Abstract

Utilizing an input-output approach, this paper reports the local economic impacts from the expansion of an ethanol plant in Missouri. With the expansion of the U.S. ethanol industry in the form of both new and expanding plants both types of growth should be taken into account. This research estimates local economic impacts from an expanding ethanol plant as an example of what local impacts can be expected from the on-going growth in the U.S. ethanol industry. The results can have important ramifications for local businesses, grain producers, and property values.

The Local Economic Impacts of Ethanol Plant Expansion: A Missouri Case Study

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Introduction

There are two ways the expansion of corn-based ethanol in the United States can lead to increased economic growth: the creation of new ethanol plants and the expansion of existing plants. The Renewable Fuels Association expects U.S. ethanol capacity to expand by eight percent in the near-term with 11 facilities currently being built or under expansion (Renewable Fuels Association, 2010). Both avenues – new plants and expanding capacity at current plants – represent significant potential impacts on local economies where processing facilities are located. In particular, some authors have found that the location of an ethanol plant can raise elevator bids for corn (O'Brien and Woolverton) and the valuation of rural property (Henderson and Gloy). Therefore, the construction and expansion of ethanol plants is important to farm managers and rural appraisers alike. This paper reports the estimated economic impacts related to the expansion of the Northeast Missouri Grain, LLC (NEMO Grain) located in Macon Missouri. Expansions of other plants may expect similar regional economic impacts depending on their local industry relationships.

Previous studies have analyzed the economic impacts of ethanol plants in Missouri. Van Dyne (2002) reports the impact of two ethanol plants operating in Missouri, the Northeast Missouri Grain, LLC and the Golden Triangle Energy, LLC plants. The Van Dyne (2002) study includes impacts from the construction and operation of the ethanol plants on several counties in the region. This research reports the projected impacts from the doubling of the Northeast Missouri Grain, LLC plant on Macon and Adair counties (Altman, 2002).

The approach followed in this report is similar to Van Dyne (2002) utilizing the input-output model IMPLAN to produce employment, labor income, value added, and total output impacts with existing production relationships. However, a further step is taken by using data from IMPLAN in an economic baseline from the Show Me input-output model, which generates employment and income impacts over an extended period of time.

Results show that local impacts are modest in this case. When compared to total employment and personal income for the region the economic impacts from ethanol plant expansion represent a 2.1 and 0.2 percent increase in jobs to Macon and Adair and an increase of 1.6 and 0.1 percent in total personal income to Macon and Adair counties respectively.

The NEMO Grain Ethanol Plant

In 2002, the Northeast Missouri Grain, LLC (NEMO Grain) operated a 22 million gallon ethanol facility employing 31 full time employees using 800,000 bushels of corn. In 2002 and 2003, NEMO Grain doubled the capacity of the plant to produce approximately 44 million gallons of ethanol per year (Burnett, 2002). This report projects the employment and income impacts of the operation of this new size of plant.

Along with the doubling the size of the plant, NEMO Grain has also entered into a contract with a marketing company, Ethanol Products CO_2, to sell the CO_2 generated in the ethanol production process. NEMO Grain has also entered into a joint venture with the City of Macon to recover waste heat from the ethanol production process (Burnett, 2002). NEMO Grains will use the steam from electricity generation in their ethanol production process. These two changes are also taken into consideration in the impacts projected in this research.

Data

Key data for this research include the prices of ethanol and co-products, the total employment and payroll at the new plant, the increase in corn prices and the amount of corn sold by local farmers. Ethanol co-products include dried distillers grains and solubles (DDGS), CO_2 and electricity produced for the city of Macon. Van Dyne (2002) reports that the employment would increase by approximately three to eight employees. On the corn price issue, Matt Gerhold, Crop Production Manager of the Northeast Missouri Grain, LLC ethanol plant, estimates the impact on the price of corn at approximately 15 cents/bushel. This price estimation is in the range of other studies. Fort and Parcell (2006) estimate the price impact on corn to be between 10-19 cents/bushel in Missouri. Macon area farmers supply 12 percent and Adair 3.35 percent of NEMO Grains inputs (Matt Gerhold, 2002). These estimates are included as benefits of the ethanol plant. Table 1 presents these key data used to create a scenario in the IMPLAN model.

These assumptions represent realistic, yet conservative estimates. Van Dyne (2002) reports a price of ethanol of $1.00-$1.65/gallon and $80/ton of DDGS but ignores the possibility of using steam in the production process since this did not seem as much as a reality at that time. Van Dyne (2002) does analyze a scenario where the CO_2 produced is sold, however he does not report expected prices. Burnett (2002) estimates that the price of CO_2 could range from $30-75/ton and the cost savings from using the steam in the range of $337,000 to $472,000.

The assumptions reported in Table 1 were used in the IMPLAN model, which generated employment, income, value added and total output impacts for Macon and Adair counties. Employment and income results were then used as a scenario in an economic base line generated from the Show Me input-output model.

