Efficiency Analysis of Commercial Grape-Producing Family Farms in the Republic of Macedonia

Influence of Selected Targets from the Rural Development Programme

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Abstract

An empirical analysis was conducted on the efficiency of commercial grape-producing family farms in the Republic of Macedonia in order to examine how farm performance is influenced by selected aspects of the current Rural Development Programme (RDP) (2007-2013). The emphasis was on Macedonian grape production on family farms and on instruments for more efficient use of resources, production modernisation, vine revitalisation, and the knowledge and managerial capacity of Macedonian grape growers. A two-stage analysis was carried out on farm-level data for the period 2006-2008. The estimated efficiency scores indicated that substantial efficiency improvements are possible on Macedonian grape-producing farms, with potential for a cost decrease of 29% (20% and 36% with parametric and bootstrapping applied) if farmers manage inputs more efficiently. Farm revenue can be improved by 47% (61% when bootstrapping applied) if farmers manage to increase the value of outputs. More efficient farms used a smaller area, irrigated a smaller proportion of total area, used less hired labour, used and paid less for inputs, but produced a larger quantity, with higher value per hectare. The technically more efficient farmers were: younger farmers, farmers with profit maximisation objectives; farmers with lower expectations of a better future for farming; farmers making choices with other family members; farmers monitoring production on the farm and maintaining bookkeeping records; those attending seminars, and those interested in competence-based knowledge such as plant protection, credit/investments. Interventions in production assortment and quality have potential to influence farm performance. Rural development policies can help improve farm efficiency. RDP measures targeted at achieving stable yield, yield improvement and modernisation of equipment, improving farmers' managerial performance and strengthening the capacity of sources providing non-formal education should be a high priority.

Keywords: data envelopment analysis, efficiency, family farms, grape, regression analysis, Republic of Macedonia, rural development programme, stochastic frontier

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Dedication

“Whatever you do you it for you”... (my parents Ika and Vlado Tasevski). Mum and Dad, thank you so much for making me aware for the importance of the decisions we bring in our lives, for your love, patience, support and trust.

To Evelina and Robert, for being my greatest support and motivation, and making my life full of love, happiness and understanding.

Contents

List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Manevska-Tasevska, G., Hansson H., Latruffe, L. (2011). Evaluating the potential effectiveness of Rural Development Programme targets on farms in FYR Macedonia – An efficiency study of grape producing family farms. Food Economics – Acta Agriculturae Scandinavica, Section C, DOI:10.1080/16507541.2011.637734.

II Manevska-Tasevska, G., Hansson H. (2011). Does managerial behaviour determine farm technical efficiency? A case of grape production in an economy in transition. Managerial and Decision Economics, 32(6), 399-412.

III Manevska-Tasevska, G . Farmers' knowledge attributes contribute for attaining higher farm technical efficiency: A transition economy case. Journal of Agricultural Education and Extension (second round submission).

IV Manevska-Tasevska, G. Influence of product assortment on the efficiency of grape-growing family farms in Macedonia - DEA approach. Submitted for publication to Journal of Wine Research.

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1 Introduction

1.1 Background to agricultural and rural development in the Republic of Macedonia: Viticulture

The Republic of Macedonia[1] is a candidate country for membership of the European Union (EU), with agricultural and rural development being key elements in the negotiations for EU accession. Since 1995, when diplomatic relations with the EU were established Macedonia has gone through gradual approximation of EU policies, legislation, principles and standards. In 2004, the National Strategy for EU Integration was adopted, where competitive agriculture able to compete in the integrated regional markets of the EU and South East Europe was the key objective developed for the agricultural sector. Increased international competitiveness of the country is required for sustainable growth and higher employment (MAFWE, 2010).

Since 2006, sustainability of the agricultural sector and rural development is expected to be ensured by the National Agricultural and Rural Development Strategy (NARDS) (2007-2013) and by the fifth component of the financial aid for pre-accession (Instrument for Pre-accession Assistance - IPA), related to rural development – the IPARD Programme). These Rural Development Programmes (RDPs)[2] have separately specified priorities (Figure 1) that work in synergy towards fulfilling the national strategy and the main objective for development of the agriculture sector and rural areas, following the EU concept for rural development.

1. Republic of Macedonia is the constitutional name of the country, provisionally referred to within the United Nations system as 'the former Yugoslav Republic of Macedonia' (UNSC Resolution 817/1993).

2. The abbreviation RDP (Rural Development Programme) is a common expression that is used when referring to the NARDS and/or the IPARD Programme in discussions.

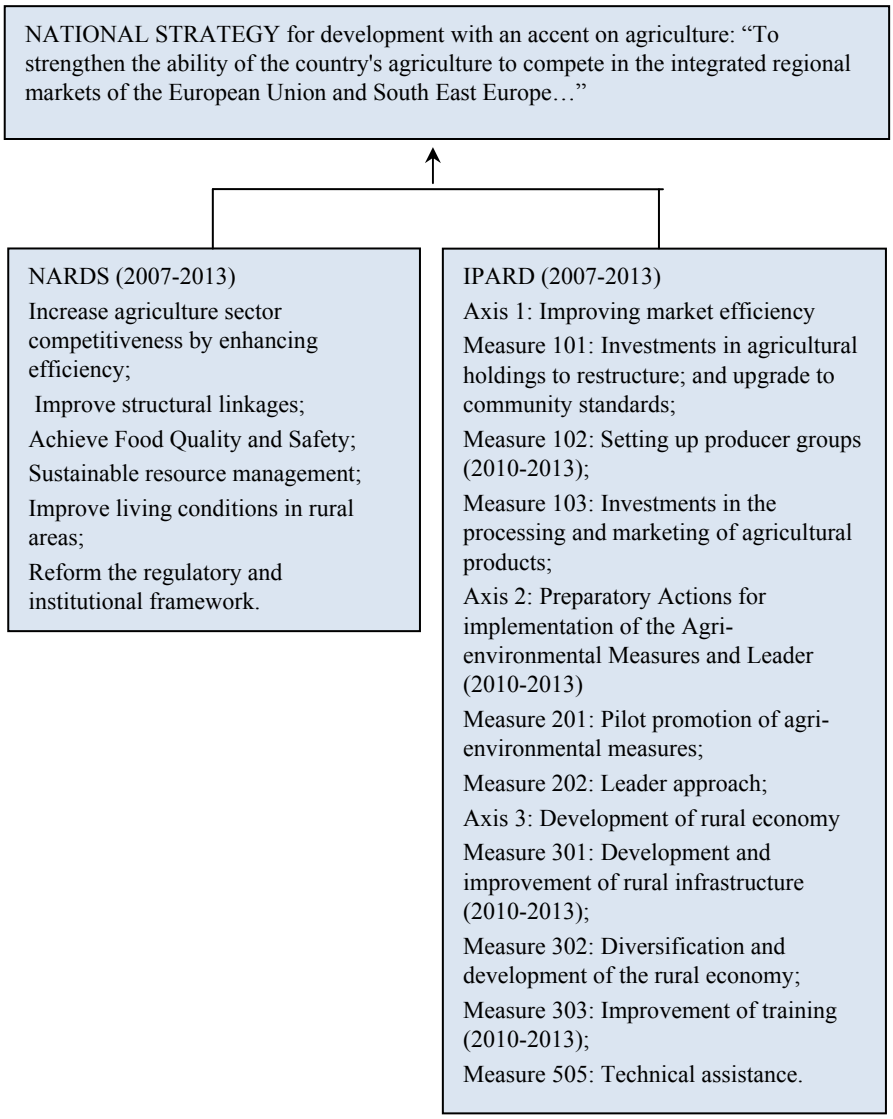

Figure 1. Strategic objectives of NARDS (2007-2013) and IPARD (2007-2013) towards fulfilling the objective of the National Strategy for agricultural development.

Governmental funding covers all costs associated with NARDS, and 25% of the IPARD programme costs, while the European Union contributes 75% of the IPARD programme costs. Both RDPs are guided by the Ministry of Agriculture, Forestry and Water Economy (MAFWE). Additional support for IPARD programme implementation is provided by the IPARD Sectoral Monitoring Committee and the Agency for financial support of Agriculture and

Rural Development (IPARD Agency). Fulfilment of the activities specified in the RDP is expected to meet the long-term MAFWE objectives, which are: to increase the efficiency of agricultural production, processing and marketing; to build appropriate, effective public and private institutions; to improve farm incomes; to ensure that consumers have access to safe, healthy food; to optimise the use of scarce land, forest and water resources in an environmentally sustainable manner; and to build viable rural communities through sustainable rural development."

