Input-Outrageous: The Economic Impacts of Modern Biofuels Production

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Abstract. Measuring the net economic impacts of ethanol plants has been problematical: access to good industrial accounts is limited, the sector has historically gone through volatile swings, regional logistical responses to a plant beyond corn inputs are not well understood, and the sector is currently expanding rapidly. In the current uncertain energy world, the prices paid for inputs and received for outputs are also volatile. There exists quite a bit of confusion about the overall value of this dimension of value added agricultural processing to local, regional, and national accounts. There is a tendency for proponents of this industry to overstate, over-describe, and outright double-count economic activity linked to ethanol and other biofuels production. There is also a rapidly emerging issue of overall regional commodity supply and price responses to an industry in regional and national transition. After describing the magnitude of highly optimistic economic impact claims and reviewing some of the more common errors in analysis,, this paper will present the findings of a modeled ethanol plant configuration in a hypothetical three-county region in Iowa. It is based on a configuration of input and output accounts for the industry that is sensitive to price, cost, and other regional production factors that can be used to manually modify regional IMPLAN accounts for that sector.

Introduction

Iowa is in the midst of a corn-ethanol construction boom. With 27 plants currently processing corn, mostly for ethanol, and another 24 either under construction, planned, or proposed, the state will see its ethanol production capacity increase from 1.3 billion gallons at current count to as much as 3.8 billion gallons in the near future if all of the announced projects are completed.

There are no doubts as to the potential value of ethanol production to Iowa. First and foremost we are mindful that ethanol plants give us jobs, and they certainly produce net new economic product in the region where they locate. Second, ethanol plant demand boosts the prices that are received by farmers for their corn or sorghum, most notably by a reduction in transport costs relative to the point of demand. Third, indeed, there is a construction boom dimension to the rapid evolution of this industry, although many analysts (like me) tend to be cautious about compiling construction economic impacts

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beyond their mere description.[1] And fourth, this industry is highly subsidized at the federal, state, and even local levels, and accounting for the lucrative federal flows, we can expect robust net transfers of federal funds into the state.

It is my contention that in the states individually and in the nation, however, we have been ill-served in this area by, perhaps, naïve users of both the Implan modeling system (Minnesota Implan Group) and the blunt-instrument use of RIMS II multipliers (of the U.S. BEA) for estimating the economic impacts of this emerging industry. Many of these poor modeling efforts have been done by consultants – but many others were conducted by university, state, and federal government researchers. In short, there are claims to economic outcomes associated with ethanol production that seasoned analysts cannot swallow, but that proponents and politicians will certainly tout as gospel unless confronted with better (or, for the most part, actual) research. The gap between sensible analysis and outright nonsense is huge. Closing that gap just a bit is the purpose of this paper.

There is a legitimate, contemporary, and urgent public policy aspect to this and other research in this area. We are presently in a period of hyper-responsiveness to energy issues. International affairs, domestic supplies, global energy competition, and a wide array of opinions and options about what to do about our future energy needs confront us. Biofuels are truly the topic *de jure*, and state and federal elected officials are allocating more and more public resources in support of biofuels initiatives, production, and R & D. If those decisions are based upon misleading or poorly crafted economic impact summaries that create expectations of very large regional or national economic outcomes, and those estimates are compiled and proliferated uncritically, then it is a certainty that large amounts of public money will have been wasted and will be wasted in the future.

Great Expectations or Multiplier Madness: Biofuels Economic Impacts

Those promoting aggressive private and public investment in more biofuels processing capacities range from farm commodity groups, farm state politicians, many environmental organizations, automobile manufacturers, to both right and left wing political orientations. There are, however, incredible ranges of economic activity attributed to biofuels production. Very little appears to be based on rigorous research even though the authors of the research often allude to the use of standard national multipliers (produced by the U.S. BEA) or input-output models (like Implan). What follows is just a brief sampling of the dimensions of economic expectations from ethanol or biofuels production.

Nationally, an Urbanchuck (2005) report using US BEA RIMS II multipliers, claimed 114,844 jobs in the national economy depended indirectly on the operation of all ethanol

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[1] Over the past decade the asset value of manufacturing machinery and structures in the U.S. has increased at an annual rate of 3.5 percent. There is to be expected, then, a regular level of capital formation that is part of the U.S.'s natural growth. Attributing that growth into "construction effects" seems odd in that we measure economic impact and outcomes based on the post-construction potential of an industry as compared to the other uses that investment capital could have been put.

plants and the purchases that are made by workers (and this does not include ethanol plant employment of perhaps 3,500 to 4,000, which were not specified in the report). Corn, a commodity that the country overproduced historically (and currently) and is subsidized heavily accounts for 85,311 of those jobs. These results intimate that increased ethanol production is expanding the number of farmers and farm related jobs in the United States (USDA statistics notwithstanding to the contrary), as that is where the vast majority of job impacts are located.

Novack (2002) of the Federal Reserve Bank of Kansas City is much more expansive, but does not cite her sources. She reported that "… the [ethanol] industry added nearly 200,000 jobs to the U.S. economy." This is truly an optimistic statement because the U.S. Census Bureau reported that in 2002 the ethyl-alcohol industry itself in the U.S. had just 2,200 jobs. She goes on to predict that "an additional 214,000 jobs will be created through the economy over the next decade." Former South Dakota U.S. Senator and biofuels advocate Tom Daschle likes Novack's numbers. He noted in an essay this year (2006) that the current U.S. production of 3.1 billion gallons of ethanol created 200,000 jobs.

