Production Efficiency of Independent Finnish Sawmills in the 2000's

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Abstract

Using stochastic frontier analysis and unbalanced panel data from 2000–2007, this study assesses Finnish independent sawmills' technical efficiency. The estimation results indicate that sawmills function under their efficient production frontier. The average technical efficiency has been 0.81 during the study period implying a moderate possibility to increase production by rationalising and optimising the use of current production technology. The results also show that although the sawmills are heterogeneous in their production efficiency, the average technical efficiency has neither improved nor worsened during the study period.

Key words: sawmills, efficiency, stochastic frontier analysis

Introduction

Since the 1990's, Finnish sawmilling industry has encountered radical changes in its operational environment. Along with Finland's membership in the EU in 1995, the system of collective stumpage price negotiations between the forest industry and the non-industrial private forest owners was gradually abolished by the end of the decade (Toppinen and Kuuluvainen 1997). Simultaneously with the reduction of the officially accepted anticompetitive practices in the domestic Finnish roundwood market, the Russian forest resources became available for nearly unregulated foreign trade. As to the wood procurement, the Finnish sawmills were facing a new and more market-oriented operational environment. On the one hand, the business cycles of international final product markets were reflected both on the accessibility and on the prices of logs more distinctly, but, on the other hand, the sources to procure logs were more plentiful than before.

During recent years, due to the stepwise implementation of customs tariffs programme for roundwood exports by the Russian Federation, the procurement of logs from Russia to Finland has become unprofitable (Solberg et al. 2010). Moreover, due to the increased production of sawnwood in Eastern and Central Europe, the supply of sawnwood on the European sawnwood markets has increased steeper than consumption. Tightening competition in conjunction with unpredictably violent up- and downturns in business cycles are currently typical of the main market area in Western Europe. Geographic location and the concurrent high transportation costs further emphasise the challenges to the competitiveness of Finnish sawmilling industry.

One important determinant of competitiveness is the efficiency of production, which can be decomposed further into technical and allocative components. Technical or production efficiency, which is a prerequisite for total efficiency, implies that companies produce the maximum output with the given inputs and technology. Allocative efficiency, in turn, takes into account the input prices requiring that the chosen technically efficient input mix is also profit maximising (cost minimising). The main hypothesis of neoclassical production theory and profit maximisation is that the companies function efficiently. In real terms however, efficient production is seldom, if ever, achieved. Recognising the companies' limited capability to efficient production forms the basis of this study.

This study endeavours to assess the level of technical efficiency, or in other words inefficiency, in the Finnish independent sawmills' production by using stochastic frontier analysis (SFA). The resulting numerical average as well as company specific measures of efficiency reveal the sawmills' potential for improving efficiency and competitiveness using the existing technology. Furthermore, the differences in companies' efficiency measures make it possible to scrutinise the underlying factors of the perceived inefficiency. The data collected from the Finnish sawmills includes observations from 2000–2007. Even though there are some international studies concerning technical efficiency within sawmilling industry (e.g. Nyrud and Bergseng 2002, Nyrud and Baarsen 2003, Helvoigt and Adams 2009, Kehinde et al. 2010), such results do not exist concerning the Finnish sawmills which have traditionally played an important role on the international sawnwood markets.

Materials and methods

Review of Finnish Sawmilling Industry

During the 2000's until 2008, the annual sawnwood production in Finland was around 13 million cubic meters. However, due to the worldwide economic slowdown, sluggish domestic and international demands for sawnwood accompanied by temporary and final closures of production capacity, the production volumes began decreasing in 2008 and reached the bottom in 2009 (Figure 1). The sawnwood production of about 8 million cubic meters in 2009 was only comparable to the production levels during the deep Finnish recession in the early 1990's. However, in 2010, the production has rapidly recovered. As to volumes, Finland has been amongst the ten largest producers of coniferous sawnwood in the world. Within the EU27, Finland currently is the fourth largest producer of sawnwood and the annual production corresponds to one tenth of the total sawnwood production of the EU27.