In 2006, a selection of priority sectors proposed by the MAFWE was adopted by a government decision. Through the decision, favoured treatment and thus a high priority position in the RDP was offered for: wine and grapes; fruit and vegetables; milk and dairy; and meat and meat products. For each of the sectors prioritised, a specific list of objectives, activities and measures was developed. Sector selection was based on extensive SWOT analysis conducted by MAFWE. In the analysis, grape growing was considered one of the strategically important industries, requiring strengthening of the industry's performance. In the Republic of Macedonia grape is a traditionally important cash crop, employing rural labour. The contribution of grape and wine production to agricultural GDP is around 17%-20%. Around 80% of total grape production is processed into wine, which is the second most important product in terms of export value of agricultural products. As for the other high priority sectors, investments in viticulture are supported by the RDP, aiming at reaching the viticulture potential that existed before 1996, when due to the transition period the grape-growing areas were considerably reduced. Currently, 61% of the total vineyard area consists of vines older than 15 years, while 38% are older than 20 years (MAFWE, 2010). The age structure of the Macedonian vineyards (Figure 2) suggests that investments in viticulture are necessary, and that this sector should remain on the high priority support list.

The decreasing trend in farmers' interest in grape production, which is apparent from the decreasing trend in vineyard area (SS0, 2011), could be controlled if higher farm outputs were achieved. The Macedonian RDP assumes that higher farm output can be the result of efficient use of inputs, adequate grape production structure in terms of assortment characteristics, reasonable investments on farms, improved managerial practices, adequate knowledge and information use. The decrease in area under vineyards contradicts the FAO (2009) call for expanded production to exploit demand for wine exceeding production since 2008, increasing wine prices and a predicted shortage on the world wine market in coming years. Due to the increased frequency of negative climate events and a government policy for uprooting vineyards and replacing them with less risky commodities, the decreasing trend

in vineyard area in the major EU wine-producing countries is expected to continue. Such market conditions provide the opportunity for strengthening the Macedonian position on the existing grape and wine markets, as well as expansion onto new markets.

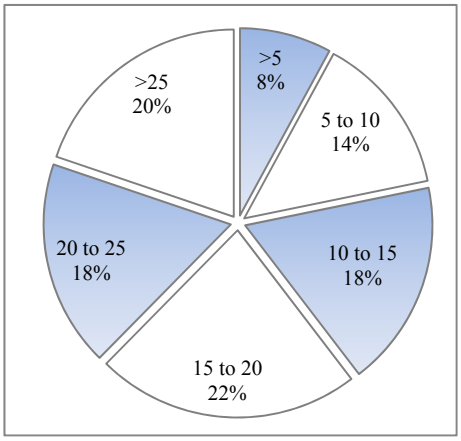

Figure 2. Age structure of the vineyards in the Republic of Macedonia.

RDPs are designed to complement each other in that NARDS supports investments and achieving yields from new vineyards, whereas the IPARD measures support reconstruction of existing areas. In both RDPs, increasing the competitiveness by enhancing higher efficiency and technical support for improving the occupational (managerial) skills and competences are the main strategic policy issues associated with grape production.

For the ongoing period 2007-2013, the following IPARD programme investments for vineyard rehabilitation are supported:

- Re-conversion, replacement of ageing vines and hybrids (older than 20 years, vineyard size 0.5-20 ha for individual producers and 0.5-50 ha for legal entities), only by recommended varieties (Book of Rules on classification of wine grape varieties OG 6/2007 Annex 21) on existing areas
- Procurement of planting material
- Procurement of works carried out by third persons for soil and land preparation, planting and replanting, with the exception of soil fertilisation
- Upgrading of the irrigation system for efficient water use
- Procurement of specialist farm equipment for crop protection, such as crop sprayers for all-terrain vehicles, atomisers and dusters
- Fertiliser spreading equipment

- Equipment for crop cultivation during the growing season (pruners, mulchers, mowers and weeders) for reduction of environmental damage
- Erection of hail protection nets, thus improving the technology level and quality of production
- Training, campaigns, visits, seminars, support for external expertise.

According to the annual report on the Programmes for Financial Support of Rural Development, NARDS funding for the period 2007-2011 was available for:

- Investment in new grape plantations
- Purchase of agricultural machinery (except tractors)
- Installation of modern and efficient irrigation systems
- Costs incurred in installing accounting software
- Expenditure on insurance of primary production
- Training
- Financial support for young farmers.

1.2 Problem

Proper formulation of the RDP measures should meet the objectives of the RDP. This is of great interest for any economy, since investments should be directed towards targets that provide benefits.

Farm efficiency is the focus of the current Macedonian RDP (2007-2013). With the aim of strengthening competitiveness by enhancing efficiency and technical support for Macedonian grape-growers in order to regain the viticulture potential that existed before 1996 (when the transition impact began) a policy decision placed grape production on the priority list for structural reforms stimulated by policy support. Instruments for more efficient use of resources, production modernisation, vine revitalisation and improving knowledge and managerial capacity of the Macedonian grape growers are imperatives in the Macedonian RDP (2007-2013), and are expected to lead to more efficient farming, and thus more competitive grape production. Successful policy implementation of the Macedonian RDP is expected to lead to a continuation of the country's grape-producing and wine-making tradition, increase the export value of grapes and wines, and revitalise rural areas.

Measures covered by government funding have not always been beneficial for the policy objectives (*e.g*. Brümmer and Loy, 2000). A unique guide for proper policy formulation does not exist. Efficiency studies providing *ex post* analysis of the impact of policy measures on farm efficiency are highly

beneficial in some regards. For example, they provide conclusions on the policy outcome and suggest directions for further policy improvements, but corrective actions that can be of use during the policy implementation are not possible. A better alternative could be an *ex ante* efficiency analysis that can show whether the Macedonian RDP is appropriate and can prevent the programme from failing to meet the objectives. The results of such analysis can be of use both as a guide for formulation of new policy measures and for taking corrective actions for measures that are in progress but the expected outcome is not noticeable. An attempt to apply the *ex ante* approach for analysing the appropriateness of selected RDP measures in Macedonia is presented in this thesis.

1.3 Literature review

In the Republic of Macedonia, measures for increasing the competitiveness of the agricultural sector dominate (Dimitrievski *et al*., 2010). In the economy, competitiveness is seen as a balance between the use of resources, operations management and human resource management, which are expected to strengthen businesses to compete more effectively. Control over resources (Barney, 1991), management skills, organisational process and routines, information and knowledge (Barney *et al*., 2001) are keys for gaining competitive advantage. The ability of businesses to compete is seen as the basis for competitiveness in the international market (Porter, 1998).

Efforts to analyse the competitiveness of Macedonian grape production and locate the main weakness have already been made (MAFWE, 2007; Manevska-Tasevska, 2006). Both studies emphasise that after 20 years of transition, Macedonian grape producers are still considered a vulnerable category. The small size of the farms; their fragmentation; out-dated production; weak horizontal (farmers' associations/cooperatives/producer groups) and vertical integration (farmers/processors); inadequate raw material supply in terms of timing, quantity and quality; under-usage of installed capacity; low level of farmers' education and training; weak support services *etc*. have been identified as key weakness in Macedonian grape production.

Economic performance characteristics are valuable parameters for assessing the differences in reform paths (Csaki and Nucifora, 2006), and increasing efficiency is among the highly prioritised objectives of the RDPs in the EU (Petrick and Weingarten, 2004; Galanopoulos et al., 2006). Different models and scenarios applying *ex ante* analyses are used for evaluating the impact of agricultural policy measures (Helming et al., 2011; Helming et al., 2008; van Ittersum et al., 2008). For Macedonian agriculture, Pelling (2007), Hristovska

(2005) and Kotevska (2010) used partial-equilibrium models for *ex ante* analysis of the effects of policy measures on a group of crop, livestock feed and animal commodities. These studies analyse the competitiveness of the production systems, but are designed to provide approximations of the expected changes in market prices and supply and demand characteristics of the products in question that would result from specific agricultural policy measures, such as direct payments. Efficiency studies (Rezitis et al., 2003; Brümmer and Loy, 2000; Kleinhanß et al., 2007; Latruffe et al., 2009; Zhu et al., 2008) providing *ex post* analysis of the impact of rural development policy measures (such as the Farm Credit Programmes and CAP direct payments) show that measures covered by funding provided by RDPs may not necessarily be appropriate for efficient agricultural production.

To date, the performance of Macedonian grape-growing farms in terms of their efficiency, which is one of the main objectives of the current Macedonian RDP (2007-2013), has never been analysed. Furthermore, to the best of my knowledge, an *ex ante* analysis based on empirical efficiency findings that provides information on the appropriateness of specific targets of the RDPs for attaining higher farm efficiency does not exist. Mid-term evaluations of the RDPs are conducted by the relevant government bodies, but such evaluations are not related to production efficiency.

