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Local acceptance and heterogeneous externalities of biorefineries

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ABSTRACT

Biofuels can potentially reduce lifecycle greenhouse gas emissions from energy use and help address the climate change problem. However, the siting and operation of a biofuel production facility can impact the members of the host community both positively (e.g. local jobs and income) and negatively (e.g. pollution and noise). Such ambivalent and heterogeneous external impacts result in either local support or opposition to the facility, which in turn becomes a key factor affecting biorefinery location decisions, and subsequent success of biorefineries. While a number of prior studies have analyzed economic and environmental impacts of biofuels, systematic analysis of local acceptability of biofuel production facilities is lacking. Our study explores factors that influence community attitudes towards biofuel facilities. We assess the strength of acceptability or opposition by estimating the local community's willingness to pay (WTP) either to support or to oppose a proposed biorefinery. We posit that such WTP estimates provide a more comprehensive measure of local acceptability. Results also suggest that county level socio-economic characteristics significantly influence these attitudes and WTP.

1. Introduction

Biofuel production has grown rapidly in the US since 2007 (Renewable Fuels Association, 2015; US EIA, 2015) in response to biofuel mandates under various laws including the Energy Security and Independence Act of 2007 which mandates the use of 36 billion gallons (136 GL) of biofuels by 2022. For the bioenergy industry, site selection is an important factor affecting the success of a project, especially because transportation costs (for both inputs and outputs) constitute a significant portion of biofuel costs. Acceptance by the local community also plays a key role in the success of a biofuel refinery project, as a more accepting community may offer incentives that can offset costs, while a less accepting community may stonewall or actively protest against the biorefinery, causing delays in permitting, increased project costs and in the worst case, forced relocation. Studies also show that opposition from the local community decreases the probability of siting a bioenergy plant (Fortenbery et al., 2013; Haddad et al., 2009; Tigges and Noble, 2012). These observations raise the question, why do communities either support or oppose biorefineries in their neighborhood, and what factors drive the degree of such support or opposition?

A biorefinery project may impose both positive and negative externalities on local communities. Potential positive impacts from biofuel facilities include improved job opportunities, increased demand and prices for local outputs, especially biofuel feedstocks, increased local tax revenues, improved local infrastructure, and indirect boost to local economic activities through increased income and purchases of local goods and services (Fletcher, 2014; Futch, 2014). As a result, many communities try to actively attract biofuel plant investments by offering incentives such as local tax relief (Abuelsamid, 2010; Blackwell, 2014; Hoppe et al., 2011). On the other hand, biofuel facilities can impose negative externalities on the local population through increased air and water pollution due to biofuel plant and transport related emissions, noise, traffic congestion, safety hazards arising from flammable fuel and toxic chemical use and storage, potential loss of property values from both pollution and aesthetics effects, which lead to potential community opposition to biorefineries. Many prior researchers have documented and studied community opposition to biofuel facilities and the "not in my backyard (NIMBY)" phenomenon (CTV Kitchener, 2012; Fortenbery et al., 2013; Haddad et al., 2009; Lambert, 2009; Selfa, 2010; Stephen et al., 2010). For example, Selfa (2010) investigates opposition to biofuel facilities by local communities in three case study locations in Kansas and Iowa. Lambert (2009) discusses how a single consulting company is helping corporations manage NIMBY wars in 135 locations. Fortenbery et al. (2013) and Haddad et al. (2009) analyze

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locational choices of biodiesel and ethanol plants, and find that population density and education levels have a negative association with the probability of biofuel plant location, and attribute it to the NIMBY phenomenon. Such local opposition reduces plant profitability (Panoutsou et al., 2013) due to project delays, lawsuits or vandalism; however opposing groups also incur costs (primarily time, but potentially out-of-pocket expenses for media campaigns or lawsuits), further lowering their welfare. The incidence of these benefits and costs varies across different segments of the population, and we posit that the heterogeneity in the relative benefits and costs of these impacts across the population, influence the degree of community acceptability/opposition of bioenergy projects.

Systematic prior assessment of community attitudes towards biofuel facilities and the degree of acceptability, can aid regional planners and biorefinery developers in making informed decisions, and help avoid potential waste of money and time by both proponents and opponents. However, such systematic analysis of local acceptability with regard to biofuel production is currently lacking (Chin et al., 2014). A relatively simple approach, commonly used to address this issue, is conducting a poll of the residents. A simple poll produces information on the proportion of local residents who are supportive or against the biorefinery. However, it does not assess the relative strength of their support or opposition, which may be influenced by the perceived welfare gains or losses associated with a new facility. For example, projects that have widespread but individually small net welfare losses, along with highly concentrated benefits to a minority, are likely to indicate lack of support in polls, but such small welfare losses may not produce strong protests and lawsuits. In contrast, substantial welfare losses to a minority may bring about vocal opposition and lawsuits. Decisions based on simple poll results in such cases may be flawed. We propose that assessing the heterogeneous welfare effects of the biorefinery across the population provides a better measure of the strength of support/opposition. We posit that the degree of local acceptance is a function of these welfare effects, and willingness to pay (WTP) either to support or oppose a biorefinery provides appropriate measure of these perceived heterogeneous welfare changes.

