Evaluating the Impacts of an Increase in Fuel-ethanol Demand on Agriculture and the Economy

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Abstract

Fuel ethanol demand is projected to increase because of proposed ban on methyl tertiary butyl ether (MTBE) in gasoline, renewable fuels standard, and the revised eight-hour ozone standards. In this paper, several scenarios of increased fuel ethanol demand and its effects on crop and feed prices, farm income and state finances under current tax-subsidy structure, are analyzed using a multi-sector econometric model AGMOD.

Key words: Ethanol, Renewable fuels, Bioenergy, Energy policy,

1. INTRODUCTION

The demand for fuel ethanol made from corn is likely to increase sharply over the next few years due to several developments such as: proposed ban on methyl tertiary butyl ether (MTBE) as a gasoline additive, the proposed renewable fuels standard under the various versions of the energy bill, rising petroleum prices, and the proposed revision of the eight hour ozone air quality standards. The increased demand for fuel ethanol will have significant implications for agriculture through likely increased corn prices, increased supply of byproduct distillers dried grains and solubles (DDGS) and corn gluten feed and meal, and ripple effects on other crops and animal feeds. It will also significantly affect state level finances due to the current ethanol subsidy and tax structure and federal gasoline tax revenue sharing with the Highway Trust Fund. Quantitative analysis of national and regional effects of these is warranted to inform farmers as well as policy makers.

In this paper, we attempt to address the following questions.

1. What are the effects of (a) a ban on MTBE, (b) a renewable fuel mandate, (c) new eight-hour ozone standards, and (d) various combinations of these, on the demand for ethanol nationally?
2. How will the increased production of ethanol affect output and prices of corn, DDGS, corn-gluten meal, soybean meal, other crops, and livestock nationally and locally in Michigan? What will be the impact on retail prices and net farm income in Michigan?
3. What are the implications for finances of the State of Michigan, of a substantial increase in ethanol use, under the current ethanol tax, subsidy and revenue sharing arrangements?

A number of previous studies have analyzed specific aspects of corn-ethanol markets, for example impacts of a MTBE ban (USDA, 1999, Gallagher et al. 2000, USEIA 2000, EPA 1999, Turner et al. 1999). However, most studies except Ferris (1995), exclude Michigan. None analyze the combined impacts of MTBE ban, renewable oxygenate mandate and the new 8 hour ozone standard. The interactions of corn-protein feeds-livestock markets at the regional level haven't been addressed. Similarly, the impacts on state finances have not been analyzed. This research addresses these lacunae and analyzes impacts specifically on Michigan agriculture and economy in addition to national impacts.

First, we estimate the projected national fuel ethanol demands for the period 2003-2010 under the following six scenarios, by drawing on earlier studies by US Department of Agriculture (USDA) and US Energy Information Administration.

1. Fourteen state MTBE ban (current situation and Reference case)
2. Fourteen state MTBE ban and Federal MTBE ban (Case A)
3. Fourteen state MTBE ban and Federal Renewable Fuel Standard (Case B)
4. Federal MTBE ban and Federal Renewable Fuel standard (Case C)

5. Fourteen State MTBE ban + Federal RFS + 8 hour ozone standards (CASE D)
6. Federal MTBE ban + Federal RFS + 8 hour ozone standards (CASE E)

In the reference case, national ethanol production is projected from 2,500 million gallons per year in 2003 to 2,880 million gallons in 2010. In the other five scenarios, the projections in 2010 ranged from 3,250 million gallons to 4,670 million gallons.

Second, we analyze the impacts increased ethanol demand on key agricultural variables both nationally and at the level of the State of Michigan using a multi-sector econometric model AGMOD developed at Michigan State University. The analysis indicates that at the national level, corn prices received by U.S. farmers will increase by 18 percent in 2007 in the high demand scenario (E) of 4670 million gal by 2010, over the reference case (R) and by 7 percent in 2010. Corn acreage increases by 4 percent in E over R by 2010. Similarly, the total area in the U.S. to the major crops increases by about 2 to 3 percent with corn and wheat acreage up by 4% and soybean acreage down by 3%. Also, expanded ethanol production will be positive for crop production in Michigan with somewhat higher output early on with production of corn and soybeans up by 4-5 percent in 2010 in E over R. The annual average net cash income for Michigan farmers for the period 2003-2010 is expected to be $976 million under the reference scenario and $1016 million under the High demand. The average annual net present value of net cash income for the period 2003-2010 is projected to increase from $581 million in the R case to $628 million under the E scenario.