The production of Finnish sawmilling industry has constituted almost entirely of coniferous (*Pinus sylvestris* and *Picea abies*) sawnwood, while the production volumes of non-coniferous sawnwood has been marginal. The Finnish sawmilling industry is highly export orientated and exports have averaged almost two thirds of the total production. The main market area consists of the euro countries and the UK. Japan and Northern Africa are also important export destinations of Finnish sawnwood.

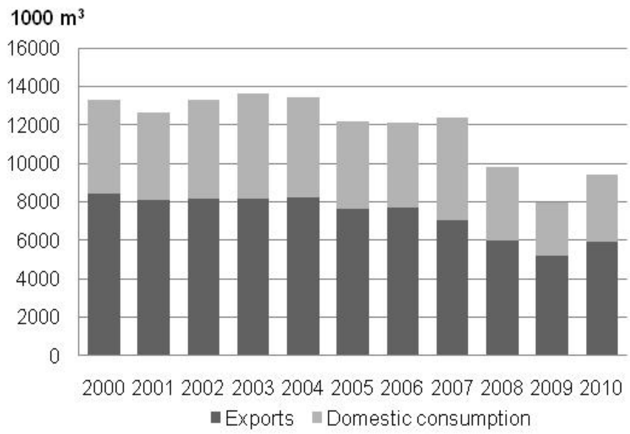

Figure 1. Coniferous sawnwood production in Finland and the proportions of exports and domestic consumption of total production in 2000-2010. Domestic consumption = production - exports. (Finnish Forest Industries Federation, Finnish National Board of Customs)

The Finnish sawmilling industry can be characterised as highly bipolar. In 2007, about 40 percent of the total production of sawnwood was produced by integrated sawmills owned by large international forest industry concerns. The rest was produced by sawmills which did not belong to the forest industry groups and which are hereafter referred to as independent sawmills. Although no compiled statistics concerning the distribution of production volumes between independent and integrated sawmills exists, it is evident that the importance of independent sawmills has increased during the 2000's. According to information provided in public sources, such as financial statements, it can be assessed that the share of independent sawmills of total sawnwood production grew from less than a half in the beginning of the decade to the current level of over 60 per cent.

It is commonly purported that there exists fundamental differences in goals and business operations between integrated and independent sawmills. The hypothesis is that while the independent sawmills aim at profit maximisation from sawnwood production, the integrated sawmills are subordinate to the large forest industries overall strategies, in which the production of pulp and paper is of special interest. In this framework, the integrated sawmills producing chips and sawdust as by products have a key role in the wood procurement for the forest industry concerns' pulp and paper divisions (e.g. Kallio 2001). Thus, the decisions and actions of the integrated sawmills are, in fact, reflecting the cost minimising behaviour of the pulp and paper industry. As the aims of integrated and independent sawmills may differ substantially, also their reactions to changes on the markets for final products are likely to differ. Moreover, the independent sawmills are vital in creating competition on the Finnish roundwood markets, where the large forest industry concerns have just recently been found exercising illegal price co-operation. Therefore, distinguishing between these two major types of sawmills is essential and taken into account in the design of this study.

Demand for Finnish sawnwood is highly sensitive to the international business cycles and, especially, to construction activity on the main export markets. During the whole 2000's, the competition on the European sawnwood markets has tightened due to increased production capacity in Germany, Sweden, the Baltic States and Eastern Europe. Along with the strong euro and consequently weakened real competitiveness, the Finnish sawmilling industry has lost market shares since 2007 with respect to main competitors such as Sweden. However, during 2010 the situation has slightly changed as the euro has devaluated in parallel with the prolonged economic crisis in certain euro countries.

Traditionally, competitive advantages to the Finnish sawmilling industry have been considered high quality of sawnwood, up-to-date technology and professional skills. Prior to entering the currency union, the frequent devaluations of Finnish mark aimed at improving the sales of Finnish export items also enhanced the competitiveness of Finnish sawnwood on the export markets. The high production costs, especially wood and labour costs, combined with long geographic distance from the main markets have been impeding factors for competitiveness. As presented in Figure 2, material costs, the overwhelming majority of which is wood costs, constitute over 60 per cent of total costs of Finnish sawmills. The 2007 peak in stumpage prices of coniferous sawlogs is also detectable, as in 2007 material costs expanded to nearly 70 per cent of total costs (Figure 2). Personnel costs and costs due to transporting and storing of finished goods are nearly equal, about 10 per cent of total costs. Compared to cost types mentioned previously, costs due to purchased energy are fractional, 2–3 per cent of the total costs. Of the energy costs the majority consists of electricity. Many sawmills have their own power stations providing heat for e.g. drying, and thus lowering the need for acquiring energy outside the plant. The rest, about 15 per cent, of total costs consists of various different cost types, such as merchandises purchased to be sold unprocessed onwards, e.g. pulpwood, repair and maintenance carried out by contractors, subcontracting costs etc.

