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EXPLAINING TOTAL FACTOR PRODUCTIVITY GROWTH IN GERMAN DAIRY FARMING: A MALMQUIST INDEX ANALYSIS

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Abstract

This study assesses the total factor productivity (TFP) growth for a sample of North-Rhine Westphalian dairy farms over the periods 2007-2014 and provides first-hand evidence of productivity growth of these farms before the milk market is liberalised. As first step a non-parametric Malmquist approach is therefore used to identify the productivity indices. The second step includes a panel regression to shed light on determinants of TFP growth. Expected results will show how TFP growth is influenced by their core components and which exogenous drivers affect the productivity growth.

Keywords

Total factor productivity, Malmquist-Index, dairy farms, DEA.

1 Introduction

In the European Union market liberalisation force farmers to improve their productivity and efficiency of the given resources to maintain high competitiveness. These policy changes will have a considerable effect in Germany, especially because milk production has historically been one of the main production lines in German agriculture comprising for 17 % of the value of agricultural output. That is why the analysis of productivity growth plays a major role for policy makers as well as for consulting services. A few recent studies have investigated productivity change in dairy farming in Germany (BRÜMMER ET AL. (2002), KELLERMANN AND SALHOFER (2011), SAUER AND LATA CZ-LOHMANN (2015)). This study, first, estimates Malmquist indices by using the well-known Data Envelopment Analysis (DEA) with employing SIMAR WILSON'S (1999) bootstrapping procedure. Second, the bootstrapped Malmquist indices are used in a second stage regression to investigate factors influencing the dynamic productivity growth.

2 Data

The data used in this study was provided from the chamber of agriculture which gathered the financial statements as well as information about the bio-technological system. The extensive dataset consists of 650 dairy farms from North-Rhine Westphalia which are observed over the period from the financial year (FY) of 2007/08 to FY 2014/15. These farms have the same milking technology which ensures that all are part of the same production technology. The dairy farms were modelled with respect to an economic livestock balance sheet which is containing all factors of production. As complement all proceeds from milk production were accounted for in the output variable. The input vector consists of labour, depreciation, feed, number of cows and intermediates which accounts all relevant input factors. Monetary inputs and outputs variables were deflated using price indices from the Federal Statistical Office.

3 Methodology

The assessment of total productivity growth will be conducted by using Malmquist productivity index, which was pioneered by CAVES ET AL (1982) and further developed by FÄRE ET AL. (1994). For each company, the output-orientation Malmquist productivity index is defined following COELLI ET AL. (2005):

$$M_o(x_{i,t}, y_{i,t}, x_{i,t+1}, y_{i,t+1}) = \frac{d_{t+1}^o(x_{t+1}, y_{t+1})}{d_t^o(x_t, y_t)} * \left[\frac{d_t^o(x_{t+1}, y_{t+1})}{d_{t+1}^o(x_{t+1}, y_{t+1})} * \frac{d_t^o(x_t, y_t)}{d_{t+1}^o(x_t, y_t)} \right]^{1/2} \quad (1)$$

The notation $d_t^o(x_{t+1}, y_{t+1})$ represents the output distance from the period t+1 observation computed using period t technology as reference technology. The TFP rate is given by M_o . Values less than one indicate a TFP decline from period t to period t+1 while values greater than one show a positive TFP growth. In equation (1) the Malmquist index can be decomposed into efficiency change and the technological change. The computation of the Malmquist Index requires the derivation of numerical measures for the distance function. Therefore two main approaches exist in literature namely the Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA). The SFA has the potential advantage to separate noise in the data from genuine variations in efficiency whereas the DEA attributes all measurement errors to inefficiency. In contrast based on the non-parametric character of the DEA there is no need for specifying a functional form for the production frontier which reduces the risk of misspecification. This in mind, the study uses the DEA to compute the output distance functions under output-orientation and variable returns to scale assumption. A further drawback of DEA is that the results may be affected by sampling variation. To account for this the study makes use of the bootstrapping method proposed by SIMAR AND WILSON (1999, 2000). Afterwards the bootstrapped Malmquist indices will be used in a second stage panel regression model to investigate the determinants of the productivity changes of the dairy farms.

4 Expected Results

The main findings will consist of two major parts. First, the analysis of total factor productivity growth and its components will give a clear indication how farms performed in the years before the market liberalization. Second, the results will show which exogenous determinants of the biological system influence the bootstrapped Malmquist indices most. This provides policy makers as well as farm consulting services useful insights about major causes of productivity growth and in which way farm's productivity can be improved.

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