Methodology

Input-output (I/O) modeling was first developed in the late 1930s and has become widely used in regional economics since that time. I/O provides a framework for measuring the linkages among sectors (a term used interchangeable with “industries”) in a region's economy. The model is based on observed economic data for a specific geographical area (e.g., a county or state). Basically, the input-output system keeps track of the flow of goods from each sector to other sectors and the final consumers. The flow of one sector's output to other industries reflects the inter-sectoral linkages in an economy.

With I/O there is a fixed proportion of inputs for each unit of output. Fixed proportions imply there are no substitutions between inputs, regardless of price changes or new technology. In addition, all the firms in a sector are assumed to need the same average mix of inputs. For example, if a sector called “vehicle construction” included firms that produce full-sized trucks and firms that produce golf-carts, I/O assumes the same proportion of inputs, capital, and labor are used in both types of firms. Fixed proportions also signify that small and large producers have the same input mix and efficiency in production.

Another assumption is constant returns to scale. That is, in order for output to double, all of the inputs used in production must double. Also, because there are no resource constraints, there is no assumed production capacity.

The full economic impact of any change in society includes the direct or initial impact of an event like ethanol plant expansion. Economic impact studies take into account indirect and induced effects, or spinoff effects, that occur because of the direct impact. Indirect impacts are effects form supporting industries while induced impacts are the additional effects from changes in household income levels attributable to the direct effect.

In the past, to use I/O in a study, a lot of time and money were needed in order to collect necessary primary and secondary data and to set up the I/O model. Today, there are several pre-packaged I/O models available to researchers that can run on personal computers. One of the more popular models is called IMpact analysis for PLANning (IMPLAN) (Minnesota IMPLAN Group, 2002). IMPLAN contains comprehensive national data that is used to estimate regional data on a county-by-county basis. This model allows the researcher to specify the geographic region of interest. In addition, the model is relatively easy to modify to include primary or more recent data. It is this flexibility that makes IMPLAN very effective in meeting the needs of various researchers.

IMPLAN is used in the creation of scenarios in conjunction with the Show Me Model. IMPLAN model is frequently used to generate estimates of total employment and income when a community is interested in knowing the impacts of an economic development event. A change in employment or income has a multiplier effect because of the inter-industry linkages in the local economy. IMPLAN measures these linkages (indirect effects) as well the households or induced effects.

The Show Me Model (Johnson and Scott, 2006) is then used to allocate the estimated changes in employment and income over several years. The fiscal, economic, and demographic projections that are made in a scenario now incorporate the new circumstances. The scenario results, when compared to the baseline, provide valuable information that can be used in local decision making by business and farm managers.

The Show Me model uses statistically estimated relationships to forecast changes in economic, demographic, and fiscal conditions for Missouri communities under alternative economic settings. The heart of the model is a series of labor market relationships – the demand for workers (local and nearby jobs), and the supply of workers (local and external labor forces). The labor market equations allocate all members of the available labor force between local jobs, external jobs, and unemployment. The fiscal equations measure: 1) the costs of providing public services; 2) the demand for public services; and 3) the size of the local tax base. Together these estimates of public costs and revenues lead to forecasts of changes in fiscal deficits or surpluses. The model does not account for changes due to the national business cycle or other macroeconomic effects. Show Me model baselines are typically 10-year projections that assume no changes in policy or economic trends in the community. Scenarios, on the other hand, reflect a shock (a real or a hypothetical one) that is expected in the local growth rates of independent variables (employment, external labor force, external employment, and total personal income).

The I/O model IMPLAN (Minnesota IMPLAN Group, 2002) is representative of regional economic models that can estimate the total economic impact of an event to a local area such as a county, a larger area such as a group of counties, state, or multiple states.

IMPLAN disaggregates an economy into 508 sectors, and assumes historical consumption and production patterns to build the economic relationships between them. Most rural areas will not have all 508 sectors active in their economy. IMPLAN bases the sectors on the six-digit North American Industry Classification System (NAICS) codes, grouping similar industries together.

In I/O modeling each sector's output, (X) is modeled as some function of intermediate demand (Z) and final demand (Y), $X_i = Z_{ij} + Y_i$ for i=1...n sectors. The inclusion of intermediate demand represents an improvement on the Keynesian accounting frameworks since inter-industry relationships are specified in I/O models through intermediate demand (Shaffer et al., 2004). I/O models assume a Leontief production function with prices and input proportions fixed. This assumption is most appropriate for shorter term analysis, when large structural changes to the economy are not expected and smaller regional areas where prices are given. Given the Leontief production function, $Z_{ij} = a_{ij}X_i$, where aij is the technical coefficient, or the relationship between sectors i and j defined by the ratio of

intermediate demand by sector j for sector i's goods and total output of sector i. The solution to the model is, in matrix notation, $X = (I-A)^{-1}Y$ where A is the technical coefficient matrix for all sectors and $(I-A)^{-1}$ is known as the Leontief inverse or the matrix of multipliers (Isard et al., 1996; Miller and Blair, 1985).