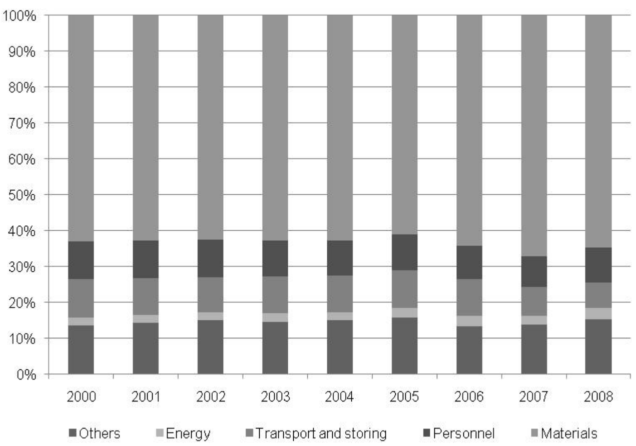

Figure 2. Cost structure (excluding depreciation) in the Finnish sawmilling industry 2000-2008 (Statis-tics Finland)

Previous studies indicate that on the Finnish roundwood market, the trade in sawlogs seem to function on a fairly competitive basis (Toppinen and Kuuluvainen 1997, Mutanen and Toppinen 2005). Furthermore, the energy prices, especially in the case of electricity, are market based. In Finland, trade unions are influential and strikes as well as other types of industrial actions are commonplace especially in traditional branches going through severe structural changes. The geographic location of Finland must also be borne in mind, not to mention the sudden changes in the political regimes of the Russian Federation. Thus, many of the factors affecting the revenues, costs, profitability and, ultimately, competitiveness of Finnish sawmilling industry are not under control of an individual sawmill. In such a market environment and under tightening competition, improving the technical efficiency of production, which by definition lies within the sphere of a sawmill's capability, is a prerequisite for survival and success.

Stochastic Frontier Estimation Methodology

Literature provides various different models and methods for analysing the technical efficiency of production. The main differences of the approaches are found in the treatment of stochastic variation and in the estimation procedure, which may be based on parametric or non-parametric methods. The pros and cons of the different approaches are detailed in Coelli et al. (1999), for example. In the selection of a suitable method, the research subject, the objectives of the study and the quality of the data are essential. While the aim of this study was to give explicit parametric estimates for the technical efficiency in a stochastic environment, the stochastic frontier analysis (SFA) was an applicable method.

To understand and to interpret the estimation results, we briefly sketch the main technical issues behind the SFA. Following Aigner et al. (1977) and Kumbhakar and Lovell (2000), consider a production technology presented as

$$q_i = f(z,\beta), \quad i = 1,\ldots,N, \tag{1}$$

where q_i is the amount of production of firm i, z is the k-dimensional vector of inputs and β is the vector of unknown coefficients. If the firm functions efficiently, (1) provides a frontier output giving the maximum production with the given inputs. However, due to several reasons, the firm's actual production typically lies below the theoretical optimal frontier. This inefficiency can be augmented into the production technology such that

$$q_i = f(z,\beta)\varepsilon_i \exp(v_i), \tag{2}$$

where $0 < \varepsilon_i \leq 1$ provides the firm specific measure of technical efficiency or in other words inefficiency and

v_i is random shocks denoted to production. If ε_i=0, the firm operates in its production frontier without any inefficiency, and is only subject to random shocks. The closer the parameter ε_i is to zero, the less efficient is the production. Following Battese and Coelli (1992), if the production technology is assumed to be of Cobb-Douglas -type, then after taking logarithms, the technology can be applied with balanced and unbalanced panel data as follows:

