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Scaling Effects in Research Employment in Publicly Funded R&D Projects

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Abstract: *This paper analyses the factors that drive the total employment in the research sphere of publicly funded research and development (R&D) projects, focusing on the contribution of essential characteristics of a project design. The aim is to examine how the project budget, implementation duration, and induced private investment affect the level of research employment during project implementation. It is analyzed using project level microdata of 1,435 publicly funded R&D projects in the Attica Region implemented between 2007-2015. To conduct the empirical study, an econometric model of the log-linear was estimated with the use of the ordinary least squares (OLS), which is the standard error robust to heteroscedasticity to determine the existence of systematic relations between the characteristics of project and employment in the research sector. These empirical findings indicate that research employment is positively and significantly influenced by all the three explanatory variables. The larger project budgets correlate with larger research capacity that is related to a higher availability of resources and a broadening in the scope of research. The relation between induced private investment and employment also demonstrates a great positive status proving that the private funding supplements the public funding. Overall, the findings provide strong evidence of the existence of economies of scale in publicly funded R&D projects. The study contributes to the relevant literature by providing project-level information on the relationship between innovation policy design and employment outcomes and highlights the importance of design features and the role of private investment in shaping the demand for research human resources.*

Keywords: *Publicly Funded R&D Projects; Total Research Employment; Scale Effects; Private Leverage; Innovation Policy*

Introduction

A significant input to the work of innovation and knowledge productions and a significant part of regional innovations systems is research employment (Zhang and Rodriguez-Pose, 2024; Destefanis and Rehman, 2023; Pyo and Choi, 2025). Publicly funded research and development (R&D) projects facilitate research labour demand by mobilising the financial resources, setting the implementation horizons, and maintaining the research team during the project lifecycle. This way, they do not only play a role in the generation of new research jobs, but also in sustaining research labour in the long run, influencing the persistence of knowledge production in regional economies (Chu and Cozzi, 2014; Agrawal et al., 2014; Ioramashvili, 2024; Aiello et al., 2019).

The current empirical research on the innovation-employment relationship is mainly on job creation or firm-level employment impacts. The existing evidence demonstrates that increased demand on highly skilled labour is correlated with high levels of R&D investment and innovation activity (Zuniga and Crespi, 2013; Hoxha and Kleinknecht, 2020; Hernandez-Trasobares and Murillo-Luna, 2025; Bogliacino, 2014; Bogliacino et al., 2013;

Avenyo et al., 2019; Stojcic et al., 2020). Most of the literature concentrates on the creation of new jobs or aggregate labour market outcomes with little information to consider what research employment might actually be overall, maintained when publicly funded innovation ventures are undertaken (Hotte et al., 2023; Jung et al., 2017; Ferraro et al., 2023; Elliott et al., 2024; Ayhan and Elal, 2023). As a result, very little is known in relation to transfer of core project design characteristics to the overall size of research labour demand at project level.

In theory, publicly financed R&D projects may be viewed as production units, which combine financial scale, implementation period, and concomitant investments by the private to generate research products. Three structural attributes of project design are postulated in this context to scale linearly with demand of research labour. First, the financial scale of a project determines the extent of research that can be carried out and the number of research teams that can be maintained. Second, implementation horizon reflects the sustainability of research activity over time and consequently the duration of labour application. Third, induced privatisation of investments has the potential to enhance the extent and intensity of research activities through resource mobilisation, which implies scale effects in the project-based research labour demand (Ciftci & Cready, 2011).

There is limited empirical research at the project level into these relationships, although they are relevant to policy, especially in relation to publicly financed innovation programmes. The majority of available studies are based on firm-level or aggregate data that cannot reflect the internal structure and design features of specific projects. Conversely, project-level microdata offers a better unit of analysis to study the effects of structural attributes, including project budget, duration, and private leverage that are associated with realised research labour input. Such data has only recently started to receive attention, with recent studies (e.g., Makryvelios and Mavrotas, 2021a, 2021b; Mavrotas and Makryvelios, 2021, Makryvelios and Papadogonas, 2026) identifying the significance of such data in assessing the effectiveness of publicly funded R&D programmes.