Efficiency studies are a common way of analysing the performance of agricultural production, and efficiency is an indicator used in EU rural policies, where highly efficient farms are considered to have higher probability of survival. Efficiency studies have been used to examine the importance of input utilisation in gaining higher competitiveness and to identify factors that influence farm performance. Farm and farmer characteristics are the most important explanatory factors for attaining higher efficiency (Sharma et al., 1999; Alvarez and Arias, 2004; Bojnec and Latruffe, 2009; Gorton and Davidova, 2004; Hansson, 2007c; Hansson, 2008a; Latruffe et al., 2005; Olson and Vu, 2009; Wilson et al., 2001; Bravo-Ureta and Evenson, 1994; Carvahlo et al., 2008). In other studies (Rezitis et al., 2003; Brümmer and Loy, 2000; Latruffe et al., 2009; Kleinhanß et al., 2007; Zhu et al., 2008), the implications on farm performance of different policy measures to strengthen the competitiveness of the agricultural sector have been analysed, and suggestions for possible policy improvements have been offered.

During the past decade, farm performance of the economies in transition has been of great interest. Empirical evidence on the performance of farms and the factors influencing their performance has been seen important, both for faster completion of the transition process and further development. Existing studies are mainly focused on Central and East European Countries, providing

empirical evidence on: i) farm efficiency level; ii) the effect of transition on the efficiency scores (Bojnec and Latruffe, 2007); ii) how farm efficiency is influenced by production orientation (animal vs. plant production) (Latruffe et al., 2004; Latruffe et al., 2005); iii) how efficiency scores are influenced by farm organisational form (individual vs. corporate) (Davidova and Latruffe, 2007; Mathijs and Vranken, 2001); and iv) the influence of farm size (Bojnec and Latruffe, 2007) and farmers' personal characteristics (Munroe, 2001; Latruffe et al., 2004) on farm efficiency. So far, knowledge and management attributes within the economy in transition concept have been only explained by years of schooling (Mathijs and Vranken, 2001), farming experience (Kurkalova and Carriquiry, 2003; Latruffe et al., 2005) or as an external outcome from contacts with advisory services (Sauer and Balint, 2008).

In efficiency studies of the economies in transition, farmers' managerial behaviour, attitude and planning abilities have been considered essential (Gorton and Davidova, 2004). However, they have never been analysed as factors influencing the efficiency, even though such results could offer crucial information to farmers on strategic planning and management, as well as to policy-makers. The necessity of research into human capital improvements has also been pointed out by Latruffe *et al*. (2005), who argue that such improvements are a difficult challenge that requires various policy instruments.

Human capital and skills are essential for growth in rural areas (European Commission, 2005). *Knowledge-based resources* are seen as critical for gaining a sustained competitive advantage (DeNisi *et al*., 2003), and are characterised as even more important than physical resources (Rivera, 2008; Rivera and Alex, 2008). The latter see knowledge and information as being key to overcoming production constraints, increasing productivity and enhancing competitive advantage. However, in the case of farming, opposing standpoints on the effect of knowledge on farm results also exist. According to some studies (Yang, 2004; Gurgand, 1993), more educated farmers prefer to devote labour and capital to non-farm production, which would lead to a reduction in total agricultural output (Gurgand, 1993). Human behaviour is governed by the criterion of optimisation under constraints (Schultz, 1975, p. 827), making individuals selectively rational (Leibenstein, 1977; Leibenstein, 1978), or bounded rational (Simon, 1945/1997). *Bounded rationality* is another potential source that influences the efficiency of businesses (Fried *et al.*, 2008). Bounded rational decisions satisfy the decision-maker's beliefs and perceptions of the outside world instead of optimising the process. Improvements in managerial capacity, competence and knowledge are considered important and are components of the Macedonian RDP for the forthcoming financial period

(2010-2013). Thus research evidence showing the contribution of such characteristics to farm performance is necessary.

The efficiency of grape farms in an economy in transition context has very rarely been analysed (e.g. Bojnec and Latruffe, 2008; Kopeva and Noev, 2001). Even though grape production occupies a large share of the agricultural output of Western Balkan countries (WBCs: Serbia, Macedonia, Montenegro), and Early Transition Countries (ETCs: Moldova, Uzbekistan, Tajikistan, Georgia, *etc*.), empirical evidence on the efficiency of grape-growing farms does not exist. An overview of selected efficiency studies is displayed in Table 1.

To summarise, RDP measures formulated for Macedonian agriculture, including grape production which is the subject of this thesis, are based on extensive SWOT analysis, which cannot describe the performance of the sector in efficiency terms. The production of empirical evidence on farm efficiency is important for farmers' possibility to decrease their costs, or increase their output. Knowledge on the personal and environmental characteristics that influence farm performance can also be used in formulation new RDPs. RDP measures should be designed to meet policy objectives. In the Republic of Macedonia, increasing efficiency is among the highly prioritised objectives of the RDPs. Although a positive outcome of the proposed policy measures on farm efficiency is expected, empirical evidence indicating the appropriateness of the RDP measures for attaining higher farm efficiency does not exist.

1.4 Aim

The two main aims with this thesis were: 1) To provide empirical evidence on the performance of Macedonian commercial grape-producing family farms in efficiency terms; and 2) to evaluate the potential impact of selected strategic policy issues of the current Macedonian RDP (2017-2013) on farm efficiency.

An initial study (Paper I) analysed how resource endowment, production quantity and value influence farm efficiency and emphasised instruments for more efficient use of resources and production modernisation. The influence of the managerial process and knowledge attributes of farmers on farm efficiency was analysed in two subsequent studies (Paper II and Paper III). Human resource capacity was considered with an assumption that supportive measures from the RDPs orientated towards better farm management (such as improved managerial practices, knowledge acquisition, information share and use) can increase farm efficiency. According to the proposed instruments of the Macedonian RDPs, improved vine structure consisting of prioritising the grape assortment is also intended to contribute to better sector performance.

Assortment management is crucial for successful business practice and a balance between assortment decisions, revenues and costs is necessary for long-term profit maximisation (Ramdas, 2003). The influence of grape assortment on the farm efficiency of Macedonian commercial grape-producing family farms was analysed in Paper IV.

1.5 Thesis outline

This thesis is based on Papers I-IV and comprises six sections. After this introductory section, methodological aspects used in the papers, such as model choice, data and variables, are explained and compared in Section 2. The results and analysis are presented in Section 3 and some conclusions in Section 4. The overall contributions of the thesis are described in Section 5 and topics for further research are proposed in Section 6.

Table 1. *Summary of selected efficiency studies*

Author/s	Region	Method	Determinant/s of efficiency
(Bojnec and Latruffe, 2008)	Slovenia	DEA, SF, TE, AA, EE, cluster analysis FADN, 130 farms, 1994-2003	Farm specialisation
(Bojnec and Latruffe, 2009)	Slovenia	DEA, SF, TE, truncated reg, OLS, FADN, 130 farms 1994-2003	Farm specialisation, rented land, hired labour, marketed output, production subsidy
(Bravo-Ureta and Evenson, 1994)	Eastern Paraguay	SF, TE, AE, EE, Anova, survey, 148 farms, 1986-1987	Age, education, assistance, crediting, advisory services
(Carvahlo *et al*., 2008)	Portugal	SF, TE, Kruskal-Wallis FADN, 22 farms, 2000-2005	Age, education, class of area, rented land, AWU, area, output, subsidies, size, legal status, ownership, gross added value, income, invest. and irrigation
(Conradie *et al*., 2006)	South Africa	SF, TE, survey, 107 farms, 2003-2004	Age, education location, % of non-bearing vines, irrigation
(Gorton and Davidova, 2004)	CEEC countries	DEA, SF, separate datasets for six CEECs	Farm organisation, farm size
(Hansson, 2007c)	Sweden	DEA, TE, AE, EE, Tobit, statistical data, 507 farms, 1998-2002	Region, area, distance to field, silo, qual of build. and machin., cooperatives, pers. characterist.
(Hansson, 2008b)	Sweden	DEA, TE, AE, EE, Tobit, Logistic reg., stat. data, 507 farms, 1998-2002	Location, values, profit. attit, locus of control, exper., age, cooper., account, budgeting and control, inform proc.
(Kurkalova and Carriquiry, 2003)	Ukraine	SFA, TE, Survey, 41farms 1989-1992	Non-agric empl., workers per hectare, distance to city, age
(Latruffe *et al.*, 2004)	Poland	DEA, SFA, TE, Tobit survey, 472 farms, 2000	Organisational type, size, livestock v. crop, hired labour, soil quality
(Latruffe *et al*., 2005)	Poland	DEA, TE, SE, Bootst. Anova, survey, 914 farms, 1996 and 2000	Crop v. livestock production efficiency
(Latruffe *et al.*, 2008)	Czech Republic	DEA, TE, Trunc. reg. Bootstrapping, FADN, 344 farms, 1999	Size, specialisation, individ. v.s. corporate, rented land, hired labour, financial stress
(Mathijs and Vranken, 2001)	Bulgaria, Hungary	DEA, TE, Tobit, survey 3629 farms, 1998	Age, educ., gender, special., dist., land-man ratio, contact.
(Sharma *et al.*, 1999)	Hawaii	DEA, SF, TE, AE, EE, Spearman coeff., Anova, 53 farms, 1994	Size, education, experience, feeding regime, location, types of pigs
(Wilson *et al*., 2001)	Eastern England	SF, TE, survey, 1993-1997	Area, experience, education, objectives, info sources

2 Method

2.1 Efficiency analysis approach

In the thesis the efficiency analysis was conducted in a two-stage process (Coelli *et al*., 2005). The efficiency coefficients were calculated in the first stage, and the factors influencing efficiency were determined in the second stage. Farm efficiency was considered in technical, allocative and economic terms and the efficiency coefficients were calculated by application of:

1) A Data Envelopment Analysis (DEA) method, using Data Envelopment Analysis (Computer) Programme (DEAP) version 2.1 (Coelli, 1996b) (for Paper I), and software for Frontier Efficiency Analysis with R (FEAR) (Wilson, 2008) (for Papers II and IV);
2) Stochastic Frontier Analysis (SFA), using the computer programme FRONTIER 4.1 (Coelli, 1996a) (for Paper III).

