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Price dynamics in Wisconsin woody biomass markets

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ABSTRACT

This study quantifies the potential impact of biofuel/bioenergy development on the pulpwood market in Wisconsin. Important demand and supply factors to take into account when quantifying the potential spillover effects include: (i) availability of regional forest residues, (ii) forest biomass demand of the Renewable Portfolio Standard (RPS) mandated by the state, and (iii) the slack pulpwood supply due to the recent economic recession. The results indicate that given the limited amount of regional forest residues, demand for primary forest resources over 2.29 million dry Mg will likely spill over into local pulpwood market and have a pronounced impact on pulpwood prices. The price effect could be more substantial if the pulp and paper industry expands production capacity significantly over the same period.

1. Introduction

Concerns about climate change and national security have driven efforts to reduce greenhouse gas emission and reliance on imported fossil fuels. Developing sustainable energy sources including primary forest products receives increasing amount of attention. In recent years we have seen an exposition of energy related policy changes to encourage production and consumption of renewable energy sources at both federal and state levels. Those policies are expected to have a significant impact on the markets of forest resources. One specific example is the Renewable Portfolio Standards (RPS), which mandates a minimum portion of electricity generated from renewable energy sources including wind, solar, biomass, and geothermal energy [1]. RPS has been enacted by many states with state-specific percentage target and timeline. For example, Wisconsin established the current RPS in 2005 requiring electric providers to gradually increase their shares of renewable resources with the statewide target of 10% by 2015. State Renewable Electricity Profile [2] reports that approximately 6.2% of the electricity generated in Wisconsin came from renewable resources in 2010, in which 1.3% is from wood and wood waste. As the No. 1 papermaking state in the US and a leading producer of lumber and other wood products, it is meaningful to investigate the evolving trend of forest product markets and quantify the potential impact of biofuel/bioenergy development in Wisconsin.

Forest residues are promising biomass materials to be employed for producing heat, bio-based materials, and advanced biofuels because of their greater availability and relatively lower economic costs. The Billion-Ton Update recently published by the U.S. Department of Energy [3] makes the effort to qualify forest residues' availability at county level. Development of biofuel and bioenergy industries and renewable energy resources including primary forest

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resources has the potential to provide profitable market opportunities for producers. However this new development could intensify the competition over raw feedstock materials and thus have a significant impact on traditional consumers and wood-using industries, such as pulpwood [4]. Exceeding the limited amount of local forest residues, high market prices resulting from biofuel/bioenergy development will generate demand spillovers into related forest product markets. In the long run, continuously evolving price signals will influence and eventually change the structure of the U.S. industrial wood sector [4].

An increasing number of studies attempt to model forest biomass supply and its interactions with emerging biofuel/bioenergy production. For example, Galik et al. [5] investigate the potential supply of woody biomass for regional bioenergy production in three southern states. The authors assume a constant stumpage price ($1 green Mg^{-1}) to quantify residue availability and a constant price elasticity (0.3) supply curve for pulpwood. They conclude that (i) a significant amount of forest residues is available in the study region, and (ii) exceeding the residue supply could induce dramatic price spikes in other related markets including pulpwood. In our study we analyze the residue availability for biofuel/bioenergy in a similar way by taking into account the biomass demand of satisfying local RPS mandate. The price impact on pulpwood market is quantified differently by employing a fully specified supply-demand system. We also incorporate potential changes of local pulp/paper industry into the framework, which enables us to provide a complete picture of the interactions between primary forest products on the value chain. Kong et al. [6] develop an integrated model for major raw forest resources including sawlogs, pulpwood, and forest residues. But their focus is on how to minimize the total cost for the combined market in the wood procurement and distribution processes. Several recent studies [7,8] investigate issues and opportunities associated with forest product markets in the development of emerging renewable energy industries in local regions.

A related line of research develops econometric models for the supply and demand of pulpwood market. Polyakov et al. [9] conduct an empirical analysis of factors influencing pulpwood supply and demand in Alabama. Adams [10] considers modeling pulpwood harvest, consumption, price and inventory patterns in Wisconsin and the Lake states. Bolkesjø et al. [11] estimate supply equations for sawlog and pulpwood by using various empirical methods and a panel dataset of Norwegian municipalities over 1980–2000. Our study applies a similar empirical method to the pulpwood market in Wisconsin.

The objective of this study is to develop an integrated analytical framework for primary forest product markets, to quantify the supply of regional forest residues, and to evaluate the potential impact of biofuel/bioenergy development on the pulpwood market in Wisconsin. To our knowledge, this is the first attempt to empirically quantify the demand spillover of high-value primary forest resources induced by biofuel/bioenergy development.

The rest of the paper proceeds as follows. First, we introduce the primary forest product markets in Wisconsin and provide an overview of current woody biomass inventories. An analytical framework of the integrated model and the supply/demand system of pulpwood market are developed. A detailed description of the data and empirical results follows. Then we apply the models to the forest residues and pulpwood markets in Wisconsin, together with several development scenarios of local pulp/paper industry, to quantify the potential impact of biofuel/bioenergy development on regional pulpwood market. Finally, key findings are summarized and discussed.

2. Background

In Wisconsin there are currently two primary forest products, sawlogs and pulpwood. According to the primary wood-using mill survey conducted by the Wisconsin Department of Natural Resources, pulpwood and sawlogs account for about 71% and 25% of total industrial roundwood production in 2008 [12]. Another distinct feature of roundwood markets is the market localness. Largely restricted by transportation cost, majority of the primary forest products are consumed close to the production sites. For example, over 82% of locally-produced roundwood was consumed in Wisconsin in 2008 with the remaining material consumed by two neighboring states, Minnesota and Michigan. Consequently the related trade is limited, which justifies the removal of inter-regional trade in our model described in a latter section.

Sawlogs, pulpwood, and harvest residues represent three different types of primary forest resources and are produced for different final uses. Sawlogs are on the top of the forest product value chain with large diameters, typically greater than 20 centimeter (cm), which are used for lumber and have the highest economic value. Pulpwood is from smaller diameter trees, typically 15–20 cm, which are too small for lumber, but still suitable for pulp production, and has a lower market value. Processing residues from sawlogs in the form of wood chips and shavings are extensively used for pulp production. Harvest residues, which are primarily tree branches stripped during logging, are not suitable for either pulpwood or sawlogs, and typically would be used as solid fuels, if harvested. Due to costs to extract from the woods and a limited market, these materials are often underutilized and currently have the lowest market value.

The associated markets for the three products have recently been separated with large price gaps. For example, the average delivered prices for sawlogs and pulpwood were $369.4 and $53.9 Mg^{-1} in Wisconsin over 1996–2011, respectively. Although there are price gaps between the three markets, they remain largely integrated, especially the pulpwood and residue markets. Typically we assume forest residues would be the first material to be employed to satisfy biofuel/bioenergy demand given its underutilization and hence lower prices. Some forest residues are currently used by local electric power companies to satisfy the state RPS mandate. The usage of wood/wood waste contributed 1.0–1.3% of total electric power in 2003–2010 in Wisconsin [2], which is equivalent to approximately 160,000 Mg of forest residues. There are other sources of wood and wood wastes that are currently used for renewable electricity generation. For simplification, we do not consider them in this study and assume that: (i) the