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A methodological approach to aggregate multiple measures of hospital quality using variance-based weights

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Key Findings

- The composite index specifies an indirect measure of hospitals' performance.
- The Accelerated Failure Time system of regressions is more efficient compared with the widely used generalized linear models (GLM) that rely on dichotomized data.
- Variance weights elicitation is data driven and less exposed to bias of normative approaches.
- Risk adjustment and acute cardio vascular events (CVE) prevent selection bias and "cherry picking".

What Problem Was This Research Addressing?

Quality of care can be defined as "health improvement in relation to the best possible outcome that could have been achieved with the application of the current medical knowledge". Essentially, the health benefits on health outcomes stem roughly from three levels: the individual level; the health care provider level that includes hospitals; and the socio-cultural context. The main objective of this study was to develop and validate a composite index to assess quality of hospital care and to observe how the variability in performance is distributed across German providers. Moreover, we attempt to rank the hospitals into league tables. In particular, we observed how the hospital ownership affects the outcomes. In order to assess the quantity of stochastic variation attributable to hospitals, the index requires: (a) different quality dimensions measurable by using distinct indicators, (b) indication-specific risk adjustment and (c) aggregation of different quality dimensions.

What This Research Adds

The methodology applies a likelihood-based Accelerated Failure Time (AFT) model and controls for correlation across different outcome indicators by a simultaneous equations estimation. The variance-based weights aggregate different quality indicators into a single composite index. The advantage of the aggregation based on statistical weights is twofold. First, the variance weights rely on the precision of the estimation. In fact, each indicator contributes more to the aggregated quality index when it has less variance. Second, the weights reduce the effects of heteroscedasticity. More important, data driven weights are robust to normative weights approaches. A viable two-stage procedure to derive hospitals' quality indicator was already suggested by Chua et al. in 2010. Unlike the linear regression based on dichotomized data adopted by Chua, the AFT model included two outcomes, mortality and readmissions, and accommodates time as 'endogenous'. Yet, two quality outcomes were aggregated across four cardiovascular events (CVE) by distinctively controlling for intervention-specific risks.

Methods

For the analysis, we obtained access to the administrative databases of a large German sickness fund. We exploited patient level data from 2005 to 2017. In the first stage of the AFT model, we simultaneously estimated eight equations (i.e., one equation for outcome and intervention). We controlled for patient characteristics, outcome- and intervention-specific

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hospital covariates, hospitals' geographical location and GDP per capita at regional level.

The variance-covariance matrix from the first step regression is not an identity matrix, since we allowed for correlation across outcomes and interventions. The weights were manually computed as the inverse of the first step variance. Hence, holding the heteroscedasticity assumption, we estimated the second step AFT by using a weighted regression. Moreover, we replaced the matrix consisting of outcome- and intervention-specific hospital 'fixed' effects in the first AFT, with the hospitals' ID dummies. Thus, we interpreted the hospitals' estimates and the confidence intervals (CI) in the second step AFT, as the adjusted measure of hospitals' performance, expunged of the effect of case-mix and providers' characteristics. For readability, we standardized the aggregated hospital quality parameters and the corresponding confidence intervals into a scale between 0 and 10. In order to test for internal validity, we run a sensitivity analysis.

Research Findings

The AFT results presented a significant negative association between teaching hospitals' bed capacity and time to event. In particular, each extra bed was associated with a 1% decrease in expected time to death or readmission. Regarding the hospitals ownership, for private hospitals the time to readmission or death resulted shorter than non-private hospitals (-16%). The West Germany providers exhibited an expected time to event 57% faster than hospitals located in East Germany. The yearly GDP per capita was significant; however, the magnitude of the negative coefficient was close to zero. As expected, the precision-based weights were higher for mortality than readmission in all CVE. The results appeared consistent with the clinical literature. Based on the AFT hospitals' parameter estimates and CI, we built the hospitals' rank. (Figures 1 and 2). All the values less or equal to the mean performance estimate (4.35) denote a poor performance and are labelled as top1, conversely, the hospitals scoring greater or equal to 4.35 are grouped into the higher performance cohort, labelled as top3 (Figure 1). As expected, teaching hospitals performed better than non-teaching, with an average rank of 4.55. In terms of hospital ownership, private non-profit hospitals revealed the highest mean estimate (4.53), as compared to private and public hospitals (Figure 2).

Policy Relevance of Research

- The variance based AFT method can aggregate several dimensions of health care outcomes.
- The quality index can foster quality-based competition in a competitive hospitals' market.
- The standardized method may support monitoring purposes in imperfect healthcare markets.
- A statistical tool based on precision of estimates may address patient's hospital choice.

Figure 1. Aggregated hospital quality with hospitals' ranking. top1= red top2=grey top3= green.

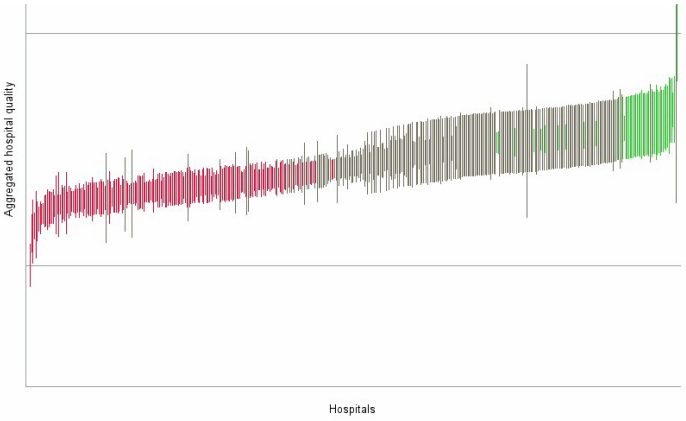
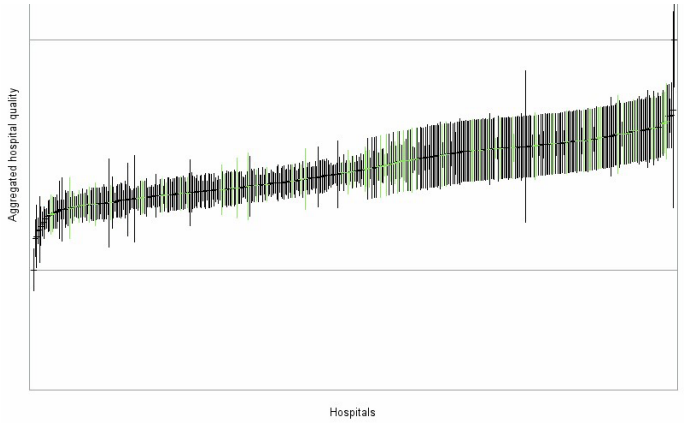


Figure 2. Aggregated hospital quality. Index range from zero to 10.



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