Thus, this paper investigates the impact of project budget, project duration, and induced privatised investments on total research employment on the basis of project level micro-data involving 1,435 publicly funded R&D projects in the Attica region in Greece. The results of the study are valuable because they not only present project-level evidence on the determinants of total research employment but also reveal systematic scale effects on project-based R&D activity. The aim is to determine the extent to which core project design features influence the need to hire research labour in the project implementation process.

Research Design

The research design that will be used in this study is quantitative studies on the basis of cross-sectional project-level data. The aim of the objective is to investigate the effects of the structural properties of publicly funded research and development (R&D) projects on the overall amount of research jobs that are sustained throughout the course of the project implementation. This analysis is based on the correlation between the aspects of project design and the magnitude of research labour mobilised in the lifecycle of innovation

projects. An ordinary least squares (OLS) regression with heteroskedasticity-robust standard errors is used to estimate the project characteristics and total research employment associations with the use of a log-linear econometric specification.

Research Method

Data

The microdata upon which the empirical study is founded is the cross-sectional project level microdata of publicly funded research and development (R&D) projects carried out in the Attica region, Greece (N = 1,435). It includes finished operational projects and stores exhaustive information on project expenditures, duration of project execution, the induced private investments, and research employment in the terms of full-time equivalent units (IPA). These indicators allow assessing how the major design characteristics of publicly funded innovation initiatives impact the intensity of research labour sustained during the implementation of the project and the following of the project-level analytic framework provided in Makryvelios and Mavrotas (2021a, 2021b) and Mavrotas and Makryvelios (2021).

Project-level data offer a suitable analytical framework to examine the internal organisation of publicly funded innovation projects and their labour demands. In contrast to firm-level or aggregate data, project-level microdata enable a more accurate investigation of the influence of particular project design features on the demand of research labour, as it occurs in the context of project implementation.

Variables and Measurement

The dependent variable in empirically estimating research employment is total research employment preserved with project implementation. The measure of research employment is total research positions in a project in terms of full-time equivalent. The dependent variable is transformed with the natural logarithm to correct skewness in the distribution of employment across projects:

$$\ln (IPA_i + 1)$$

where IPA_i represents total research employment in full-time equivalent units for project i. The natural logarithm of the total research employment that each project produces, in units of full time equivalent (ln(IPA + 1)). The fact that the distribution of employment across projects is skewed is captured in the logarithmic transformation, but the introduction of a unit can deal with a project with no reported research employment. This specification suggests a cumulative measure of the total scale of research labour being sustained in operation wherever a project is in progress (and not only newly generated research jobs).

Three core explanatory variables are included in the model. First, the natural logarithm of the final project budget ($\ln(B_i)$) captures the financial scale of each project and reflects the volume of resources available to support research activities. Larger project budgets are expected to sustain higher levels of research labour by enabling more extensive research tasks and broader research teams. Second, project duration measured in years (D_i)

reflects the implementation horizon and the temporal persistence of research activity. The longer implementation time is expected to mean that research personnel will need to be engaged over time, which will raise overall research employment. Third, induced private investments (ln(I)) is a natural logarithm of induced private investments, which has become a measure of the degree of privatisation being undertaken by the government, and the degree of mobilisation of complementary private resources necessary to increase research activity and the related labour demand.

Econometric Model

The estimation of the following log-linear econometric model is used to test the relationship between project characteristics and total research employment:

$$ln(\mathrm{IPA_i} + 1) = a + \beta_1 ln(\mathrm{B_i}) + \beta_2 \mathrm{D_i} + \beta_3 ln(\mathrm{I_i}) + \varepsilon_i$$

where $\mathrm{IPA_i}$ represents total research employment for project I, $\mathrm{B_i}$ denotes the final project budget, $\mathrm{D_i}$ is the project duration, and $\mathrm{I_i}$ represents the induced private investments. The error term ε_i captures unobserved factors influencing research employment. The coefficients β_1 and β_3 can be interpreted as elasticities of total research employment with respect to project budget and induced investments, respectively, while β_2 represents a semi-elastic effect associated with project duration.