At the state level, a 2003 Minnesota Department of Agriculture study concluded that state's 356 direct ethanol production jobs created a total of 2,562 jobs using in this case, Implan, as the basis for its estimation. More robust job multipliers using Implan are found in a recent University of Missouri Extension report (2006). It concluded just 4 plants employing 154 persons in the state accounted for 2,784 total jobs – a hefty jobs multiplier of 18. In Evans's, 1997, work for the Midwest Governors' Conference, the author figured that 800 total jobs in ethanol production in Iowa alone sparked an increase of 5,800 jobs in machinery manufacturing in the state and 33,900 additional jobs related to the enhancement of farm income for a jobs multiplier of 51.

A Des Moines Register story in April of 2006 quoted an industry advocate from an organization called BIOWA claiming that 10 new bio-refinery plants in Iowa would create 22,000 jobs. That advocate cites a University of Northern Iowa study in support of those figures, but he could not produce a copy of that research when asked. Iowa's Soybean Association announced in March of 2006 that it had done a study in which they predict soy biodiesel will add $1.3 billion in income to the state and 15,000 jobs, although one cannot obtain their study via their press linkages.

In very stark contrast to this numerical enthusiasm, there are other reports that provide markedly lower estimates of job impacts for Iowa. A 2006 (Imerman and Otto) report on energy supply and usage in Iowa contained a table on the economic impacts of 800 million gallons of ethanol in Iowa produced for export. That table is more modest compared to previous estimates and concluded that 2,400 total jobs were impacted by the industry (outside of corn production) in the production of those export sales. That analysis and conclusion were reached by a university researcher and professor in a different university in Iowa who has a good sense of input output analysis, especially in value added agricultural situations.

There are reports by researchers linked to agribusiness that are much more modest in their expectations. In the Stueffen (2005) report produced for the South Dakota Corn Growers Association, the author removes the corn inputs from his impact calculations – a step in the right direction as the corn was already produced in his study area. Just on the ethanol side, this author concluded that 473 direct jobs were tied to 2,972 jobs in the state economy. Another more modest finding was produced by Petersan (2002) of the Nebraska Public Power District. Noting that "the existence of this facility will not result in the production of additional agricultural products within the study area…" Petersan found that an 80 MGY plant in an rural Nebraska area would require 48 direct workers and would link to just 163 total jobs in the rural regional economy.[2]

The attached graph shows some of the different job multipliers that were discerned from these research reports by the analytical foundation for the estimates (RIMS II or Implan). They ranged from a low of just 3.4 for one plant in Nebraska, to over 50 in the case of Evans's estimate for the state of Iowa.

Estimated Jobs Multipliers in Ethanol Studies
(Excluding Construction Effects)
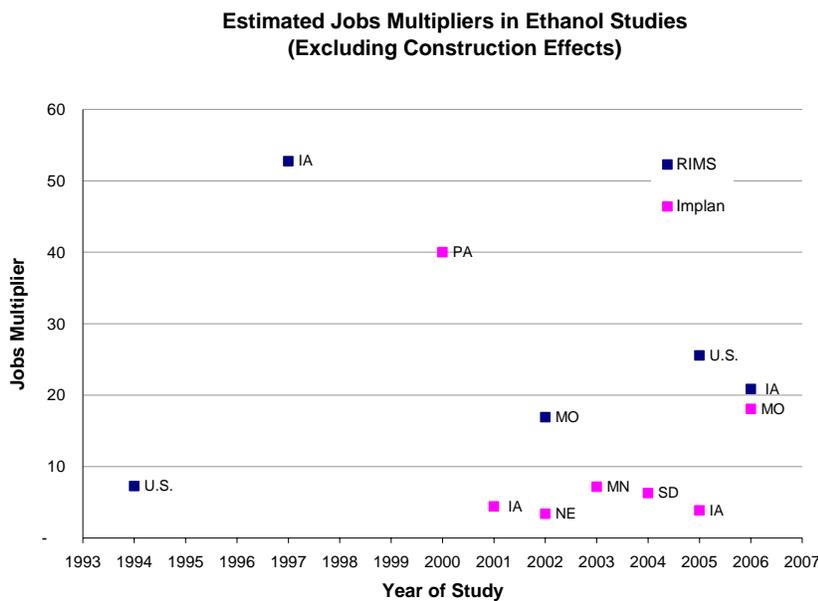
What's Wrong With the Estimates?

It would be wrong-headed to assert that the producers of the bloated impact statistics (or the uncritical conveyors of them) are insidious in their intentions. Instead it looks like there is just a whole lot of input-outputting run amok going on.[3] The same can be said for the examples that rely on the RIMS II multipliers from the BEA. People trust that smart people put these systems together, that they are adequately documented, that they are indeed intended for use by non-economists (else why publish the multipliers or make

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[2] Modesty prevents me from touting my own earlier effort (2005), but its outcomes align closely with the Petersan example.

[3] After all, it's not like you have to demonstrate any competence before you buy or use an Implan model.

Implan so darned easy to use?), and if they attach either the BEA or Implan reference to their report they are lending an air of authority to their efforts.

Cause and effect. The most common error is the assumption of cause and effect – that if the economy does this, then the economy automatically does that. The final demand multipliers that may be procured from RIMS II or generated in Implan do not automatically mean causation. They are outcome ratios that describe the magnitude of inter-industrial linkages that exist in an economy as commodities make their way to intermediate or to final demand. These ratios represent the current average production relationships in an economy at a fixed time and considering fixed prices. Indeed, input-output models are considered to be fixed price models. One must exercise serious caution when inferring the effects of marginal change on the entire economy, especially in terms of job production. Generally, the likely upstream bumps in production need to be identified and specified cleanly, measured properly, and, importantly, justified.

