Lithuanian Institute of Agrarian Economics

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ADVANCED ANALYSIS OF EFFICIENCY OF LITHUANIAN AGRICULTURAL SECTOR

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INTRODUCTION

An important aim of much economic research is to ensure proper allocation of resources, leading to social and economic welfare (Latruffe, 2010). Various methodologies are available to identify best practice. Performance management aims at identifying and emulating best practices within an organization, sector, or the whole economy. Relative performance evaluation, benchmarking, entails systematic comparison of one production entity (decision making unit) against other entities (Bogetoft, Otto, 2011). According to Jack and Boone (2009) benchmarking can create motivation for change; provide a vision for what an organization can look like after change; provide data, evidence, and success stories for inspiring change; identify best practices for how to manage change; and create a baseline or yardstick by which to evaluate the impact of earlier changes.

The agricultural sector is important in terms of both social and economic development in many countries, and is furthermore heavily influenced by both public support schemes as well as regulatory regimes. The application of appropriate benchmarking techniques is especially important for inducing sustainable agricultural development. Furthermore, productive efficiency improvements might result into lower costs as well as greater profit margins for producers as well as better prices for the participants in the agricultural supply chain (Samarajeewa et al., 2012). Nauges et al. (2011) presented the following factors stressing the need for research into agricultural efficiency. First, agricultural producers typically own land and live on their farms, therefore the standard assumption that only efficient producers are to maintain their market activity usually does not hold in agriculture; moreover, suchlike adjustments would result in various social problems. Second, policy interventions are available, such as education, training, and extension programmes, that can potentially increase the efficiency. Third, policy issues relating to farm structure and production practices are of high importance across many regions.

Benchmarking analysis necessitates understanding of terms like effectiveness, efficiency, and productivity. Effectiveness can be evaluated when utility or objective functions are defined (Bogetoft, Otto, 2011). In real life, however, this is typically not the case and the ideal behaviour can be described only by analysing observed data, i. e. by means of benchmarking. Efficiency is then defined as the performance of a production entity relative to the best practice identified through benchmarking. Finally, productivity means the ability to convert inputs to outputs. A distinction can be made between total factor productivity (Solow, 1957) and partial (single factor) productivity. Productivity growth is a source of a non-inflatory growth and should be encouraged, facilitated by means of, e. g., benchmarking and efficiency management.

According to Alvarez and Arias (2004) and Gorton and Davidova (2004), frontier techniques are the most widely applied methods for efficiency measurement in agriculture. The frontier methods can be grouped into parametric and non-parametric approaches. Thiele and Brodersen (1999) used Data Envelopment Analysis (DEA) to analyse the underlying differences in efficiency as regards East German and West German farms. Brümmer (2001) employed DEA and stochastic frontier analysis (SFA) to analyse the efficiency of Slovenian farms. Brümmer et al. (2002) utilised SFA to analyse the changes in total factor productivity in dairy farms across Germany, Poland and the Netherlands. Rasmussen (2011) employed the same method for analysis of the Danish farms. Bezlepkina and Lansik (2006) utilised DEA in a two-stage framework to analyse the impact of financial indicators upon technical efficiency in Russian farms. Later on, Bojnec and Latruffe (2011, 2013) analysed the relationships between size and efficiency of Slovenian farms. Bojnec and Fertő (2013) employed SFA to analyse the relationships between efficiency and off-farm income. Latruffe et al. (2004, 2005) employed the bootstrapped DEA along with the SFA to estimate the efficiency of Polish farms. Balcombe et al. (2008) analysed the determinants of the total factor productivity change in Polish farms. Davidova and Latruffe (2007) related the Czech farm efficiency to the financial indicators. Latruffe et al. (2008) utilised the double bootstrapping methodology to assess the Czech farm efficiency. Chaplin et al. (2004) analysed the efficiency of Polish, Czech, and Hungarian farms. Latruffe et al. (2012) compared the Hungarian and French farm performance by the means of DEA and meta-frontier approach. Baležentis and Kriščiukaitienė (2013) analysed the determinants of Lithuanian family farms' efficiency by the means of the Tobit model, whereas Baležentis et al. (2014) employed the bootstrapped DEA and the non-parametric regression for the latter purpose. Fousekis et al. (2014) utilised the conditional framework to analyse the performance of Greek olive farms. Rahman and Salim (2013) employed the Färe-Primont index to analyse the TFP growth in the Bangladesh agriculture. There are also a number of appliactions of DEA (Aristovnik, 2012), SFA (Aysan et al., 2011; Chou et al., 2012; Zhan, 2012), and deterministic frontiers (Bilgin et al., 2012) outside the domain of agriculture.

Topicality of the research. Family farming has played an important role in Lithuania since early 1990s when the collective farming system was deconstructed. Since then the Lithuanian farming system has undergone many economic, structural, and institutional reforms. Year 2004 marked the accession to the European Union (EU) which is related to the Common Agricultural Policy. The Lithuanian farming system, however, is not fully developed yet. In terms of the utilized agricultural area, the average Lithuanian farm expanded from 9.2 ha up to 13.7 ha during 2003–2010, whereas the total utilized agricultural area increased by some 10% and the number of agricultural holdings decreased by 27% from 272 000 in 2003 down to less than 200 000 in 2010 (Statistics Lithuania, 2014). Indeed, the number of the smallest farms has decreased and these adjustments lead to a farm structure which begins to resemble that of other European countries. There is, however, a substantial area of state-owned or abandoned land which can be employed for agricultural activities in the future. Therefore it is important to analyse farming efficiency which might impact a number of factors influencing farmers' decisions.

