The Economic Impact of the Demand for Ethanol

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Executive Summary

- The 1997 demand for ethanol is estimated at 1.52 billion gallons, or 0.60 billion bushels. That will boost the price of corn, which will reduce the demand for other uses of corn, including exports. The net effect in 1997 is that the demand for ethanol will boost corn production by 0.42 billion bushels, and raise the price of corn by 45¢/bushel.

- The increase in production and price will raise gross farm income by $5.0 billion, and net farm income by $4.5 billion, in 1997.

- The rise in farm income, combined with multiplier effects, will boost employment by 169,400 in 1997. Most of this represents off-farm expenditures.

- The increase in purchases of farm equipment, combined with multiplier effects, will boost employment by an additional 12,500. The operation of ethanol plants, combined with multiplier effects, will boost employment by another 13,300.

- Thus the total increase in employment in 1997 due to the demand for ethanol will be 195,200 jobs.

- On a regional basis, employment will increase by the following amounts in the 10 major corn-growing states; the table below also includes a figure for all other corn-growing states.

- The higher level of economic activity will boost state and local tax receipts in the farm-growing states by the amounts given in the table.

State	Rise in 1997 Employment, thousands of jobs	Increase in tax receipts, millions of dollars
Iowa	42.2	111.0
Illinois	33.8	96.3
Nebraska	24.8	64.1
Minnesota	16.4	63.3
Indiana	14.1	43.0
Ohio	7.4	22.9
Wisconsin	9.0	30.3
South Dakota	6.8	10.1
Missouri	5.1	12.2
Michigan	2.7	11.6
All Other States	32.9	--
Total, all corn-growing states	196.2	464.8

- Because of the higher level of economic activity, Federal tax receipts will rise by an additional $3.6 billion, and unemployment payments will decline by $0.6 billion. Offsetting these gains, the cost of the ethanol subsidy for 1997 is $0.6 billion. The net result is to reduce the Federal deficit by $3.6 billion.

- The increase in food prices caused by the demand for ethanol will be fully offset by a decline in the price of energy. Hence there will be no negative impact on the cost of living caused by the demand for ethanol.

- Because of the increase in exports of ethanol by-products and the decline in imports of gasoline and oxygenates, the trade balance will improve by $2.0 billion in 1997.

1. Outline of this report

This report is divided into 11 sections, including this outline. The other 10 sections are as follows:

2. Increase in farm income due to the demand for ethanol

3. Increase in jobs due to higher farm income

4. Increase in jobs due to greater investment in farm equipment

5. Increase in jobs due to operating ethanol plants

6. Total increase in jobs in major corn-growing states

7. Decline in Federal budget deficit

8. Increase in state and local tax receipts

9. Improvement in foreign trade balance

10. Other agricultural and macroeconomic issues

11. Conclusion

Initially, we estimate the increase in farm income due to the demand for ethanol. This estimate is based on a simultaneous equation model that predicts the price and production of corn. The price of corn depends on several factors, including the demand for ethanol; production then depends on lagged prices. Thus the model can be used to determine how much both corn production and prices rise at various different levels of ethanol demand.

Once the increase in corn production and prices have been determined, it is a simple matter to calculate the rise in gross and net farm income stemming from the demand for ethanol. This figure can then be used to determine the increase in jobs related to the demand for ethanol.

First, the average value added per job is calculated for 1997, and this figure is then applied to the rise in net farm income (and GDP) to determine the increase in employment due to the initial impact of the demand for ethanol. These figures are then expanded by the average multiplier for Farm Belt states in order to determine the total increase in jobs stemming from higher farm income.

In addition, further jobs are created by an increase in purchases and production of farm equipment, and in the operation of ethanol plants. In both cases, these figures are also adjusted by the appropriate multipliers to determine the total increase in employment stemming from the demand for ethanol.

Once the total number of jobs has been determined, these are then apportioned among the 10 major corn-growing states, based on the estimated proportion of the total corn crop in each state for 1997, where the farm equipment manufacturing facilities are located, and where the ethanol plants are located.

The increase in employment can then be translated into increases in wages and salaries, consumption expenditures, farm income, and corporate income, and the appropriate tax rates for the Federal government can then be applied to determine the increase in Federal tax rates and the decline in unemployment payments. This figure is netted against the cost of the ethanol subsidy to determine the net gain to the U.S. Treasury. A similar method is used to determine the increase in tax receipts for each major corn-growing state, taking into account the rates for sales, personal income, and corporate income taxes in each state.