$$\ln(q_{it}) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(z_{jit}) + v_{it} - u_{it}, \quad (3)$$

where β_0 is a constant, t denotes time, $u_{it}=-\ln(\varepsilon_{it})$ and v_{it} is stochastic error term for random shocks and assumed to be normally distributed over the observations, $v_{it} \sim N(0,\sigma_v^2)$. While inefficiency means less production, $u_{it} \geq 0$ and thus, the distribution of u_{it} is restricted to be positive and can be specified as half-normal, exponential or truncated normal (see Kumbhakar and Lovell 2000 for details). u_{it} and v_{it} are also assumed to be independently distributed, thus cov(u_{it}, v_{it})=0.

While standard estimation does not give a consistent estimator for the constant and it is efficient only among linear estimators, Aigner et al. (1977) derived maximum likelihood estimators (ML) to overcome these problems. Based on this ML estimation, Battese and Coelli (1992) suggested a clear interpretation of production efficiency through the variance parameters of the estimation. While the compound variance can be decomposed as

$$\sigma^2 = \sigma_v^2 + \sigma_u^2, \quad (4)$$

the ratio

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \quad (5)$$

can be interpreted as follows. If $\gamma = 0$, the deviation from the frontier is entirely due to the random noise and the model is reduced to standard average production function. If $\gamma = 1$, the deviation is only due to production inefficiency. When $0<\gamma<1$, the magnitude of the parameter determines the relative proportions of the reasons for deviation.

The panel characteristic of the data allows one important additional feature to be tested, that is, whether the firm specific production inefficiency term is constant over time. Consider that the inefficiency is re-expressed as

$$u_{it} = \eta_{it} u_i = \exp[-n(t-T)]u_i, \quad t \in \Im(i), i = 1,\ldots,N \quad (6)$$

where η describes the time variant behaviour of inefficiency component. $\Im(i)$ gives the observations which are available from the studied time period T. If $\eta > 0$, $\eta = 0$ or $\eta < 0$, then the firm specific non-negative inefficiency is decreasing, constant or increasing over time, respectively.

In order to test alternative model specifications, the stochastic production function is estimated with the following parameter restrictions:

1. Time variant inefficiency term u_{it} is assumed to follow the non-negative truncated normal distribution, $u_{it} \sim N^+(\mu,\sigma_u^2)$, as in Battesse and Coelli (1992).
2. Time variant inefficiency term u_{it} is assumed to follow the non-negative half normal distribution, $u_{it} \sim N^+(0,\sigma_u^2)$, as in Battesse and Coelli (1992).
3. The inefficiency term is assumed to be time invariant, η=0, and follow the non-negative truncated normal distribution, as in Battesse et al. (1989).
4. The inefficiency term is assumed to be time invariant, $\eta=\mu=0$, and follow the half normal distribution, $u_i \sim N^+(0,\sigma_u^2)$, as in Pitt and Lee (1981).
5. The model is reduced to average production function without any firm specific inefficiency terms, $\eta=\mu=\gamma=0$, as in Battesse and Corra (1977).

The estimation of all these models gives parameter estimates for the unknown coefficients. Also, the models 1–4 generate firm specific inefficiency components. The random shock component in all the models is assumed to be normally distributed. The suitability of different model specifications for describing the data can be assessed by using the following likelihood ratio test:

$$LR=-2\{\ln[L(H_0)/L(H_1)]\}=-2\{\ln[L(H_0)]-\ln[L(H_1)]\}, \quad (7)$$

where $L(H_0)$ and $L(H_1)$ are the likelihood function values of the models estimated under the hypotheses H_0 and H_1. The LR statistics follows χ^2 distribution with the degrees of freedom equal to the number of restrictions in the hypothesis.

Data

The population of the study comprised of independent Finnish sawmills, the main product of which was standard sawnwood and with the exception of planning performed only minor upgrading. The original sample size was 30 enterprises, whose annual production constituted the majority of the total production of independent sawmills in Finland. According to the recommendation by the European Commission (2003/361/EC), the sampled sawmills fell into the category medium size enterprises (50–249 employees, turnover 10–50 mil €).

