



The impact of health research on length of stay in Spanish public hospitals



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ABSTRACT

Research is a key determinant of health improvement. However, there is little empirical evidence showing how the research conducted in hospitals affects healthcare outcomes. To address this issue, we used panel data of 189 Spanish public hospitals over the period 1996–2009 to estimate the causal effect of both clinical and basic research on hospitals' efficiency, measuring their impact on the average length of stay (LOS). We considered two fixed effects econometric models; one for medical and the other for surgical specialties respectively. Our results show that increases in the quantity of research produced in medical (surgical) disciplines contribute significantly to the reduction of hospital LOS in medical (surgical) specialties. This effect is greater for hospitals with higher absorptive capacity (high R&D investment and with teaching status). There is also clear evidence that basic research produces efficiency gains in clinical outcomes. Furthermore, we have identified other important determinants of hospitals' efficiency namely, hospitals' characteristics, human resources, diagnostic activity, hospital investment and hospitals' absorptive capacity. Finally, we evaluated the economic impact of increases in medical, surgical and basic research on hospitals' cost efficiency gains by measuring the corresponding reduction in the average cost of stay in Spanish hospitals.

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1. Introduction

To date, much attention has been paid to the evaluation of scientific research on health from the point of view of measuring the performance of scientific output (i.e., number of published papers) or scientific impact (i.e., number of citations, citations per document). This approach has played a pivotal role in the design of research policies or in establishing priority settings in health research. Nevertheless, in recent years, research policy has leaned towards a more stakeholder-oriented view that emphasizes the societal returns of research (Bornmann, 2013). Consistently, there is a need for new approaches capable of measuring the “real” effects of research on society (Smith, 2001; Cozzens, 2000; Patel et al., 2011).

In the case of health-related research, its societal impacts can be observed in many aspects such as the development and improvement of new drugs and health technologies (Toole, 2007), or the creation of spin-offs (Haeussler and Colyvas, 2011; Quilter-Pinner

and Muir, 2015). However, one of the most relevant returns from research conducted in hospitals is the improvement of clinical outcomes such as a reduction in length of stay (henceforth LOS), which has both direct and indirect effects on cost reduction and other efficiency gains.

In this context, the main aim of this paper is to explain the effects of research carried out in hospitals on their average LOS, and subsequently, on hospital costs. Formally, LOS is the term used to measure the duration of a single episode of hospitalization (Preedy and Watson, 2010). There are many indicators commonly used for measuring clinical outcomes. However, there is a lack of consensus among experts as to what constitutes a healthcare outcome (Porter, 2010). Our decision to choose LOS as the dependent variable to be explained by our models is based on three reasons: (i) LOS is a standard measure commonly used in health care management and is available for any hospital in any country; (ii) this characteristic favors comparability among different studies; (iii) LOS is an outcome that can be translated in terms of economic cost, which allows extracting policy recommendations.

We describe the mechanisms through which research output improves healthcare outcomes taking advantage of two approaches: the translational research approach (*direct channel*) and the absorptive capacity approach (*indirect channel*). On the

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one hand, the translational approach shows that clinical research bridges the gap between the lab and the patients. Under this mechanism, clinicians apply the knowledge generated in earlier stages of research (i.e., basic, preclinical, clinical trials, etc.), contributing to fostering treatment improvements. On the other hand, research output, as well as training and R&D, generate increases in the overall hospital's absorptive capacity, which facilitate the assimilation and the transformation of the global knowledge generated by different sources inside and outside the hospital in effective routines and treatments.

To measure research activities, we considered both research output (i.e., number of documents), and research impact (i.e., citations per document and average quality of journals through the *SCImago Journal Rank* –SJR). We noticed that there are several types of research carried out in hospitals. For this reason, we first distinguished between clinical and basic research. While basic research is conducted in laboratories, clinical research focuses on the study of health and disease in people, which is the way surgeons and physicians learn to prevent, diagnose and treat disease. Second, we divided clinical research into three categories: i) medical research; ii) surgical research, which includes four surgical-medical specialties; and iii) other research, which comprises such specialties as Health Services Research (HSR), Epidemiology, etc.

