



# Financial Intensity or Project Duration: What Drives Patents and Spin-Offs in Public R&D Projects?

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**Abstract:** The aim of the research is to examine the aspects that govern the innovation outcomes of publicly funded Research and Development (R&D) projects at the project level, focusing on the intensity of funding, implementation period, and the resulting induced private investment. The empirical model relies on a sample of 1,435 projects in the Attica Region and approximates a log-linear econometric model with the OLS technique and heteroscedasticity-robust standard errors. The innovation performance is measured using the logarithm of the total number of patents and spin-offs generated by an individual project. The findings indicate that final project budget and induced private investment have a positive and statistically significant impact on innovation outcomes, with the largest impact being that of private leverage. Conversely, project implementation does not have an ordered contributor to patent and spin-off production.

**Keywords:** R&D Projects, Innovation Outputs, Patents, Spin-Offs, Induced Private Investment

## Introduction

Publicly funded R&D initiatives are expected to produce specific outputs of innovation, e.g. patents and spin-offs, which are direct demonstrations of knowledge generation and commercialisation opportunities. Although the efficacy of governmental R&D support has frequently been determined by way of inputs, akin to amount of financing or number of employees, codified innovation outputs are more concrete measurements of project-scale innovation execution.

Presented in the literature, numerous studies find that overall the level of public support of R&D, in terms of subsidies and financial support, has a positive impact on the innovation activities and outcomes of companies, including the propensity to innovate, product innovation, and patent rates (Bruno, Castellano & Punzo, 2026) (Spanos, Vonortas & Voudouris, 2015) (Busom & Fernández-Ribas, 2008). A positive correlation between public R&D funding and the outcomes of innovation has been extensively reported in the empirical literature (European Commission, 2020) especially in cases where the investment in this area is complemented by the required population crowds in the private sector (Croonen and Huizingh, 2025) (OECD, 2015) (Cheah & Ho, 2020) (Plank & Doblinger, 2018) (Torregrosa-Hetland et al, 2019) (Kolympiris, Kalaitzandonakes & Miller, 2014). Nevertheless, the majority of the research is conducted at the firm-level or programme-level,

and it lacks evidence of how critical characteristics of project design influence the measurable innovation output at the micro level (Aiello et al, 2019) (Link and van Hasselt, 2019) (Stone and Lane, 2012). Moreover, recent studies also point out that the performance of public funding in R&D is reinforced by effective partnerships and comprehensive assessment systems (Mavrotas and Makryvelios, 2021) (2023). Particularly, the comparative significance of financial intensity, project tenure, and induced private leverage in influencing patents and spin-offs are not comprehensively studied in the project-level analysis (Wang and Shapira, 2015) (Yu et al, 2023) (Zhang et al, 2022) (Czarnitzki & Hussinger, 2018) (Herrmann, Gassmann & Eisert, 2007)

The present paper fills this gap by offering brief econometric data on determinants of the outputs of innovation produced by publicly funded R&D projects. With a dataset of 1,435 projects deployed in the Attica Region, we consider the question of whether the performance of innovations is more determined by the financial intensity, implementation duration, or the induced extent of private investment. The analysis is based on a parsimonious log-linear specification that is estimated using heteroskedasticity-robust standard errors and a clear interpretation of the elasticities that are estimated (Meuleman & De Maeseneire, 2012) (Herzer, 2025) (Wang & Chen, 2026) (Shao & Wang, 2023) (Han et al, 2024) (Li, Li & Liu, 2025).

The findings suggest that output of innovation is mostly responsive to financial aspects. Project budget and induced private investment have positive relationships with patent and spin-off production, and the most significant effect is seen with private leverage. Conversely, project duration is not systematically positively effective when financial intensity is considered. These results underscore the key role of complementary private investment in changing public R&D investment in the form of practical and commercially applicable innovation products.

## Research Method

### Data

The empirical data relies on project microdata on publicly funded research and development (R&D) projects in the Attica Region between 2007 and 2016. The sample consists of 1,435 projects funded by co-financed national and European R&D programmes (Makryvelios and Mavrotas, 2021a). The results are based on the official monitoring and evaluation system of research, technological development and innovation activities and were employed in earlier empirical research on the effectiveness and absorption of R&D funding in Greece (Makryvelios and Mavrotas, 2021b).

