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Attitudinal and revenue effects on non-industrial private forest owners' willingness-to-harvest timber and woody biomass

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ABSTRACT

In the U.S., prospects for greater use of woody biomass as a source of renewable energy are largely contingent on supply from privately-owned forestlands. This study surveyed non-industrial private forest (NIPF) owners in the states of Michigan, Minnesota and Wisconsin to elicit their willingness-to-harvest (WTH) timber and woody biomass. Results consistently showed that higher revenues, associated with higher prices, and attitudes supporting harvesting of woody biomass were associated with greater WTH levels. Intentions of not conducting a commercial harvest in the future were a strong predictor of WTH. Average effects differed by state. Else constant, Minnesota respondents reported higher WTH and showed greater responsiveness to timber and biomass revenue changes compared to their counterparts in Michigan and Wisconsin. Absentee ownerships, different opinions regarding environmental impacts of biomass harvesting, divergent ownership objectives, past harvest experiences and future harvest plans, and environmental organization membership helped explain different WTH levels across states. Marginal probability analyses suggest revenues from woody biomass, as compared to timber, had much lesser influence on potential supply of woody biomass from NIPFs. Differences in WTH estimates between states suggest that strategies to increase availability of woody biomass should be crafted to each state's conditions and emphasize alternatives to increase timber revenues.

1. Introduction

Woody biomass may be defined as "the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest management" (U.S. Forest Service, 2008). The utilization of woody biomass for energy creates a market for traditionally unusable materials, supports associated job opportunities and can reduce forest fire hazards (Hall, 1997; Aguilar and Garrett, 2009; U.S. Forest Service, 2008; Department of Energy, 2010). Energy derived from woody biomass and other wood materials already account for 22% of the renewable energy consumed in the U.S. and its use in recent years has grown significantly in co-firing systems for power generation (to replace coal) and the residential sector (Aguilar and Mabee, 2014; Energy Information Administration, 2014). Given its physical availability, and if used efficiently, woody biomass could be part of a comprehensive approach to decrease carbon emissions associated with energy generation and reduce dependence on fossil fuels (Bartuska, 2010). The environmental and economic benefits associated with the utilization of woody biomass as a renewable, reliable and domestically produced fuel and its potential to displace fossil fuels has been recognized nationally (EPA, 2010; Public Law 110-140, 2007; Aguilar and Saunders, 2010).

Forests cover about 33% or 303.9 million hectares of land in the U.S. and nearly 40% of these forestlands are owned by non-industrial private forest (NIPF) owners (Butler, 2008; Smith et al., 2009). U.S. NIPF owners represent the nation's largest ownership group and, thus, constitute one of the most important sources of forest resources (Butler, 2008). In the U.S. Great Lakes States of Michigan, Minnesota and Wisconsin, the predominance of private ownership is notably pronounced at 58% of the 21.1 million hectares of forests in the region (Smith et al., 2009). NIPFs extend over 10 million hectares which equates to approximately 83% of all private forestlands in the Great Lakes region (Butler, 2008). This translates to NIPF ownership representing 48% of forestlands in Michigan, 36% in Minnesota and 59% in Wisconsin (Smith et al., 2009).

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Bio-physical estimates on woody biomass have been derived for the Great Lakes region (e.g. U.S. Department of Energy, 2011; Goerndt et al., 2012) demonstrating the capacity of Michigan, Minnesota and Wisconsin to create a viable wood-based bioenergy market. But the availability and ultimate supply of woody biomass can be constrained by social factors. Specifically, Butler et al. (2010) stress the importance of social availability of woody biomass as a concept denoting how social factors will determine actual versus potential woody biomass supply. Given the extent of NIPFs in a region identified for its potential to use woody biomass for renewable energy generation the decisions NIPF owners will be instrumental in determining the social availability of woody biomass (Butler et al., 2010). The aim of this study was to examine and compare regional differences associated with NIPF owners' willingness-to-harvest (WTH) timber and woody biomass in the U.S. Great Lakes States of Michigan, Minnesota and Wisconsin. This region was selected due to its reported potentially available woody biomass, where biophysical availability was estimated to be 37 million dry tons per year according to Becker et al. (2009). Social availability has been explored in Minnesota, Wisconsin and Michigan (Becker et al., 2013; Aguilar et al., 2014a,b), however, no study has examined state-level differences in NIPF owners' WTH nor simultaneously evaluated how supply is affected by commercial timber and woody biomass prices and corresponding revenue levels. Specific objectives were to identify and compare factors influencing NIPF owners' WTH timber and woody biomass and to examine and contrast NIPF owners' WTH responsiveness to timber and biomass revenue changes in each state.