To achieve our goals, we built a panel of 189 Spanish hospitals for the period 1996–2009, and we estimated two fixed effects models, one for medical and the other for surgical specialties that control for unobserved heterogeneity at hospital level. Unlike other studies, we followed a panel data approach that controls for other important variables affecting LOS and would therefore allow us to discuss a causal relationship from research to clinical outcomes. In such analysis, we can isolate from other factors the impact of changes over time in scientific production on changes in LOS. *Our basic claim is that, for a given hospital, an increase in its scientific output leads to a reduction in its LOS.*

First, we found that increases in the extensive measures of research output such as the number of articles published in medical (surgical) specialties have a significant causal effect on the reduction of LOS in medical (surgical) specialties. Second, we showed that intensive research output in terms of citations per article in surgical specialties also has spillover effects on the reduction in LOS of medical specialties. Last, we found strong evidence supporting the hypothesis that conducting basic research causes reductions in LOS.

Furthermore, we also obtained stronger effects in hospitals having high absorptive capacity. That is, in those hospitals that are investing in R&D, have a teaching status and have more skilled physicians.

Finally, we estimated the cost reduction due to the decrease in LOS from research performance by using the cost per day estimations provided in Peiró et al. (2007). We found that an increase in one standard deviation in the number of published articles in medical (surgical) specialties, would lead to direct saving around €123 million (€79.5 million) per year at national level.

Our results raise important policy implications that question recent budget cuts in basic as well as clinical research in certain countries like Spain, which may end up generating significant increases in medical costs in terms of the corresponding increases in LOS.

The paper is structured as follows. Section 2 provides a brief review of the literature, the research questions of interest, and the main hypotheses we would like to test as well as the underlying mechanisms connecting research output with healthcare outcomes. In Section 3, we describe the panel database and the econometric fixed effects methodology to analyze the causal effects of scientific research on healthcare outcomes. In Section 4, we show the empirical results obtained from the econometric models discussed in the previous section. In Section 5, we carry out some

extensions of the analysis for testing the effect of basic research on healthcare outcomes as well as to analyze the key role played by hospitals' absorptive capacity. In Section 6, we include the cost evaluation of the efficiency gains in terms of reductions in LOS. Finally, Section 7 presents the main conclusions of the paper and some final remarks.

2. Background and motivation

In this section, we focus on three relevant aspects that will help us understand our approach and the empirical results obtained. First, we establish the current state of the art in the measurement of healthcare outcomes. This is important for justifying our choice of LOS as the proxy for medical outcomes in our models. Second, we provide a comprehensive description of the related literature, and finally, we state the theoretical underpinnings to our hypotheses of interest.

2.1. Healthcare outcome measurement and length of stay (LOS)

Although there is a broad set of healthcare outcome indicators, there is still a lack of consensus as to what constitutes a proper healthcare outcome measure (Porter, 2010). In his analysis of the state of the art of this topic, Porter found significant limitations in the way healthcare outcomes were measured. He concluded that as a service, health outcomes should be measured from the patients' point of view. However, the most commonly used indicators are devised from the healthcare providers' point of view. Porter, also suggested that healthcare providers usually tend to measure those indicators that can be most easily tracked (Porter, 2010).

In this paper, we selected Length of Stay (LOS) as the proxy for healthcare outcome. This variable is commonly used as an indicator of efficiency (OECD, 2015). All other things being equal, a shorter stay will reduce the cost per discharge. In the paragraphs below, we justify this decision and discuss the main advantages and limitations of this measure.

LOS has substantial advantages from the methodological point of view. First, it is a commonly used indicator in all Healthcare Systems, and it is available for any hospital in any country. This favors reproducibility and comparability among different studies. Second, LOS is strongly correlated with total hospitalization costs (OTA, 1983). Total hospitalization costs can be calculated by multiplying average LOS by average cost per day:

$$\text{Total hospitalization cost} = \text{Cost per day} \times \text{LOS}$$

The use of this variable thus facilitates the measure of the effect of research on healthcare costs. In this paper, we used the *Cost per Day* estimated in Peiró et al. (2007) to extract policy recommendations.

Regarding the limitations and caveats of LOS as an outcome measure, some authors have pointed out that healthcare providers could have incentives to discharge patients sooner, which may distort the measure of LOS as a proxy of healthcare outcome (Lave and Frank, 1990). Premature discharge could be a source of increased cost since it leads to greater readmission rates and, therefore, to total expenses. In this study, this limitation is not present since our dataset comprises only Spanish public hospitals where there are few, if any, incentives to discharge patients prematurely.

2.2. Literature review

The measurement of societal return from health research is difficult but important since it provides essential information for policy making (Smith, 2001). In recent years, research policy stakeholders have emphasized their interest in knowing the societal returns

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