise as factors of production. The knowledge generated does not compete with other knowledge and expands through dissemination. However, the social benefits cannot be fully internalized by private actors (Arrow 1962; Nelson 1959). For this reason, without government involvement, market failure would result from underinvestment in cost-intensive basic research and the resulting follow-up funding for application-oriented research projects. In this context, government spending does not constitute direct market intervention, but rather a correction of an imperfect market (Stiglitz 1989). This fact illustrates the complementary effect of government investment in R&D and the possible existence of a presumed crowding-in effect in this context.

In addition to promoting stability and reducing uncertainty, public R&D funding also generates knowledge spillovers that extend beyond institutional and sectoral boundaries, leading – particularly in private-sector firms – to new insights and processes, as well as a skilled workforce, without these actors having to bear the costs of generating this knowledge (Griliches 1992; Jones & Williams 1998). Furthermore, government funding programs lower barriers to market entry through

open infrastructures and accessible research results, making it easier for companies to engage in innovative activities (Audretsch & Keilbach 2007). This is of central importance, particularly for attracting investors and increasing a location’s attractiveness, and it fosters greater competition. In summary, these mechanisms imply a strategic complementary relationship between government and private R&D investments. By reducing uncertainties, information asymmetries, and risks, government R&D investments lower barriers to entry and act as a catalyst for private investment strategies, which result in technological development and productivity gains at the macroeconomic level (Aghion et al. 2015; Mazzucato 2018). Therefore, under appropriate institutional conditions, a complementary relationship can be assumed to give rise to a stable crowding-in effect that supports long-term growth and technological dynamism.

In order to place these theoretical principles in an empirical context, the analysis in this article is based on the evaluation of time series from statistical surveys conducted by the German Federal Statistical Office (Destatis). The underlying data sets contain government and private investment in R&D for the period from 2000 to 2023. The two-time series are compared and contrasted to illustrate the assumed dynamics and a possible complementary relationship. For visual orientation, these compared time series are presented graphically. The aim of this analysis is to examine in a descriptive manner whether volatile phases are reflected in both curves and to provide an indication of a connection in the context of the crowding-in effect. Nevertheless, it should be noted at this point that the empirical evaluation in this article, based on the Destatis survey, cannot claim to establish a causal relationship. This data basis is summarized and compared in Table 1.

*Table 1. Comparison of Public vs. Private R&D-Investment.
Own representation according to Destatis (2024).*

Year	Public R&D-Investment (in € thousand)	Private R&D-Investment (in € thousand)
2000	50.825	34.333
2001	53.500	35.095
2002	55.300	35.904
2003	56.100	38.060
2004	57.100	38.394
2005	55.897	39.569
2006	61.000	42.281
2007	63.800	43.768
2008	67.600	46.890
2009	69.700	46.019
2010	70.014	47.409
2011	75.569	51.448
2012	79.110	54.109
2013	79.730	54.569
2014	84.246	58.115
2015	88.782	60.940
2016	92.174	61.673
2017	99.554	69.066
2018	104.669	72.662
2019	110.025	75.288
2020	106.583	70.627
2021	113.184	77.601
2022	121.421	83.422
2023	129.676	88.707

A comparison of the time series for public and private R&D investment (see Table 1) already provides compelling arguments that support the theoretical assumptions. Across the time series, government spending had a stabilizing effect even during the crisis years 2007 to 2009 (global economic crisis) and 2020 to 2022 (COVID-19 pandemic and energy crisis). This is evident from the increase in spending on both sides, without any suggestion of crowding out. Based on the significant increases in private investment, it can be inferred that public spending has a positive impact on the return expectations of the other side. This fact confirms Romer's theory (1990). In addition, the graphical comparison of the time series examined illustrates the complementary relationship (see Figure 2).