The estimation is conducted with the assistance of ordinary least squares (OLS) and heteroskedasticity-robust standard errors (HC1) because of the cross-sectional nature of the data and the potential existence of heteroskedasticity between the projects. Though the reduced-form specification yields strong conditional correlations among project design attributes and the overall research employment, it does not aim to trace stronger causal effects, where larger or more complex projects can not only cause greater private investment, but may also require more research labour. Nevertheless, the methodology provides informative evidence on systematic scaling connections between project resources, the implementation scope, and the overall requirement of research labour in publicly funded innovation projects.

Conceptual overlap between project budget and induced private investments may exist, as part of the entire budget is often constituted by the private co-financing, so we determined the variance inflation factors (VIFs) to assess multicollinearity. The VIFs were much lower compared to the conventional cutoff of 10, indicating that multicollinearity is not a critical concern in the given specification and that the estimated coefficients may be discovered.

A potential limitation of the empirical specification is that project scale, private leverage, and research labour demand are endogenous. Greater complexity or size of a project may attract greater co-finance by the private sector, and may also require additional research personnel, a feature of collective decision-making embodied in the joint work of project design and project selection. The estimated coefficients should, then, be regarded as powerful conditional relationships, and not deterministic causal effects. Nevertheless, the reduced-form specification provides informative evidence of systematic scaling

relationships between project structural features and the quantity of research labour sustained throughout the project implementation.

The empirical analysis has also considered the aspect of robustness. Alternate model specifications with alternative functional forms of the explanatory variables were estimated to ensure the stability of the results. The estimated coefficients were similar in their sign and statistical significance, indicating that the relationships between the project characteristics and overall research employment identified are resilient to small specification changes.

Results and discussion

The empirical research question examines the overall research employment generated during project implementation in units of full-time equivalent (IPA) in the logarithmic form. It is defined by 3 project level predictors log project budget, project duration, and log induced private investments that specify the financial scale, implementation time, and leverage of publicly financed innovation projects. Table 1 presents the estimation result of the log-linear regression model. The coefficients reflect the relationship between major project attributes and the overall research employment it sustain throughout the project implementation.

Table 1. OLS estimates for total research employment (IPA), Attica (N = 1,435)

Variable	Coefficient	Robust s.e.	t-statistic	p-value
Constant	-0.784	0.115	-6.812	< 0.001
log(final project budget)	0.065	0.011	5.915	< 0.001
Project duration (years)	0.145	0.010	14.365	< 0.001
log(induced investments)	3.192	0.873	3.657	< 0.001

The estimation results indicate that all three explanatory variables have positive and statistically significant effects on total research employment. Project budget exhibits a positive elasticity ($\beta = 0.065$, $p < 0.001$), which can be interpreted as an approximate elasticity between project budget and total research employment. This finding is consistent with the view that greater financial resources enable more extensive research tasks and broader research teams during project implementation.

Project duration displays a strong positive semi-elastic effect ($\beta = 0.145$, $p < 0.001$), suggesting that longer implementation horizons are associated with sustained engagement of research personnel over time. This result highlights the temporal dimension of research labour demand, whereby extended project lifecycles require continuous mobilisation of research staff and thus lead to higher cumulative research employment measured in IPA units.

Induced private investments also show a positive and statistically significant elasticity ($\beta = 3.192$, $p < 0.001$), indicating that projects leveraging additional private resources tend to sustain substantially larger volumes of research labour. Such a large amount of such elasticity should be interpreted with caution, as it may also be a system of complementarities between publicly and privately funded R&D, and also an unobserved project complexity, which increases at the same time both the private co-financing and the

research labour requirement. In this respect, induced investments could reveal not only the financial leverage, but also the overall technological breadth and project vigour.

