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Are Biofuels Revitalizing Rural Economies? Projected Versus Actual Labor

Market Impacts in the Great Plains

Janet A. Schlosser John C. Leatherman Jeffrey M. Peterson Kansas State University

May 1, 2008

Contact: Janet Schlosser, Graduate Research Assistant Department of Agricultural Economics 342 Waters Hall Kansas State University Manhattan, KS 66506 USA janetschlosser@agecon.ksu.edu 785.532.6702

Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, Florida, July 27-29 1, 2008.

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Schlosser is Graduate Research Assistant, Leatherman is Professor, and Peterson is Associate Professor, all in the Department of Agricultural Economics, Kansas State University, Manhattan, Kansas. The authors are grateful to Tyler Turner and Josh Roe for their able research assistance.

Introduction and objective

Rising fuel prices and government policy have caused a sharp increase in demand for biofuels in the United States. To meet this increased demand, biofuel plants are being built throughout the grain belt. Due to their reliance on farm products for inputs, nearly all biofuel plants are situated in rural communities proximate to grain supplies.

As the biofuel industry continues to grow and plants are built throughout the grain belt economists have become increasingly interested in the impacts these new plants have on rural communities. Changes in the labor market are of special importance in evaluating rural development. A primary obstacle for most rural communities is the lack of job opportunities outside the farm sector, where labor requirements continue to diminish.

A tool commonly used by many economists to predict the labor impact of new biofuel plants is Input-output (I-O) analysis. Given estimates of direct economic impacts (the original economic shock), software such as Impact Analysis for Planning (IMPLAN) estimates endogenous linkages between production, labor and capital income, trade, and household expenditures providing estimated effects on sector output, value added, household income, and employment (MIG, 1999). The process captures not only the *direct* and *indirect* effects in production, but *induced* effects, as well. The I-O model will provide estimates of not only the scale of total employment impacts, but also those sectors most directly linked to the biofuel sector.

Many economists have warned that projected impacts from I-O models are likely to be biased upward unless care is taken in customizing the model to the situation of interest. Given that the value of direct industry output is used to stimulate the local economy when estimating

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the indirect and induced effects, rather large secondary and tertiary impacts are generated with the uncritical use of I-O modeling techniques. As such, many of the publicized projections may be dangerously misleading, giving policy makers' and the public's false expectations. Swenson (2006) found that many of these inflated estimates are a result of using an I-O model without critical assessment of the outputs generated. For example, after a more critical analysis of the Iowa ethanol industry, he found only 4,100-4,700 jobs have been created in the state by that industry. This is only about 10% of the number estimated by the Iowa Renewable Fuels Association.

The objective of this paper is to evaluate the accuracy of I-O impact projections by retrospectively comparing the estimated labor market impacts for an existing biofuels plant in Kansas to the actual number of new jobs created after the plant began operation. For this study we will examine a 40 MGY facility in Russell County established in October 2001.

Previous studies and predictions

Although estimates vary widely, many studies project a significant number of new jobs are created in rural communities when an ethanol plant is built. Swenson (2005) published an impact study of a 41 million gallon per year (MGY) plant that opened in 2003 in Iowa. Swenson made the assumption that the plant would not substantially increase corn production in the region, as it was already in full agricultural production. Even with this precaution, the model estimated that 135 new jobs would be created by the building of a new ethanol facility.

Flanders, et al. (2007) used input-output analysis to predict the economic impacts of constructing and operating a 100 MGY plant in Georgia. This was a fairly uncritical study and

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no adjustments made to discount for the fact that there would not be an increase in jobs as a result of an increased demand for grains. As a result a total of 408 new jobs were predicted.

Labor predictions have also been made for ethanol plants in the plains states. Petersan (2002), estimated jobs created by a proposed 80 million gallon per year plant located in Buffalo County, Nebraska. In his estimate Petersan made the assumption that a new plant would not cause an increase in agricultural production and therefore restricted agriculture in his model to current production levels. Keeping this in mind, final estimates were that the plant would create 48 direct jobs and a total of 163 new jobs in the community.

Most of these predictions are fairly conservative estimates in comparison to other recent, more general studies. In 2003 the Minnesota Department of Agriculture estimated 4 new plants would create 154 direct jobs and a total of 2,784 new jobs. A study conducted for the Renewable Fuels Association found that 46,937 jobs were created by Iowa's ethanol industry.

Methods

IMPLAN was used to generate ethanol employment and labor income impacts for Russell County, Kansas. The model was calibrated to 2001, the year the ethanol facility was constructed. The outputs from IMPLAN were used as the inputs into an econometrically estimated labor market module. This model, the Kansas County Impact Model (Leatherman and Yeo, 2004), predicts the impact of an exogenous employment and labor income change on local labor force, population, commuting patterns, and local government revenues and expenditures in a particular Kansas county.