2. Literature review

The literature to-date has discussed at length the impacts of numerous conditions on landowners' decisions to engage in forest harvest (Amacher et al., 2003; Kurtz and Lewis, 1981; Tonisson, 2012; Vokoun et al., 2005; Young and Reichenbach, 1987). Specific factors found to affect landowners' timber harvesting decisions include stumpage price, parcel size, technical assistance, ownership objectives, membership in an organization and demographics like age, income and education (Amacher et al., 2003; Beach et al., 2005; Binkley, 1981; Butler, 2007; Kurtz and Lewis, 1981; Vokoun et al., 2005; Young and Reichenbach, 1987). However, their reported magnitude and statistical significance on NIPF owners' harvest preferences have not been consistent across studies (Beach et al., 2005; Gregory et al., 2003). For instance, timber price was found to significantly affect NIPF owners' harvesting behavior in several studies completed in New Hampshire and the Southeastern U.S. region (Binkley, 1981; Boyd, 1984; Newman and Wear, 1993; Pattanayak et al., 2003). But other studies conducted with NIFP owners in Virginia and North Carolina found no statistically discernible timber price effects (Conway et al., 2000; Prestemon and Wear, 2000). Regarding ownership size, Binkley (1981), Conway et al. (2000), and Bolkesjø and Baardsen (2002) reported a direct association between parcel size and NIPF owners' harvest behavior after examining NIPF forests in New Hampshire, Central Virginia, and Norway. However, no such significant impact was found in Conway et al. (2000) study conducted in Southwest Virginia. According to Beach et al. (2005), who reviewed 18 empirical timber harvest studies, some of the reasons for the apparent inconsistency in reported effects might be associated to heterogeneous regions and differences in data collection, data type and quality and analytical methods.

Recent studies have also explored factors influencing stated preferences toward woody biomass harvesting among NIPF owners. Main findings have highlighted the role of biomass prices and demographic profiles on potential supplies. Becker et al. (2010) found that biomass price positively influenced forest owners' likelihood of harvesting biomass in Minnesota. Education positively influenced decisions to harvest woody biomass in the southern U.S., Minnesota and Missouri (Aguilar et al., 2014a; Becker et al., 2010; Gruchy et al., 2011; Joshi and Mehmood, 2011). Becker et al. (2010) reported significantly lower WTH woody biomass levels among absentee owners (i.e. those who did not reside on their woodlands) and those who did not believe its harvesting could improve U.S. energy independence. As it has been the case with WTH timber, heterogeneous results associated with ownership factors impacting NIPF owners' WTH woody biomass are reported. Owners' demographic characteristics such as age influence ownership objectives since older landowners are more likely to transfer or bequeath their forestland in the near future and would likely be less interested in harvesting timber and/or biomass (Butler and Leatherberry, 2004). Accordingly, older landowners have been found to be less likely to engage in commercial harvesting (Aguilar et al., 2014a; Becker et al., 2010; Gruchy et al., 2011; Joshi and Mehmood, 2011). However, a study conducted in Mississippi (Joshi et al., 2013) found that older NIPF owners were more likely to supply woody biomass as compared with younger landowners. Another example relates to the correlation of ownership sizes and WTH woody biomass. NIPF owners' stated WTH woody biomass for bioenergy in Arkansas, Florida and Virginia revealed similar findings with timber studies where an increase in forest ownership was positively associated with willingness to supply biomass (Joshi and Mehmood, 2011). However, a study of NIPF owners in Mississippi found that an increase in ownership size was inversely associated with WTH woody biomass (Gruchy et al., 2011). The effect of acreage on WTH, thus, is an important factor influencing NIPF owners' harvesting choices although the direction of its effect may not be certain.

This study contributes to the existing literature in three particular aspects. First, it aims to shed light on factors behind heterogeneous NIPF owners' WTH timber and woody biomass preferences between states in the selected study region. The degree of inconsistency in model estimates captures intrinsic regional differences, however, some of the apparent inconsistency may be associated to different research methods. This study examined differences in WTH and effects of explanatory variables across regions while using the same research methods including the same questionnaires, sampling technique, data collection methods, and analytical tools. To our knowledge, few studies have been conducted to explicitly examine regional differences associated with NIPF owners' WTH and none has simultaneously controlled for timber and biomass harvest effects. Second, the examination of NIPF owners' WTH woody biomass was elicited based on both woody biomass and timber revenues. A woody biomass harvest must be done in conjunction with higher-value products (e.g. timber and pulpwood) in order to be economically feasible (Aguilar et al., 2014a; Hubbard et al., 2007; Saunders et al., 2012), but as pointed out by Aguilar et al. (2014a), the published literature has come short in evaluating the social availability of woody biomass by not considering timber prices explicitly when estimating NIPF owners' WTH biomass. Third, this study contributes to the exploration of responsiveness to price and corresponding revenue per hectare changes. The literature has examined the impacts of timber and biomass prices on NIPF owners' WTH separately and often on an absolute basis instead of estimating elasticities to percent revenue changes. By doing so, this research discerns the impacts associated to timber and biomass price and corresponding revenues in the same units which is important given the significant price disparities between them.

3. Theoretical framework

This study modeled NIPF owners' decisions as a utility maximizing choice determined by NIPF owner-specific attributes, land attributes and factors external to both owner and land, more specifically, market revenues for timber and woody biomass. Hence, utility