The identified positive correlation between project scale and overall research employment is generally consistent with results in the literature on innovation and employment. Empirical research has demonstrated in the past that increased R&D investment and innovation activity correlates with greater demand in highly skilled labour, especially in knowledge-intensive industries (Zuniga and Crespi, 2013; Bogliacino, 2014; Avenyo et. al, 2019). In a similar vein, studies that have investigated effects of innovation policies on employment have noted that publicly funded R&D activities are likely to boost labour demand by expanding research activities and technological development. Nevertheless, the majority of current research examines these relationships on a firm or sectoral level. The current research builds upon this body of literature by providing project-level support demonstrating that the same scaling relations apply to the interior organisation of publicly-funded R and D projects. In this respect, the results help in the interpretation of how certain attributes of project design translate to the mobilisation of research labour in publicly funded innovation programmes.

In addition to their empirical implications, the findings can be understood in the framework of the economics of innovation generally. R&D projects funded by the state may be viewed as organised units of production that bring together financial resources, human capital, and other complementary investments to produce knowledge outputs. The scaling characteristics of the knowledge production activities are manifested in positive relationship between project budget, duration and private leverage and research employment in this standpoint. The bigger the project, the bigger the research teams, the longer the implementation period allows to sustain labour participation and the related and complementary investments of the research activities make technology more multifaceted. These processes indicate that the features of project design also serve as structural forces of research labour demand in publicly financed innovative systems.

Combined, the direction and the value of the estimated coefficients indicate that there are systematic scale effects in the project-based research activity. The magnitudes of financial increases, project duration and privatisation are systematically related to high rates of research labour upheld in the project implementation. This pattern implies that the mathematical control of research job creation is the same structural property that determines the total scale of research job mobilisation in the project life cycle.

Figure 1 illustrates how the predicted values of total research employment are plotted against induced private investments after keeping other variables constant at their sample means. The strength of relationship between the two sides is that projects with more personal co-financing commitment tend to persist in supporting larger proportion of the research labour, but differences are more pronounced at lower levels of induced investment, as projects will still support a minimum level of research labour even in absence of large-scale personal leverage.

