



Beyond the “Innovation's Black-Box”: Translating R&D outlays into employment and economic growth



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ABSTRACT

The emergence of the so-called “European Paradox” shows that increasing Governmental R&D Investment is far from being a ‘panacea’ for stagnant growth. Surprisingly, Governmental R&D Employment does not contribute to ‘mass-market’ employment, despite its important role in reducing Youth-Unemployment. Despite the negative side-effect of Governmental R&D Employment on economic growth, University R&D Employment appears to have a quite important role in reducing Unemployment, especially Youth-Unemployment, while it also does not have a downside in terms of economic growth. Technological Capacity enhancement is the most effective instrument for reducing Youth-Unemployment and is a policy with a quite robust effect regarding sustainable economic development.

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1. Introduction

Managing innovation, managing something new, involving change and uncertainty, albeit of use to society, oftentimes generating considerable commercial value and market response [93], is not only difficult but risky too, as it requires a different set of skills, building on different disciplines and functions, not only within enterprises but in whole markets and sectors, according to differing structural factors [145]. The rewards of successful innovation cannot, however, be ignored. Over the last three decades, following the mandate for ever faster growth supported by innovation [44], European regions have experienced considerable industrial restructuring towards a more decentralised and flexible industry structure in order to harness the forces of technology – “the theoretical and practical knowledge, skills, and artefacts that can be used to develop products and services as well as their production and delivery systems” [37, p. 2] – and globalisation [21], shifting from traditional manufacturing towards new and more complex industries, such as Information and Communication Technologies (ICT), Biotechnology and Big-Pharma [22,41,43]. In this process,

Regional Innovation Systems (RIS) – “a set of networks between public and private agents that interact and give mutual feedback in a specific territory by taking advantage of their own infrastructure to adapt, generate and extend knowledge and innovation” [98, p. 100] – thus seen as spatially organised systems, in place at the regional level, that may increase and leverage entrepreneurial knowledge and innovation for increased regional growth, employment, and generally increasing regional well-being (see Ref. [138], for a discussion of locational behaviour) – play an important role for two main reasons. The first is that the use of new technologies such as software, e-commerce and Enterprise Resource Planning (ERP) has reduced the importance of scale economies in many sectors [22,40,125,152]. The role of new business formation on technological change is enhanced by reductions in economies of scale and by increasing global economic uncertainty [18,19,21,107]. Small and Medium Enterprises (SME) rely on their regional economies to cope with this volatile market environment through access to specialised knowledge sources and technology transfer networks, enabling them to develop innovative, high value-added and marketable products at competitive prices [16,17,23,78,101]. The second reason concerns the increasing pace of innovation associated with the shortening of technology and product life-cycles [4–6,24,52,69,91]. This development appears to favour new entrants, in particular, the industry spin-offs and knowledge-based start-ups that have greater flexibility than

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established corporations in coping with decreasing time-to-market and other disruptive changes [30,92,121,152]. Thus, it is especially important to find out what components of an R&D system are most decisive as engines of economic growth [18,55,78] and what are the key factors determining systems' innovative capacity [10,15,16]. As Edquist points out, "given our limited systematic knowledge about determinants of innovation [the fuzzy front end of innovation] case studies comparing innovation systems of various kinds as well as the determinants of innovation processes within them [...] have great potential" [57, p. 201]. Consequently, these questions about the determinants of innovation and the degree to which one may control innovation systems, in particular at the regional level, have captured the attention of academic researchers and those with political responsibilities [60,97,104,116]. This has given rise to a series of important studies, both theoretical and empirical (e.g., Refs. [12,20,22,24,35,55,75,78,89,99,121,128]) though, to date, "the problem of studying innovation and business effectiveness at the regional level has not yet been completely resolved" [98, p. 99]. Consequently, it is these questions, concerned with the universal fostering of innovation by way of the most effective (i.e., public and private) investment, adapted to each case, to reap the most benefits, in terms of employment and economic growth, which we will attempt to answer in the present work, for the case of European regions, starting for this purpose from an approach that combines different theoretical streams. Following the approach of Furman and Hayes [72] our analysis is based on the core ideas-driven endogenous growth theory (e.g., Refs. [79,126,132,133]); the competitive advantages perspective (e.g., Refs. [73,127]); the innovation evolutionary approach (e.g., Refs. [5,14,146]); the Triple Helix dynamics (e.g., Refs. [100,128]) and the concept of RIS (e.g., Refs. [10,22,46,54]). Based on this literature and theoretical framework a broad range of explanatory factors of the production of new knowledge could be defined. Furthermore, the innovation evolutionary approach underpins – besides the regional context – the institutional framework [33,85,128] and the fact that its outcomes depend on a broad heterogeneous number of constructs [14,15,113,114]. It is precisely these differential effects of specific RIS 'subsystems' that make it difficult to operationalise innovation-enhancing programs, for policy purposes, as dynamic systems, such as those in question, tend to be highly interdependent, as noted by Uyarra [146, p. 116].