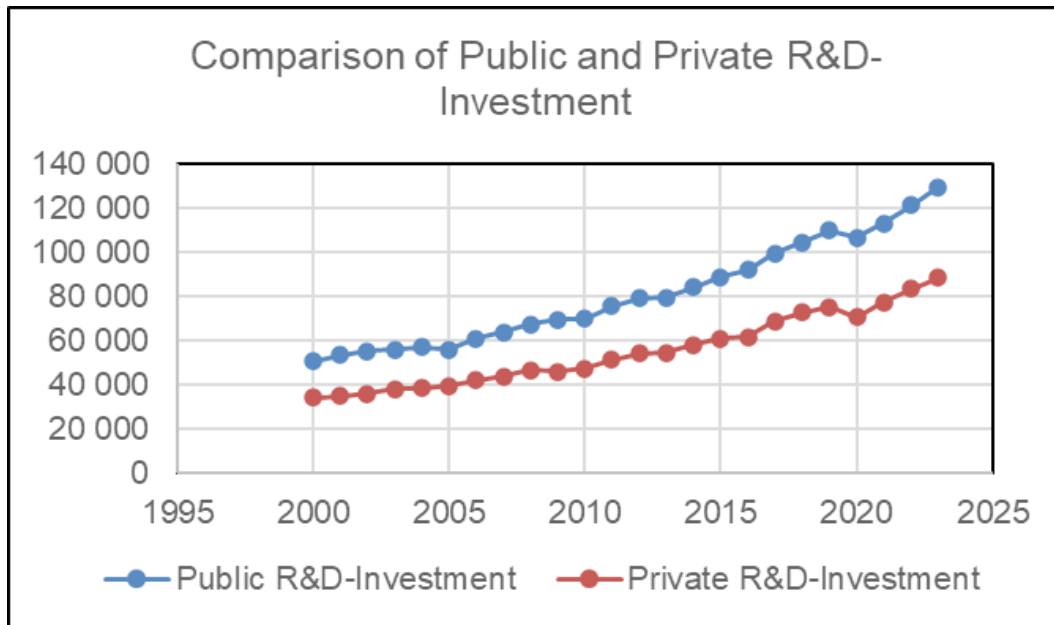


Fig. 2. Comparison of Public vs. Private R&D-Investment.
Own illustration according to Destatis (2024).

The graphical representation of these time series shows an almost identical trend in these investment volumes. Instead of displacement, this empirical analysis of investments between 2000 and 2023 shows that the increase in private investment is complementary to public spending in the area of R&D. This fact provides descriptive evidence to support the hypothesis of the existence of a crowding-in effect.

Based on the data, it can be assumed that the German funding structure for the research landscape fulfills the appropriate institutional conditions that provide a platform for further private capital commitment. Government investment in R&D does not replace private research funding, but rather expands it by providing or kick-starting research infrastructure and human capital. This empirical contextualization supports the theoretical considerations and provides a basis for assuming a crowding-in effect of government research investment.

Due to the heterogeneous nature of the German research landscape, a differentiated analysis of R&D investments is necessary for a comprehensive empirical classification of the underlying theoretical assumptions about the crowding-in effect. The structure of German research funding is characterized by a division of labor between basic research, which is predominantly funded by the government, and private investment in application-oriented research projects (BMBF 2022; OECD 2023). This innovation system is designed to generate knowledge and support it in a targeted manner through diffusion, so that government investment does not compete with private investment (Mazzucato 2013).

As the central channel for government R&D investment, knowledge transfer is the key mechanism for commercially exploiting knowledge generated through research collaborations, joint projects, spin-offs, and licenses. This multiplies the positive effect of this government spending in the overall economic context (Audretsch & Keilbach 2007). This transfer mechanism accelerates innovation cycles and improves investment conditions and returns expectations for private actors.

