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The exploitation of complementarities in scientific production process at the laboratory level

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Abstract

The paper analyses the scientific research production of more than 80 laboratories belonging to Louis Pasteur University, a large and well-ranked European research university. We study research organisation of the labs focusing on the structure of research personnel and outcomes. The paper proposes a typology of laboratories, which enables us to stress different design for research organisation. The main results show how appropriate combinations of research personnel may strongly influence the publication and patent productivity.

JEL classification: L31; 031; 032; 034; 038

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1. Introduction

This paper argues that the laboratory is the locus of many complementarities between researchers that should be taken into account to understand academic research organisation and production. In that respect, we depart from the literature in economics, which usually focuses on the individual level of analysis (Diamond, 1986; Levin and Stephan, 1991; Stephan, 1998). In the meantime, the literature recognises that complementarities are important to understand scientific productivity and scholars also repeatedly argue on the necessity to take into account the collective level of organisation and especially the laboratory level (Dasgupta and David, 1994; Stephan, 1996).

Nevertheless, there are only few economic empirical contributions devoted to the laboratory level of academic organisation. Joly and Mangematin (1996) build a typology of public laboratories based on three categories of variables: scientific production, type of funding and the research themes. They analyse the type of relationships each category of laboratory establishes with private partners. Laredo and Mustar (2000) develop a model for characterising the 'activity profiles' of labs based on their relative involvement in five different activities: production of certified knowledge, embodied knowledge, participation to competitive advantages, to public debates and involvement in the construction of public goods. Bonaccorsi and Daraio (2003) stress that the distributions of the average age of scientists in the labs and the size of the labs are correlated. In three out of six domains, they found that the size of the labs is negatively correlated with productivity.

The originality of our study resides mainly in the attention devoted to the structure and characteristics of both laboratory personnel (status, age, full-time research or teach-and-research position, non-researchers, subdisciplines, etc.) and laboratory outcomes (publication counts and distribution, co-publication behaviour and patent counts). Our work is based on an original and unique database concerning the research activity of more than 80 scientific labs belonging to Louis Pasteur University (ULP) of Strasbourg and, covering more than a decade.

We show that permanent and non-permanent researchers are complements: Professors tend to attract Ph.D. students and post-docs choose labs with highly

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recognised full-time researchers. Moreover, we observe that the labs that patent more are also those that publish with industry and with international co-authors. Even if some permanent researchers (university professors and un-promoted permanents) are less productive than others (full-time scientists), complementarities between them exist: the shares of the categories of personnel affect their productivity. For instance, an equal share of professors and full-time scientists stimulates productivity.

The paper is organised as follows. In Section 2, we underline the added value of the laboratory level of analysis. Section 3 offers information on the data and some descriptive statistics. In Section 4, we develop a correlation study: between the variables characterising the labour force of the research laboratories, between patents and publications and finally between input and outcome indicators. Section 5 presents the typology, which identifies five 'styles of research production process' at the lab level. The last section discusses our main results.

2. Literature review and expected added value of analysing scientific production at the laboratory level

This section aims to illustrate how the laboratory level of analysis may contribute to enrich our knowledge on academic research production, taking into account the characteristics of the researchers (the type of position, their age, their discipline, etc.) and of the laboratory (size, scientific prestige etc.) and also the diversity of their outcomes. We argue that different types of complementarities exist and may be better grasped at the laboratory level: between different types of researchers (2.1), between the various outcomes (patents and publications) (2.2), reputation externalities (2.3) and size of laboratories (2.4). For each effect, we review the empirical literature and infer possible implications for our analysis.

2.1. Complementarities between different types of researchers: positions and age

The sociology of science questions whether research and teaching in academia are complementary or competitive activities at the individual level. Some authors consider them as joint activities in the sense that one reinforces the other. Others regard them as "conflicting roles with different expectations and obligations" (Fox, 1992: p. 293). Fox (1992) used a survey based on a sample of social science faculties and showed that faculty members with high publication productivity exhibit strong interest in and commitment of time to research. They are not strongly involved in both activities, but favour research activities. Thus, her findings tend to prove that research and teaching are conflicting actions. If we follow her argumentation, it could be concluded that for productivity purposes it would be better to have full-time researchers instead of a majority of professorship positions.

In France, some scientists occupy full-time research positions and others are professors. At the laboratory level, it becomes interesting to analyse the advantages and shortages of each positions and to tackle the issue of a 'right proportion' of both types and of their complementarities. We will for instance show that university professors, generally less productive than full-time researchers, may enhance the productivity of the latter by driving Ph.D. students to them. This raises new questions in terms of access to non-permanent researchers (Ph.Ds and post-docs) and their impact on productivity. We will tackle this important issue, ignored by the specialised literature.

Some economists (Diamond, 1986; Levin and Stephan, 1991; Stephan, 1996; Weiss and Lillard, 1982; Zuckerman and Merton, 1972; Mairesse and Turner, 2002) focused on the publishing activity of scientists in life-cycle models, trying to explain the link between age and scientific production. They all show for various disciplines and scientists that publishing activity first increases, reaches a peak and declines.

At the laboratory level, the presence of different generations of scientists will probably induce collective effects. Thus, our investigation is no more related to the productivity trajectory over the life cycle but concerns the complementarities and reinforcing effects of researchers of different ages and the attractiveness of some labs. Bonaccorsi and Daraio (2003) develop this latter idea in their analysis of labs of the Italian National Research Council (CNR). They observe a negative relationship between productivity indicators and the average age of researchers. However, the average age of promoted permanents is not significantly related to productivity. According to them, the average age of researchers in a laboratory reflects its attractiveness and scientific vitality, following a virtual circle: Higher prestige institutions generally induce greater resource availability for young researcher positions and thus increases the attractiveness, etc.

2.2. Complementarities between outcomes

Stephan et al. (2002) analysed the patent activity of a sample of doctoral scientists and engineers, focusing on the relationship between patenting and publishing at the individual level both in academia and industry. Their main question was whether publications and patents were complements or substitutes. They first underlined that for the whole sample, less then 20% of scientists applied for at least one patent while 70% published at least one paper. For academia, these