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Putting Bounds on Estimating Economywide Impacts from Adopting the Renewable Fuels Standard

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In this paper, we assess the economywide impacts of adopting the Renewable Fuels Standard by using "land-constrained" and "land-unconstrained" scenarios to establish lower and upper bounds. Adopting the RFS would stimulate between $3.4 billion and $6.9 billion in new output and generate 12,600 to 31,400 jobs.

Key words: RFS, FAPSIM, input-output, economywide impacts.

Introduction

As part of the Energy Policy Act of 2002, the Renewable Fuel Standard (RFS) would increase the demand for renewable fuels. Most of this expansion in renewable fuels is expected to be ethanol produced from corn but also includes some biodiesel produced from soybean oil. By 2012, ethanol demand is expected to increase from 3.05 billion gallons to 4.43 billion gallons, for an increase of 1.38 billion gallons, due to the RFS. The projected new demand of 122 million gallons of biodiesel would require 938 million pounds of soybean oil in 2012 (United States Department of Agriculture [USDA] Office of Energy Policy and New Uses, 2002). We estimate the economywide impacts of these new demands for renewable fuels on employment and output.

The increased demand for ethanol from corn and biodiesel from soybean oil will induce a supply response from the food processing sectors: corn milling and soy mills. One key to understanding the economywide outcome of adopting the RFS is to understand how farmers would respond to the new induced demands for corn and soybeans. In the case of an aggregate fixed supply of cropland, corn and soybeans are substitutes, and choosing to plant one crop or another depends on expectations about future prices and the structure of government programs. These production decisions can set in motion price changes that also induce substitution effects among downstream users of these two commodities. That is, the increased demand for ethanol and biodiesel could crowd out other demand-side uses of corn and soybeans such as exports, feed for livestock, or other processed food products. Alternatively, producers may be able to expand production by increasing planted acreage. In this second case, increasing the supply of cropland devoted to the production of corn and soybeans does not raise commodity prices and the supply-side substitutions do not occur.

Methodology and Scenario Design

We construct one scenario with a binding land constraint and one without. The first scenario incorporates the initial increase in demand for ethanol and soybean oil and the producer response given a fixed aggregate supply of cropland. We call this scenario the "constrained scenario" and use the Food and Agricultural Policy Simulator (FAPSIM) to develop this composite agricultural shock (Salathe, Price, & Gadson, 1982). FAPSIM is a large-scale econometric model of the US agricultural sector maintained by the USDA's Economic Research Service (ERS) with which we account for the price and substitution effects on corn and soybeans markets from an increase in demand for ethanol and biodiesel. Next, we feed this composite shock through an Input-Output (I-O) multiplier model to obtain the direct and indirect changes in sectoral output and employment for the US economy (Schluter & Edmondson, 1994). The I-O model, also maintained at ERS, uses an updated version of the 1992 benchmark input-output table published by the US Department of Commerce Bureau of Economic Analysis. In the second scenario, called the "unconstrained scenario," we simulate directly the estimates of the increased demand for soybean oil and ethanol in the I-O model. In this case, we are assuming that farmers are able to supply all the required corn and soybeans to processors.

For both scenarios, the projected increased domestic use of ethanol beyond existing capacity is 1.38 billion gallons valued at $2,053 million. The projected increased use of soybean oil for biodiesel is 938 million pounds valued at $236 million, and the byproduct soybean meal is projected to be 2 million tons valued at $605 million. Consequently, the value of the biodiesel shock on soy mills is $841 million. All values are in terms of 2002 prices. These estimates incorporate the projected conversion rates for raw products into ethanol and biodiesel based on new technologies currently being adopted (USDA Office of Energy Policy and New Uses,

2002). Further technological change in crop production or in the crushing process would change the employment impacts reported below.

The major assumption underlying the I-O multiplier framework is that sufficient crushing capacity will exist to meet the additional demand for ethanol and soybean oil. Currently, the industry is not experiencing a capacity constraint, as ethanol producers have built a number of new plants over the past couple of years and plan to build additional plants in the future (California Energy Commission, 2001). Should bioenergy demand increase beyond these projected levels, current federal programs also provide incentives encouraging capacity expansion (USDA Farm Service Agency, 2000; USDA Office of Communications, 2003).

Scenario: Impacts under the Binding Cropland Constraint

In the first scenario, the composite shock was calculated from the results of the FAPSIM simulation for the 2011-2012 crop marketing year, when it is assumed that market adjustments will have stabilized. Adopting the RFS represents a $1,693 million positive shock in 2002 prices to the US economy (column 1 in Table 1). The new ethanol demand of $2,053 million increases derived demand for corn, raising its price and thus inducing a net fall in corn demand of $123 million destined for feed use and exports. Because corn is a primary feed in the final stages of fattening cattle and hogs for production of beef and pork products, the increased corn price increases the input costs to producers of meat animals. Consequently, meat output falls by $141 million as its retail price rises and sales fall. The contraction in meat production reduces demand for soybean meal, causing the soybean meal price to decline. In turn, the fall in soybean meal price reduces input costs to the poultry producers and induces an increase of $83 million in processed poultry products at lowered consumer prices. The changes in retail sales of meat and poultry and other marketing adjustments lead to a net negative shock to the trade and transportation sector of $37 million.