In the Republic of Macedonia, improved farm efficiency in terms of better input utilisation and achieving higher output is expected to be achieved by policy interventions, through implementation of instruments of the current RDP (2007-2013). In the studies, the potential influence of selected RDP targets on the efficiency coefficients obtained was analysed in the second stage by using the statistical package STATA, and application of Tobit, Truncated and Ordinary Least Squares (OLS) regression.

The choice of methods applied for the efficiency analysis is discussed further and justified in Papers I-IV. Only a brief overview is given here.

2.1.1 Estimation of efficiency scores

What is efficiency, and in what ways can efficiency be explained? How does the efficiency approach selected work for the production system and data set

under study? Getting the most output for the least inputs (Cook and Hunsaker, 2001, p. 23), is one of the simplest definitions of efficiency. Efficiency has been represented as a degree of success that producers achieve by allocating the available inputs and the outputs they produce, in order to achieve their goals (Kumbhakar and Lovell, 2000, p 15).

In this thesis, the analysis of farm efficiency was based on the framework of Farrell (1957) and explained the efficiency through an input and output perspective (where DEA applied), considering the efficiency in technical, allocative and economic terms. Technical efficiency (TE) is the most commonly used parameter for efficiency analyses, whereas the allocative efficiency (AE) and the economic efficiency (EE) are rarely calculated, especially in efficiency studies of the economies in transition. In Paper I, all three coefficients were estimated from input-orientated perspective. The remaining three papers (II, III, IV) focused solely on the TE of farms. Paper II analysed both the input and output-orientated TE, whereas the output orientation was deemed appropriate for Paper IV. The estimated efficiency coefficients, model and orientation applied in the first stage of the efficiency analysis in Papers I-IV are summarised in Table 2.

Table 2. *Estimated efficiency coefficients, selected models and orientation used in the first [and second] stage of the analysis*

	Paper I	Paper II	Paper III	Paper IV
Data Envelopment Analysis				
Input-orientation				
TE	√	√		
AE	√			
EE	√			
Output-orientation				
TE		√		√
AE				
EE				
Tobit regression	√	√		√
Truncated regression		√		√
Bootstrapping		√		√
Stochastic Frontier Analysis				
TE			√	
Ordinary Least Squares			√	

The Farrell framework measures assume equal access to inputs by all farms (Cooper *et al.*, 2004), where not all farms use the same input amounts. Thus,

efficiency depends on the input use by each farm, input prices and the outputs being produced. The input perspective is suitable for cost minimisation goals and production, where output is assumed as a fixed category, while inputs can vary. From the input-orientated perspective, TE measures showed the ability of grape producers to produce a given output with the smallest quantity of inputs possible given the production technology. AE assessed their ability to use inputs in optimal proportions, given their respective prices and the production technology. The product of both measures provided the value of the economic efficiency obtained on the farms analysed. The output perspective is preferable for a profit maximisation goal, or when the aim is production of maximum output from a given set of inputs, which is a characteristic when inputs are fixed in the short term.

To assess the production frontiers and estimate efficiency scores, both the non-parametric DEA (developed by Charnes *et al*., 1978) and the parametric SF analysis (Aigner et al., 1977; Meeusen and Broeck, 1977) were adopted. Both models apply a frontier approach, where the frontier obtained represents the best practice technology among the grape-growing farms in the sample, against which the efficiency of the other grape producers within the sample is measured.

DEA is a mathematical linear programming method that allows individual and multiple efficiency analyses for more than one producer and large numbers of inputs and outputs with different measurement units. In grape production, not all producers were expected to operate under the optimal scale, since the production process is very sensitive to external factors (such as climate and demographic influences, pests, diseases and managerial ability to complete all the necessary operations in a proper way and on time). Thus, the notion of Variable Returns to Scale (VRS) was assumed necessary. DEA does not require specification of the functional form or distribution terms and therefore avoids misspecification errors. However, DEA has been largely criticised as sensitive to data noise such as outliers, the data gathering process (Simar and Wilson, 1998; Simar and Wilson, 2000), and that as a non-parametric model it does not count the statistical inference. Thus is characterised as producing biased efficiency coefficients. In this thesis, the effect of outliers was minimised in two ways: First, by taking average of the input use, prices and the output produced during the three production years (2006-2008) (Papers I-IV); and second, by eliminating the outliers from the data sample (Paper I). As previously mentioned, Paper I estimated TE, AE and EE, and full information on the input quantities and prices was necessary. At first, the efficiency analysis was performed on the full data set (300 farms) but the presence of the outliers (25 farms) did not allow the model to work properly and thus their

removal was necessary. Papers II, III, and IV focused solely on the TE and the presentation of inputs differed slightly. The new input presentation did not cause calculation errors and thus the full data set, without omission of outliers, was used. Similar mean values of estimated TE were obtained from both data sets.

In this study, Simar and Wilson's (1998) criticism was also considered and homogeneous bootstrapping for non-parametric efficiency analyses was applied (Papers II and IV) (see Table 2). Simar and Wilson (1998) propose bootstrapping to be used in cases where analytical derivation of sampling properties of estimators is either difficult or impossible. When applied for providing statistical inference for efficiency coefficients (obtained by non-parametric efficiency analysis), homogeneous bootstrapping approximates the sampling variation of the estimated frontier, and provides results on the sensitivity of the efficiency scores of the decision-making production units.

Basically, no model developed for efficiency estimation is without failings. In this thesis, an alternative efficiency model, the parametric SF model (Aigner et al., 1977; Meeusen and Broeck, 1977) was also considered. The SF model is a standard econometric platform for measuring efficiency (Greene, 2008). As it is a parametric model, it is suggested for solving the statistical inference problem by distinguishing the effects of noise from those of inefficiency. The model requires a stochastic production function specification, which presents the attainable outcome within an environment influenced by external factors (positive and/or negative) which are outside the producer's control. In the literature, the Cobb-Douglas and translog model applications dominate (Greene, 2008). In the SF approach, the variance is assumed to be distributed normally, and inefficiency level to be higher than zero. Both the Ordinary Least Square (OLS) and Maximum Likelihood (ML) methods can be used for obtaining consistent slope parameters. The issue of appropriate production function selection in the SF model has been widely discussed, and the criticism has been made that misspecification is possible. Therefore, SF analysis can also produce biased results when the production function is not properly selected.

The efficiency coefficient ranges between 0 and 1, where 1 represents fully attained (100%) efficiency.

2.1.2 Regression analysis

To evaluate the impact of the predicted determinants of efficiency, a two-stage process was used (Coelli, 2005). This involved running a regression analysis where the efficiency scores (TE, AE, EE) obtained in the first stage were used as dependent variables, and the production characteristic (Paper I), managerial

characteristic (Paper II), knowledge management characteristic (Paper III) and assortment characteristic (Paper IV) were used as explanatory variables (Figure 3).

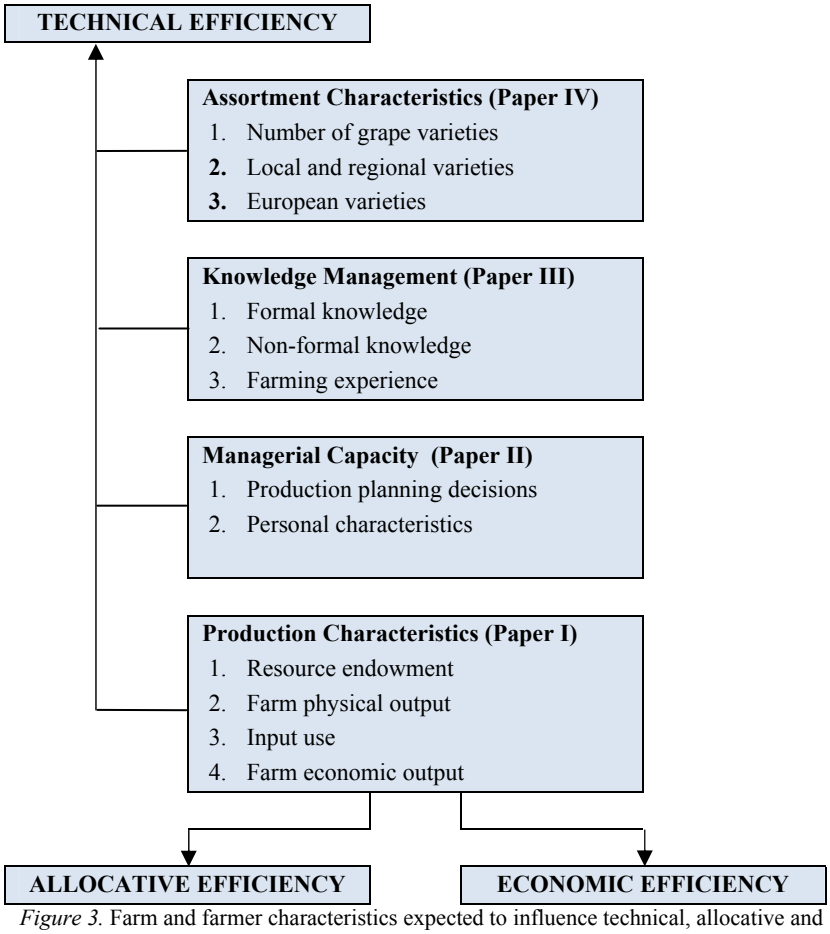

Figure 3. Farm and farmer characteristics expected to influence technical, allocative and economic efficiency.