Increased corn production. The most obvious causal reaction that nearly all of the examples that I listed above is for more corn to be grown, resulting in all concomitant impacts in the corn industry to be compiled simultaneously with the ethanol plant. It may come as a surprise to many, but the corn already had been grown. And if it had not, then the land was used productively for other uses that were profitable (to the extent that farming is profitable). Indeed, what is happening is that existing surplus that was historically exported is being transformed into alcohol locally. There is precious little evidence that there are significant changes in the amount of agricultural land in production as a consequence of an ethanol plant placement. Hence the claim of an impact on corn production (along with all multiplied-through outcomes) is spurious. For example, recent indications in light of quite high corn futures prices, are that farmers in the Midwest will increase corn acres. That will come almost entirely at the expense, however, of other crops. Shifts in production from one crop to another are not economic impacts; they are planting decisions.

There are other upstream and downstream impact assumption considerations. I will touch on a few:

Trucking and transport. Several modelers factor in a boost to local trucking companies and their output and employment. In the main all of the corn used for ethanol production had to be hauled somewhere in the region prior to the introduction of the plant. It remains to be proven that there are significant weight and miles-driven trucking differences once a plant is established. It is highly likely that the ethanol will be rail-shipped, as would the vast majority of the corn that had historically fed into regional grain terminals. Total transport effects need to be assessed cautiously.

Declining cost industries. Ethanol industries tap into large amounts of energy. In particular they need electricity and natural gas. Both are large, declining-cost industries and the ethanol industry uses a large amount of product. Meeting the needs of a new plant does not yield average utility industrial output, job, or earnings outcomes; instead, they yield *marginal* outcomes which can be very meager if not nearly zero. A similar

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situation arises in their demand for regionally supplied water, especially if that demand taps into existing rural water systems with excess capacities. Large amounts of use yield very small changes in industrial labor and other costs. Our modeling systems always over-describe impacts in these industries.

The same can be said of the industry's heavy use of rail transport. Even if total commodity hauled is enhanced (comparing grain hauling versus ethanol and byproducts hauling), the marginal multiplier effects are likely to be relatively small. All of the plants in Iowa are located on or very near existing rail facilities, so the provision of rail services is an incremental change in railway use, and given that large quantities of corn had historically been shipped in grain cars, it is not clear that total railway tonnage has increased either.

Producer premium estimates. Corn producers and sellers in the region receive a better price than if they would have had they marketed their corn to some other buyer. The reason is that transport costs are reduced significantly by having a local buyer versus the assumed transport costs they would have borne had the grain been marketed to a buyer at a greater distance. Farmers near a plant receive slightly higher prices than those farther away as a consequence, and the entire corn industry is boosted some as local demand increases and regional supply has competition for uses. How much different? Earlier claims were of a $.10 to $.12 per bushel bump. Now conventional wisdom cedes that the average price bump in a 30 mile radius is at best $.05, although as energy prices rise, so too might the transport savings. A 50 MGY plant uses about 18.5 million bushels of corn. That works out to a premium at a $.05 a bushel of $930,000 to the supplying farmers in the region. Many modelers place the assumed premium money into the household income category or treat it as simple earnings. In effect, they let the farmers spend the money locally like take-home pay, which is speculative at best.

But there are offsets at work: if returns are higher, then land values increase. That's good if you're an owner looking at asset accumulation, but bad if you're a renter, which many farmers are in whole or part. Second, in the current federal program, higher prices everywhere yield lower federal subsidies. The net regional gain to boosted commodity prices has not been investigated well, and assumptions about the price boost need to be modeled carefully if not separately.

Ignoring other regional offsets. Competing users of corn, like hog and poultry producers, will need to pay more for their inputs, and recent news stories are highlighting this concern. Other grain handling and use will also shift in the region from systems designed to store and manage the efficient outflow of grain for export. The byproducts of ethanol, distillers' grains, are currently not suitable for feeding to swine and poultry, and can be used only as a limited supplement for dairy cattle feed. In Iowa, the most dense hog operations are located in the areas with the most dense corn production. Now ethanol plants are aggressively locating in the same space. Regardless of claims to the contrary, there is competition for local grain that is impacting the margins of hog and poultry producers.

<u>Unacknowledged or emerging externalities</u>. There are external costs, too, that only now being acknowledged. These plants are heavy users of water, they have a high amount of waste discharge, and their air emissions are becoming a problem (it's not just steam coming out of the plant, as Dan Rather claimed in a recent 60 Minutes story on CBS, especially in the new coal-fired plants). The plants have begun to attract the attention of state and federal environmental regulators.

Construction Happens: Those Interminable Construction Impacts

In our model, to be described shortly, we figured a total cost of $1.47 per gallon of rated production,[4] so a modern 50 MGY plant would cost $73.5 million. Obviously, the capital, land, and labor costs of a new ethanol plant are huge and represent quite a bump in rural area capital stock. Nearly every estimate of ethanol impacts that were reviewed count construction impacts, even if the plants were many years old – proponents and their hired-hands love big numbers, even if they are difficult to explain or justify, and this leads to the need for a discussion of the propriety of compiling and listing construction impacts in the first place.