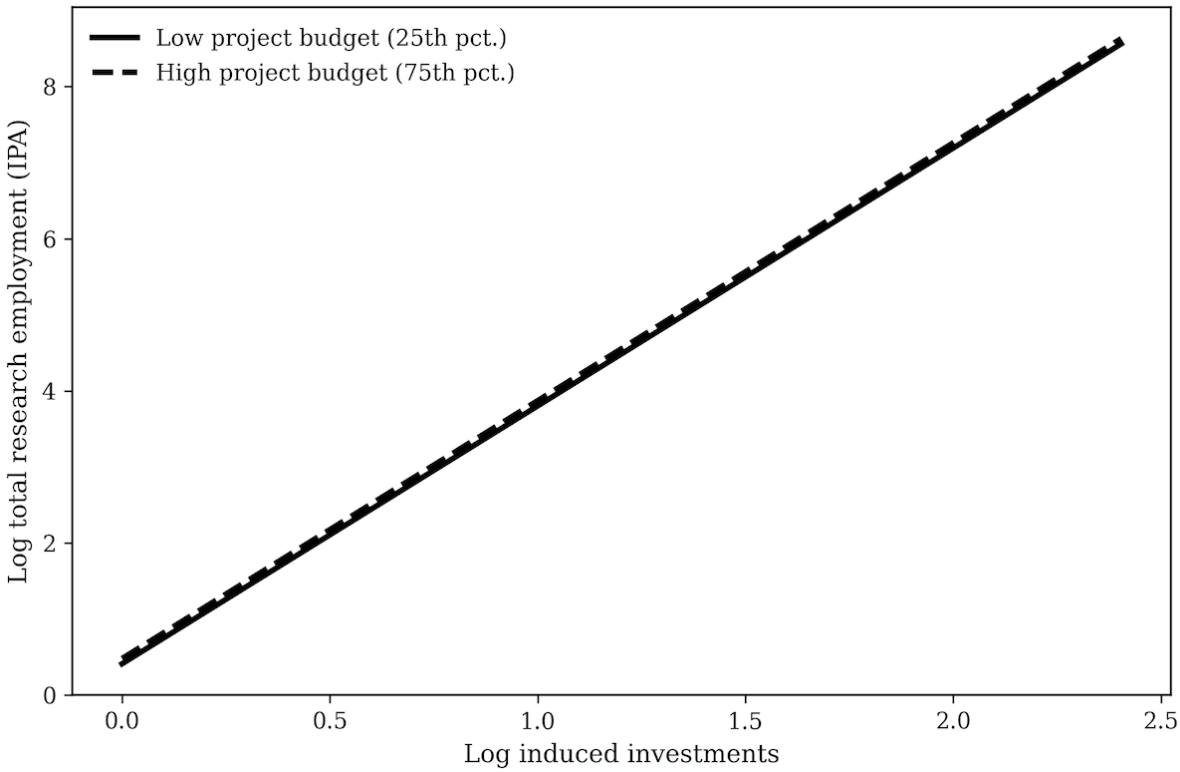

Figure 1. Predicted total research employment by induced investments, Attica

Overall, econometric and graphical evidence confirms that stable scaling relationships exist between publicly-funded R&D projects: a larger budget size, a longer view of implementation, and higher private leverage, are all systematically related to correspondingly large amounts of research labour maintained during the conduct of a project. These outcomes should be considered as powerful conditional relationships, rather than as non-negotiable causal effects, because the intensity of project, private co-finance and research labour demand can be collectively established through the procedure of project design and selection.

Policy wise, the findings show the significance of the characteristics of project design in determining employment outcomes of publicly funded innovation programmes. The presence of funding schemes to enable more substantial project budgets, more extended implementation horizons and more robust mechanisms of co-financing by the private sector might help to maintain greater levels of research labour in the implementation of projects. Here, the policy tools of innovation which promote complementary private investment and long term research partnership can be used to reinforce the human capital foundation of regional innovation systems and to improve labour absorption potential of publicly funded R&D projects.

Combined, the empirical data offer coherent support that the magnitude of publicly funded R&D projects is a factor of great importance in influencing the demand of research labour at the project level.

Conclusions

This analysis reveals that budget, projects duration and consequent investments in the private area of the research industry are structural peculiarities of publicly funded projects in the field of research and development, which determine the employment patterns, which attests to stable economies of scale in the project-based innovational activity. The results indicate that employment intensity is not only a factor of the state of funding, but also heavily relies on the design of interventions, with combinations of larger-scale projects, adequate duration, and positive participation of the private sector leading to higher and moresustainable levels of the research workforce. Here, the need to develop integrated funding mechanisms that capitalize on the complementarities between the funding of population and investment by the local is underlying, as well as increasing both the employment outcomes and accumulation of human capital in the local innovation systems. In practical terms, the success of innovation policies will largely rely on whether the balance between the activities of the innovation policy funds, the time horizon, and the incentives to follow the way of more intense and sustainable types of employment in the sector of research is maintained in order to provide the innovation system with greater resilience.

Suggestion / Further Research Proposals

Empirical studies in other geographical and institutional settings would be the first and foremost future research objective with the goal of trying to establish the external validity of the discovered correlations between the magnitudes of state-funded R&D projects, amount of leverage to the privates, and total research employment. Meanwhile, the fact that these relationships have been studied with regard to other regional innovation systems may allow concluding whether the phenomena shown by the scale effect on the demand in research personnel is a general phenomenon or is dependent on the country policy of innovation as well as the development degree of financial markets. Moreover, the inclusion of sectoral analyses should underscore possible differences in the effect of project design features on research staffing requirements in different knowledge intensive industries. Lastly, time-series data may be utilized and more sophisticated econometric tools deployed to establish causal effects might contribute greatly to our knowledge of the dynamics by which publicly funded R&D initiatives R&D initiatives affect employment in the research sector.

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