The impact on the U.S. net trade balance is also assessed by considering the increase in exports of ethanol by-products, and the reduction in imports of gasoline and oxygenates.

The macroeconomic ramifications of the rise in food prices, the decline in gasoline prices, and the reduction in the public sector deficit are briefly discussed; on balance, these factors have very little influence on the overall results and are not treated separately.

The conclusion reemphasizes the degree to which the ethanol subsidy more than pays for itself by boosting real income, employment, and tax receipts.

2. Increase in farm income due to the demand for ethanol

The demand for ethanol has had two positive impacts on farm income. First, the demand for ethanol raises the price of corn. Second, higher corn prices have increased the amount of corn acreage planted and harvested, thus boosting the size of the total corn crop. Initially, a rise in the price of corn might boost corn acreage at the expense of soybean acreage. In the longer run, though, past historical evidence -- especially for the 1970s -- shows that such a development would boost soybean prices, leading to an increase in acreage for that crop as well.

When longer-run dynamic effects are fully considered, an exogenous increase in demand for corn -- such as ethanol -- not only raises corn prices but may also boost soybean prices. In this study we have taken a very conservative approach and assumed that soybean prices and acreage are unchanged; hence these results may well understate the total gain in farm income caused by the demand for ethanol.

The impact on the price of corn is considered first. The price of corn is a function of corn production (with a negative sign), exports of corn, demand for ethanol in bushels, and the support price for corn. A dummy variable is also included for the 1973-74 period of price controls and the Soviet export orders. This equation, which is estimated for the sample period from 1961 through 1995, is given in Table 1. The actual and simulated values of this equation for the sample period are shown in Figure 1.

The coefficient for the ethanol term is 0.906. That means holding everything else constant, if the demand for ethanol were the equivalent of 600 million bushels, the price of corn would be 54¢/bu higher. However, that is only a partial solution. We must also consider that if the price were higher, that would eventually boost production as well. As a result, the total effect of ethanol demand on corn prices is to raise prices by 45¢/bu.

It is indeed the case that the results in this paper depend critically on this 45¢/bu estimate. If the actual number were substantially lower, the increase in farm income, and hence the rise in employment and tax receipts, would also be much lower. Hence we focus closely on the reliability of this figure.

Is it "reasonable"? Since 1980, ethanol demand in bushels has risen from zero to about 600 million bushels, which is about 6.6% of the expected 1997 corn crop. We estimate that this increase has boosted prices by 45¢/bu, which is 18.6% of the price, using the average price with and without ethanol demand. Those two figures yield a price elasticity of -0.36. That is certainly well within the range of other estimates; numerous studies have shown that the demand for corn is price-inelastic.

Another way to "test" this figure is to observe what happened in the times of major changes in export demand, holding production constant. From 1971 to 1975, exports rose from 14.2% to 28.4% of total corn production of about 5.7 billion bushels; over the same period, the price rose 82.5%, yielding an elasticity of only -0.17. Some might object that was a "special case," so we also observe what happened in the 1980s, when a rise in corn exports from 24.1% of the crop in 1987 to 31.5% of the crop in 1989 resulted in a 20% increase in the price of corn; here the indicated price elasticity was -0.37. Many examples can be found for similar price elasticities relative to production in years when exports and other components of demand were relatively stable.

Hence the elasticity estimate used in this study is based not only on rigorous econometric techniques, but is consistent with historical evidence in both the 1970s and 1980s, and is at the upper end of the range that USDA uses in its own estimates, according to Dr. John W. McClelland, Associate Director of the Office of Energy for USDA.

Nonetheless, we will agree that this figure, which is based both on regression analysis and the solution of a simultaneous equation model, is higher than many previous estimates. There are at least three major reasons for this result. First, as the demand for ethanol continues to increase, it has a proportionately larger impact on corn prices; the same phenomenon has previously been observed when corn exports rise significantly. Second, with the more market-oriented farm sector today, much of the "safety-net" for farmers has been removed, so that prices could drop much more sharply if ethanol demand were to decline. Third, corn supplies are relatively tight in 1997; if there were a glut of corn, the elasticity might be somewhat smaller.