Input-output models measure the annual outcomes of industrial activity in an economy. Those outcomes are best represented by the description of economic product (payments to labor, owners, investors, and indirectly to government) that is generated, which is based on accurate descriptions of industrial payments for inputs. In a contemporaneous situation, which is what I-O models are supposed to represent, that is how we gauge the size and value of a regional economy. Important elements to any industry's product are the costs that it must pay annually, amortized appropriately and depreciated regularly, for its use of borrowed, saved, or investor capital. Stated simply, just like a house mortgage, business pays off its costs of construction as an annual payment just like all other payments on-going annual payments.   The cumulative construction effects, the very broad demands that the industry made for plant, land, technical and machine assets, and any other physical assets are already factored into the industry's input matrix. That also includes the price of using borrowed or equity financed resources. In effect, folks who try to measure construction costs are actually double counting numbers that have already been factored into the annual accounts.

Another problem is that the investment capital opportunity costs are never discussed. Whether these projects are locally owned or externally invested begs the question, what was the money being used for before and where? When a project is totally funded by external money to the region, then in the main there truly is a net accumulation of regional assets from the "outside." When a project is funded in whole or part from local investors, then there is shift in the use of already existing regional assets, the difference in value being the returns received on this (the ethanol plant) choice versus the other uses to which that money was put regionally before.

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[4] Like everything, per rated gallon costs of production decline markedly as the size of the plant increases.

Nationally, there is a generally fixed rate of capital formation in our manufacturing sector. Any shift to value added agricultural production into ethanol, with concomitant offsets in the other manufactured uses of crop products, would likely be nothing but a blip on the entire spectrum of national capital investment. To attribute a construction impact nationally in light of annual expectations for capital growth seems to be something of a stretch – especially of the shift is rendering inefficient or obsolete all infrastructure that had historically moved surplus grain (like Mississippi River barge, locks, and terminals infrastructure for moving corn).

Still, a plant does create a local, short term stir. It takes 18 months or so to build a plant, and there are some discernible localized effects that should be acknowledged.

- The costs of preparing the land, engineering and constructing drainage, site paving, and access road enhancement are all likely to be bid locally, which is beneficial to the regional economy.
- Additional, non-technical structures and facilities, too, might be bid locally.
- Pipe fitting and steam fitting expertise, along with other mechanical and electrical systems would likely have to be imported, but local contractors or subcontractors might handle some of the less technical needs.
- Qualified unemployed construction workers in the region, to the extent that they exist, would find work.

There are not very many large aspects of the total construction costs that will be obtained locally nor their measurement easily configured. First, there are only a limited number of plant construction outfits in the Midwest. Second, much of what these firms will do at a site is to assemble a plant – nearly all of the technical and physical needs of the plant will have to be imported from somewhere else, to include also the engineering, design, and specialized construction labor. Boilers, cookers, generators, and all grain processing equipment, and nearly all pipes, vats, tanks, gauges, electronics, security apparatus, and other essential plant infrastructure will all be purchased outside of the study area and, importantly, probably outside of the state of construction.

The total construction margins on large projects like this, to include specialized engineering, may only be from 15 to 20 percent. Everything else is a direct purchase of land, service, or equipment inputs specific for the project. Yet, persons conducting estimates of short-term construction effects will run the entire construction amount (all land, labor, equipment, and other purchases) against a RIMS II construction multiplier, or enter the total into a construction sector of the IMPLAN model thus grossly overstating the regional or national effects, and in the wrong sectors, to boot.

Last, while many analysts are very careful to denote that, "construction impacts are temporary …", the fact remains that the construction effects are almost as a rule added to the operations impact statistics and described in the totals as if they were part of the annual production figures in many of the promotional reports and news stories that were reviewed. And the media are no more likely to parse those numbers than other non-technical reviewers.

Getting at More Reasonable Estimates for Iowa

There are several major difficulties with compiling the economic impacts, regionally, statewide, or nationally of biofuels in general and ethanol in particular. They are

- The absence of accurate default industrial accounts for the industry in current versions of either RIMS II or Implan.
- The costs and the revenues of ethanol production are both volatile in the current energy market, and somewhat difficult to discern.
- The amounts and the allocation of current windfall profits are uncertain.
- No consensus on upstream causality or of lateral agri-economic offsets.
- Cumulative federal, state, and local subsidies are very difficult to attribute and factor into or out of the output values. Consequently the prices received are understatements of gross receipts to a region and to investors.
- These are truly economies of scale industries where increments to productive capacity require comparatively little additional labor or technical enhancements.
- The industry is booming, yet volatile, and is therefore not a stable member of a typical input-output accounting structure.

While there is not much the average analyst can do about these difficulties, an improvement in input-output measurement can be made if models are constructed that reasonably specify the technical, service, financial, and labor inputs into modern ethanol plants. What we want to measure is the net increment to a region's or a state's economic product as a result of an ethanol plant addition.

Perhaps the best work to date in this area comes from Douglas Tiffany's research at the University of Minnesota. That effort has been adapted and modified regionally at ISU by Robert Jolly as part of his Extension services. In our research we have replicated portions of their basic models in an effort to generate production information that is reasonably accurate (or at least closer to right than wrong), allows for a recalculation of several input prices, can make variable assumptions about capital costs, financing, and payments to investors, and is sensitive to ethanol and byproducts prices in a contemporary market.