The current study attempts to assess local acceptability of a biorefinery and identify factors that influence such acceptability by estimating WTP either to support or oppose a biorefinery. Empirical implementation involves a statewide telephone sample survey that invited responses to a scenario in which a proposed biorefinery is sited in the community where the respondent lived. We adopt a two-step framework to stratify supporters and opponents, and estimate the WTPs conditional on their initial attitude towards the biorefinery. The Heckman procedure is used to correct for potential sample selection bias. Finally we include spatial analysis to demonstrate how the results can be used to map areas reflective of local acceptance or opposition. While the current study specifically analyzes community acceptance of biorefineries, the methods are broadly applicable to assessing acceptability of other kinds of facilities, including other energy production facilities that impose heterogeneous welfare changes on community members.

2. Literature review

Studies on local acceptance of renewable energy facilities began appearing in the literature in the late 1990s (Roos et al., 1999). The early literature focused more on the opposition part of local acceptance, i.e. NIMBYism, but then shifted to more generic ideas about public attitudes towards such facilities, suggesting that NIMBYism is not the only factor influencing public attitudes towards proposed projects, and labeling opposition as NIMBYism may oversimplify its causes (Chin et al., 2014; Devine-Wright, 2005; Wolsink, 2007a). For instance, local opposition to wind power facilities was found to be independent of the distance between the respondent and the facilities (Wolsink, 2000, 2007b).

The terms used to describe attitudes of the local community towards a certain project include community acceptance (Wüstenhagen et al., 2007), local social acceptance (Breukers and Wolsink, 2007), local acceptance (Soland et al., 2013), among others. We use “local acceptance” to refer to public attitudes of the local community and “social acceptance” when the scope includes the broader society.

The acceptance of bio-energy plants from the general public, local or not, is important (Breukers and Wolsink, 2007; McCormick, 2010), but understanding of the factors contributing to local acceptance of biorefineries or bio-energy plants is limited. Many articles discuss the acceptance of renewable energy facilities such as wind farms and solar farms, but only few analyze acceptance of biofuel production facilities. Chin et al. (2014) discuss social acceptance of biofuel development, but do not conduct any quantitative analysis. Sacchelli (2014) use a Fuzzy Cognitive Map technique to identify the factors influencing social acceptance of biomass plants from the view of bio-energy experts rather than local community. To understand local attitudes towards the biofuel facilities, Amigun et al. (2011) conducted interviews and a survey to explore the local acceptance of biodiesel production in South Africa and found the main concerns were pollution and health risks.

Similarly, among dozens articles which analyze site selection decisions of biofuel facilities, only a few consider local acceptance somewhat tangentially. For example, Tigges and Noble (2012) qualitatively assess socio-economic factors influencing biofuel facility location decisions in Wisconsin. Haddad et al. (2009) analyze location choices of ethanol plants in the Midwest and find feedstock corn availability, rail access, and proximity to blending terminals, as significant factors driving plant location, but also find a negative association between population density and the probability of plant location. They interpret this as an indicator of NIMBY-related community opposition. Similarly Fortenbery et al. (2013) analyze biofuel location decisions employing a large number of spatial variables including roads/infrastructure, crop production, and policy indicators, and interpret the negative association found between probability of biofuel plant location and population density and education levels and as arising from NIMBYism. Very few studies explicitly analyze factors influencing local acceptance of biofuel facilities from the perspective of local residents. A notable exception is the study by Soland et al. (2013), which draws on social justice theory and quantitatively explores the local acceptance of a biogas plant using a structural model that included measures of distributive and procedural justice, in addition to other qualitative indicators of perceived benefits and costs.

As mentioned in the introduction, polls or similar methods may not adequately assess the degree of support or opposition since a biofuel facility would bring various kinds of positive and negative impacts, which affect different sections of the community in different ways. As a result, the degree of opposition/support can vary significantly across members of a community, which may not be captured with a “yes/no” format, or even with Likert scale type questions. The WTP method is an alternative to polls not only to explore the public opinions on certain policies but also to elicit the strength of such opinions (Hall et al., 2004; Joewono, 2009; Jones-Lee, 1993; Nagin et al., 2006; Walton et al., 2004). Nagin et al. (2006) argue that WTP method is more accurate than traditional poll since a WTP involves explicit evaluation of a respondents' welfare change. The WTP approach also allows decision makers to anchor the possible benefits or costs due to the biorefinery which a poll cannot. To our knowledge, no prior study has estimated public WTP for a biorefinery. Our study thus addresses this gap in the literature, and also offers a method that might be used for siting decisions of other types of facilities where opinions about the desirability of the facility may differ among members of potential host communities.

3. Method

Conventionally, contingent valuation methods estimating WTP assume that WTP is non-negative (Clinch and Murphy, 2001) due to the