We emphasize that the impact on corn prices of the demand for ethanol is determined only after solving a simultaneous equation for both corn prices and production. That is because a rise in corn prices diminishes the export demand for corn, and it is the total demand for corn that determines production in future years. Hence the ethanol coefficient in the corn equation cannot be taken as the marginal effect without considering the dynamic interaction between prices and production.

In order to assess the overall effect of ethanol demand on corn prices, we thus estimate a second equation in which corn acreage harvested is a function of the price of corn in the previous two years; the yield is assumed to be exogenous. The equation for corn acreage harvested is given in Table 2. It shows that a $1.00/bu increase in the price of corn would result in an 8.3 million increase in acreage harvested.

The impact of the demand for ethanol on corn prices and production can now be combined, taking into account (a) the amount that the demand for ethanol boosts corn prices, and (b) the amount that the rise in corn prices boost production, which then has a negative impact on prices. These effects are combined in a simulation model, the results of which are shown in Figures 2 and 3 and Table 3.

Both figures contain two lines. The upper line is the simulated values for the price of corn that were obtained based on the actual level of the demand for ethanol. The lower line is the price of corn that would have occurred if the demand for ethanol would have been zero. Table 3 shows that the difference between these two simulations was $0.45 per bushel in the 1995/96 crop year; we will use that figure for the 1996/97 year as well. It also shows that production of corn was 0.39 billion bushels higher in the 1995/96 crop year than would have been the case if the demand for ethanol was zero. Since 1995/96 production was unusually low, but 1996/97 production is expected to return to normal levels, we have boosted that figure to 0.42 billion bushels when calculating the economic impact in 1997.

The yield in bushels/acre is considered to be exogenous, since it is primarily tied to weather conditions. The trend yield for the 1996/97 crop year (beginning in October 1996) based on this simple extrapolation is 127.3 bushels/acre. This is virtually identical to the latest (January 1997) USDA estimate of 127.1 bushels/acre, so the figure of 127 bushels/acre is used without further adjustment. The actual and trend figures for yield/acre are shown in Figure 4.

Based on the prices of the past two years, this equation predicts that corn acreage harvested will be 72.0 million acres in the 1996/97 crop year; this figure is slightly lower than the 73.1 million figure which is the latest estimate of USDA. Using the 72.0 million acreage figure times a yield/acre of 127 bushels yields a total corn crop of 9.14 billion bushels. This is the baseline figure used for the rest of the calculations in this study.

The remaining factor is what will the production of ethanol be in 1997. Until 1996, production of ethanol had progressed along a fairly smooth upward trend, rising an average of the equivalent of 33 million bushels of corn, or 82 million gallons per year. However, in 1996, ethanol production dropped sharply off the track, as can be seen in Figure 5. This was due in large part to the shortfall of corn in the 1995/96 crop year. It is assumed that ethanol production will return to its trend rate in 1997, which would be about 600 million bushels, or 1.52 billion gallons.

So far we have determined that (a) corn prices will be $0.45/bu higher in 1997 than would have been the case if ethanol demand were zero, and (b) corn production will be 0.42 billion bushels higher, assuming that ethanol production returns to its trend level of 600 million bushels, or 1.52 million gallons.

We now apply these incremental differences to the baseline estimates of corn production and prices for 1997. We have already calculated that production will be 9.14 billion bushels. The simulation model indicates a season average price of $2.75/bu, which is close to the middle of the latest USDA range of $2.55-$2.85/bu.

The incremental impact on cash flow is then calculated as follows. Total cash receipts from corn for 1996/97 year are expected to be 9.14 billion times $2.75, or $25.1 billion. If the demand for ethanol were zero, we estimate that corn production would be 8.72 billion bushels, and the average price would be $2.30. In that case, total cash receipts from corn would be $20.1 billion. Thus gross cash receipts to corn growers are $5.0 billion higher because of the demand for ethanol. Of this amount, $1.2 billion is due to an increase in production, and $3.8 billion is due to higher prices. These different parts will be used separately in the following analysis.

Some studies have suggested that the net change in farm income would be lower than the $5.0 billion we have calculated because of the decline in soybean prices and production. That argument would claim that because of the increase in ethanol by-products that compete with soybean meal and oil, those prices would fall. However, it is also the case that a rise in corn prices would have some effect in raising soybean prices. This point is discussed below in Section 10, but at this juncture we can say that on balance, soybean prices certainly do not decline, and probably increase.