In the papers where the non-parametric DEA was adopted, a censored Tobit (Paper I) and a truncated regression analysis (Papers II and IV) were applied. Both models were considered applicable. The reasoning in the choice was the assumption that, for a censored model a maximal and/or minimal value constraint has been put on the efficiency variable, whereas for the truncated model observations above a certain cut-off-value are excluded. Both models have been used in efficiency studies (Latruffe et al., 2008; Larsén, 2010; Haji, 2007) and for comparison both models were used in this study.

Simar and Wilson (2007) extend their criticism to the second-stage non-parametric efficiency analysis and suggest that double bootstrapping be implemented to improve the statistical efficiency of the second-stage regression. They argue that the variables used to construct the efficiency scores are correlated to the error term in the second-stage regression, which causes heteroscedasticity. They also criticise the Tobit model used for the second stage regression as inappropriate, with an argument that efficiency scores are not really censored (2007). In this thesis (Papers II and IV), both these criticisms were considered. The heteroscedasticity problem was solved by basing the statistical inference in the second stage regression on bootstrapped, heteroscedasticity-corrected standard deviations. The approach accounts for the problems raised by Simar and Wilson (2007), but it is also more straightforward to implement in a standard statistical package STATA. As previously mentioned, the regression result was validated by using both Tobit and the truncated models. Regression results obtained by the original and the bootstrapped two-stage procedure in recent studies are similar (eg. Afonso and St. Aubyn, 2006; Larsén, 2010).

In Paper III the parametric SF approach was adopted and thus the OLS estimates were derived. A summary of the models chosen for application in the second stage of the efficiency analysis in Papers I-IV is given in Table 2.

2.2 Data

2.2.1 Region specifics

In order to minimise the influence of ecological, geographical and social conditions and thus obtain more harmonised data, the analysis was delimited to only one production region. It was considered that grape producers belonging to one production region have adjusted their production practices according to the natural, regional and market characteristics.

The analysis focused on the Tikvesh vineyard district. It belongs to the Vardar Valley Region, which is the largest and economically most important grape- and wine-producing region. Besides Tikvesh, five other vineyard districts (Skopje, Veles, Gevgelija-Valandovo, Strumica-Radovish and Ovcepole) belong to the Vardar Valley Region. However, Tikvesh is recognised for its production quantity and for the socio-economic influence of grape population. Tikvesh is situated in the central-southern part of the Republic of Macedonia, spread along the Vardar River, covering the vineyards of the municipalities of Kavadarci, Negotino, Demir Kapija, Rosoman and Gradsko. The Tikvesh vineyards are cultivated mainly on rolling terrain with mild slopes, with the current average size of the parcels being between 1.1 ha

and 1.3 ha, fragmented into plots of 0.3/0.4 ha (MAFWE, 2007). The territory is influenced by a Mediterranean climate that comes from the Aegean Sea, with an average temperature of about 14 °C, precipitation of about 450 mm and a fertile soil. The vine assortment contains both wine and table grape varieties, with 70% of total production represented by the wine varieties Vranec, Merlo, Kadarka, Cabernet Sauvignon, Stanushina, Burgundec white, Smederevka, Rizling, Semijon, Chardonnay, Zilavka, Temjanika and Rkaciteli. The remaining 30% are table grape varieties, mostly Afus-Ali, Kardinal and Muscat Hamburg.

2.2.2 Data, data collection and quality

Farm level data were gathered by a survey conducted through face-to-face interviews with 300 grape-growing family farms in Tikvesh vineyard district. No official data records, such as the Farm Accounting Data Network (FADN) available in all EU countries, exist for the specified category of farmers, hence the necessity to resort to farm surveys. In the Republic of Macedonia family farms produce 70% of the total grape production and were thus considered a representative target group of the study. The term 'commercial production' distinguished family farms from households growing grapes for their own consumption.

The survey was conducted in two batches and provided data for three production years, 2006 to 2008. During the first batch (June-July 2008), data for 2006 and 2007 were collected, while the second batch, (January-February 2009) provided data for 2008. One production year corresponded to one calendar year, from 1 January to 31 December.

The data collection process was carried out by six qualified interviewers from the Tikvesh vineyard district, with each interviewer collecting data from 50 farms. Data collection was constantly monitored by regular contact with the interviewers, so that units and item non-responses and respondent and interviewer falsifications were minimised. As official farm level data for the selected production and region did not exist, random sampling was not applicable. A combination purpose-based and quota sampling method (Biemer and Lyberg, 2003) was chosen as an alternative sampling procedure, but systematic implications from the data were not expected.

In the Tikvesh vineyard district, family grape-growing farms cultivate around 6200 ha[3]. The average vineyard area of the farms included and analysed in this study was around 600 ha, which is about 10% of the total area cultivated by family grape-growing farms (both commercial and non-commercial) in the Tikvesh vineyard district. The selection process was based on the criteria that: i) the farm belonged to the selected vineyard district; ii) the farm had commercially orientated production (utilised area equal or larger than 0.3 ha and the products sold to a private buyer); and iii) there was a trusted verbal agreement between the interviewers and the respondents (farmers) for two-year participation in the survey.

The survey provided information on the entire production process, including output and input quantities, input and output prices, farm and farmer characteristics, and decision-making practices and procedures. Output characteristics, inputs and their respective prices were collected and used for empirical estimation of the efficiency scores. Information on farm and farmer characteristics and on the production and the decision-making practices and procedures were used for determination of the factors influencing farm efficiency, and thus for evaluation of the appropriateness of selected RDP measures.

2.2.3 Questionnaire structure

The questionnaire comprised two parts, A and B. Part A consisted of a set of instructions for guiding the interviewers in how to proceed with the data collection, and informed them about their responsibilities and rights. Part B provided detailed information on conducting an efficiency analysis (explained technical and economic aspects: output, inputs, prices *etc*.) and listed all the information requested for the regression analysis (such as farmer characteristics, goals, planning expectations, decision-making practices and procedures, production characteristics *etc*.) that provided answers regarding the appropriateness of the selected RDP measures.

The questionnaire consisted of structured questions and a few open-ended questions. The open-ended questions were optional, and were included to allow the respondent to talk about issues that affected his/her work on the farm. Such information was not used for the analysis.

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3. Estimate based on Agricultural Census data (SSO, 2007). The estimated number was obtained by considering the total vineyard area in the Tikvesh municipalities, and that 70% of the total vineyards area is cultivated by family farms. The publication is available at: http://www.stat.gov.mk/Publikacii/PopisNaZemjodelstvo2007/knigaII.pdf

The questionnaire was prepared in coordination with the supervisors, Bo Öhlmer, Helena Hansson and Dragi Dimitrievski. Valuable suggestions and ideas were also received from Aleksandra Martinovska Stojceska, Daniel Lunneryd, Dobre Milenkovski, Gjoko Danailov, the interviewers and the farmers interviewed. An outline of the questionnaire is presented in Table 3.

Table 3. *Outline of the questionnaire*

Information	**Content**
A: Instructions	
Aim of data collection	Brief explanation
Data collection procedure	The interviewer's role in the data collection process, criteria for participation in the survey
Payment and procedure	Wages, travel costs
Survey quality control	External co-operator and the survey organiser
Communication	Communication with the survey organiser
B: Questions	
Basic farm data	Name, contact, location
Land resources	Total area and property status
Labour force	Family and hired labour
Farm debt	Credit and funds use
Farm income	From subsidies or other funds
Machinery and buildings	Year of purchase, purchased value, current value
Vineyards and production characteristics	Total bearing and non-bearing area, vine age, assortment, irrigation, yield, market price, market
Input use and input prices	Fertilisers, crop protection, irrigation, oil, lubricants, fuel, and other materials (banding, packaging)
Labour force management	Family and hired labour in a specific activity, wages
Machinery management	Own machinery and paid services in specific activity,
Data on farmers	Education, experience, training, degree of analysis *etc.*
Objectives and expectations	Short-term and long-term
Decision-making and planning	Making decisions, reviewing decisions, planning
Production and sales	Production intensification, market, contracts, setting prices, problems, cooperation
Open-ended optional question	Farmers' opinion, ideas, problems to discuss

2.2.4 Survey quality report

The survey quality report presented the main data and survey quality characteristics; the realised and expected pitfalls and the strengths of the data and survey process. Considering that the whole analysis is based on survey data, the existence of such reports was of great importance.