Research problem. The present research is motivated by both the importance of efficiency measurement and the lack of suchlike studies in the Lithuanian context. The Lithuanian farming system is still underperforming compared to western standards. For instance, the aggregate results from the Farm Accountancy data Network show that the yields of maize and milk in Lithuania amounted to some 71% and 65% of those in Denmark, respectively (as of 2012; see European Commission, 2015). Thus, it is important to identify individual farms, or certain types of farms which are the forerunners vis-à-vis laggards in terms of operating efficiency. Furthermore, both public and private investments are needed in the Lithuanian agricultural sector to improve its efficiency and productivity (OECD, FAO, 2011). To be specific, some 2.287 billion EUR were assigned under the Lithuanian Rural Development Programme for 2007–2013. The appropriate allocation of such investments, does, however, require a decision support system based and, consequently, it is important to develop benchmarking frameworks and integrate them into the processes of the strategic management. The forthcoming programming period of 2014–2020 together with the new Rural Development Programme will certainly require suchlike management decisions. Up to now, only a handful of studies have attempted to analyse the farming efficiency in Lithuania (Rimkuvienė et al., 2010, Baležentis, Baležentis, 2011; Baležentis, Kriščiukaitienė, 2012a). Moreover, these papers were focused on diachronic analysis or different farming types were analysed by employing single–period data. Another issue to be tackled is post–efficiency analysis. Indeed, the uncertainties associated with the agricultural production data do also require appropriate techniques for efficiency estimation.

The research **aims** to develop an integrated framework for measurement and perform an analysis of the productive efficiency of Lithuanian family farms and identify related implications for efficiency improvement. The proposed framework is mainly based on non-parametric frontier methods. The following **tasks** are, therefore, set: (i) to present the research methodology for efficiency analysis, (ii) to develop appropriate techniques for analysis of agricultural efficiency; (iii) to estimate the technical efficiency of Lithuanian family farms by means of non-parametric techniques, (iv) to analyse the underlying technology as well as its shifts, and (v) to quantify the impact of the efficiency and productivity change effects. The **object** of the research is Lithuanian family farms reporting to the Farm Accountancy Data Network.

Novelty of the research. The research features both empirical and theoretical novelty in that it develops some new techniques for efficiency analysis and employs them to analyse the performance of Lithuanian family farms. Specifically, the hybrid method DEA-MULTIMOORA is introduced to analyse the TFP changes with respect to multiple criteria. In addition, the fuzzy FDH method based on α-cuts is suggested to tackle the uncertainty associated with the production data. The MEA method is extended to meta-frontier analysis. Considering the empirical novelty, the research develops and employs a systematic framework for the analysis of the agricultural sector in terms of the efficiency and TFP measures. The research thus estimates the technical, allocative, and cost efficiency of Lithuanian family farms. A variety of TFP indices, viz. Malmquist, Hicks-Moorsteen, Färe-Primont, Malmquist-Luenberger indices, are employed to estimate the TFP change as well as bias of the production frontier. The factors driving the change in the analysed variables are also identified by employing regression and multivariate statistics. Furthermore, the optimal farm size is estimated by the means of DEA. Noteworthy, these measures have not been estimated for Lithuanian family farms before. The results of the research provide insights into the causes and sources of (in)efficiency prevailing among Lithuanian family farms. Suchlike information can be used to facilitate a reasonable decision making, especially at the macro level.

Practical value. The research estimates the level of efficiency for different farming types along with the determinants of efficiency. Therefore, it is possible to identify the causes of inefficiency prevailing among Lithuanian family farms. Such knowledge is beneficial for decision makers and farmers alike in order to better understand ways in which performance can be improved. Analysis of the most productive scale size is particularly important for land market regulation, which limits the maximal land area per farm. The methodologies proposed in the research can also be employed in other instances of economic analysis and thus contribute to improved managerial decision making.

Research methodology. The efficiency analysis rests on the neo-classical production theory. The research is mainly based on the non-parametric technique, viz. DEA. This technique is implemented by the means of linear programming. The robust production frontiers are estimated via bootstrapping and Monte Carlo simulations. Uncertainty is dealt with by the means of fuzzy numbers. The program (i. e. farming type) efficiency is assessed by utilising the MEA methodology along with the meta-frontier approach. TFP changes are measured by employing TFP indices, which are based on DEA models. The results are analysed by means of regression models (truncated regression, panel models) and multivariate statistical methods (namely cluster analysis and multiple correspondence analysis). Environmental performance is analysed by applying weak disposability measures based on the assumption of weak disposability. Furthermore, the concept of decoupling is considered to describe the relationships between resource use and economic activity.

The monograph is **structured** as follows. Section 1 presents the preliminaries for efficiency analysis. Section 2 presents general trends prevailing in Lithuanian agriculture, where the attention is mainly paid to the general development of the sector and its position amongst other sectors of the Lithuanian economy. Section 3 focuses on the performance of Lithuanian family farms. In order to account for uncertainties in the data, the technical efficiency is further analysed by means of the simulation-based methodology (bootstrapped DEA, robust frontiers, double bootstrap, conditional measures) and fuzzy FDH. Section 4 is dedicated to analysis of the total factor productivity change in Lithuanian family farms. Section 5 aims to analyse the underlying productive technology of Lithuanian family farms. Therefore, the technical change is analysed with respect to change in the input productivity. Another important issue to be addressed is that of the optimal farm size (i. e. returns to scale). Section 6 analyses the agricultural sector alongside the whole economy in terms of resource and carbon emission efficiency.

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