### Variables and Measurement

The dependent variable is a composite indicator of innovation performance, defined as the sum of patents and spin-offs generated by each project. For the econometric analysis, the natural logarithm of this index is used, i.e.  $\ln(\text{Patents}_i + \text{Spin-offs}_i + 1)$ , in order to capture proportional changes in innovation performance and address the presence of zero values.

The main explanatory variables are: (i) the natural logarithm of the final project budget, as a measure of financial intensity, (ii) the implementation duration in years, and (iii) the natural logarithm of induced private investment, as an indicator of private leverage.

### Econometric Model

The empirical model is formulated as follows:

$$\ln(O_i) = \alpha + \beta_1 \ln(B_i) + \beta_2 D_i + \beta_3 \ln(I_i) + \varepsilon_i$$

where  $O_i$  denotes the innovation output of project  $i$ ,  $B_i$  the final project budget,  $D_i$  the implementation duration, and  $I_i$  the induced private investment. The model is estimated using ordinary least squares (OLS) with heteroskedasticity-robust standard errors, allowing reliable statistical inference and a direct interpretation of the estimated coefficients as elasticities.

In this framework, coefficients  $\beta_1$  and  $\beta_3$  capture the effects of financial intensity and private leverage, respectively, while coefficient  $\beta_2$  examines whether implementation duration systematically affects the production of patents and spin-offs.

### Results and discussion

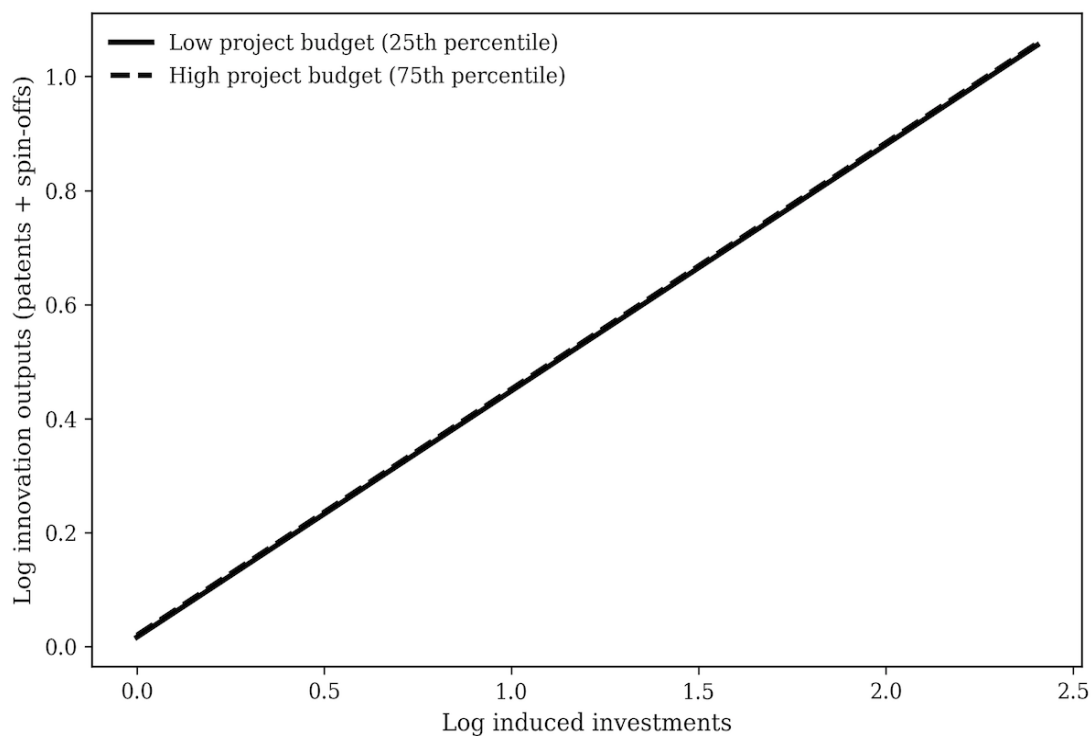
The outcomes of OLS estimates of innovation, the logarithm of the sum of patents and spin-offs produced by individual projects, are shown in Table 1. The findings indicate a distinct and consistent trend regarding the determinants of innovation performance.