The labor force was determined by county employed, unemployed, incommuters, and outcommuters. Incommuters and outcommuters are both a function of the county labor force,

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employment outside the county, and the labor force outside the county. In the Kansas model, population is a function of the county labor force and the labor force participation rate (a lower rate equates to a higher number of dependents per worker). School enrollment is a function of the labor force, the male participation rate, and the dependency rate. These equations were estimated simultaneously using three stage least squares using Kansas data from 1997.

For the fiscal component of the Kansas model, revenues and expenditures are a function of population, income, education, assessed valuation, retail sales, local revenues, intergovernmental revenues, and population density. These equations were also estimated simultaneously using three stage least squares.

To simulate the model from the estimated equations, a baseline is first run for the county of interest. Then the IMPLAN employment change projections are entered to estimate the labor force, incommuters, outcommuters, population, and school enrollment as a result of the economic shock. The estimated population change is then fed into the fiscal equations to estimate county government revenues and expenditures. These amounts are then compared to the baseline amounts to determine net labor market and fiscal impacts. The Kansas County Impact Model used for this exercise is calibrated to the year 2000 which allows us to predict the effects as they would have been predicted prior to the plant opening.

Results

Modeling IMPLAN Scenarios

White Energy, located in Russell, KS, is owned by White Energy Holding Company. The plant began production in October, 2001, and was acquired by White Energy in May, 2006. Managers at the facility provided detailed budgets of facility inputs and outputs. The facility's

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primary output is denatured ethanol produced from grain sorghum and wheat. Its current level of production is 52 million gallons per year valued at nearly \$125 million. The plant maintains a workforce of 44 employees.

Given the capital-intensive nature of ethanol production, this translates into over \$3.5 million worth of output per worker. This illustrates the problem typically found in many impact analyses. A relatively few number of workers produce a large quantity of output that is, in turn, fed back into the economy to generate indirect and induced impacts. The question is how best to adjust modeling procedures to minimize the generation of unrealistic and incorrect impact estimates.

In the case of Russell, KS, the first step was to examine the IMPLAN data for 2001, the year the facility came on line. The facility's activity was classified within IMPLAN sector 51, wet corn milling. The only other sector likely to contain the facility would be sector 151, other basic organic chemical manufacturing. However this sector had no economic activity and thus was eliminated from consideration.

Within the sector, there was considerably more activity than what would be associated with ethanol production, so other wet corn milling firms were present. This creates "averaged" production functions which are inappropriate to use in conducting an ethanol impact analysis. Still, this serves as the starting point as an analyst would approach the task of estimating the impact of ethanol production. In the first two scenarios modeled, it is recognized that in most instances an analyst is dealing with a lack of detailed information. Typically, the only information available is projected total sales and employment. Sometimes, projected payroll is also known. More often than not, this is all the information available to work with.

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In Scenario 1, it is presumed the only information known is the number of employees, in this case 44. The first step is to look at the model, and see if any activity exists in the appropriate sector. In the case of the Russell County plant there is activity in sector 51, so the 44 employees are entered into this sector in the IMPLAN impact analysis routine. IMPLAN fills in the rest of the information. As seen in Table 1, entering the 44 employees into the wet corn milling sector produces an average industry output considerably below what we know the plant produces. However, if this is unknown, no further adjustments would be made and the analysis would proceed. This would result in a total economic impact of about 166 jobs and an employment multiplier of almost 4. This would include a known source of "double counting" in ethanol analysis having to do with grain production, where IMPLAN projects the creation of 42 new jobs growing more grain. This is the same problem Swenson (2005) ran into in his analysis.

Scenario 2 is similar to Scenario 1, except now it is assumed the only information available is the projected sales number. As shown in Table 2, without adjustment, entering in our \$125 million in total sales as output would generate an average of 169 jobs in the sector. Following through with the analysis as before and understanding the linear nature of I-O relationships, the same employment multiplier is calculated, but now there is a projection of nearly 700 new jobs in the county (160 in new grain production).

Scenario 3 reflects the fact that detailed budget information for the plant is now available. With this information the actual technology in use is will be captured. To enter this information into IMPLAN the budget information provided by the firm must be converted to the element of value added. Then, the amounts in sector 51 are changed to the equivalent of one employee and the social accounts are recalculated. Next, the plant's production budget data is converted into the categories recognized by IMPLAN. Then, the production function for the sector is edited by swapping the proportions of inputs provided by the firm with the national average production function found in IMPLAN. As long as the proportions input do not exceed the absorption coefficient, IMPLAN will automatically rebalance the entire production function and the social accounts can again be rebalanced.