DISCUSSION

This article combines theoretical principles with empirical surveys on public and private research funding. By comparing the time series, the theoretical aspects can be reinforced, thereby consolidating the considerations on the connection between the crowding-in effect. However, the study in this article reaches the limits of its significance because the data series are heavily aggregated and individual funding structures remain unaffected by the heterogeneity of the German research landscape. The main finding is that no decline in private investment can be observed on the basis of rising government spending on R&D. Further studies comparing similar time series from different countries and periods and combining more advanced analytical approaches may demonstrate a causal relationship between the reciprocal effect of public R&D expenditure and private capital formation.

Nevertheless, the empirical analysis in this article contradicts the assumption that government investment in research systematically displaces private activity and supports the thesis of a complementary relationship between these actors. The central argument is based on the imperfection of financial markets, whereby further analysis of the structure of endogenous money creation by financial institutions in the context of debt-financed government spending on R&D can generate additional insights in this regard. Particularly exposed in this context is the government's ability to use public funding to achieve productivity gains in the context of technological development, which can be driven by research.

By examining the total factor productivity indicator in the context of the work of Bloom et al. (2019), it can be shown that the positive effects of government research funding on economic growth occur with a time lag. In addition to the level of public funding, the aspect of planning security is a decisive factor in the private sector's assessment, enabling it to derive its own investment strategies. This correlation must be internalized by political decision-makers in order to adopt funding strategies that not only generate short-term momentum but also pursue long-term growth and enable anticipation by the private sector.

In the overall context, the findings compared in this discussion confirm that the theoretical assumption of a complementary relationship between public and private investment in R&D corresponds to the crowding-in effect. Accordingly, a purely quantitative limitation of public decision-making in the context of R&D funding is an analytically simplified representation. In this context, the quality of institutional support, planning security, and the stability of support programs are of essential importance. This connection represents a key argument for the design of a productivity-oriented fiscal policy.

Based on the findings, far-reaching implications for the political design of fiscal decision-making can be derived. In the basic understanding of endogenous growth theory, government investment in research is not classified as consumptive expenditure, but as a form of productive capital commitment in the areas of knowledge, human capital, and (research) infrastructure. These government investments have long-term effects that have a positive impact on productivity (Romer 1990). Contrary to this logic, political decision-making on fiscal measures is restrictive. Furthermore, there is a debate within European countries about restricting productive investment through strict deficit limits and spending restrictions (Truger 2015). In this context, the lack of innovation and economic growth should also be quantified as opportunity costs in the context of political decision-making. Furthermore, the narrative in political discourse needs to be rethought, as the basic assumptions underlying fiscal strategy decision-making are often based on analytically simplistic assumptions and consider spending to be negative based on its volume.

The planning security and assessment of the stability of the government support structure by the private sector, as already described, goes hand in hand with return expectations and productivity gains. These premises are necessary for a crowding-in effect (Bloom et al. 2019). Governments should therefore design sound spending policies that are not only based on avoiding debt and declining expenditure but also convey certainty.

These implications are rounded off by the need for institutional quality on the part of the authorities (bureaucracy reduction) and transparency of processes, for example in the allocation of

funding programs. A credible innovation policy therefore requires stable funding commitments that extend beyond political election cycles. Multi-year budget frameworks, institutionally secured basic funding for public research institutions, and transparent funding mechanisms are key instruments for this (Edler & Fagerberg 2017; Rodrik 2008). Simply increasing spending without targeted use of funding through efficient institutional structures can distort the crowding-in effect. A reduction in public R&D funding can significantly impair long-term growth opportunities and weaken international competitiveness (Mazzucato 2013).

Finally, when considering the political implications of the findings in this article, it should be noted that government R&D investments should play a prominent role in fiscal policy. They should not be interpreted as expenditures that reduce success, but rather as strategic investments in technological development and productivity gains, which are the determinants of economic growth. The complementary relationship surrounding the existence of crowding-in effects should be internalized in the political debate in this context.