The relationship between output and final demand, $X = (I-A)^{-1}Y$, is the fundamental assumption for the IMPLAN model. Following this relationship, changes in final demand multiplied by the Leontief inverse, which is calculated from historical production and consumption data, can yield changes or the total effects of economic impacts or: $\Delta X = (I-A)^{-1}\Delta Y$. IMPLAN can be used to calculate impacts in terms of total output, employment, and value added for the given region.

Results

The results reported from the IMPLAN model are for two areas, Macon County and the combined effect on Macon and Adair counties. Adair county is an adjacent county to Macon. The results from the Show Me model are reported for Macon and Adair counties. The results from IMPLAN for Macon County are reported in Table 2.

The impacts on Macon County of the 44 million gallon per year plant from IMPLAN were a total effect of 230.6 jobs, $6.4 million in income, $9 million in value added to the region, and an increase of total output of $68.9 million dollars. This is the impact of the whole plant on the Macon economy. Data put into the Show Me model should only represent the impact of doubling the size of the plant, thus the impact of the original sized plant was subtracted. The IMPLAN results for the Macon and Adair area are reported in Table 3.

Results for the Macon and Adair area of the total 44 million gallon per year plant was 255.4 jobs, $7.4 million in labor income, $10.4 million in value added, and $70.4 million in total output. To generate the data for Adair in the Show Me model, the effects of the Macon and Adair region must be subtracted from the effects of the Macon area plant. Thus, the data for the Show Me model (estimated using IMPLAN) for Macon are presented in Table 4.

The data from IMPLAN for the Show Me for Macon county are the net impacts of 114.7 jobs and $3.228 million in income. The results for Adair are shown in Table 5.

The net impacts from the IMPLAN model from doubling the size of the ethanol plant in Adair county is an increase of 12.4 jobs and $0.46 million in income for the region. These results are also the data used in the Show Me model. The results from the Show Me model are reported in Table 6.

The results for the Show Me model indicate small to modest increases for Adair and Macon counties from the doubling of the size of the ethanol plant, selling the CO_2, and using the steam in the production process. For Macon County, employment can be expected to increase by 128 jobs and income to increase by just under $10 million dollars. Adair County could expect to enjoy less economic benefits with an increase of 12 jobs and approximately $1 million in income compared to Macon County.

Conclusion

Overall the impacts from doubling the size of the ethanol plant, selling the CO_2 generated, and using steam from electricity generation in Macon county can be expected to generate small to modest benefits for the region. Macon County can expect an increase in employment of two percent and an increase in income to the county of one percent. Adair would receive benefits of relatively smaller amounts. Adair can expect an increase in employment of 0.2 percent and income of 0.1 percent. Other plants in the Unites States that are undergoing similar expansion should expect comparable local economic impacts. Overall, the economic impacts are somewhat modest and while they may raise the value of farm ground (through higher local crop prices), the impact on more suburban property values (through increased economic activity) is likely to be small. The placement of new plants – with greater initial construction costs – will undoubtedly provide a large economic impact, especially in very rural areas where the relative benefit may be greater.

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Table 1. Key data for the IMPLAN model scenario

Area	Macon & Macon/Adair
Employment	36
Payroll	$1,318,065
Sales	44 million gallons ethanol* $0.85/gallon
	120 thousand tons DDGS*$80/ton
	64 thousand tons CO_2*$30/ton
	steam from electricity generation savings $400,000
Total sales	$51million

Table 2. IMPLAN results – Macon

Impact	Direct	Indirect	Induced	Total
Employment	36 jobs	161.6 jobs	32.8 jobs	230.6 jobs
Millions of Dollars				
Labor Income	$1.318	$3.773	$0.474	$6.491
Value Added	$1.318	$5.938	$0.895	$9.089
Total Output	$51	$16.622	$1.454	$68.934

Table 3. IMPLAN results – Macon and Adair

Impact	Direct	Indirect	Induced	Total
Employment	36 jobs	161.6 jobs	32.8 jobs	230.6 jobs
Millions of Dollars				
Labor Income	$1.318	$3.773	$0.474	$6.491
Value Added	$1.318	$5.938	$0.895	$9.089
Total Output	$51	$16.622	$1.454	$68.934

Table 4. Data for the Show Me Model – Macon

	Doubled Size	Original Size	Net Impact
Employment	230.6 jobs	128.3 jobs	102.3 jobs
Income (in millions)	$6.491	$3.263	$3.228

Table 5. Data for the Show Me Model – Adair

Macon/Adair Counties			
	Double sized	Original Size	Net Impact
Employment	255.4 jobs	140.7 jobs	114.7 jobs
Income (in millions)	$7.4	$3.732	$3.688
Adair County			
	Macon/Adair	Macon	Net Impact
Employment	114.7 jobs	102.3 jobs	12.4 jobs
Income (in millions)	$3.688	$3.228	$0.46

Table 6. The Show Me Model results

	Macon	Adair
Employment	128 jobs	12 jobs
Income (in millions)	$9.991	$1.061