In this regard, we can reference what actually happened to corn and soybean prices and acreage when faced with a major exogenous factor that increases the overall demand for corn. Most of the time, corn and soybean prices move in the same proportion; the major time they did not was during the Russian grain deal, when the ratio of the average season price of corn/soybeans rose from 0.36 to 0.52.

Initially, corn acreage rose and soybean acreage fell. However, that development pushed soybean prices to near record-high levels, which caused soybean acreage to rise. By the time a new equilibrium had been reached, soybean acreage had increased 51%, while corn acreage was up a more modest 20%.

Furthermore, and even more important, in the long run, both soybean and corn prices remained higher than would otherwise have been the case because of the increased demand for exports. The important point of this episode is it shows there is really no evidence that the shock dampens out in the long run. Neither corn nor soybean prices ever fell back to their pre-1973 levels.

Thus the net long-term effect of an increase in ethanol demand often turns out to be that (a) corn acreage will rise, (b) corn prices will rise, (c) soybean acreage will rise, and (d) soybean prices will rise. Hence the results in this paper take a very conservative stance because they assume that soybean and other feed grain prices remain unchanged. If they had risen, the positive impact on farm income would have been even larger.

3. Increase in jobs due to higher farm income

We now turn to the calculation of the increase in employment due to the rise in farm income. In later sections we will estimate the gain in jobs due to higher investment in farm equipment, and the employment gains from operating the ethanol production plants.

The increase in farm income stems from two sources: an increase in corn production, and a higher price for corn.

The increase in corn production will boost gross farm cash receipts by $1.2 billion, as shown in the previous section. Of that $1.2 billion, part will be spent on seed and fertilizer, part will be spent on increased hired labor, with the remainder resulting in an increase in net farm income and GDP. We estimate that slightly more than half of the $1.2 billion, or $0.7 billion, will be reflected in higher GDP. When added to the $3.8 billion rise in farm income due to higher prices, we obtain the figure that the boost in net farm income and GDP will be $4.5 billion before taking any multiplier effects into account. The multipliers used in this study to calculate these impacts are those used by the Department of Commerce in its RIMS II regional multiplier study, and are the standard figures used in economic impact studies.

The average of the multiplier for farm production, weighted by corn-producing states, is 2.33; this figure is discussed later in the regional section of this report. That means, once we take out the “leakages” due to tax payments, retirement of debt, and other elements that do not increase aggregate demand, that a $1 billion rise in gross farm income will boost real GDP by $2.33 billion. This does not take into account the increased investment or the rise in output from ethanol plants, which are considered separately.

Thus the $4.5 billion rise in farm income results in an increase in overall GDP of $10.5 billion. In other words, GDP in 1997 would be $10.5 billion higher than if ethanol demand and production were zero. We stress at this point this is a partial result: we have not yet considered the impact of investment, ethanol production, net exports, changes in the public sector surplus or deficit, or any impact on the price of food and the CPI. The next step is to translate the $10.5 billion figure into a net increase in jobs for the total U.S. economy.

It should be noted at this point that most of the newly created jobs, while they do occur in the farm belt, are nonfarm jobs. After all, even in Iowa, which depends most heavily on the farm industry, fewer than 10% of the total jobs are actually on the farm. However, many of the other jobs are tied directly to the farm sector, including manufacturing and selling seed, fertilizer, machinery purchases, repairs, and so on. In addition, a boost in farm income will result in an increase in non-farm goods and services as disposable income rises.

The standard procedure is to calculate the average value added per job, defined as total GDP divided by total employment, and apply that figure to the $10.5 billion increase in GDP to determine how many additional jobs are created as a result of the rise in farm income.

Total GDP in 1997 will be very close to $8,000 billion, and total employment (household survey) will be about 129 million, which works out to value added of $62,000 per job. Hence $10.5 billion divided by $62,000 would be a net job creation of 169,400 jobs stemming from the $4.5 billion increase in net farm income. We next add the impact of purchases of machinery, and operation of the ethanol plants to this number.

4. Increase in jobs due to greater investment in farm equipment

The multiplier analysis used above is based only on consumption; investment must be treated separately, especially when it is financed with borrowed funds. In this section we are assuming adequate credit and no negative impact on interest rates. But as will be shown later, interest rates probably drop because of the smaller deficit.

