Title: “Improved BioMass Market Efficiency and Price Discovery from Online Auctions”

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Summary

The market for alternative energy is growing throughout Europe, this includes the wood energy market. The market for wood energy has evolved from rural area traditional wood fuel use to modern wood chip and pellets technologies that require adequate supply chains, trade and marketing mechanisms. This largely explains how these “relationship” based market transactions began, as foresters and forest owners relied upon their personal contacts of regional wood energy companies to remove this material. This process of trade and price discovery was, and often still largely is, relying on localized, one-to-one personal relationships for buying/selling of wood energy feedstock now limits or constrains the market for functioning in an efficient manner with respect to the main aspects: the optimization, i.e. minimization of supply costs due to transport costs of material and machinery. This optimization is only possible if the location and the price of all material on the market is known to the demand side and the adequate market prices are established. This inefficiency in how the price discovery process occurs likewise leads to a broader market coordination loss resulting from how wood material flows from the forest to end-users. These authors maintain that this disorganization loss is large, especially when measured at the market level and across a broad geographical level and ultimately limits the market for wood energy throughout Europe. This research paper offers an alternative and illustrates this market inefficiency through development of an optimization model that characterizes biomass flows given existing “relationship” based price discovery and that of an “online” auction. This is developed from data of existing bioenergy firms operating in southern Germany.

Methodology

The real life problem can be viewed as a transshipment problem of operations research, where there are supply points (piles), bioenergy firms and final wood chip customers. The shipments can be done between two supply points, a supply point and a firm, a firm and a demand point and a supply point and a demand point. In this transshipment model, trucks collect piles from supply points and delivers either to bioenergy firms or directly to the customers. The simulation of the real problem is set by using mixed integer programming methodology.

Data Collection

In the simulation models, it is aimed to represent real-world conditions in south-western Germany. Three bioenergy firms are located in the model. For the current market functioning, supply points and the customers of the bioenergy firms are located in their certain proximity.

The data used in simulations are acquired through the interviews conducted with a bioenergy firm in the region. In the interviews, the monthly demand amount of the customers, either small or big, is asked considering the seasonality effect. Also, the supply volume at each location is based upon the interviews with the bioenergy firm. The cost parameters used in the model are obtained based on the trucks that local bioenergy firm uses. The distance and time to travel information from and to each supply point and firm and customer are calculated in ArcGIS, based on the interviews that were held with local bioenergy firm.

Findings

Two different scenarios are created in the simulation model, one for the current market functioning in the region, where each firm have limited number of supply points per each month and predetermined number of customers with their monthly demands. In this scenario, firms try to optimize their total operating costs given available supply. The second scenario represents the online auction model, where the firms have the complete information of the available supply in that particular month, giving the firms more flexibility on optimizing the operating costs.

In both simulation models, three bioenergy firms are simulated. Each firm has the same number of supply points and the same number of customers. With their trucks and chippers, firms can collect piles from supply points and, either bring them to the firm or directly transport to final customers, if the customer is a heat plant. Operation costs consist of chipping cost, chipper relocation cost and truck transport cost.

It has been observed that in the online auction model, each firm faces an increased set of supply points, many of which are closer and more optimal for their operations. Hence, this reduces the miles travelled for chip trucks and minimizes the chipper relocation giving a minimized total cost for each firm. Monthly simulation models for both scenarios are solved for both scenarios and total costs occurred in the chain in euros per cubic meter are displayed below.

Table 1: Comparison of simulation results in euros per cubic meter

Months	Scenario 1	Scenario 2	Percentage Savings
1	6.32 €	6.20 €	2%
2	6.12 €	5.97 €	2%
3	6.14 €	6.09 €	1%
4	6.18 €	5.97 €	3%
5	6.09 €	5.93 €	3%
6	6.83 €	6.12 €	10%
7	6.65 €	6.13 €	8%
8	6.62 €	6.21 €	6%
9	6.32 €	5.97 €	6%
10	6.17 €	6.01 €	3%
11	6.16 €	6.03 €	2%
12	6.23 €	6.11 €	2%
Average	6.32 €	6.06 €	4%

Discussion

In simulation studies a total savings of 0.26 euros per cubic meter (53000 euros in total for the test case) are observed when the full information on supply is made available to all firms. As shown in Table 1, percentage savings on operating costs increase in summer months, when the demand is relatively less than winter months leaving the firms more flexibility in organizing their operations. A saving of 10% is reached at month 6 and 8% at month 7, also a 6% percent of savings are observed at months 8 and 9.

It can be also commented that the percentage savings on operating costs highly depend on the supply base of the first scenario. In the first scenario, the supply points are configured in a certain perimeter of the firms. This could explain the closeness of the results between the scenarios. Different supply base configurations in current market functioning scenario will essentially change the percentage on savings. Alternative scenarios, like different market powers of the firms, more firms in the market and different geographic configurations of the firms, where the supply points and customers are located far away from the firm, should be tried out to conclude more reliable results. The improved scenarios will relay on detailed level analysis of regional wood chip companies from the region over one complete business year. These scenarios are being worked on and consequently the simulation results will be reported.

Already, it can be concluded that online portals have the potential to strongly improve the competitiveness of biomass in regions where such portals are established. With the future work, we intend to provide a realistic quantification of the potential savings for a region covering parts of the Upper Rhine Valley including neighbor regions in France and Germany.

References

Winston, W. L., 2004. Operations Research Applications and Algorithms (4th ed.). Belmont, MA: Brooks/Cole-Thomson Learning