The next step is to edit the byproducts for sector 51. In this case, byproducts were distributed to wet corn production, wet corn milling and other basic organic chemicals. The byproduct coefficients were changed to 0.0 for wet corn production and wet corn milling, and to 1.0 for organic chemicals. Finally, the multipliers were calculated. The last step is to enter the employment into sector 51 in the impact analysis routine and calculate the impacts.

In Scenario 3, the actual production technology is used in calculating the impacts, but the correction for grain production is not performed. As shown in Table 1, the analysis assumes that 286 jobs are created in new grain production and 587 new jobs overall, resulting in an unrealistically large multiplier of 16.

The problem observed with Scenario 3 is the assumption regarding grain production. In I-O analysis, it is assumed there are no limits to the provision of production inputs. In the case of ethanol, the primary input is grain. However, the ethanol plant has little influence on grain production because if the plant were not there the grain produced in the county would have an alternative market. Essentially, no more grain is produced as a result of the plant. All we observe when ethanol enters the picture is a shift of grain deliveries from one market to an alternative market. Most or all of the agricultural land was already in productive use. We would not observe

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a dramatic increase in acreage or production as implied by the analysis. To control for this the regional purchase coefficient (RPC) for the grain sector is adjusted.

The RPC governs the extent to which production is assumed to satisfy local versus nonlocal demand. Each production sector has an individual RPC for what it produces. By setting the RPC to zero any new demand for grain would be satisfied with imports from other counties. This assumption prevents IMPLAN from forecasting an increase in the amount of grain produced.

In Scenario 4, Scenario 3 was repeated, but the grain RPC was set to 0.0. This results in no impact on the grain farming sector. The total employment impact is about 200 and the employment multiplier is 5.7. This number is still larger then realistic expectation, so the next step is to analyze the individual sector impacts.

For Scenario 5, detailed impact estimates generated by IMPLAN are examined. Most of the sectors showed impacts which were small enough and within the bounds of reason, however two sectors came to our attention. As shown in Table 2, after having taken into account everything reasonable to this point, IMPLAN still predicts 95 jobs will be created in the wholesale trade sector and 10 jobs in the government enterprise sector.

It seems unlikely that 95 new wholesalers were needed to keep the facility supplied. Also, while the plant consumes considerable quantities of water, it is doubtful ten new government workers were needed to pump the water. Absent any definitive procedural rationale for adjusting these values, an ad hoc approach of simply reducing them to a reasonable number is employed. In this case, the sectors were given a 10 percent credit. The resulting total impact was a little over 100 jobs, and the employment multiplier was estimated to be 3.0.

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While in this case, our ad hoc adjustment procedure was used on only two sectors, a more comprehensive list of suspect candidates is offered from the detailed employment generation output in Table 3. Of course, with different production technologies represented in different plants and places, the list could look quite different in subsequent analyses.

Econometric Analysis

To get a better look at the effect of the ethanol plant the IMPLAN projections were entered into the Kansas County Impact Model. This model, in turn, projects employment, labor force, unemployment, and population changes in Russell County based on our IMPLAN projected total employment and total labor income impacts of the ethanol plant. The impact numbers from all five scenarios were entered and the results plotted against the actual changes in Russell County as reported by the Bureau of Labor Statistics.

Figure 1 shows the actual changes and projected changes in employment in Russell County from 2001 to 2005, the time in which most of the effects of the newly opened plant would have played out. Scenario four, one of the most critical analyses, seems to best follow the actual trend of employment change over that time period. In 2003 there is a considerable increase in employment which then declines in 2004. This may be the point at which the full impact of the ethanol plant is recognized through the creation of indirect and induced jobs.

The next impact analyzed was labor force in Russell County. Figure 2 shows the actual and predicted changes in labor force from 2001-2005. There was a considerable influx of labor between 2002 and 2003; this may be the point at which Russell County sees the greatest impact of the plant on employment. None of the scenarios did a spot on job of forecasting the actual labor force changes during this period.

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Figure 3 gives a picture of unemployment. It appears there was a large decrease in unemployment between 2002 and 2003, but it is important to look at the scale. The difference in unemployment in 2001 and 2003 is 20 people. Once again this decrease in unemployment may be reflective of the increase in employment in 2003. In this area all of the scenarios predicted unemployment to increase more than it actually did during the four years.