"Data quality is purely a function of the amount of error in the data"
(Biemer and Lyberg, 2003 , p.34)

The report was structured according to the Biemer and Lyberg (2003) standardised concept for potential sampling and non-sampling error sources. The structure of the report is given in Table 4, which explains the sampling and non-sampling sources and control over the factors influencing the whole process.

Table 4. *Qualitative, survey-quality overview for potential sampling errors*

	SOURCE	CONTROL
SAMPLING ERRORS	Sampling procedure: Non-random – purpose based, quota sampling	Partial: The randomisation is only approached. The sampling procedure choice corresponds to the data availability, and applicable methods for data collection. Both DEA and the regression analysis sensitive to non-random data
NON-SAMPLING ERRORS (1-5)	1. Specification errors	Complete: Concepts, objectives and data elements – adjusted to the scientifically accepted standard and procedures
	2. Frame errors	Partial: Omissions – widely dependent on the sampling procedure. Duplications – completely under control
	3. Non-response errors	Complete: Unit non-response – regulated with the administration mode (face-to face interviewing), and accepted agreement for participation in the survey for a three-year period. Item non-response – regulated by the administration mode (editing was required)
	4. Measurement errors	Partial: Respondent falsification – to some extent controlled by competent sector specialists working and living in the region and by the repetitive data collection procedure (3-year data collection). Interviewer falsification – controlled by the repetitive data collection procedure. Questionnaire design – controlled, by the supervisors, interviewers, and questionnaire test
	5. Processing errors	Complete: Gradual data recording, provided by the PhD student. All questionnaires are available in the personal archive, any inconsistency can be checked later

3 Results and analysis

In all papers, the same data set (panel data for 2006-2008) and methodological approach (two-stage efficiency analysis) were used. For each paper methodological specifics were defined by model selection, orientation (input and/or output) and variable selection.

The results and the analysis are presented below in three separate sections organised as follows: i) A summary of the results in the first stage of the analysis; ii) a brief presentation of the papers with an emphasis on the results obtained in the second stage; and iii) an explanation of the relationship between the regression results and the instruments proposed with the RDP.

3.1 Efficiency scores

Evidence for the TE scores was provided by the non-parametric DEA (input and output perspective) and parametric SF approach. This is the first study that provides evidence of the 'bias-corrected' technical efficiency index for grape production. The estimated TE score obtained with DEA was 0.71 for the input orientation (or 0.64 when bias-corrected), and 0.53 for output orientation (or 0.39 when bias-corrected). The TE value obtained with the SF approach was 0.80. The average estimated allocative efficiency was 0.79 and the economic efficiency 0.56. Based on the findings, Macedonian grape growers have the potential for a cost decrease of about 30% if farmers manage to apply better input management. Farm revenue can be improved by about 50% if farmers manage to increase the value of their outputs.

As presented, higher mean technical input-orientated efficiency was obtained. The difference between the input-orientated and output-orientated TE scores of the Macedonian grape-growing farms suggests that these farms have more adjusted practices for the use of inputs but vary in production assortment and quality. Comparative analyses of the efficiency scores in input and output

perspectives have been carried out in many studies and different results have been obtained. For example, a higher value of input-orientated efficiency has been obtained for Greek olive farms (Tzouvelekas *et al.*, 2001), output-orientated efficiency has been found to be higher for Swedish dairy production (Hansson, 2007b), and the two values have been found to be similar for collective Ukraine farms (Kurkalova and Carriquiry, 2003). DEA and SFA are expected to give similar relative ranking of the businesses analysed in cases when the two approaches are comparable (Haji and Andersson, 2006). In this study, the Spearman rank correlation between the technical output efficiency result obtained with DEA and SFA was 0.60 (p<0.01).

Similar results for the technical efficiency of Portuguese and South African grape growers have been reported by Carvahlo *et al*. (2008) and Contradie *et al*. (2006). The correlation coefficient between DEA and SF was slightly lower but approaches the values estimated by Haji and Andersson (2006), Hansson (2007a), and Sharma *et al*. (1999). As expected, DEA provided lower results for the efficiency scores, but the difference between the technical efficiency scores obtained with DEA and SFA was somewhat higher than expected, *e.g*. that reported by Sharma *et al*. (1999), and Haji and Andersson (2006). However, Bojnec and Latruffe (2008) reported even higher difference between the average efficiency scores obtained by DEA and SF approach (TE, AE and EE of 1, 0.94, 0.99, respectively, using DEA and 0.56, 0.62, and 0.90, respectively, using SF.

Mean values of the TE scores, farm area (A), farm yield per hectare (Q), variable costs per hectare (VC), revenue per hectare (R), and variable costs as a relative share of total revenue (Share) for each interviewer are presented in Table 5.

Table 5. *Mean value of selected farm characteristics at interviewer level*

Interviewer	TE	Q	A	VC	R	Share
Interv1	0.67	1238.05	18.60	6251.92	14664.12	42.6%
Interv2	0.83	2071.83	14.93	4952.00	24544.71	20.2%
Interv3	0.73	1685.49	18.06	6363.79	19233.20	33.1%
Interv4	0.75	1273.45	21.93	4707.05	14138.14	33.3%
Interv5	0.60	1509.00	19.78	6341.32	18101.37	35.0%
Interv6	0.67	1244.54	25.77	4825.09	13197.89	36.6%

The mean estimated TE scores among the interviewers ranged between 0.60 for Interviewer 5 to 0.83 for Interviewer 2. Comparative analysis of the farm characteristics shows that the VC share of farm revenue is rather balanced

(Table 5). However, the lowest share of 20% occurs on the most efficient farms, which have the smallest area but highest yield per hectare.

3.2 Summary of Papers I-IV: Methodological approach and regression results

3.2.1 Paper I

Evaluating the potential effectiveness of Rural Development Programme targets on farms in the Republic of Macedonia – An efficiency study of grape-growing family farms

Paper I evaluated whether selected RDP instruments for improving the competitiveness and efficiency of grape-growing family farms in Macedonia have the potential to be effective. DEA and Tobit regression were applied. The analysis was based on the influence of these RDP instruments on farm technical, allocative and economic efficiency. Regression variables chosen to reflect the RDP instruments were grouped into four categories, and all related to farm characteristics such as: resource endowment (represented by: farm area, farm irrigation, number of machines and current value of machinery on the farm), production (proxied by farm yield), input use (proxied by the material and labour costs paid by each farmer), and economics (represented by the total standard output). The results indicated huge potential for efficiency improvement. More efficient farms used a smaller area, irrigated a smaller proportion of their total area, used less hired labour and used and paid less for inputs, but produced a larger quantity, with higher value per hectare.

The positive influence of grape yield and total standard output obtained in Paper I confirmed findings reported by Henriques *et al*. (2009) that the economic size of vineyards has a positive influence on the efficiency of Portuguese grape-growing farms. Scale effects have been found to be relatively unimportant for the efficiency of grape production in South Africa (Conradie *et al*., 2006), but important for crop (Bravo-Ureta and Evenson, 1994), mixed (Puig-Junoy and Argiles, 2004), vegetable (Haji and Andersson, 2006) and dairy production (Hansson, 2008a). In Paper I, the negative influence of farm size on Macedonian grape growing farms was explained by the production system and the labour characteristics. Grape production is labour-intensive and family farm labour has limited capacity to manage larger plantations. Larger vineyards decrease the possibility for exclusive use of family labour and thus extra labour units need to be hired. This increases the variable cost of labour used on the farm and decreases farm efficiency. A negative influence of labour use on TE and EE has also been found for grape production in South Africa (Townsend *et al*., 1998). Modern tools and equipment should strengthen the ability of farmers to organise their production with as little hired labour as

possible and contribute to more efficient use of inputs. This in turn will lower farm variable costs, which were also found to have a negative impact on farm efficiency. In Paper I, a significant influence of machinery was not found but it was emphasised that only the number and value of pieces of farm equipment were considered in the study. Irrigation was also found to be negatively associated with the efficiency score attained. The influence of irrigation has also been found to be negative for mixed farm production in Catalonia (Puig-Junoy and Argiles, 2004), but positive for vegetable production in Ethiopia (Haji and Andersson, 2006). When grape production is considered, a positive influence has been found only for table grapes (Conradie *et al*., 2006). Paper I explained the attributed negative effect found there to the poor condition of Macedonian irrigation systems. Installation of new irrigation systems is at a very early stage and thus the results of this measure are not yet apparent.