The data were collected using a semi-structured questionnaire during the spring of 2009. The CEOs (or as high as possible front runner) of the sampled sawmills were contacted personally. Eventually, after two rounds, 10 sawmills constituting 33 per cent of the original sample, answered the questionnaire. However, as the answers of one sawmill were both quantitatively and qualitatively inadequate this sawmill was dropped from the analysis. Therefore, the final sample included 9 sawmills. Most importantly, the questionnaire provided information on sawmills' annual sawnwood production (m^3/a), total production capacity (m^3/a), labour (number of employees), purchased electricity (MWh/a) and consumption of sawlogs (m^3/a). Also other factors possibly affecting the technical efficiency were inquired, such as the average age of production capacity, dimensions of consumed sawlogs, magnitude of R&D and importance of upgraded production. However, as there were insuperable deficiencies in answering the questionnaire and eventually, the data set used in the analyses constituted of an unbalanced panel of 9 sawmills and 54 of the possible 72 observations for 2000–2007.

Despite the low sample size, the data represented fairly well the Finnish sawmilling industry. The sawnwood production of the sawmills, that participated in the study corresponded 10 per cent of the total production of Finnish sawmilling industry. As to turnover and labour force, the shares of the sawmills in the data were 6 and 8 per cent, respectively. As to the numerical values of factors of production, an average sawmill in the data had a production capacity of 171,581 cubic meters of sawnwood, produced 105 840 cubic meters of sawnwood, consumed 252,322 cubic meters of sawlogs, had 65 employees and purchased 7,734 MWh of electricity annually. According to database of Statistics Finland, these figures represent rather well larger than average sized sawmills in Finland.

Results

The maximum likelihood estimates of the parameters were based on a standard Cobb-Douglas logarithmic functional form (3). While some of the sawmills produced also upgraded products, the models were augmented to include a dummy variable to reveal whether the production frontier of these sawmills differed from those of the standard sawnwood producers. The results for alternative stochastic model specifications (models 1–4) and for average production function (model 5) are presented in Table 1.

The statistically significant coefficients for sawlogs in all the models emphasised the well-known, essential role of sawlogs in sawnwood production. The logarithmic functional form indicates that one per cent increase in sawlog use results 0.63–0.85 per cent increase in sawnwood production. These decreasing returns to scale are realistic and in accordance with economic theory. Since in the case of Cobb-Douglas technology the coefficients can also be interpreted as cost shares, the estimates are closely related to the official wood cost share figure of over 60 per cent (Figure 2).

Table 1. Maximum likelihood results for stochastic frontier models and for the average production function

	Model				
	Time variant inefficiency term		Time invariant inefficiency term		Average production function
	1	2	3	4	5
Constant	1.43	-0.62	0.84	0.52	2.61**
	(0.84)	(0.89)	(0.59)	(0.69)	(0.35)
Sawlogs	0.68**	0.85**	0.73**	0.74**	0.63**
	(0.09)	(0.11)	(0.08)	(0.10)	(0.05)
Electricity	0.23**	0.07	0.21**	0.18**	0.14**
	(0.06)	(0.11)	(0.07)	(0.09)	(0.02)
Capital	0.02	0.09	0.04	0.05	-0.08
	(0.08)	(0.08)	(0.07)	(0.08)	(0.05)
Labour	-0.09	0.03	-0.10	-0.06	0.22**
	(0.10)	(0.07)	(0.07)	(0.10)	(0.04)
Dummy	-0.43**	0.04	-0.32**	-0.22	-0.51**
	(0.14)	(0.17)	(0.13)	(0.15)	(0.05)
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.03	0.11	0.04	0.08	0.01**
	(0.02)	(0.06)	(0.03)	(0.05)	(0.00)
$\gamma = \sigma_u^2 / \sigma_s^2$	0.88**	0.97**	0.91**	0.96**	
	(0.11)	(0.02)	(0.07)	(0.03)	
μ	0.22**		0.23		
	(0.10)		(0.13)		
η	0.02	-0.04			
	(0.03)	(0.04)			
Log likelihood	62.99	62.89	62.69	62.49	49.26
Mean technical efficiency	0.78	0.88	0.78	0.81	