Although this new demand from biodiesel increases the domestic use of soybean oil, this additional demand is met by diversions of alternative uses of soybean oil—not by increases in production. That is, biodiesel partially crowds out the other uses of soybean oil by driving up its price. Furthermore, the increased demand for corn induces producers to shift land away from soybeans into corn, leading to a drop in soybean production. Hence, a reduction in the supply of soybeans means that the value of soybean oil and meal together fall by $141 million.

The changes in sectoral output reflect the market interplay of substitutions among producers and consumers of corn and soybeans. Adopting the RFS in the constrained scenario leads to an increase of $3,407 million in total output for the US economy as a whole, of which 9% occurs in agriculture, 55% in food processing, and 36% in the nonfood sectors (column 2 of Table 1). Within farming, corn experiences an increase in output of $527 million, offset by output declines of $142 million for oilseed producers and $91 million for livestock producers. In food processing, an increase in the ethanol production of $1,963 million is augmented by an increase of $92 million in poultry processing, and offset by a decline of $194 million in soy mills and meat processing. Service sector output rises by $647 million, trade and transportation by $265 million, and manufacturing by $325 million.

Adopting the RFS under the constrained scenario creates 12,580 additional jobs for the U.S. economy as a whole, with 19 percent of them arising in farming, 24 percent in food processing, and 57 percent in the nonfood sectors (Column 3 of Table 1).[1] Within farming, employment in corn increases by 4,150 jobs, offset by declines of 1,120 jobs in the oilseeds and 720 jobs in the livestock sectors. In food processing, an increase of 3,230 jobs in the ethanol sector is augmented by an increase of 320 jobs in poultry processing, and offset by a decline of 560 jobs in soy mills and meat processing. Employment in services rises by 4,560 jobs, trade and transportation by 1,560 jobs, and manufacturing by 1,040 jobs.

Impacts under No Cropland Constraint

Without any supply-side substitution effects in the unconstrained scenario, the composite shock of $3,046 million almost doubles the stimulus created in the constrained scenario. In addition to the direct shocks on ethanol and soy mills, increased supplies of distillers dried grain and soybean meal reduce costs to meat and poultry

1. *Employment is expressed as full-time equivalent jobs in 2002. Because the two scenarios use the end-year FAPSIM estimates in 2011 for these new uses, we have assumed that labor productivity increases 1% per year such that, from 2002 to 2011, jobs per billion dollars of output would fall by 10% across all sectors. By reducing the job estimates from the I-O simulation by 10%, we account for the increase in labor productivity in the employment estimates that will have occurred over this period.*

Table 1. Changes in employment and output under the proposed Renewable Fuel Standards.

	Constrained scenario with demand- and supply-side substitution			Unconstrained scenario		
Sector	Composite Shock (2002 $mil)	Total Changes in Output (2002 $mil)	Total Changes in Employment (number of jobs)	Composite Shock (2002 $mil)	Total Changes in Output (2002 $mil)	Total Changes in Employment (number of jobs)
Total economy	1,693	3,407	12,580	3,046	7,326	34,110
Farm	-123	309	2,430	0	1,474	11,610
Livestock	0	-91	-720	0	82	640
Crops	-123	400	3,150	0	1,392	10,970
Corn	-123	527	4,150	0	703	5540
Soybeans	0	-142	-1,120	0	660	5200
Other crops	0	15	120	0	29	230
Food Processing	1,853	1,861	2,990	2,999	3,171	5,470
Poultry	83	92	320	83	93	320
Meat	-141	-134	-460	22	26	90
Soy Mills	-141	-60	-100	841	898	1,480
Ethanol (Corn milling)	2,053	1,963	3,230	2,053	2,050	3,390
Other Food Processing	0	0	0	0	103	190
Manufacturing	0	325	1,040	0	665	2,210
Trade & Transport	-37	265	1,560	47	703	5,110
Services	0	647	4,560	0	1,315	9,710

processors, inducing $105 million in new output in these sectors (from our FAPSIM simulations). In turn, the increased sales of meat and poultry products leads to a $47 million increase in trade and transportation.

In the unconstrained scenario, aggregate US output increased by $7,326 million and employment by 34,110 jobs (columns 5 and 6 of Table 1). Farm output grows by $1,474 million, generating 11,610 jobs; food processing increases by $3,171 million, generating 5,470 new jobs. Nonfood sectors increase output by $2,682 million and employment by 17,030 jobs.

The central question raised by the results in the unconstrained scenario is: To what extent are producers able to expand production to support the new demand of $1,348 million for corn and soybeans? An additional 1.9 million acres are required for the production of $703 million of corn; 2.1 million acres are required for the production of $660 million of soybeans. The additional acreage for both crops represent 2.5% to 3.0% of each crop's total acreage, depending on whether these percentages are based on a 10-year average or acreage planted in 2001-2002 marketing year. Whether this additional acreage would be available without cross-crop substitution effects is uncertain at best. (With respect to biomass crops, Raneses, Hanson, and Shapouri, 1998, also addressed shifting cropland from food to fuel production.)

Conclusion

In summary, fully adopting the RFS would stimulate between $3.4 billion and $7.3 billion in new output and generate 12,600 to 34,100 jobs. For both scenarios, adopting the RFS represents a direct positive shock to corn milling and soy mills. However, in the constrained scenario, the binding land constraint leads to partially offsetting market adjustments by consumers and producers of corn and soybean products, reducing the job and output impacts. In the unconstrained scenario, the higher job and output impacts reflect the employment of previously unused land, labor, and capital.

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