The following examples refer to a 50 MGY plant located amidst our three county region (hence TriCo). Although the TriCo Model at ISU was constructed relying heavily on ethanol plant decision making models crafted both at the University of Minnesota and at Iowa State University, it has been updated to reflect, to the extent that we can know them, current (2005) costs. Those data were then used to modify an Implan-generated model for three rural counties in Iowa. In the first table we specify construction and labor factors, plus the source and cost of financing and expected rates of return. In the spreadsheet, all of the shaded cells can be changed.[5]

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[5] Modelers wishing for a copy of the spreadsheet may receive one from the author (see the email contact information on the title of this report).

Table 1: TriCo Base Data

Total Costs & Labor Assumptions		
Base investment cost ($/gal)	$ 1.45	
Land cost ($/acre)	3000	
Land area required (acres)	320	
Engineering and installation cost	15%	
Overall project cost ($/gal)	1.4692	
Total project cost ($)	$ 73,460,000	
Distribution of cost across years D/E	60%	40%
Interest rate	10%	
Years	10	
Annual Debt Service Costs	$7,173,166	
Investors' return	20%	
Labor		
FTE	35	
Average Wage and Benefits	$67,700	
Management over Labor costs	20%	
Total labor and management	$2,843,400	

Table 2 contains assumptions about production in the model and indications of existing ranges that are pertinent per category. The size of the plant is specified as well as the "nameplate" factor, which is an estimation of how much of their rated capacity that they will use. The alcohol and other byproducts yields are also specified.

Table 2. TriCo Production Assumptions

Production Assumptions	Baseline	Ranges
Rated capacity (gal per year)	50,000,000	20 million to 100 million
Nameplate factor	115%	90% to 120%
Denatured Alcohol (gal per bushel)	2.75	2.5 to 2.9
DDGS yield (lb per bushel)	17.5	15 to 22
CO2 yield (lb per bushel)	17.5	15 to 22

Table 3 contains the basis and prices for determining primary input costs along with other pertinent inputs. Corn, of course, accounts for the vast majority of payments, followed by natural gas, rail transportation, and all processing chemicals (yeasts, enzymes, denaturants). In this example, value added is composed of payments to labor and management, the expected rate of return to investors, and indirect tax payments. Surpluses and losses are re-compiled later.

Table 3. TriCo Inputs, Prices, and Units

Primary Inputs	Input Costs	Prices / cost	Unit/Basis
Corn (bu)	39,727,273	1.90	Bushel
Water (gal) (plus treatment)	1,819,091	0.01740	Bushel
KwH Electricity	2,618,550	0.04140	KwH
Natural Gas (btu* bushel*alcohol yield)	16,552,813	8.22500	Million BTU
Other energy substitute			
Other Inputs			
Enzymes	3,136,615	0.15001	Bushel
Yeasts	1,438,462	0.06880	Bushel
Chemicals: processing and antibiotics	1,307,487	0.06253	Bushel
Chemicals: boiling and cooling	327,436	0.01566	Bushel
Denaturants	2,287,538	0.10940	Bushel
Waste management	1,089,364	0.05210	Bushel
Maintenance	756,909	0.03620	Bushel
Transportation (rail only)	10,062,500	0.00050	gallon per mile
All debt service costs	7,173,166	0.34306	Bushel
All other unspecified	4,600,000	0.22000	Bushel
Depreciation (Simple - straight 10 years)	7,346,000	0.35133	Bushel
Value Added Costs			
Labor	2,369,500	0.11332	Bushel
Management	473,900	0.02266	Bushel
Expected Return to investors	5,876,800	0.28106	Bushel
Indirect taxes	1,022,795	0.04892	Bushel
Total Costs	109,986,199		

Finally, at least for the period measured, we have a statement of gross receipts and a restatement of value added. Those values are in Table 4. In this example, and including what we believe to be the average prices paid and the average prices received for 2005, our hypothetical plant generated $8.66 million more revenues than costs making the total value added $18.4 million with the surplus.

Table 4. TriCo Income, Prices Received, and Value Added

Production Income		Price Received	
Denatured alcohol (gal)	103,500,000	1.80	Gallon
DDGS (tons)	14,050,909	76.80	Ton
CO2 (tons)	1,097,727	6.00	Ton
	118,648,636		
Sum of Value Added from above	*9,742,995*		
Surplus Value Added: Profit to be divided among shareholders and other uses	*8,662,438*		
Total Value Added with Profits	*$ 18,405,433*		

The next step in this process is compiling the table of total requirements (Table 5) in order to begin our modification of the Implan model for TriCo. Those data are contained in Table 5. Here we show what fraction of output is determined by the following inputs. These total requirements must next be multiplied by the regional purchase coefficients that the researchers believe will be operational in the study area. We, for example, set the

corn RPC at 85% to allow for a modicum of corn imports in our region. Once the local production functions and RPCs are determined, they can be entered in manually into the TriCo model (making sure that the RPCs are modified last or they don't stick).[6]

Table 5

Primary Inputs	Input Costs	Total Requirements
Corn (bu)	39,727,273	0.334831
Water (gal)	1,819,091	0.015332
KwH Electricity	2,618,550	0.022070
Natural Gas (btu* bushel*alcohol yield)	16,552,813	0.139511
Enzymes	3,136,615	0.026436
Yeasts	1,438,462	0.012124
Chemicals: processing and antibiotics	1,307,487	0.011020
Chemicals: boiling and cooling	327,436	0.002760
Denaturants	2,287,538	0.019280
Waste management	1,089,364	0.009181
Maintenance	756,909	0.006379
Transportation (rail only)	10,062,500	0.084809
All debt service costs	7,173,166	0.060457
All other unspecified	4,600,000	0.038770
Depreciation (Simple - straight 10 years)	7,346,000	0.061914

Impact Decision Making

A truism about an ethanol plant is that the only difference between a corn producing county without an ethanol plant and one with a plant is, well, an ethanol plant. That said, we need to determine just what we are going to allow our Implan model to count and not count as part of the estimating process.[7] Step 1 involves shocking our model by the amount of output estimated in our worksheet, $118.65 million. By so doing, we stimulated (purchased existing stocks of) $36.7 million in local corn supply (most from farmers, but a little from grain handlers). Knowing that we are not creating more corn production in our region, then, we manually adjust our scenario by reducing the grain sector by $36.7 million.