CONCLUSION

The aim of this article was to present the theoretical foundations of the mechanisms of action of government spending on R&D in relation to private investment and to analyze them empirically. The focus of this study is the question of whether government spending on R&D crowds out or stimulates private investment in this sector. The starting point for this discussion is the crowding-out or crowding-in effect. To answer this question, this article combines a presentation of the theoretical foundations with an analysis of empirical surveys conducted by the Federal Statistical Office. Based on neoclassical theory, rising government spending leads to a crowding out of private investment, while Keynesian models and endogenous growth theory open up an analytical framework in which public investment in productivity-enhancing areas can stimulate private engagement.

Analysis of the theoretical principles has shown that government spending on R&D plays a prominent role in the assessment of the crowding-out and crowding-in theorems, since the generation of knowledge as a factor of production is not rivalrous and cannot be fully internalized by private actors. Thus, under certain conditions, government spending does not constitute a substitute intervention in the market. Under certain circumstances, it merely serves to compensate for allocation problems that may result from market failure. In this context, the reduction of uncertainty and the provision of research infrastructure are of essential importance, creating a complementary relationship with private investment. They thus form a central channel for long-term productivity gains and technological progress.

The theoretical assumptions are confirmed by the analysis of data series on public and private R&D investment in Germany for the period from 2000 to 2023. The development trends of these two variables show a significant increase overall, and the almost parallel curves in the graphical representation (Figure 2) suggest a crowding-in relationship. Analysis of this empirical data points to a complementary relationship between public and private R&D investment, which rules out the crowding-out hypothesis in this area. Nevertheless, it should be noted that the underlying data does not describe a causal relationship, but it does contradict the assumption that rising public R&D spending crowds out private investment. From a broader perspective, the article makes it clear that restrictive spending should not be understood primarily as a quantitative limitation on government spending, but rather as a qualitative focus on productive and growth-promoting investments. Qualitative conditions such as institutional efficiency, planning security for the private sector, and the reduction of uncertainties are crucial for this complementary relationship.

In conclusion, it can be said that in the area of R&D investment, there is a complementary relationship between the state and private investors, which supports the crowding-in theory. This finding can serve to adjust fiscal policy strategy by being internalized in the decision-making process of political actors. Further investigation of data series and econometric analyses that can build on this point to provide evidence-based proof of a causal relationship would generate added value for the economic sciences.

