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Comparing forest sector modelling and qualitative foresight analysis: Cases on wood products industry

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ABSTRACT

Scenario analyses are widely used in forest sector foresight studies, being typically based on either qualitative or quantitative approaches. As scenario analyses are used for informing decision-makers, it is of interest to contrast the similarities and differences between the scenario processes and outcomes using quantitative and qualitative approaches and to explore the underlying causes of differences. This paper uses the output from a qualitative scenario study to design forest sector model (FSM) scenarios and compares the results from the two approaches. We analyse two cases on wood products markets in Norway: i) Wood products suppliers establish a developer firm specializing on wood construction to boost demand, and ii) Levying a carbon tax while reducing CO_2 emissions in cement production. Comparing the qualitative studies (innovation diffusion analysis, backcasting and Delphi) and FSM analyses (NorFor model), the results resemble for case ii) but deviate strongly for case i). Notably, the strategy aiming to boost the demand for domestic wood products leads in NorFor mainly to an increase in imports with limited impact on Norwegian sawnwood production. Causes of the discrepancies are discussed. Despite the challenges of combining the two frameworks, we believe that the method where assumptions based on stakeholder input or other qualitative research approaches are elaborated in a FSM and compared, should be more explored. Importantly, applying various methods and frameworks allows for complementing and diversifying the picture, and thus improving the knowledge base.

Introduction

Various techniques and approaches exist for the study of the future. It makes sense to pursue diverse approaches in forward-looking studies to gain a holistic view of the problem (For-learn, 2016). Further, as noted by Gordon & Glenn (2009), diverse methods can identify affecting factors which any of the techniques alone might have missed. The simultaneous use and comparison of alternative research approaches, methods and data in the study of the same phenomenon can be referred to with the term “triangulation”. This form of triangulation remains rare in forest sector outlook literature (Hurmekoski & Hetemäki, 2013).

Despite the clear motives, joint undertakings between qualitative and quantitative research are not the norm in practice (Varho & Tapio, 2013). According to Lüdeke (2013), researchers tend to take one of the two following positions: Either that only quantitative methods are regarded as truly scientific or that quantitative methods tend to obscure the reality of the phenomena under study, because they underestimate or neglect the non-measurable factors. As further argued by Lüdeke (2013), quantitative approaches allow for handling the information in consistent and reproducible ways, combining figures, comparing data, and examining rates of change, which allows for much greater precision than simply talking about increases or decreases. Yet the operational range of any model, including quantitative models, is restricted by the data. The intangible nature of some of the affecting factors of which we have very limited data or knowledge, implies that qualitative approaches may be equally useful, for example in bringing forward information that can be incorporated into quantitative models.

There are very few studies in the forest sector literature explicitly comparing or combining forest sector modelling and qualitative foresight methods (e.g., Sjølie et al., 2016, see also Hurmekoski

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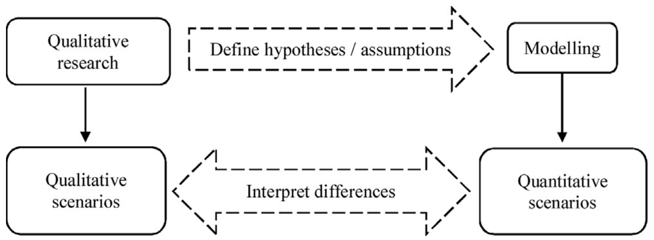

Fig. 1. Process for linking qualitative foresight approaches and quantitative methods and comparing the outcomes (based on Fortes et al., 2015).

& Hetemäki, 2013). The objective of the paper is to compare the research outcomes obtained by qualitative foresight analysis and forest sector modelling through selected case studies on wood products markets. The findings from the empirical cases are used to identify needs for further method development and possible directions towards combining different lines of research. In the next section, we will put forward the methods and data used for the study, while Section 3 describes the two case studies that form the basis for the scenarios. The results are described in section 4, followed by conclusive remarks.

Methods and data

The research design follows the framework set by Fortes et al. (2015) for combining and comparing qualitative and quantitative approaches (see Fig. 1), in which the results of the qualitative studies are used to focus and set up the scenarios for the quantitative study. Moreover, the framework suggests exploring, whether the conclusions from the different lines of research conflict each other, and whether some results are exclusive to one of the approaches.