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[6] A brief note on inserting this industry into TriCo. This industry did not exist in the region. To take care of that problem we created a make-believe wet milling industry in the region (Implan no longer has a dry milling option. We could also use the organic chemical industry sector, where the ethanol industry is rightly slotted in NAICS, or we could have used a blank industry). We took values from our spreadsheet and converted them to a per-employee value. We next inserted that one employee and all of the output and value added assumptions at the state level. Then we were able to build a model with a reference to the industry that we were injecting that had all of the primary social account data from our original model system. Once built, we then changed the pertinent production functions to reflect our now, dry milling-ethanol operation, and we adjusted the RPCs.   After that the model was ready to be shocked by the addition of the entire industry effects.

[7] When this model was constructed, all value added payments beyond labor and indirect taxes are recorded as returns on investment – none to local proprietors. We are not trying to account for any local ownership. We are assuming simply unknown external investor ownership, to which local investors would participate at some fixed rate already contained in the Implan model.

The results are displayed in Table 6. The effect of the offset is to reduce the corn indirect values (and their subsequent regional indirect purchases and resultant multipliers) as, frankly, the plant did not cause them. Once adjusted, we get much smaller local impact values, although the jobs multiplier is still quite robust owing to the relatively sparse demand for labor in the plant relative to its output and expected relationship to supplying industries in the region.

In producing its output, this plant required just $13.3 million in what we think are new, regionally supplied inputs, which in turn supports 125 jobs. When those workers and the workers in the plants spend their paychecks, they induce another round of spending in the region to the tune of $3.2 million, which requires 47 jobs. The sum of all of the effects is $135.2 million in regional sales, 24.6 million in regional product, and 207 jobs. A multiplier is simply the total value divided by the direct value.

An assessment of the estimated 125 indirect jobs found that the model allocated 22 jobs in maintenance and repair industries, highly plausible given the mechanical configuration of the plant, 14 regional wholesaling jobs, 10 new trucking jobs, and several more in power generation, rail transportation, and dining and drinking.[8]

Table 6. TriCo Ethanol Plant Impacts

TriCo Impact Summary	Direct	Indirect	Induced	Total	Multipliers
Output	118,648,636	13,301,156	3,223,705	135,173,497	1.139
Value Added	15,562,033	7,108,906	1,964,160	24,635,099	1.583
Jobs	35	125	47	207	5.923

The total values are still impressive and important, but nowhere near the highly optimistic figures reported earlier in this study. Were they to be fully realized, they would contribute noticeably to the economic health of this three county region, especially in the industries that supply high value inputs to the plant (besides corn and trucking that I argue were already there). Notice, however, that despite producing $24.6 million in total value added under our assumptions, and this is assuming a very high amount of profit in the measurement year, the local boost to household spending (the induced value) is just $3.22 million to be distributed across the three county region. Economists and policy makers need to be mindful of the gap between the realized product of these plants and the effects they may yield on "downtown" type spending, especially if profits become tighter in future years.

Lastly, this research produced a jobs multiplier of nearly 6 – for every 1 job in an ethanol plant, 5 more regional jobs were sustained. Does this multiplier apply everywhere and

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[8] In modifying the original Implan model production functions, regional trucking purchases by this industry were reduced sharply. The farmer pays the transport into the plant, not the firm in my model. And the ethanol firm moves nearly its entire product out by rail.

under all circumstances? The quick answer is no. There are different industrial relationships in every county, so the linkage to input suppliers can be stronger or weaker. There are also many different assumptions or conclusions one can make about the regional economies. If these plants locate in an area that has slack or under-used capacities that link to the plant, then the more full utilization of those capacities might not produce the number of jobs anticipated. Similarly, a plant twice as large as the one modeled might only require 5 more direct jobs and similarly might tap into other economies of scale relationships with regional suppliers yielding much lower total job effects. In short, it would be irresponsible of an analyst in Iowa to provide a "rule of thumb" job or regional income multiplier for this industry. Despite our efforts to standardize and improve the analysis, the amount not known about the ethanol industry exceeds the amount known by a large margin.

Other Impacts: Corn Producers

We still have decisions to make about remaining impact calculations. In the first instance, we have nearly 21 million bushels of corn purchased in the surrounding region. Working on a reasonable assumption that the average difference in price received by the producers is $.05 per bushel for a total of $1.05 million, we are faced with a modeling decision. We could go back to the baseline model and like many others before us bump household spending by an equal amount (less of course taxes and all other reductions in disposable income). But this seems arbitrary and doesn't factor in any information about the farm sector, their average costs, and the uses to which proprietors put their profits. Indeed, this area needs to be researched much more carefully before impact analysts start shocking spending sectors.