The equation we have estimated shows that a $1 billion rise in net farm income will boost purchases of capital equipment by farmers by $0.2 billion. The equation is given in Table 4, with the actual and simulated values given in Figure 6. The key (actual variables in this equation are net farm income in constant prices, the real long-term bond yield (actual bond yield adjusted for inflation), disposable personal income, the availability of consumer credit, and the value of the investment tax credit.

The $4.5 billion rise in net farm income will thus boost machinery purchases by about $0.9 billion above the level that would occur if ethanol demand and production were zero. In 1996, total purchases of farm equipment were approximately $21 billion in current and $19 billion in constant (1992) dollars; we expect them to be about 3% higher in 1997. Total employment in the farm machinery industry, which incorporates SIC 3523 (farm machinery and equipment) but also includes some other industries, is approximately 116,000. Thus an incremental gain of $0.9 billion in constant-dollar machinery purchases would be approximately a 4.7% increase in shipments. That would generate an increase of 5,600 jobs before multiplier impacts.

Most of the manufacturing plants for farm machinery are in Iowa and Illinois, with the rest widely scattered throughout the U.S. While production at any given facility can vary depending on the specific machine ordered, the approximate proportions are that one-half of these jobs are located in Iowa, another one-quarter in Illinois, and the remaining one-quarter in other states. We have used these proportions and applied the appropriate multipliers for machinery production in Iowa and Illinois. With multiplier effects, purchases of additional farm machinery result in an additional 12,500 jobs in the U.S. economy.

The value added per farm machinery worker is estimated at $114,000, so when that is multiplied by 5,600 jobs, total GDP rises an additional $0.6 billion. There are also about 6,900 secondary jobs generated from the multiplier effect, with an average value added of $62,000, which boosts GDP another $0.4 billion. As a result, GDP rises by an incremental $1.0 billion from the increase in machinery.

5. Increase in jobs due to operating ethanol plants

The breakdown of ethanol production by state in 1997 is shown in Figure 7. Using the industry estimate of 3 employees per 1 million gallons, and assuming there will be just over 1.5 billion gallons produced in 1997, that is a total of 4,800 additional jobs at ethanol plants. The multiplier for food manufacturing averages is 2.77, which would generate a total of 13,300 additional jobs. While some additional ethanol plants might be built in 1997, we have not included these figures in our calculations because of the sharply reduced operating rates that were in effect for much of 1996.

In terms of the incremental addition to GDP, we calculate that 13,300 jobs times an average value added of $62,000 yields an additional increase in GDP of approximately $0.8 billion.

6. Total increase in jobs in major corn-growing states in 1997

We now consider the impact of ethanol demand on employment in the 10 major corn-growing states. These figures thus represent the total gain in jobs from higher farm income, higher farm investment, and operation of ethanol plants divided among the major corn-growing states.

Table 5 shows the calculations used to determine the number of jobs stemming directly from higher farm income. The various columns include:

- Percentage of the total corn crop expected in 1997 for each state
- The total corn crop for each of these states
- The value of the corn crop due to ethanol demand
- Average value/added per job for each state
- The number of additional jobs stemming directly from higher farm income
- The multiplier for each state for agricultural production
- The total number of additional jobs, stemming directly and indirectly, from higher farm income due to the demand for ethanol

The percent of the corn crop for each state is based on the average percentage in each state over the past five years. This figure is then multiplied by the estimated value of the total 1997 corn crop of $25 billion. For example, for Iowa, $25 billion multiplied by 0.187 gives a figure of $4.7 billion as the value of the Iowa corn crop.

This figure is then converted to the net value of the corn crop due to the demand for ethanol. The value of the corn crop for each state is multiplied by 0.18 to obtain the net value added due to ethanol. The 0.18 figure is equivalent to $4.5/$25, where $4.5 billion is the net value added to the corn crop because of the demand for ethanol. This figure subtracts out the additional costs of $0.5 billion needed for growing more corn. This figure may seem unusually low but, as noted earlier, most of the gain in farm income stems from higher prices.

The figures for value added/job are taken from various state data found in the Statistical Abstract and other standard sources of government data. The total increase in value added (or GDP) from the demand for ethanol is then divided by the value added per worker, which provides us with the number of new primary jobs that would be created.

Finally, the multiplier for each state for agricultural production is applied to the number of primary jobs in order to determine the total number of additional jobs stemming from the rise in farm income due to the demand for ethanol. The multipliers for each state are taken from Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). The weighted average of these multipliers for the top 10 corn-producing states was 2.33, so this figure was also applied to the remaining states.