The research process consisted of three stages: First, the existing literature on the factors affecting the markets of sawnwood used for construction – the single most significant end use category of wood products – were identified and analysed. These data convey numerous factors affecting the wood construction market that could feed into a modelling exercise as variables. Second, scenarios were developed for two case studies, chosen based on the ability of the forest sector models (FSM) (see, e.g., Kallio et al., 1987; Latta et al., 2013) to quantify the affecting factors, and on the novelty of the perspectives given the existing literature. Third, the scenarios of the two cases were run with a FSM, and the results were compared to the results from the qualitative studies.

The qualitative data are based on a state-of-the-art literature review and an expert survey (Hurmekoski 2016), building on innovation diffusion analysis (Rogers 2003), participative backcasting (Dreborg 1996) and Delphi (Linstone and Turoff, 2002). The innovation diffusion framework identifies a variety of complex and interrelated factors related to the attributes of a given product or technology, the perceptions towards it and the context structure (Roos et al., 2014), and explores the possible rate of market diffusion based on the total of these factors. Backcasting entails looking back from a preferred future typically set by stakeholders and identifying the steps that need to be taken to achieve it. Empirical data for the backcasting exercise were collected by performing a Delphi survey, employing a web-based questionnaire and semi-structured interviews. The combined results of these approaches were used to guide the scenario analysis for the two case studies.

The scenarios were run with the partial equilibrium forest sector model NorFor (Sjølie et al., 2011a), that has been applied for several studies of economic and greenhouse gas mitigation potentials in the Norwegian forest sector (Sjølie et al., 2011b, 2013a, 2013b, 2016). The NorFor model maximises the discounted social welfare in the Norwegian forest sector (i.e., producer surplus plus consumer surplus net of transport and investment costs) by simulating the behaviour of three groups of agents: forest owners, forest industry and consumers of wood products. Forest owners are assumed to maximize the profit from selling timber and harvest residues and the utility from owning old-growth forest, industry to maximize the profit from producing and selling wood products and consumers to maximize the utility from consuming wood products. The model simulates how these groups of agents adapt to changes in economic and policy frames ('what if' scenarios), based on perfect foresight (intertemporal optimization) in 5-year periods to year 2100.

The growth and management of almost 9,000 plots covering all productive forest in Norway are simulated, with management and harvest timing (including never harvest) being endogenous to the model. The optimal management regime and harvest timing for all forest land is found as part of the optimal solution. Harvest residual supply costs are given on the county level, with supply in each period being capped by the county harvest level.

There are only about 20 pulp, paper and board mills in Norway, each specified in the model with input-output coefficients and capacities. These parameters are modelled on the county level for the sawnwood and bioenergy industries. Sawnwood products include spruce, pine and birch sawnwood. The pulp, paper, board and bioenergy industries consume sawmill chips and pulpwood, and the bioenergy sector also harvest residuals. Bio-heat options include stoves in homes burning wood or pellets and water-borne heating systems fed by chips or pellets for consumers and industry.

Demand for wood products is given on the county level and changes with price and GDP growth, the latter being influenced by population growth. The assumed GDP growth rate is 1.5% p.a. in Norway and 1.0% p.a. in other counties. Two foreign regions ensure balance in the markets; trade with foreign markets or between some of the nineteen domestic regions takes place as long as the price difference between two regions exceeds transportation costs.

Carbon is accounted for in the major components in the model: carbon sequestered as trees grow and stored in stem, branches, tips and roots as well as in the soil, based on the Marklund (1988) functions. Greenhouse gas emission rates from silviculture, the use of machinery, transportation and processing are added based on life-cycle analyses; a full account of these numbers are given in Trømborg and Sjølie (2011). Carbon stored in wood products are included, as well as the products' expected life span and substitution rates, based on Petersen and Solberg (2005). All wood products are assumed to be combusted at the end of their life cycle, and to replace domestic heating oil.

Given the degrees of economic sectoral details that few other quantitative models can match, combined with the carbon fluxes and possibilities for pricing carbon, we found the NorFor model being very suitable for carrying out this analysis.

Case studies

Case one: Moving downstream in the construction value chain

A recent backcasting study (Hurmekoski et al., 2017) identified two major pathways for increasing the market share of wood construction and the value added of the industries by 2030. One is based on gradual process change and standardisation. The other is based on firms moving downstream in the construction value chain, for example, by wood products suppliers establishing a joint developer firm that would specialize on wood construction. The latter pathway was by the interviewed experts regarded to be markedly more efficient in pursuing the targets of higher market share and value added. Several measures for reaching these targets were identified, such as industrial prefabrication, standardisation, and shifts