The final graph, Figure 4, shows the actual and predicted changes in population for Russell County. Out migration is a concern in the Great Plains states and the graph gives a good picture of why. Despite the job opportunities promised and created with the new ethanol plant there is still a decrease in the county population of 380 people between 2001 and 2005. This phenomenon is not something IMPLAN accounts for and therefore all the scenarios show population increasing as a result of the new plant.

Conclusion

Predicting the future is a risky and uncertain business. There are always unforeseen events that cannot be predicted or accounted for. With the case of the Russell County ethanol plant we found that when using input-output analysis such as IMPLAN there are really two directions the analyst can go. If information is limited the predictions tend to be optimistic. That was the case with Scenarios 1 and 2. The projections were based on the employment and/or projected sales information that was available and the effects were projected from this limited information as is. As a result the predictions were always more optimistic, more jobs created or a higher population, than what was actually occurring in Russell County at the time.

The second option is to be a bit more critical in the analysis; however this requires access to more information. In this case there was information on the Russell County plant to enter the

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actual production technology into IMPLAN. In Scenario 5 the IMPLAN predictions were even adjusted based on realistic expectations. Using this approach the estimations were much more conservative and in most cases led to labor force projections that were lower then what actually occurred.

Labor impacts often carry over to neighboring counties. To observe a regional view of labor force changes it would be beneficial to further this research by looking at labor effects in contiguous counties. It is possible that some of the effects of the plant were felt in other counties and did not show up in the Russell County data. In this case, looking at adjacent counties would help us have a more complete understanding of the plant's overall impact.

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Table 1. IMPLAN Output

Scenario	Total Sales Direct Impact (Dollars)	Total Employment Direct Impact (Jobs)	Grain RPC	IMPLAN Grain Farming Impact (Jobs)	IMPLAN Total Employment Impact (Jobs)	IMPLAN Total Labor Income Impact (Dollars)	Employment Multiplier
1. Russell Unadjusted FTE	\$32,507,160	44	0.151342	42.2	165.5	\$3,559,856	3.76
2. Russell Unadjusted Sales	\$124,852,708	169	0.151342	162.2	635.7	\$13,672,606	3.76
3. Russell Custom Technology Unadjusted	\$124,852,708	44	0.152968	285.8	587.3	\$8,656,735	13.35
4. Russell Custom Technology RPC 0	\$124,852,708	44	0.000000	0.0	228.8	\$6,549,336	5.20
5. Russell Custom Technology Fully Adjusted	\$124,852,708	44	0.000000	0.0	228.8	\$6,549,336	5.20

Table 2. Adjustments for Scenario 5

IMP	LAN Sector	IMPLAN Projected Employment Impact	IMPLAN Projected Income Impact	Adjustment Factor	Adjusted Employment Impact	Adjusted Income Impact	Employment Impact Difference	Income Impact Difference
390	Wholesale trade	95.6	\$2,411,228	0.1	9.56	\$241,123	86.0	\$2,170,105
499	Other State and local government enterprises	9.8	\$327,622	0.1	0.98	\$32,762	8.8	\$294,860
	Sum	105.4	\$2,738,850		10.54	\$273,885	94.9	\$2,464,965

IMP	LAN Sector	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Actual
2	Grain farming	42.2	162.3	285.8	0.0	0.0	0.0
18	Agriculture and forestry support activities	5.3	20.3	34.9	0.0	0.0	0.0
43	Maintenance and repair of nonresidential buildings	1.5	5.9	8.1	7.5	7.5	0.0
51	Wet corn milling	44.2	169.7	44.0	44.0	44.0	0.0
390	Wholesale trade	22.3	85.8	104.5	95.6	9.6	31.0
394	Truck transportation	3.6	14.0	19.3	18.4	18.4	25.0
400	Warehousing and storage	0.2	0.6	3.6	3.4	3.4	-7.0
451	Management of companies and enterprises	4.6	17.6	3.5	2.4	2.7	2.0
460	Waste management and remediation services	0.4	1.4	3.8	3.7	3.7	0.0
483	Automotive repair and maintenance- except car wash	4.9	18.9	2.9	2.0	2.0	2.0
499	Other State and local government enterprises	1.7	6.5	11.1	9.8	1.0	0.0
	Total Employment Change	165.5	635.7	587.3	228.8	133.9	53.0

Table 3. Detailed Sectors Related to Biofuels Production



Figure 1. Actual Versus Projected Employment Changes in Russell County



Figure 2. Actual Versus Projected Labor Changes in Russell County



Figure 3. Actual Versus Projected Unemployment Changes in Russell County

* Scenario 1 & Scenario 5 project the same changes; Scenario 2 and Scenario 3 project the same changes



Figure 4. Actual Versus Projected Population Changes in Russell County