3.2.2 Paper II

Does managerial behaviour determine farm technical efficiency? A case of grape production in an economy in transition

Paper II explored how managerial behaviour aspects influence the deviations from what is rational (efficient). Technical efficiency coefficients both from input and output-orientated perspective were estimated with DEA. Regression analysis was conducted with Tobit and truncated regression and the regression results were justified by double-bootstrapping application. The aspects selected from the RDPs referred to the technical support for improvements in occupational skills and competence. Paper II went further by considering farmers' bounded rationality as a key issue for managerial behaviour, which was explored under conditions of economies in transition. Managerial behaviour is manifested through how farmers make decisions (what information they use, how they process information and how they review the outcome). The results suggested that bounded rationality in farmers' production planning decisions causes inefficiency. Production planning decisions supported by: a review of farming results; application of bookkeeping and budgeting practices; involving family members; and not being a member of farmers' associations made farmers less bounded rational, and thus more efficient. The impact of bounded rationality on the TE values obtained can also be decreased if farmer's objectives are economically orientated and farmers have lower expectations and interest in farming.

In the literature, check accounting (Hansson, 2008b), management based on reliable accounting information and control phases (Puig-Junoy and Argiles, 2004) and contact with advisory services (Bravo-Ureta and Evenson, 1994;

Hansson, 2008b; Moock, 1981) have been identified as positive factors for farm efficiency. A negative influence of advisory visits has been found for the Ethiopian vegetable-dominated mix farming systems (Haji, 2007), where producers reported that they did not gain new skills and information and did not learn from contacts with the advisory services. In Paper II no statistically significant influence of advisory services was found, which was attributed to the rare use of such services by Macedonian grape growers. The economically orientated objectives were found to be important for input-orientated TE, which is in line with Wilson *et al*. (2001). The negative influence of high expectations by farmers and interest in farming on TE in Paper II was explained by the assumption that 'higher expectations for better future of farming' makes farmers more inert in their attempts to produce more output (thus affecting output-orientated TE), whereas farmers with a lower interest in farming are more concerned about other external events (such as environmental changes with political, ecological or social implications), which are probably important factors for efficient farming.

3.2.3 Paper III

Farmers' knowledge attributes contribute to attaining higher farm technical efficiency: A transition economy case

Paper III explored how farmers' knowledge attributes influence the economic performance of their farms. SF for parametric efficiency analysis was applied. This study used a conceptualisation and developed a model where in addition to formal levels of education and experience in farming, farm efficiency was associated with: the influence of specific education (such as agricultural or economics), know-how learning for specific farming skills, interpersonal relations, and structured relationships. As in Papers I and II, the study associated the findings with the current RDP (2007-2013) and evaluated the instruments intended to improve Macedonian educational potential. The results suggest that farmers' knowledge attributes have the potential to influence farm economic performance. Attending seminars and interest in competence-based knowledge on plant protection, investments and crediting, and formulating the grape price are important for better farm performance. Farmers' managerial experience and farm management based on instructions provided by friends, colleagues and neighbours were found to be negatively associated with the TE.

Dajnoki *et al*. (2010) showed that in Hungary, information concerning administration and applications is highly demanded by farmers. In the current study, farmers' experience was found to have a negative influence on farm efficiency. The influence of farmers' experience has been analysed by many

authors and both positive and negative impacts have been found. Proxies such as farmers' age (Moock, 1981; Latruffe et al., 2004; Puig-Junoy and Argiles, 2004; Hansson, 2008b), and/or managerial experience in farming have been used (Wilson et al., 2001; Hansson, 2008b). The result showing the negative impact of using the experiences of other farmers, friends, colleagues and neighbours as a knowledge source can be compared for example with findings reported by Hansson (2008b). In her study, contacts with friends and colleagues had a statistically significant negative influence on the allocative efficiency of Swedish dairy farms, whereas discussing decisions was significantly negative for EE and AE in both the short and long term.

3.2.4 Paper IV

Influence of product assortment on the efficiency of grape growing family farms in Macedonia - DEA Approach

Paper IV analysed the influence of grape assortment on farm technical efficiency. As in the previous papers, a two-stage efficiency analysis was adopted. In the first stage, output-orientated ordinary DEA and bias-corrected technical efficiency scores accompanied with confidence intervals were obtained. In the second stage, the impact of grape assortment characteristics on the efficiency scores obtained was explained. Regression results were justified by Tobit and truncated regression where bias-corrected bootstrapped standard errors derived with regular bootstrapping were used. In the study, the influence of two assortment dimensions was distinguished: 1) product diversification in terms of the number of grape varieties on the farm; 2) product diversification in terms of the product-function/product-consistency dimension, represented by three production options (regional/local wine grape varieties, European wine grape varieties and table grape varieties). A statistically significant positive influence was observed for the regional and local grapes, and table grape varieties. European wine grape varieties had a positive but statistically non significant influence. The number of varieties per farm had a statistically significant negative influence.

Paper IV identified assortment characteristics as a possible solution for attaining higher output efficiency. Product diversification was found to have a negative influence on farm efficiency, which was attributed to growing an additional crop and thus higher diversification, which is often seen as a risk reduction strategy when unexpected events occur, but more knowledge of production and managerial practices is needed. In the same way, Llewelyn and Williams (1996) argued that government policies that encourage diversification of cropping practices in Java may decrease TE, but emphasised that the

situation may change if farmers improve their ability to grow new crops. At present, there seems to be no consensus on the influence of product differentiation on farm efficiency, with both positive (Brümmer, 2001; Coelli and Fleming, 2004) and negative (Bojnec and Latruffe, 2009; Haji, 2007; Llewelyn and Williams, 1996) influences having been reported. In Paper IV, a statistically significant positive influence of regional, local and table grape varieties was observed. In general, product assortment needs to be adjusted to the production capacity and the technologies available (Ventura and Milone, 2000), but also consumer preferences, production constraints, environmental factors and organisation (Mantrala *et al*., 2009). In Paper IV only the producers' side was analysed, but the call by producers and specialists for expansion of the regional Vranec variety was stressed.

3.3 Efficiency results vs. rural development policy instruments

Grape production has been placed on the priority list for policy support, and instruments for strengthening competitiveness through increased efficiency and managerial and knowledge capacity of grape-growers have been proposed. As previously mentioned, the potential influence of selected RDP instruments on farm efficiency was analysed in this thesis. A summary of the selected instruments in the RDPs and efficiency results obtained with the regression analysis (selected farm and farmer characteristic) is displayed in Table 6.

Instruments for the restructuring of grape production with regard to production modernisation and replacement of vines were analysed in Papers I and IV. All of the measures and targets analysed belong to AXIS I of the IPARD Programme and Annual Programmes for Financial Support of Rural Development (funding for the period 2007-2011).

The positive influence of grape yield and total standard output suggests that policy instruments targeted at stabilising yield and achieving yield improvements are important for enhancing and improving farm efficiency. Such measures (see: IPARD Programme p. 12-13) are included in the RDP proposed for Macedonian grape production and, based on the findings in this thesis, their continuation is justifiable. Improvements in yield quantity and output value are also expected to be achieved by the gradual replacement of ageing vines and non-attractive hybrids. According to the results obtained in Paper IV, vine replacements with domestic/regional and table grape varieties should be prioritised.

The Macedonian RDP provides financial support for grape-growing family farms of up to 20 hectares and supports investment in irrigation systems. In Paper I, a negative influence of farm size and of irrigation practices was found.

It was concluded that increasing the size of vineyards should be accompanied by measures that improve the capacity of farmers to manage these larger plantations. The negative impact of irrigation practices was explained by the poor condition of existing irrigation systems. Paper I did not account for the existence of different irrigation systems, but in the data sample it was characteristic for vines to be irrigated from open channels and for drop irrigation system to be infrequent. However, the RDP does not specify where the irrigation system is expected to make the highest contribution to production quality and quantity, which can also be considered a limitation, as different grape varieties, soils and regions have different water requirements (Conradie *et al*., 2006).

Funds for vineyard mechanisation are offered by the Macedonian RDP, but a significant influence of machinery on farm efficiency was not found and thus the appropriateness of this measure was not verified. The influence of the relative share of machinery and technical equipment in farm capital on farms efficiency has been analysed previously and a significant positive impact was reported for cereal and vegetable producers, but a significant negative impact for grape producers (Kopeva and Noev, 2001). Paper I emphasised that grape-growing is a labour-intensive form of production, but in that analysis only the number and value of pieces of farm equipment were considered. For drawing appropriate policy recommendations, more detailed analysis on machinery use is necessary.

