A TOTEX Malmquist Index for RPI-X Regulation

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Overview

Price-based network regulation aims to mimic competition by setting a prescribed revenue path for regulated firms independent of their actual cost levels. The basic formula is known as RPI-X regulation, which goes back to the seminal paper of Littlechild (1983). The two terms in the simplified RPI-X formula are the retail price index (RPI) and the sectoral productivity growth (X), which captures the frontier shift. The regulatory problem is to accurately determine X, based on incomplete and asymmetric information on cost, productivity change, input and output quantities and prices.

The common regulatory practice is to apply the Törnquist index. The weakness of this method is that it cannot distinguish between a frontier shift and catch-up effects. The Törnquist index will overestimate the frontier shift, if firms improve their technical efficiency over time. As an alternative, the Malmquist index addresses precisely this problem and distinguishes analytically between frontier shift and catch-up effects. There is quite a bit of literature on the Malmquist index in a general context, but hardly so in the context of network regulation. The paper contributes to regulatory theory and practice as it examines the question whether the Malmquist index can be usefully applied in setting the X-factor in RPI-X regulation of monopoly.

The X-factor consist of two components, the input prices index (Δw) and the sectoral change in total factor productivity (ΔTFP). The difference of both, Δw- ΔTFP, gives the efficient cost change (ECC), which is the theoretically correct revenue adjustment patch, if perfect competition is the ideal reference. The cost Malmquist index, derived by Maniadakis & Thanassoulis (2004), can calculate both terms in combination by applying benchmarking techniques like data envelopment analysis (DEA). However, this requires data on input prices and quantities. What if the regulator only has information on aggregated total cost (TOTEX)? For this case, a TOTEX Malmquist index is derived, which only utilizes TOTEX data, while ignoring individual price and quantity information. This results in the total cost change (TCC).

This paper makes two innovations. First, it develops and defines a TOTEX-Malmquist index which can be applied by regulators in absence of input price and quantity data. Second, it analyses the accuracy of the TOTEX-Malmquist from a theoretical point of view; in other words, which information on the true frontier shift gets lost, if we do not have data on input prices and quantities, but only on TOTEX?

Methods

The innovation of the cost Malmquist index (Maniadakis & Thanassoulis, 2004) is that it introduces price and quantity data to the traditional production Malmquist index (Malmquist, 1953). By moving from a production to a cost approach, both regulatory terms, Δw and ΔTFP, can be measured in combination, instead of only addressing technical change (ΔTFP). However, in absence of separate price and quantity data of the regulated firms, a precise measurement and decomposition of the cost Malmquist index is not possible, since changes in allocative efficiency (adjusting input quantity ratios to factor price ratios) cannot be isolated.

Taking account of the limited cost information of regulators, the TOTEX Malmquist only utilizes aggregated TOTEX data. It basically combines the production and cost Malmquist by applying a production Malmquist with TOTEX as the only input. Doing so, the TOTEX Malmquist ignores issues of allocative inefficiency. Within this paper, we analyse the accuracy of the TOTEX Malmquist as a regulatory means to approximate the true frontier shift, the ECC. The theoretical analysis is based on of a linearly homogenous cost function. We investigate two different scenarios under which distortions may occur. The first scenario relates to the assumptions regarding

allocative efficiency of the "best practice" firms in the sample of regulated firms, while the second scenario addresses the potential effect of groups of firms facing different input prices.

Results

For the first scenario we assume that all firms face the same input prices, but firms may be technically or allocatively inefficient. We find that the TOTEX Malmquist index leads to an undistorted measure for the true frontier shift only if the frontier in benchmarking is set by firms which are either technically and allocatively efficient in both periods or if their inefficiencies stay constant over time. The problem of the TOTEX Malmquist is that by disregarding input prices and quantities it cannot identify changes in allocative efficiency of the frontier firms. Hence, if the best practice firms in the sample realize a positive catch-up effect in allocative efficiency, this will wrongly be assigned to the frontier shift. The true frontier shift will then be overestimated.

The second scenario assumes technically and allocatively efficient frontier firms, but allows for two groups of firms facing different input prices. Again, the problem of the TOTEX Malmquist is that factor price effects cannot be isolated. A distortion occurs, if a firm is benchmarked against pears with lower input prices. For example, assume that a regulatory regime covers firms in two structurally or geographically different areas, and that wages increase faster in one area than in the other. The TOTEX Malmquist index cannot identify this difference. Instead it calculates an average for both areas, with the result that the frontier shift is overestimated in one area and underestimated in the other. The analysis shows that the TOTEX Malmquist is only undistorted, if factor prices of both groups change by the same proportion.

Conclusions

The TOTEX Malmquist index may be used by regulators as an approximation for the cost frontier shift, which is the efficient cost change ECC. The advantage of this approach is evident: the regulator can make use of data it already has instead of relying on external data bases which may be inconsistent or not even available. Moreover, the technical change and the input price changes can be calculated in combination, which directly gives an approximation of the regulatory term "$\Delta w - \Delta TFP$".

However, this simplicity comes at a cost: the quality of the Malmquist calculation critically depends on the data for a limited number of firms, which are identified as best practice firms in the benchmarking procedure. These pears form the basis for calculating productivity shifts over time, and both allocative and technical inefficiencies may lead to biased estimations of the true productivity shift.

The assumption of technical efficiency for some firms in the sample is required for all Malmquist approaches and seems plausible given there is an effective regulatory regime in place. However, the limitation of the TOTEX Malmquist is that in contrast to the cost Malmquist index it disregards prices effects and therefore allocative inefficiency. Given long-lived capital assets especially in case of network industries, an instant adjustment of inputs to changing factor prices is unlikely even for best practice firms in the sample. Hence, the TOTEX Malmquist only gives an undistorted approximation for the true frontier shift if there is no catch-up effect of the pear firms. In case of significant price effects, a distortion can only be avoided by collecting data on input prices and quantities and applying a cost Malmquist index.

Similarly, if firms are facing different input prices, distortions may occur if firms are compared to pears with lower prices. The TOTEX Malmquist is unbiased only if factor prices change by the same proportion. Otherwise, a distortion may be avoided if different price groups can be identified and the TOTEX Malmquist is applied separately to these different groups. In practice, we would assume however that severe cases of asymmetric development of input prices are known and can be addressed on an ad-hoc basis.

References

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