The asterisks denote statistical significance of a coefficient: ** differs statistically from zero at 1 per cent level, * differs statistically from zero at 5 per cent level. The standard errors of the estimates are given in parentheses

The coefficients of electricity were statistically significant in all the models except model 2. The magnitude of these coefficients reveals about one fifth relationship between the use of electricity and sawnwood production. The signs of the coefficients for capital and labour varied and in the case of labour were often of the wrong sign. However, neither the coefficients for labour nor capital were statistically significant in stochastic frontier models 1–4. Only in model 5, the coefficient of labour was statistically significant. The statistical insignificance of the coefficients of labour and capital reflects the fact that compared to wood raw material and electricity, labour and capital can be considered as virtually fixed inputs.

The dummy variable, which tested whether the behaviour of sawmills with upgraded production differed from those of the mills with only standard sawnwood production, became statistically significant in stochastic models 1 and 3, and in the average production function, model 5. This implicates that the production frontier of mills with upgraded production lies below the production frontier of those mills with only standard sawnwood production. The result is logical as in these sawmills inputs have to be used also in the production of upgraded products, not only in production of standard sawnwood. In the data, it was impossible to detect e.g. the share of consumed electricity due to production of upgraded products.

As to the parameters of technical inefficiency in models 1–4, the values of *ć* varied between 0.88 and 0.97 implying that most of the deviation from the production frontier was due to inefficiency. The mean technical efficiency, which was calculated from firm specific values $\varepsilon_i = \exp(-u_i)$, varied in the range of 0.78–0.88. These figures can be interpreted as the ratios of observed to efficient production.

In order to determine, which of the models was most suitable for the empirical data, three likelihood ratio tests were performed (Table 2). Firstly, the hypothesis whether the firm-specific inefficiency terms belonged to the model at all was tested. The result was that the inefficiency terms should be included in the model. Secondly, it was tested whether the inefficiency terms were evolving over time or not. The result was that the terms were time invariant. Thirdly, it was tested, which of the time invariant models, the one with half normal distribution of inefficiency terms or the one with truncated normal distribution of inefficiency terms was more suitable for the data. The result favoured the half normal distribution.

Table 2. Results of likelihood ratio tests

Test	H_0	$\bullet^{2}$	$\bullet^{2}_{0.95}$	Decision
Model 5 vs. Model 1	• = • = • = 0	27.46	7.81	Reject H_0
Model 3 vs. Model 1	• = 0	0.60	3.84	Accept H_0
Model 4 vs. Model 3	• = 0	0.41	3.84	Accept H_0

According to the likelihood ratio tests, model 4 was most suitable for the data. Thus, according to this model the inefficiency terms were constant in time and followed half normal distribution. The calculated mean value for technical efficiency was 0.81, the interpretation of which is that the sawmills could theoretically increase their production from the current level on an average 23.5 per cent solely by improving technical efficiency. However, the firm specific efficiency values varied in a relatively wide range of 0.57–0.97. Accordingly, in some sawmills, the potential for improving technical efficiency was virtually exhausted, whereas in some sawmills the technical efficiency was considerably low.

As the differences in sawmills' technical efficiency figures were significant, the next logical step was to model the reasons affecting perceived variation. The data in use included several background variables of sawmills' investment behaviour, quality distribution of sawnwood produced, quality of machinery, R&D activity and use of imported wood raw material. In addition, previously collected data of the sawmills' strategic behaviour were also available. However, due to limited number of observations, the attempts to model the sources of inefficiency provided no meaningful results. The low number of observations and consequently limited degrees of freedom also restricted the tests of suitability of other functional forms of production technology, such as translog production technology, in the data.

Discussion and conclusions

The profitability of sawmilling industry depends highly on the market prices of sawnwood and used inputs. The tightening competition on sawnwood markets both in Finland and in the main export market areas accompanied by complicated sawlog procurement further emphasises the role of a single sawmill as a price taker. In such a market environment, along with the apt and timely choices of business strategy, technically efficient use of inputs is vital for success.