Investing in human capital and skills is crucial to developing opportunities for growth and employment in rural areas (European Commission, 2005). Instruments for improving the knowledge and managerial potential of farmers are expected to lead to higher efficiency, and are part of the Macedonian RDP for the current period (2010-2013). Technical support for improving occupational and competence skills is provided by the measures in AXIS 3 of the IPARD Programme and the Annual Programmes for Financial Support of Rural Development (funding for the period 2007-2011). Papers II and III both showed that the managerial characteristics and knowledge attributes of farmers have the potential to influence their ability to improve the economic performance of their farms. Monitoring farm results and book-keeping records, book-keeping practices (Paper II), and contacting specialists for proper plant protection, investments and credit and for grape price calculation (Paper III), were found to have a positive influence on farm efficiency. Thus farm support for such measures, as well as support for establishing accounting software, seem to be appropriate. Attending seminars was also found to have a positive impact (Paper III). However, the use of advisory services was found to be a critical issue (Paper II and III), since no significant influence was found. Weak

competence-based knowledge is reported to be characteristic of the advisory services in the economies in transition in general. Mandler (2010) and Imami *et al*. (2010) argue that these services are not adequately developed, while according to Djanibekov *et al*. (2010) they do not transfer agricultural knowledge from knowledge producers to farmers.

Table 6. *Policy instruments vs. efficiency result*

Policy instruments	**Significant[4] second-stage variables (+/-)**
GROUP 1: Improving sector competitiveness and efficiency	
1) Stable yield guarantee: recovery of older grape plantations with an area between 0.2 and 20 hectares (ha), building new irrigation systems and improving existing systems, anti-hail protection, installation of components for construction support 2) Yield improvement: purchase of phyto-sanitary planting material, replacement of non-recommended hybrids by recognised vine varieties 3) Equipment modernisation 4) Procurement of labour force for re-planting and installation of vineyards	Total area (—) Irrigated area (—) Yield production (+) Costs for materials (—) Costs for hired labour (—/+) Total standard output (+) Domestic and regional grape varieties (+) Table grape varieties (+) Product diversification (—)
GROUP 2: Technical support for improving occupational and competence skills	
1) Vocational training and information actions 2) Use of advisory services by farmers 3) Promoting the establishment of young farmers (under 40 years of age) 4) Early retirement for farmers in order to transfer their farm to younger farmers 5) Establishment of advisory services and farm assistance 6) Farm management support 7) Establishing accounting systems	Family-based decisions and planning (+) Friends, neighbours, colleagues (—) Farmers' managerial experience (—) Seminars (+) Membership of associations (—) Interest in farming (—) Profit maximising objectives (+) Production quality objectives (+) Monitoring farm results (+) Monitoring book-keeping results (+) Plant protection info (+) Investments and crediting info (+) Grape price info (+)

4. Please note that only the significant second-stage variables are displayed. The full set of the variables used for the regression analysis and the results obtained are resented in Papers I-IV.

There is some encouraging evidence from 2002 of a positive influence of advisory services and training on Romanian farm efficiency (Sauer and Balint, 2008). However, Romania joined the EU in 2004 and thus this positive result can be associated with the preparatory actions taken to strengthen service quality before joining.

Farmers' experience had a negative influence on farm efficiency. The Macedonian RDP (2007-2013) promotes establishment of young farmers (under 40 years of age) and early retirement for farmers and, based on our analysis, a positive influence of this measure can be expected. Vocational training, information actions, farm assistance and farm management support, are necessary instruments in the current Macedonian RDP (2007-2013), but additional training for organisations and people providing information and knowledge to farmers is needed.

4 Conclusions

This thesis analysed the performance of Macedonian grape growers in efficiency terms, and evaluated the potential impact of RDP instruments formulated to strengthen the competitiveness of the sector by enhancing efficiency and providing technical support for producers. Rural development policies can help to improve farm efficiency and thus the vitality of rural areas, but not all of the proposed RDP measures intended to increase efficiency on commercial grape-growing farms in Macedonia were justified. However, there were some important reservations regarding the data analysis and, accordingly, the conclusions regarding the appropriateness of the RDP measures.

The efficiency scores produced indicated that substantial efficiency improvements are possible on the farms analysed. Macedonian grape growers have the potential for an approx. 30% decrease in costs if farmers can improve their input management and an approx. 50% increase in revenue if they can manage to increase the value of their outputs. As the results shown are relative values of the achievements on the farms included in the data sample, applying the practices of the most successful farmers could be of great use for the remaining farms.

RDP measures targeted at stable yield and yield improvement are important for enhancing and improving farm efficiency and, consequently, the competitiveness and economic importance of the entire sector. Such measures are part of the Macedonian PRD and their existence has been justified. However, the programme supports revitalisation and investments in better grape assortment, but the preferred grape varieties are not well defined. This thesis makes a distinction between three groups of grape varieties, and suggests that local/regionally recognised and table grape varieties should be promoted. The findings also show that grape variety diversification is not recommended. Machinery variables did not have a significant influence on farm efficiency. This finding is noteworthy, as mechanisation and modernisation is a policy

measure targeted in the Macedonia and many other RDPs. In the case of labour-intensive production such as grape growing, more detailed analysis of machinery use is necessary before appropriate policy recommendations can be made.

Policy support for improving the managerial capacity and knowledge capacity of farmers through gradual implementation of requirements for bookkeeping and preparation of budgets on family farms, supporting non-formal education and the recruitment of young farmers to farming, competence-based and long-life learning are part of the current Macedonian RDP (2007-2013). This thesis shows that their inclusion is justified as they contribute to higher farm efficiency and thus should remain high priorities. Strengthening the capacity of the advisory services is also planned within the platform for technical support for the period 2010-2013, but a noticeable beneficial influence on farm efficiency can only be expected some years later, when the actions proposed with the measure are completed.

5 Contribution of the thesis

An efficiency analysis that offers an *ex ante* analysis of the potential impact of selected instruments of the RDP on performance improvement of the grape production sector would be beneficial in both an empirical and theoretical context for policy-makers, the actors engaged in grape and wine production, and the national economy of the Republic of Macedonia.

This thesis represents a first attempt to evaluate the potential impact of RDP targets on farm efficiency, in order to determine whether efficiency studies can be used as a guide for the *ex ante* design of RDP. For the activities of the RDP that have already taken place, the results can serve a checklist for goal achievement and can initiate corrective actions where critical points and opportunities for policy actions are identified.

Farm efficiency was analysed here in technical, allocative and economic terms and bootstrapping was applied, a combination which is rare in important literature about farm efficiency in economies in transition. The bounded rationality concept in Paper II has never been used previously to explain technical inefficiency. Paper II makes a practical contribution by considering the managerial behaviour of farmers on a sufficiently detailed level that the results can be of use when discussing ways to strengthen their managerial capacity. Knowledge management and the grape variety management issue studied in Papers III and IV are of value to the literature explaining the importance of knowledge and assortment characteristics in strengthening farm performance in the economies in transition.

All four papers relate to specific RDP instruments, thus making practical contributions for policy-makers, for whom *ex-ante* evaluation is of great importance, since to optimise government spending on RDPs, the measures that provide the greatest benefits should be targeted. Establishing whether, and how, the priorities targeted in the RDP can improve the efficiency of the

agricultural sector is vital for understanding how rural policy interventions can contribute to the maintenance of farming in rural areas.

Last but not the least, producers will benefit by obtaining information on: i) whether they are using inputs efficiently and how to improve their efficiency of use; ii) how grape production structure needs to be organised in terms of assortment characteristics; iii) key areas for investment on the farm; iv) managerial and production practices that make grape growers more efficient; and v) how they should use their knowledge and that of their network of friends, colleagues and others.

6 Fields for further research

Based on the shortcomings identified in this study, extensive further research is necessary on the use of irrigation systems and machinery. More accurate results could be obtained if the analysis made a distinction between different irrigation systems and different machine operations. Information obtained in the current data set did not allow such analysis.

This thesis focuses solely on grape production and only from the producers' perspective. To make Macedonian viticulture more industry-orientated, analysis of the sector from the consumers' side is also necessary so that the entire chain of grape and wine production is appraised.

Two out of four objectives defined with the current RDP were covered in this thesis. The remaining two objectives refer to: 1) implementation of agro-environmental measures and strategies for local rural development; and 2) rural economic development, with emphasis on development and diversification of rural economic activities and rural infrastructure. Both issues are of great importance for the national rural economy and are in synergy with the stated EU interest and intention to develop rural areas. Further research on the effects of related measures is necessary.

Macedonian RDP do not give exclusive priority to grapes and wines, as milk, meat, fruit and vegetables are also on the list of priorities. Corresponding studies would be necessary for these industries.

Comparative efficiency studies among countries with similar conditions are common practice. In that perspective, the efficiency of agricultural production in farms from the Balkan region can be compared. Efficiency differences can be then related to the policy measures applied in each country.

Generalisations on efficiency results should always be made with caution. This thesis attempts to explain the connection between current RDP instruments and farm performance. Thus the appropriateness and potential influence of the policy instruments were analysed from an efficiency aspect.

However, policy design and implementation should be based on more extensive economic research that examines the appropriateness of measures using other economic analysis approaches.

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