Where the money gets put can really matter. To investigate this we constructed a sensitivity table derived from the original social account matrix (SAM) from the TriCo model. This model was processed outside of Implan in the conventional, Leontief Inverse procedure to determine total final demand multipliers for my region. Using those coefficients, we then developed a model to see what happened when we put different amounts of payments into proprietor or into household income accounts cells, given the existing construction of the Implan accounts for my study area.[9]

Having compiled the SAM and determined our base values, we then allocated $1.05 million more money in the region divided first evenly between proprietors (that aligned with the upper income group[10]) and with the upper income group (our property owning and investing class) as if this money was being received as an investment (mostly as a rent premium). In so doing, we were able to discern the effects listed in Table 7. Next we allocated all of the returns just to our farm proprietors. Those outcomes are displayed in Table 8.

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[9] We in effect are pretending that the price premium is exacted by the farmer locally away from some external beneficiary, i.e., investment payments that accumulate outside of the region. I simply transfer that money back into the region and allocate it in the manners described in the text. We keep the propensity to purchase locally at the same levels specified by the model.

[10] We collapsed the household income sectors to under $25,000, $25,000 to $75,000, and $75,000 or more.

By letting the model calculate the expected effects of putting the corn price premiums into two different categories (Table 7) we get an expected regional output bump of $560,000, which would yield $350,000 in value added. After everything multiplied through, and holding to existing model assumptions about internal and external to the economy spending, there would be a total household income impact in the region of $1.28 million (including within the original $1.05 million).

Table 7. TriCo Corn Producer Impacts ($.05 / bushel premium) of
$1.05 Million Split Equally Between Proprietors and Investors

	Baseline	After Shock	Impact
Output	2,632.0	2,632.6	0.56
Value Added	1,164.6	1,164.9	0.35
Household Income	1,184.8	1,186.1	1.28
Amounts in Millions			

Table 8 puts all of the money into farm proprietors' hands. The impacts are decidedly different, given the construction of this SAM from Implan, and the model has proprietors generating substantially greater effects from the premium. Output in the region goes up by $770,000, value added is enhanced by $470,000, and total household income by $1.71 million.

Table 8. TriCo Corn Producer Impacts ($.05 / bushel premium) of
$1.05 Million Allocated Solely to Proprietors

	Baseline	After Shock	Impact
Output	2,632.0	2,632.8	0.77
Value Added	1,164.6	1,165.1	0.47
Household Income	1,184.8	1,186.5	1.71
Amounts in Millions			

These two tables can represent a range of expected impacts as if the corn price premium resulted in returns to either farm proprietors other investors linked to the farm sector (land owners) or both.

In our examples, we are not comfortable treating the ostensible price premium as household income. To do so would be a gross oversimplification of producer and consumer behaviors in our study areas. We treat it as realized proprietors' or investors' incomes locally. Farm decision making surveys at Iowa State University in past years found that farmers that received windfall profits (or hugely beneficial subsidies) tended to convert about a third of their net receipts to either debt reduction or another investment, a third to improvements of their operation, and a third into family spending. As a matter of practice, we have used this "thirds" formula to anticipate farmer behavior in other modeling exercises. The findings in Tables 7 and 8 appear to justify that assumption, i.e., that a comparatively small amount of the "windfall" finds its way into regional purchases.

Other Impacts: Construction

For a short period of time, this region will enjoy a boom in construction activity. Perhaps as many as 60 workers will be involved in the plant site preparation, erection, equipment installation, maintenance, and configuration. While bids to local workers are always desirable, there are regionally and statewide large firms that receive a preponderance of large construction contracts, to include paving, mechanicals, electrical, and other facilities and equipment. The fraction of those workers that are local is unknown but likely to be very small – most rural areas of Iowa have low unemployment rates. As there are only a few firms that build ethanol plants, one must assume that the majority of its labor is highly specialized and external to the region. The origin of the remaining labor and the uses to which they put their paychecks regionally is speculative.

A last point on construction. Except for local gravel, asphalt and concrete cement, and some local labor and other relatively minor inputs, nearly everything else that goes into making a modern ethanol plant must be purchased from outside of the region and, significantly, from outside of the state. Only a comparatively small amount of the total investment cost gets spent locally. Modelers who assume otherwise or who naively shock the construction sector by the total amount of capital outlay grossly overstate localized benefits and distort the construction effects (not impacts) that accrue. Again, as it has already been said, the costs of construction are already a portion of the input-output accounts on an amortized basis.

The appropriate way to measure the localized construction effects is to find out exactly how much of the project has been bid to local construction firms, local suppliers, etc., and to then build a scenario where those industries are shocked by that much output to see what the expected average consequences of those local sales would be. Those outcomes can be reported separately and appropriately, but they must never be added to the values listed above that describe the operational impacts of the plant.[11]

Other Impacts: Losses or Gains to Other Producers and Firms

Earlier I stated that the only difference between a corn producing county with a plant and without a plant is the plant. That is, of course, too simple of a statement. The placement of that much demand for corn within a study region has an effect on many industries that must be acknowledged even though we may not be able to measure them well. As more and more plants vie for an ever-shrinking corn base, these outcomes might become more acute.

1. Regionally higher prices for corn reduce the profits of other corn users, most noticeably for Iowa, hog and poultry operations. A newspaper story in July 2005 relying on the comments of the USDA's chief economist said that "[t]here will no increase in food prices because of the ethanol production until 2009." I think that the USDA might, in light of more recent events, rethink that conclusion.

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[11] Wouldn't it be fair to, in the full first year of operation, compile an "absence-of-construction" negative economic impact? After all, that activity was now gone from the economy.