Figure 8 shows the total increase in jobs for each state that are due to the rise in farm income; these are the same figures as the right-hand column in Table 5.

Similar, although less detailed, calculations are shown for the number of additional jobs stemming from additional purchases of farm machinery, and the operation of ethanol plants. Table 6 shows the calculations for additional purchases of farm machinery, and Table 7 shows the calculations for the operation of ethanol plants. In all cases, the state multipliers are those calculated in the RIMS II model. Table 8 then summarizes the gains in employment from these three sources.

Figure 9 shows the total increase in jobs for each state stemming from higher farm income, additional purchase of farm machinery, and operation of ethanol plants. Figure 10 then shows these additional jobs as a percentage of total employment in each state for 1997.

7. Decline in Federal budget deficit

The impact on the Federal deficit consists of several offsetting items: the rise in increased tax revenues because of a higher level of GDP, minus the drop in unemployment benefits, minus the subsidy paid to gasoline refiners and blenders. It used to be the case that a drop in corn production would result in an increase in deficiency payments to farmers, but the legislation changed in 1996 and that is no longer the case, so that item is omitted.

The subsidy on gasoline is 5.4¢/gallon on gasoline that is blended with ethanol. Since the blending is ordinarily 10% ethanol, that means the subsidy on ethanol itself is 54¢/gallon. Ethanol production is expected to be 1.52 billion gallons in 1997, of which approximately 1.2 billion gallons will qualify for the subsidy; the remaining ethanol is used for industrial purposes. Hence the total subsidy in 1997 is estimated at $648 million.

The increase in revenues from higher GDP, employment, farm income, and corporate income can be calculated as follows. These figures are based on the total rise in real GDP of $12.3 billion, of which $10.5 billion is from the rise in farm income, 1.0 billion from the purchase of additional machinery, and $0.8 billion from the operation of ethanol plants, for a total of $12.3 billion. This amount is proportioned as follows: personal income, wages and salaries, $6.0 billion; net farm income, $4.5 billion; corporate income excluding farms, $1.8 billion. The relevant budget items for our calculations are the following:

- Personal Income Taxes from wages and salaries
- Personal Income Taxes from unincorporated proprietors (farm) income
- Social Security Taxes (employer and employee contributions)
- Decline in Unemployment Compensation payments
- Corporate Income Taxes, including payments of ethanol subsidies to corporations

Personal Income Taxes, wages and salaries: As noted above, there has been a net job creation of 197,000. Almost all of these jobs are off the farms. For 1997 it is assumed that average personal income will be $30,500. After considering the average deductions and exemptions, we estimate that the average Federal income tax paid on that amount will be $2,700 per person, for a total of $532 million.

Personal Income Taxes, farm income: It is assumed that the rise of $4.5 billion in net farm income is taxed at a 15% tax rate, for a total gain of $675 million.

Social Security Taxes are calculated at 15.3% of $30,500, or $4,666.50 per person times 197,000 jobs, which is $919 million. In addition, $4.5 billion of net farm income is taxed at a 15.3% rate, which is $689 million. Hence total Social Security taxes rise by $1,608 million.

Decline in unemployment compensation payments. Of the 197,000 new jobs, assume _ are covered, which is the national average. The average unemployment compensation payment is $8,500 per year times 66,000 workers is $561 million.

Corporate Income Taxes: Corporate income is estimated to rise $1.8 billion from the demand for ethanol. If it is taxed at a 35% marginal rate, that would raise Federal tax receipts by $630 million. In addition, the $648 million paid in ethanol subsidies is also taxed at a 35% rate, boosting revenues by an additional $216 million.

The summary statistics are given in Table 9.

Table 9

Effect on Net Federal Budget Position from Demand for Ethanol

Type of revenue gain or loss	Millions of $
Personal income taxes, wages and salaries	532
Personal income taxes, farm income	675
Social security taxes	1,608
Decline in unemployment benefits paid	561
Corporate income taxes	846
Subtotal	4,222
Less: Ethanol subsidy	648
Net reduction in Federal government deficit	3,574

Thus even after including the cost of the ethanol subsidy, the net effect of this subsidy is to decrease the Federal budget deficit by almost $3.6 billion in 1997.

8. Increase in state and local tax receipts

The calculations in this section are performed in several steps, which are summarized here. The following calculations are shown in Table 10.