For all these reasons we developed a new procedure in this type of research, by combining Factor Analysis – a multivariate statistical technique "that can assist the researcher in conceptualising a problem especially with regards to data reduction and the exploration of underlying dimensions" [129, p. 222] thus locating and identifying "fundamental properties underlying the results of tests or measurements and which cannot be measured directly" [129, p. 222] – with Structural Equation Modelling (SEM) which "may portray the structure (i.e., of an economic model) of an economy" [80, p. 737], based on "the incorporation of not directly observable variables (i.e., latent variables or constructs)" [109, p. 14] generated by the Factor Analysis. Furthermore, the evolutionary perspective induces us to work with a Factor Analysis that permits the use of a broad number of explanatory variables [105,123]. On the other hand, the SEM methodology considers the explanatory variables as interdependent and highlights the difficulty of classifying them between causes and consequences [84,106,130], in terms of employment and economic growth. For instance, successful companies, universities and other research institutions do coincide normally in the same regions [2,3,70,71,139]. Additionally, industries develop in regions that offer highly qualified human capital and knowledge intensive services [55,78,100,140]. However, it is not clear who induces who [122,141,144]. In such a dynamic system in which all factors do influence each other [46,133,146] it is

impossible to use the traditional econometric methods based on individual variables [149].

The aim of this paper is to answer research questions deemed critical in RIS research, and innovation management generally, at the regional level, as portrayed by the two hypotheses below. Policy makers need quantitative research, based on novel mathematical approaches and using large samples, on which to base their decisions, which need to be as informed and transparent as possible, in particular in pluralistic economies where competition is high and is seen to be a prerequisite for economic development [1]. Thus, herein, we have developed a new more holistic approach using a broad set of variables to analyse the core constructs of innovative activity, that helps us to demonstrate empirically that a RIS consists of multiple, interrelated elements and each of them have a certain impact on the macro-economic performance of the region. This approach is inherent to the evolutionary theory that underpins that innovation has to be considered as a multidimensional activity [73,100]. The literature also emphasises the difficulty and the weaknesses of the use of individual indicators to measure the macro-economic results of innovation [137,150]. Invention – "the first occurrence of an idea for a new product or process" [64, p. 4] – and innovation – "the first attempt to carry out (i.e., an idea for a new product or process) in practice" [64, p. 4] – appear to be inherent tendencies within human beings. Inventive activity is not the issue here, but what has determined its rate and direction in history [112, p. 16]. How can societies foster innovation so that R&D investment, both public and private, has measurable, sustained and sustainable positive effects on employment and economic growth? Can innovation be described as a systematic, standardised and reproducible process? Can the same operational model be applied effectively across different nations, industries or regions, despite their idiosyncrasies? From a wider perspective, these appear to be important research questions because governments often actively engage in policies intended to support research, innovation and entrepreneurship. Within the European Union (EU 28), government efforts to foster innovation have been considerable, with the public sector accounting for 32.8% of Gross Domestic Expenditure on R&D (GERD), the higher-education sector accounting for 0.9% of GERD in 2012 [61,62] and R&D Expenditures accounting for 2.0% of GDP, on average, in 2013 [63]. Given these allocations of resources, one might expect that increasing R&D investment would induce higher economic growth and that encouraging knowledge-based entrepreneurship would generate additional employment [69,144], however this is not the case as, in particular, knowledge-based entrepreneurship has come short of its promise [119]. As shown by the "Swedish Paradox" and the so-called "European Paradox", increasing R&D investment and encouraging knowledge-based entrepreneurship are insufficient to foster employment and economic growth [7,22,58,147].

In light of the above considerations, the main purpose of this study is to show a clear path to development, based on innovation and creative destruction and on policies implemented at the regional level, uncovering the requirements for institutional developments – both economic and also political, and both public and private – which will lead to far-reaching positive economic change in open, competitive, free market environments [1]. We thus seek to fill in the gap between R&D efforts and the attainment of measurable, sustained and sustainable outcomes in terms of employment and economic growth. Based on the assumption that innovation is a 'place-based phenomenon', where specific investments pay off in the form of specific outcomes [22,97,121], this study seeks to address the following research questions:

- (a) Is it possible to identify the composite dimensions of RIS that can be adopted and managed as independent economic

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