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Productivity growth, case mix and optimal size of hospitals. A 16-year study of the Norwegian hospital sector

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ABSTRACT

Background and objectives: This paper analyses productivity growth in the Norwegian hospital sector over a period of 16 years, 1999–2014. This period was characterized by a large ownership reform with subsequent hospital reorganizations and mergers. We describe how technological change, technical productivity, scale efficiency and the estimated optimal size of hospitals have evolved during this period.
Material and methods: Hospital admissions were grouped into diagnosis-related groups using a fixed-grouper logic. Four composite outputs were defined and inputs were measured as operating costs. Productivity and efficiency were estimated with bootstrapped data envelopment analyses.
Results: Mean productivity increased by 24.6% points from 1999 to 2014, an average annual change of 1.5%. There was a substantial growth in productivity and hospital size following the ownership reform. After the reform (2003–2014), average annual growth was <0.5%. There was no evidence of technical change. Estimated optimal size was smaller than the actual size of most hospitals, yet scale efficiency was high even after hospital mergers. However, the later hospital mergers have not been followed by similar productivity growth as around time of the reform.
Conclusions: This study addresses the issues of both cross-sectional and longitudinal comparability of case mix between hospitals, and thus provides a framework for future studies. The study adds to the discussion on optimal hospital size.

1. Introduction

In the past 20 years, many countries have undergone large changes in the way health care is organized, financed and delivered. Under the umbrella of new public management, there has been an increase in quasi-markets, choice and competition, and increased use of activity- and results-based financing. In traditionally public tax-based systems, such as the UK and Norway, public hospitals have been reorganized into trusts with a large degree of autonomy [1,2]. At the same time, several countries have pursued a policy of centralization, both in terms of exploiting perceived scale efficiency in the provision of services and by

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shifting power from local to central authorities [2,3]. The recession in 2009 spurred a policy of fiscal austerity that has put health care, together with other publicly funded welfare services, under pressure.

Health care reforms, as well as increased fiscal pressure, infer an increased focus on how resources allocated to health care are used. Efficient use of available resources is an important policy goal in all health care systems. Regulators and policy makers will typically be interested in the level of productivity, whether and at what rate productivity increases or decrease over time, and the relationships between productivity and different regulatory, structural and financial policy measures. Hospitals constitute a major part of the health care sector; therefore, policy makers are particularly interested in assessing their performance. However, comparisons of productivity across hospitals are inherently difficult because of differences in case mix. Differences in case mix are often controlled for by using patient classification systems such as the diagnosis-related groups (DRGs) when describing hospital activity [4].

In this paper, we describe and discuss how hospital productivity has evolved in Norway from 1999 to 2014. Our analysis of this 16-year period enabled us to look at productivity from the long-term perspective of a period that included one major health care reform. Before 2002, all hospitals were owned and operated by the counties, and the hospitals had long waiting times and large deficits. The counties could not levy taxes themselves, so there was gaming of the budgeting and consequently soft budgeting as additional funding was provided by the central government [3,5,6]. In 2002, hospital ownership was transferred from 19 counties to the central government, and the responsibility for the provision of services was given to five (currently four) regional health authorities. The regional health authorities organized hospitals through hospital trusts.

Following the reform, there was major structural changes as the number of hospital trusts has decreased through mergers and reorganizations. Some minor hospitals that were located near larger hospitals were closed after mergers and reorganization of services. As a result, several hospital trusts are now multi-sited hospitals, and some even administer several multi-sited hospitals. According to Jacobs et al. [7], entities used in productivity analyses must have discretion about the conversion from inputs to outputs, must capture the entire production process and must be comparable. This applies to hospitals, hospital trusts and multi-site hospital trusts. Throughout this paper, we denote the organizational units as "hospitals" while acknowledging that these units often encompass several locations or physical hospitals.

This paper comprises three parts. First, we propose a way of describing hospital activity that captures both longitudinal and cross-sectional differences in case mix. This is crucial for capturing the effects of changes in treatment procedures on hospital productivity and enables us to relate the observed changes in productivity to the institutional and structural changes that have taken place during this period. In addition to the hospital reform in 2002, there has also been a substantial transition from inpatient to day care and outpatient treatment. To determine the long-term effects of reforms and policy changes, it is important to use data over a long time span. This is not commonly done, and most hospital efficiency analyses are either cross-sectional or span 1 year before and 1 year after a reform [8,9]. In this analysis, we used data envelopment analysis (DEA) with a long time series and case mix-adjusted output measures. A long term approach was also presented by Halsteinli et al. [10], who used data for 9 years in their analysis of child and adolescent mental health services, and that of Biørn et al. [11], who used a 10-year span when evaluating a hospital financing reform. However, these two Norwegian studies did not adequately adjust for potential longitudinal changes in case mix.

Second, we estimate Malmquist indices [12,13] to analyse to what extent the observed changes in productivity resulted from technical change (the best becoming better) or from changes in relative efficiency ("catching up"). Technical change is based on the performance of the best practice hospitals and it is as such it is often the result of a general development rather than the institutional environment or local policy initiatives. Thus, the relative share of the catching up and technical change elements provide an indication of the relationships between institutional environment, policy measures and provider performance.

Third, following the reform in 2002, the average hospital size has increased substantially, through reorganizations, mergers and hospital closures. There are arguments both for economies and diseconomies of scale in the literature [13–15], and we measured scale efficiency and estimated optimal scale and tracked the changes in these variables.

It is difficult to hypothesize the effects of the reform on catching up or technical change because the reformed implied both centralization and decentralization. If the governance of hospitals is strengthened, we might expect increased homogeneity in the results and thus reduced variance behind the frontier. However, technical change may not necessarily coincide with the reform if efficient hospitals already have exhausted their potential for improvement.

2. Materials and methods

2.1. Measuring hospital inputs and outputs

There are two issues that must be dealt with in an analysis of productivity growth. First, differences in case mix *between hospitals* must be adjusted for. Relative cost-weights (DRG prices) can be used to aggregate individual episodes into larger groups of hospital activity. However, such aggregation requires the assumption that relative treatment costs are independent of hospital case mix and size. Moreover, the results are usually sensitive to the type of case-mix adjustment that is chosen [8,16–18]. Too many output categories can artificially inflate the number of efficient hospitals because rarer combinations of outputs determine the estimated best-practice front. Using all DRG groups as output dimensions would give no degrees of freedom because the number of DRGs would surpass the number of hospitals. A different approach would be to aggregate all hospital activity into one group, but that would underestimate differences between hospitals. Our