1. The increase in employment, as calculated in Section 6 is multiplied by the average annual wage rate in each state. The product is equal to the total gain in wages and salaries due to ethanol demand in each state.

2. The gain in wages and salaries is then multiplied by the average tax rate on personal income in each state to obtain the increase in income taxes from that source.

3. The gain in farm income is calculated as proportional to the share of the corn harvest in each state.

4. The average tax rate for personal income is also applied to farm income, and the amount of increase in taxes from higher farm income is calculated.

The following calculations are shown in Table 11.

1. The total increase in consumption in each state is calculated as 80% of the increase in wages and salaries, and 60% of the increase in farm income. The same proportions are used for all states.

2. The increase in consumption is multiplied by the average sales tax rate for each state to obtain the increase in sales taxes due to ethanol demand.

3. The rise in corporate income is assumed to be equal to 10% of the increase in wages and salaries, which is the national average.

4. The increase in corporate income is then multiplied by the average corporate income tax rate to obtain the increase in corporate income taxes.

Table 12 shows the summation of these four sources of additional taxes, and compares that figure with total estimated state tax receipts in 1997. The final column shows the percentage of total taxes that is accounted for by the demand for ethanol.

Finally, Table 13 shows the increases in state and local taxes for these four sources of tax revenues, plus the total. For the 10 top corn-growing states, state and local tax revenues are boosted a total of $464.8 million in 1997 by the demand for ethanol. The biggest proportion of those increased revenues is received by Iowa, where receipts rise by $111 billion, or 2.34% of total state tax revenues. The biggest percentage increase accrues to Nebraska, where revenues are 2.56% higher because of the demand for ethanol.

The increase in actual taxes, and the gain as a proportion of total tax receipts, are shown in Figures 11 and 12 for the 10 major corn-growing states.

9. Improvement in foreign trade balance

Approximately _ of the by-products of the ethanol process are exported. The principal categories are listed below. In addition, we have assumed that the 1.52 billion gallons of ethanol produced in 1997 produce a reduction of 1.2 billion gallons of imports of gasoline and oxygenates; the remaining ethanol is assumed to be used for industrial uses and hence does not displace imports of energy. The gasoline and oxygenate imports are valued at $0.92/gallon.

In addition to the rise in exports of corn by-products and the decline in energy imports, we also need to consider the impact of the demand for ethanol on the value of corn exports. 1997 exports of corn are likely to be about 2 billion bushels, and farmers will receive an extra $0.45/bu because of the demand for ethanol, resulting in an increase in exports of $900 million. From this must be subtracted the loss in corn exports due to higher prices. If the entire 180 million bushel decline in corn demand caused by higher prices occurs in the export sector, and the average price of corn in 1997 is $2.75/bu, then exports would be reduced by $495 million. All of these figures are summarized in
Table 14.

10. Other agricultural and macroeconomic effects

So far we have calculated how many new jobs are created by the rise in farm income, increased purchases of farm equipment, and increased production of ethanol. However, there could be some secondary impacts, positive or negative, at the macro level, that would also affect job growth. They are:

1. An increase in corn prices would boost livestock and food prices, thereby reducing the demand for food -- or alternatively, reduce their demand for other goods and services.

2. Net exports would rise, as the by-products of ethanol production are exported, and less gasoline or MTBE is imported.

3. Higher tax receipts to the Federal and state and local governments could reduce interest rates because of decreased borrowing requirements.

Other studies estimating the economic impact of ethanol demand have attempted to determine how soybean and other crop prices would be affected. There are two offsetting forces. First, a rise in the price of corn will cause some users to switch to soybean products, resulting in an increase in soybean prices as well. On the other hand, the price of soybeans might fall because ethanol generates protein-rich feed and corn oil by-products that compete with soybean meal and oil. On balance, we calculate that these two factors offset each other to the extent there is no significant change in soybean product prices in either direction.

Of the $4.5 billion increase in net farm income, approximately $3.2 billion would show up in higher prices of food to consumers; the remaining $1.3 billion reflects exports or industrial use of corn. This $3.2 billion increase might cause consumers to buy less food, or alternatively reduce their expenditures of other goods and services. If they did not cut back on their spending but instead saved less, interest rates might rise, thereby reducing fixed investment. Also, it could be argued that the increase in food prices, by raising the inflation rate, would boost interest rates.