This study assessed the technical efficiency of production amongst Finnish sawmills by employing stochastic frontier analysis and unbalanced panel data from nine independent sawmills. Even though the sample size was low, the data represented fairly well the independent Finnish sawmilling industry. However, the limited number of observations restricted deeper testing and econometric analysis of the reasons affecting the perceived variation in the technical efficiency across the firms. The main result was that, on average, independent Finnish sawmills were not functioning on the efficient frontier. Thus in general, there was room for improving the sawmills' technical efficiency, yet in the same time, the differences in the efficiency levels were significant. Therefore, the traditional approach of using aggregated data and the average production function for describing the production technology of the Finnish sawmilling industry can be considered too general and even misleading.

As the results of this study revealed valuable new information of the production technology and level of technical efficiency within the Finnish sawmilling industry, they were by no means all-embracing. Especially, the study failed to expound the factors affecting the variation in the efficiency levels. Different forms of ownership ranging from family businesses to public companies, geographic location and export intensity, for example, are possible reasons which may explain the firm specific efficiency. In addition, an important section of the industry, the integrated sawmills, was not scrutinised. A major part of these deficiencies were attributable to the challenges posed by data collection: while public data of adequate specificity did not exist, it was demanding to motivate the firms to provide the needed information voluntarily.

The structural change in sawmilling industry has challenged researchers to test alternative data sets and to apply different analytical and econometric methods, such as in Niquidet and Nelson (2010), to better understand the dynamics of production, market competition and the correspondent local income and employment effects. While it would also be interesting to compare the relative efficiency and competiveness of Finnish sawmilling industry, similar results concerning technical efficiency from main competitor countries in international markets do not exist. Especially, it would be fertile to compare the efficiency against competitors in the Baltic Sea region, where the transportation and sawlog costs are typically high and thus, the role of technical efficiency is emphasised. Despite the difficulties in modelling the reasons for inefficiency, the results of this study are in accordance with Helvoigt and Adams (2009) and Kehinde et al. (2010) who found strong evidence of inefficiency prevailing sawmills' production and reported similar statistical significant relationships between sawlogs and sawnwood while other inputs showed either minor significance or have no effect on the firm's production.

Concerning Finnish sawnwood industry, Lähtinen and Toppinen (2008) found that the business success of Finnish large- and medium-sized independent sawmills differed from the average success of the whole industry. Their analysis of financial statements and cost efficiency revealed that profitability and turnover growth of independent sawmills were, on an average, higher with respect to economic performance of the sawmilling industry in general. Lähtinen et al. (2008, 2009) emphasised the role of intangible resources (personnel, collaboration, technological knowledge, and reputation and services) in addition to tangible resources (raw material and geographic location) to explain business success of Finnish sawmills. All of these previous findings are in accordance with the methodology of this study to concentrate in explaining the economic behaviour of independent sawmills separately of the integrated sawmills.

For the future studies, compilation of more detailed firm specific data is unquestionably a challenge for a deeper analysis of the Finnish sawmilling industry. In the Finnish context, one obvious extension of this study would be the comparison between the independent and integrated sawmills in their production efficiency and strategic choices. Moreover, the underlying reasons for variation in efficiency require deeper analysis urgently. By detecting the factors affecting the shortcomings in meeting the efficient production frontier, the future activities aimed at enhancing the competitiveness of the sawmilling industry could be targeted more accurately.

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ПРОИЗВОДСТВЕННАЯ ЭФФЕКТИВНОСТЬ НЕЗАВИСИМЫХ ФИНСКИХ ДЕРЕВООБРАБАТЫВАЮЩИХ ПРЕДПРИЯТИЙ В 2000-ЫХ ГГ.

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Резюме

Используя стохастический граничный анализ и массив неравновесных панельных данных за период с 2000 по 2007 гг. мы провели оценку технической эффективности независимых финских деревообрабатывающих предприятий. Результаты исследования продемонстрировали, что деревообрабатывающие предприятия не достигают уровня эффективного производства. Средняя техническая эффективность составила 0,81 во время исследования с возможностью умеренного повышения эффективности за счет рационализации, оптимизации и использования новых технологий. Согласно результатам исследования, деревообрабатывающие предприятия весьма разнообразны в плане показателей эффективности, а средние показатели не уменьшились и не увеличились за данный период.

Ключевые слова: деревообрабатывающие предприятия, эффективность, стохастический граничный анализ