2. The ethanol distillers' grains byproducts are beneficial to cattle feeders, and somewhat so for dairy operations, but the vast majority of cattle in our state and the nation is located at some distance from concentrations of ethanol plants. If cattle are attracted, will hogs be shunted out? Will there be a reconfiguration in animal feeding operations in the state? Can the land take that much manure? Will ethanol plants organize horizontally to include cattle feeding and reduce the viabilities of small and medium cattle feeder operations? Will hog production move, change, shift, or reconfigure?

3. Will land currently not in production because it is marginal or is environmentally sensitive be put into production? Will there be a slow but decided shift away from soybean or other grain and oilseeds production in the Midwest. If so, will those shifts affect feed and food prices and other downstream industries that existed to process or convert those agricultural commodities?

4. The state of Iowa has an extensive system of local grain elevators, grain handlers, and transport systems that historically moved grain onto Mississippi River barges for transport to Gulf of Mexico terminals. With the proliferation of ethanol plants, those facilities will move less grain, be less efficient, and will realize reduced profits on operations. The existing infrastructure that moved grain (i.e., grain cars) will have to be substituted with tankers to haul ethanol. In all, there will be excess capacity in the state's grain handling and transportation infrastructure.[12]

5. Finally, and importantly, just how durable is the corn-to-ethanol industry in light of medium term technical possibilities, ever-increasing scrutiny of the "green" content of corn-based ethanol, and the likelihood that most new technical commercial investment geared for the long run will likely exclude corn as a major source of ethanol in the future? That's why many of the self-styled "green" ethanol proponents call corn based ethanol a transitional fuel at best.

Remember, those multipliers, whatever they end up being, also work in reverse.

Conclusions and Concerns

The ethanol industry in American and in Iowa, the current center of the biofuels galaxy, is transforming rapidly. The state is slated in the very near future to add 1,600 MGY in capacity in 16 new or expanded plants beyond what is now under construction. Some outfits are expanding from, say, 45 MGY to 100 MGY. Others are proposing new 100 MGY plants, and some of the big producers, Cargill and ADM are announcing even larger expansions. These newer plant configurations benefit from substantial efficiencies.

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[12] It is interesting to note that the proliferation of ethanol plants and the redirection of corn from barge to rail tankers as ethanol is rapidly erasing the corn-producers' and other supporters' justification for expanding and upgrading the Mississippi River locks and dams to accommodate future corn exports.

As an example, current operations in Iowa of between 40 and 50 MGY require from 35 to 50 workers. The old rule of thumb was one worker per MGY of production. One Iowa plant, however, has announced that it expanding from 45 MGY to 100 MGY. It currently has 45 workers, the old expected average, but it will only need 5 more workers to handle the 100 MGY plant. Our assumptions about the direct effects to workers, consequently, must change to reflect this. We now model 100 MGY plants to require 50 to 55 workers. The point is that the marginal changes in this expanding industry are much different than the average values that existed until just recently. Much also can be said for size efficiencies associated with the entire technical infrastructure of these new or expanded facilities.

There are many other important uncertainties to confront. The very high prices paid for ethanol currently, $3.50 a gallon for Iowa as of 1 June 2006, obscure other sharp increases, especially on energy costs and demands. Some new plants are or are considering switching to coal as a heating source, but those costs, too, have risen markedly during this decade. High prices for ethanol also obscure our conclusions about the distribution or disposal of byproducts. While there are prices quoted, for example, of dried distillers' grains, there is ample recent anecdotal evidence that this byproduct is essentially dumped at bargain basement prices for those who can get it off the hands of the plants on a reliable schedule.

Who wins and who loses as this industry matures are important considerations. Currently, ethanol plants are benefiting from a perfect storm, as one local educator put it, of stable corn prices and windfall ethanol prices. Many of the small to medium plants in Iowa and Minnesota were organized as cooperatives or as having high local investor content. In fact, this researcher is finishing work that demonstrates a decidedly large localized economic impact attributable to local ownership. However, as the industry rapidly expands, as both the dimensions of risk and rewards become larger, there has been a sharp inflow of external capital into this system, either by already established producers like Cargill and ADM, or by new ventures. Many of the smaller, locally owned systems are cashing out and selling to external investors. Again, and as a consequence, it is expected that the localized economic benefit outcomes will change as we adjust our assumptions on the realization of the value added produced in these plants.

In all, there is enough uncertainty in the ethanol industry both in its current configuration and in its anticipated future manifestations for prudent analysts to exercise extreme caution when making claims as to the net economic product in this country that is attributable to ethanol, who the linked beneficiaries of this increment are, and where they are. Most of the current efforts grossly overstate the regional, state, and national effects of the ethanol industry.

A personal note on economic impact modeling: There is a major analytical breakdown in this area and other similar areas, and it has been evident for quite some time now: rural economists and regional scientists have not systematically addressed these abuses adequately.

As many of the questionable analyses on the ethanol industry economic impacts have originated in state universities or in state agencies (in Iowa) as have the more prudent ones, although the preponderance of really questionable impact assessments usually come from private consultants who simply misunderstand or mis-apply the basics of input-output modeling. Similar extraordinary local and statewide multiplier reports in recent years have been made relative to cattle and hog operations, meat packing operations, locally and investor owned wind-energy facilities, and tourism.   If it is a hot issue, if there are strong advocacies, then the odds are that there will be a bloated impact summary floating around.

If scarce public money is allocated on the basis of poorly articulated or wildly optimistic impact summaries, everyone loses except, of course, the industrial beneficiary of the bias. And we as analysts especially lose because our credibility is undermined.

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