We now assess the economic impact of the demand for ethanol on the consumer price index excluding food. Of the 1.5 billion barrels of ethanol produced, approximately 1.2 billion barrels are used for fuel, resulting in a 1.2 billion decline in imports of MTBE. That is approximately equal to 1% of the imports of crude petroleum and its products. While there are no firm estimates, it is reasonable to assume that a 1% reduction in energy imports reduces the price of energy by 1%.

We now consider how this affects consumer prices. According to DOE projections, expenditures for energy in 1997 are estimated at $591 billion, with the breakdown by major fuel shown in Table 15.

Table 15

1997 Expenditures by Major Type of Fuel

Gasoline	$154 billion
Other petroleum products	$113 billion
Natural gas	$ 90 billion
Coal, directly	$ 33 billion
Coal, used in electric utilities	$123 billion

(Electric utility sales from nuclear and renewable, estimated at $78 billion, are not included in this calculation, as it is assumed they will not be affected by a change in petroleum prices).

These numbers are derived as follows. The projections for each type of fuel in quads is taken from the U.S. Energy Information Administration's Annual Energy Outlook. These figures are then converted to barrels, mbf, and tons, and then converted to market prices for 1997, assuming that benchmark crude oil averages $22.00/bbl.

Of the $154 billion spent on gasoline, Federal, state and local excise taxes account for $54 billion, leaving $100 billion in costs excluding excise taxes. It is furthermore assumed that the amount of excise tax collected is not influenced by a change in price. No other adjustments are made to the expenditure figures.

If the price of gasoline declines by 1%, then gasoline purchases fall by $1 billion. We then need to determine how much will the CPI be affected by changes in other sources of energy if the price of petroleum products falls 1%. For other petroleum products, mainly airline jet fuel and heating oil, it is assumed the price adjustment factor will also be one-to-one. For natural gas, we assume that a 1% change in petroleum prices changes natural gas prices by _%, which are then passed along to consumers. For coal, a 1% change in petroleum prices changes coal prices by _%. This figure is also used for fossil-fuel fired utilities. These percentages are then used to calculate the decline in energy costs to consumers stemming from a 1% drop in petroleum prices.

Gasoline	$1.0 billion
Other petroleum products	1.1 billion
Natural gas	0.6 billion
Coal, directly	0.1 billion
Fossil-fuel utilities	0.4 billion
Total decline in cost to consumers	$3.2 billion

This figure is equal to the $3.2 billion rise in consumer costs due to higher food prices. Hence that increase is completely offset by lower energy prices.

If the rate of inflation does not rise, then on balance one could argue that these results have understated the overall economic impact of the demand for ethanol because they do not take into account (a) the improvement in net exports, or (b) the reduction in the public sector deficit ratio, which would cause interest rates to decline. However, it is likely that these impacts are also small. Thus given the inability of a robust estimate of the supply-price elasticity of oil imports, we have assumed that the macroeconomic effects are not large enough to affect the results found here. However, to the degree that they all move in the direction of boosting real GDP, the beneficial impacts of ethanol demand are understated in this study.

11. Conclusion

This study has shown that the effects of the demand for ethanol on the U.S. economy are unequivocally positive in spite of the subsidy paid to gasoline blenders and refiners. It boosts total employment by almost 200,000, reduces the Federal budget deficit by over $3.5 billion, improves the trade balance by over $2 billion, and adds over $450 million to state tax receipts. In key farm states such as Iowa and Nebraska, the increase in employment and tax receipts caused by the demand for ethanol is approximately 3% of the total figures for those states.

One may legitimately inquire how a subsidy that benefits farmers also manages to benefit the entire economy; if this were the case, one could perhaps argue for larger farm subsidies in general, hence reversing recent trends in Congress. However, there are several unique aspects to the ethanol subsidy. First, the additional corn that is grown is used for motor vehicle fuel; it is not stored, given away, or sold at reduced prices. Second, the by-products of ethanol processing boost exports. Third, and equally important, the increased reliance on domestic sources of motor fuel reduces the dependence of the U.S. economy on foreign energy sources, and in the long run will keep those prices from accelerating. Thus any increase in food prices to the consumer is offset by lower energy prices.

Once it is established that the net result of the ethanol subsidy is to boost real GDP instead of diminishing, the benefits of gains in employment and higher tax receipts to the Federal and state governments follow directly. As a result, we have once again seen that a non-inflationary boost in total production increases the efficacy of the U.S. economy.