REFERENCES

- AGHION et al., 2015. Innovation and Top Income Inequality. *Review of Economic Studies* 86 (1): 1–45.
- ARROW, K. J., 1962. Economic Welfare and the Allocation of Resources for Invention. In: *The Rate and Direction of Inventive Activity*, edited by Richard R. Nelson, 609–626. Princeton, NJ: Princeton University Press.
- AUDRETSCH, D. B.; KEILBACH, Max, 2007. The Theory of Knowledge Spillover Entrepreneurship. *Journal of Management Studies* 44 (7): 1242–1254.
- BARRO, R. J., 1974. Are Government Bonds Net Wealth? *Journal of Political Economy* 82 (6): 1095–1117.
- BARRO, R. J., 1989. The Ricardian Approach to Budget Deficits. *Journal of Economic Perspectives* 3 (2): 37–54.
- BARRO, R. J., 1990. Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy* 98 (5): S103–S125.
- BLANCHARD, O., 2019. *Public Debt and Low Interest Rates*. American Economic Association Presidential Address.
- BLOOM, N.; Van REENEN, J.; WILLIAMS, H., 2019. A Toolkit of Policies to Promote Innovation. *Journal of Economic Perspectives* 33 (3): 163–184.
- Bundesministerium für Bildung und Forschung (BMBF), 2022. Bundesbericht Forschung und Innovation. Berlin.
- DeLONG, J.; SUMMERS, L. H., 2012. Fiscal Policy in a Depressed Economy. *Brookings Papers on Economic Activity* 2012 (Spring): 233–297.
- DIXIT, A. K.; PINDYCK, R. S., 1994. *Investment under Uncertainty*. Princeton, NJ: Princeton University Press.
- EDLER, J.; FAGERBERG, J., 2017. Innovation Policy: What, Why, and How. *Oxford Review of Economic Policy* 33 (1): 2–23.
- GRILICHES, Z., 1992. The Search for R&D Spillovers. *Scandinavian Journal of Economics* 94 (Supplement): S29–S47.
- JONES, C. I.; WILLIAMS, J. C., 1998. Measuring the Social Return to R&D. *Quarterly Journal of Economics* 113 (4): 1119–1135.
- KEYNES, J. M., 1936. *The General Theory of Employment, Interest and Money*. London: Macmillan.
- MANKIW, N., 2019. *Macroeconomics*. 10th ed. New York: Worth Publishers.
- MAZZUCATO, M., 2013. *The Entrepreneurial State*. London: Anthem Press.
- MAZZUCATO, M., 2018. *The Value of Everything*. London: Allen Lane.
- MODIGLIANI, F., 1961. Long-Run Implications of Alternative Fiscal Policies. *Economic Journal* 71 (284): 730–755.
- NELSON, R. R., 1959. The Simple Economics of Basic Scientific Research. *Journal of Political Economy* 67 (3): 297–306.
- OECD. 2023. *Main Science and Technology Indicators*. Paris.
- RODRIK, D., 2008. Industrial Policy: Don't Ask Why, Ask How. *Middle East Development Journal* 1 (1): 1–29.
- ROMER, P. M., 1990. Endogenous Technological Change. *Journal of Political Economy* 98 (5): S71–S102.
- Statistisches Bundesamt (Destatis). 2024. Private and Public Expenditure on Research and Development in Germany, 1999–2023. Wiesbaden.
- STIGLITZ, J. E., 1989. Markets, Market Failures, and Development. *American Economic Review* 79 (2): 197–203.
- TRUGER, A., 2015. Implementing the Golden Rule for Public Investment. *International Journal of Public Policy* 11 (1–2): 16–31.

УПРАВЛЕНИЕ НА ИНФОРМАЦИЯТА И ЗНАНИЯТА В ОБЛАСТТА НА ПУБЛИЧНИТЕ РАЗХОДИ ЗА НАУЧНИ ИЗСЛЕДВАНИЯ И РАЗВИТИЕ И ЧАСТНИТЕ ИНВЕСТИЦИИ

Резюме: В настоящата статия се разглежда дали държавните разходи за научноизследователска и развойна дейност (R&D) изместват, или стимулират частните инвестиции в Германия. Докато традиционните икономически подходи наблягат на ефектите на изместване, произтичащи от конкуренцията за финансиране, алтернативни теоретични модели сочат, че публичните R&D могат да допълват частните инвестиции, като намаляват несигурността, подобряват ефективността и разширяват технологичните възможности. По-конкретно, финансираните от държавата фундаментални научни изследвания, изглежда, подкрепят корпоративните иновации, като предоставят основополагащи знания, върху които могат да се надграждат частните инвестиции. Анализът съчетава концептуално обсъждане на механизмите на изместване и привличане с

описателно проучване на дългосрочните тенденции в публичните и частните разходи за R&D от 2000 до 2023 г. Отвъд макроикономическата си перспектива, изследването допринася за по-широк академичен дискурс относно създаването, разпространението и използването на знания. Чрез разглеждане на ролята на публичното финансиране на научните изследвания като катализатор за генериране на знания и иновации статията подчертава значението на институционалните рамки, които превръщат научните знания в икономическа и обществена стойност. Резултатите показват, че публичните инвестиции в научни изследвания функционират като капиталобразуване, стимулиращо растежа, а не като заместител на частната дейност.

Ключови думи: държавни разходи; научноизследователска дейност; развойна дейност; частни инвестиции; ефект на привличане; иновационна политика; ендогенен растеж

Нико Фриш, докторант

Researcher ID (ORCID: 0009-0009-1047-1352)

Университет по библиотекознание и информационни технологии

E-mail: nico.frisch@outlook.de