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Do nonrenewable-energy prices affect renewable-energy volatility? The case of wood pellets

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ABSTRACT

Over the past decade, the U.S. Southeast has experienced a rapid expansion of wood-pellet biomass production for European export. This renewable wood-pellet supply requires nonrenewable-energy inputs in its manufacturing and logistics, which suggests possible price-volatility spillovers between renewable and nonrenewable markets. A BEKK-MGARCH model is employed for investigating these possible price-volatility spillovers. Overall, results suggest a limited negative effect of past volatile nonrenewable-energy prices influencing current wood-pellet price volatility. Specifically, high volatilities in nonrenewable-energy prices do not affect the volatility of wood-pellet prices. Thus, any stability concerns in terms of nonrenewable-input prices affecting the wood-pellet market are not warranted.

Introduction

Historically, many renewable-energy sources for electricity were unable to economically compete with traditional nonrenewable fossil fuels. However, the competitiveness of renewables has a promising outlook. Recent levelized cost declines and expected continued downward cost in electricity generation from renewables (including biomass, solar, and wind) along with policies to curb greenhouse-gas emissions are favorable to renewables (Verbruggen et al., 2010). This trend toward cost parity is chipping away the key cost barrier for renewables' entry into the U.S. energy portfolio. There are, however, other barriers (technical, inconsistent pricing structures, regulatory, and social) before a viable renewable energy market is realized (Galik, 2015; Painuly, 2001).

One such barrier is the dependence of a renewable production process on nonrenewable resources such as coal, natural gas, and oil. The manufacturing of turbines, generators, blades, solar panels, wood pellets, and transformers are produced in plants which use fossil fuels. Given this reliance, increased nonrenewable-energy price volatility could result in higher renewable-price volatility, thus potentially negatively affecting the renewables market. The price stability of the renewable-energy industry may well depend on how any price uncertainties in the nonrenewable markets are transferred into renewable markets.

In addition to direct competition with nonrenewables, wood pellets have the potential to reduce greenhouse gases, increase energy security and diversification, enhance local air quality, and reduce energy-price volatility (Kennedy et al., 2011; Stupak et al., 2007). Further, co-firing wood pellets with coal for electric power generation can yield a diversification effect, which reduces energy portfolio variance (Xian et al., 2015). As a result, driven by a European demand surge for biomass fuel, the U.S. Southeast has experienced a rapid expansion in wood-pellet production. Pellets exported from the United States to the European Union have increased from 0.8 million tons in 2011 to 2.9 million tons in 2013, and are projected to reach 5.2 million tons by 2015 (Dwivedi et al., 2014; EIA, 2014b).

Not all studies support carbon dioxide emission reduction through forestry bioenergy (Hudiburg et al., 2011; Schulze et al., 2012) and any reductions are predicated on biomass feedstock sourcing and trajectories toward mature optimal supply strategies (Latta et al., 2013). A potential further concern is the use of nonrenewable energy in the production of wood pellets. Despite the

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recent growth of the wood-pellet market, the production process requires significant nonrenewable-energy inputs. During the manufacturing process that includes drying, milling, and pelletizing to increase biomass density yielding higher energy, lower moisture, and uniform size (Spelter and Toth, 2009), nonrenewable-energy inputs (natural gas and coal generated electricity) may be used. Depending upon the magnitude of the price transmission from nonrenewable markets on wood pellets, this interdependence could ultimately affect the stability of the wood-pellet industry. This creates a further complication in considering bioenergy, which could benefit from economic analysis.

For developing a stronger understanding of the role nonrenewables play in the stability of renewable-energy markets, this study provides one of the first analyses of price-volatility spillovers from nonrenewable to renewable-energy products. The specific focus is on the renewable resource wood pellets with the hypothesis that nonrenewable-energy price volatilities in previous periods may impact current renewable-energy price volatilities.

As a test of this hypothesis, a Baba–Engle–Kraft–Kroner Multivariate Generalized Autoregressive Conditional Heteroscedasticity (BEKK-MGARCH) model is estimated using price series from nonrenewable energies (natural gas and electricity) and renewables (pulpwood and wood pellets). The analysis indicates high volatilities in nonrenewable-energy prices do not affect the volatility of wood-pellet prices. Although this result has no bearing on the greenhouse gas consequences of wood pellets, it does complement the greenhouse-gas literature.

Literature

With a few exceptions, the energy price-volatility literature has relied on GARCH-type models (Cabrera and Schulz, 2013; Serra et al., 2011; Wu and Li, 2013; Zhang et al., 2009a). Other studies narrowed their focus to the relation among fossil fuels with agricultural-commodity prices without incorporating biofuel (renewable energy) prices (Du et al., 2011; Nazlioglu et al., 2013). In general, these studies did discover volatility spillovers since 2008 among fossil fuels and agricultural commodities.