**Table 1.** OLS estimates for innovation outputs (N = 1,435)

Variable	Coefficient	Robust s.e.	t-statistic	p-value
Constant	-0.001	0.014	-0.060	0.952
log(final project budget)	0.003	0.001	2.346	0.019
Project duration (years)	-0.004	0.002	-1.677	0.094
log(induced investments)	0.432	0.095	4.543	< 0.001

The project budget has a positive and statistically significant effect ( $\beta_1 = 0.003$ ,  $p < 0.05$ ), suggesting that projects with greater financial intensity tend to produce more patents and spin-offs. Even stronger is the effect of induced private investment ( $\beta_3 = 0.432$ ,  $p < 0.01$ ), demonstrating that private leverage is a key factor in producing measurable innovation outcomes. In contrast, the duration of project implementation enters with a negative coefficient ( $\beta_2 = -0.004$ ), which is only marginally statistically significant at conventional levels ( $p = 0.094$ ). This finding suggests that extending the implementation time horizon does not systematically enhance innovation performance when financial intensity and private leverage are taken into account.

On the whole, the findings indicate that quantifiable innovation outcomes are primarily dependent on the financial magnitude of projects and, specifically, on their capacity to attract complementary private capital, but not on the duration of implementation. The significant impact of private leverage may be viewed as the reflection of higher technological maturity and market proximity, which contributes to turning research activity into commercially viable outcome of innovation (Hall & Lerner, 2010) (Howell, 2017) (Meuleman & De Maeseneire, 2012).



**Figure 1.** Predicted innovation outputs (log patents + spin-offs) by induced private investment and project budget

This pattern is confirmed by the graphical representation. Figure 1 demonstrates that the highest innovation scores, indicating the highest expected outcomes, are found in projects with high budgets and high levels of private participation, which take up the upper half of the distribution. This is in line with other assessments of Greek R&D programmes which suggest dependent factors of complementary individual contribution and absorbance capacity to measure project performance (Makryvelios and Mavrotas, 2021b).

## Conclusions

This research paper contributes empirically at the project level to the determinants of quantifiable innovation outputs produced by publicly funded Research and Development projects. Based on 1,435 projects implemented in the Attica Region data, we demonstrate that patents and spin-offs predominantly depend on the financial intensity of the projects

and, specifically, induced private investment, and the implementation period is not a systematic positive impact.

The results indicate the conclusive influence of the private leverage as a channel by which the public R&D funding is converted into actual and commercially viable consequences of innovation. The findings, in general, imply that the success of R&D programmes is associated more with the financial magnitudes and the mobilisation of complementary private resources than with the extension of the project implementation period.

Policy-wise, the findings have certain implications on the development of research and innovation programmes. Managing authorities should look at structuring funding tools that either incentivize or mandate involvement by the private sector, to guarantee the commercial exploitation of the project outcomes. Moreover, assessment systems may prefer projects that have proven capacity to attract private co-finance because this seems to be an excellent indicator of tangible innovation deliverables in the form of patent and spin off. A change in focus towards increasing rather than increasing the project time-line could lead to a more efficient use of public spending on R&D.

Some limitations are associated with this study and also present prospects of future research. First, the study is geographically restricted to the Attica Region, and therefore the study may not be applicable to other areas with varying industrial or research ecosystems. Second, the composite innovation indicator is not a qualitative measure of the difference between patents (e.g., citation impact) or spin-offs (e.g., survival rates). Future studies may build upon this analysis by including sectoral disaggregations, regional spillovers or qualitative measures to determine the long-term effect of the public funding in R&D on the performance of innovation.

### **Suggestion / Further Research Proposals**

One of the promising areas of further research is the extension of the empirical analysis to other geographical and institutional settings. It would be possible under such an approach to establish the robustness of the documented relationship between public R&D funding, private leverage, and innovation outcomes across different institutional arrangements and innovation policy regimes. It is also suggested that qualitative indicators of innovation should be integrated so as to measure long-term value of innovation more efficiently. Other measures that can be relevant are the survival and growth rates of spin-offs, as well as the number of times a patent is cited in order that the lasting effect and commercial use of the research output may be better reflected. Moreover, some sector-specific analysis in all the R.T.D.I. sectors is justified, as well as a more systematic study of collaborative patterns between universities, research organisations, and firms, with an objective of explaining and underlining the processes that produce commercially feasible innovative outputs.

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