However, a literature review revealed no study on the price linkages among nonrenewable and renewable energy. In terms of biomass, wood pellets are the only biomass with a sustained market generating price for any type of time-series analysis. A body of literature exists in terms of the relation between wood pellets and nonrenewable inputs in transportation logistics. Timmons and Mejía (2010) employ an OLS regression to explore the dependence between wood chips and diesel fuel. Graham et al. (1997) and Möller (2003) study the optimal location strategies for wood-chips facilities to minimize transportation costs. Han (2011) and Caputo et al. (2005) investigate the economics of woody-biomass transportation by selecting appropriate logistics modes. In terms of wood-pellet logistics, studies have revealed the location of both wood basins and port access can be key factors affecting optimal pellet-mill location (Woodworth, 2012; Strauss, 2013). Additional literature exists on the impact of wood for energy in alternative co-fire boiler types on forest sector markets (Ince et al., 2011; Moiseyev et al., 2013).

In contrast to limited literature addressing nonrenewable-energy price volatility spillovers, a wealth of research is directed toward the amount of nonrenewable energy used for the production and distribution of renewables. Yang and Chen (2012), for instance, estimated it takes 1.7 times the energy of nonrenewable to supply one unit of renewable (corn based ethanol). In contrast, Wang et al. (2013) estimated the energy cost of wood pellet production in China as 0.09 J from nonrenewables to yield 1 J of renewable energy, implying that wood pellets are truly renewable. von Blottnitz and Curran (2007) in reviewing this energy-use literature summarized and compared 47 publications assessing net energy and environmental effects on the bio-ethanol system.

The U.S. wood pellet export market

European Union's renewable policy

In 2007, the EU Renewable Energy Sources (RES) directive stated in 2020 20% (20–20–20) of energy consumption should be from renewable sources (Sikkema et al., 2011). This directive targets reducing greenhouse gas emissions by at least 20%, increasing the share of renewable energy by 20%, and advancing toward enhancing energy efficiency by 20%, called the 20–20–20 targets. In response, European governments are providing economic incentives for industries to employ various renewable energies, including solar, wind, hydropower, and biomass, to achieve this 20–20–20 goal. In terms of biomass, with minimal retro-fitting costs, wood pellets for generating electricity can be co-fired with coal. As a result of the RES, the European Union became a major importer of U.S. Southeast wood pellets. The abundance of wood resources and relatively low shipping costs to the European Union provide the U.S. Southeast a comparative advantage in wood-pellet production. Within the United States, the Southeast is expected to account for 60% of wood-pellet projects (both under construction and in the permitting stage) between 2012 and 2020 (Dwivedi et al., 2014).

Feedstock of exported wood pellets: pine pulpwood

Woody biomass can be sourced from roundwood, mill wastes, harvest residuals, and construction and demolition debris or waste. Though mill residuals and wastes cost less compared to roundwood, their quantity and quality are not sufficient to meet the pellet-standard requirements for a large-capacity pellet facility. Mill efficiency yields limited mill residuals and collection along with transportation costs make log-site waste use generally infeasible. Thus, roundwood is the common feedstock for most pellet exporters to meet European Union's stringent quality requirements (Qian and McDow, 2013). For roundwood, pine pulpwood is widely used in U.S. Southeast pellet mills. Historically, the pulp/paper and oriented strand board (OSB) industries are the two largest consumers of pine pulpwood in the southern U.S., and wood pellet mills are now competing with these two major industries (Kinney, 2014). As projected by Kinney (2014), pellet mills have a potential to approach the pine-pulpwood consumption level of OSB mills in 2020, which is approximately 20 million tons per year.

Pine pulpwood is sold by forest landowners through stumpage sales and 95% of all timber harvested comes from private timberlands in the U.S. Southeast (McCraw, 2014; Oswalt and Smith, 2014). Studies indicate these private timberland owners have a willingness to harvest woody biomass and thus fill the gap associated with limited mill residuals and log-site waste (Joshi et al., 2013). Currently, it is not common for these suppliers to enter into long-term contracts with buyers (Galik, 2015; Qian and McDow, 2013; LaMontagne, 2014), and the wood fiber buying organizations usually only have 10–20% of their wood contracted under some sort of long-term agreement (Stewart, 2014). Thus, the pine-pulpwood prices for a pellet mill are not fixed in the long run. Instead, they are stochastic and affected by area competition among buyers, negotiation between sellers and buyers, available supply volume, and other demand or supply shocks causing price fluctuations.

In terms of wood-pellet production, Qian and McDow (2013) breakdown the input production cost. Fig. 1 illustrates this production cost as a percentage of total cost. Energy cost represents slightly over 8% of total production cost. Within this energy cost,