Third, we analyze impacts on Michigan state finances. We assume that all the incremental ethanol is sold as a 10% mixture with gasoline, and Michigan's share of national gasoline consumption remains unchanged. Our estimates indicate that the state gasoline tax revenues will increase (due to lower energy content of ethanol) by $4.8 million in E compared to R. At the same time, transfers into the Highway Trust fund and hence Michigan's share of the Highway Trust fund will decline by up to $51 million in 2010.

The rest of the paper is organized as follows: in the second section we provide a brief background on the regulatory and legislative developments that are leading to an increased demand for fuel ethanol. The third section describes the scenarios being analyzed. The fourth section provides a description of AGMOD and our analysis methods. The penultimate section presents the results of the analyses and the final section presents policy implications and conclusions.

2. BACKGROUND

Alternative transportation fuels, especially bio-based renewable fuels such as ethanol, have been receiving increasing attention as likely solutions to the problems of urban air quality, global warming, and excessive dependence on imported oil. Ethanol fuel policy initiatives so far include Federal and state level tax exemptions and subsidies, and mandated use as a fuel oxygenate in non-attainment areas. Under the Clean Air Act (Amendments) of 1990, gasoline containing oxygenates has been mandated in areas with

severe air quality problems: oxygenated reformulated gasoline (RFG) in non-attainment areas for ground level ozone, and winter-oxygenated fuels in areas with carbon monoxide problems. Ethanol accounts for about 23% of the US oxygenate supply. Ethanol use has also been promoted by state gasoline content mandates (e.g. Minnesota), or indirectly through alternative fuel vehicle mandates for fleets under the Energy Policy Act, 1992. Alternative Motor Fuels Act (AMFA) 1988 provides a credit of 1.2 mpg for alternative fuel vehicles in meeting the Corporate Average Fuel Efficiency (CAFÉ) standards. This has resulted in production of over 1.2 million flexible fuel vehicles (FFV), which can operate with mixtures containing up to 85% ethanol (E85). As a result, annual production of fuel-ethanol in the US has steadily increased from 175 million gallons to 2810 million gallons between the years 1980 and 2003.

The demand for ethanol as a motor fuel additive is likely increase sharply over the next few years due to several recent developments including:

1. MTBE, which currently accounts for 77% of oxygenate use, was detected in drinking water supplies. Since MTBE is water-soluble and does not biodegrade easily, a Blue Ribbon Panel formed by the EPA, studying oxygenates in gasoline recommended phasing out MTBE from gasoline (EPA 1999). California phased out MTBE from RFG in 2002. 13 other states that have passed legislation limiting MTBE include Arizona, Connecticut, Maine, Michigan, Minnesota, Nebraska, New York, and South Dakota. USDA's forecasts indicate that if MTBE were to be replaced completely, ethanol production would have to increase to over 3 billion gallons per year (USDA, 1999). Several bills to federally ban MTBE use in gasoline have been introduced in the Congress. [e.g. H.R. 6, H.R. 837, S. 385]

2. The Conference Committee version of the Energy Bill 2004 [HR 6], which is currently back in committee, proposed a national renewable fuel standard (RFS) with specific targets based on national gasoline consumption along with extension of the current excise tax incentives for ethanol beyond 2006. Similar provisions for extending the ethanol tax incentives beyond 2006 are included the Transportation Bill (H.R. 3119), and other bills in the Congress [H.R. 3550, H.R. 2896]. Such mandates will increase ethanol use sharply. In fact, RFS is expected to increase the consumption of fuel ethanol to 5 billion gallons per year by 2012.

3. Blending ethanol with regular gasoline as an octane enhancer is cost effective at high gas prices. For example, Marathon Oil and Sunoco currently blend 10% ethanol in regular gasoline in many midwestern markets. Since Energy Information Administration's projections indicate rising petroleum prices, ethanol blending in regular gasoline is likely to increase even without a statutory mandate.

4. A final Supreme Court ruling in February 2001, supported USEPA's decision to issue revised national ambient air quality standards for 8-hour ozone concentrations. Many areas including 14 counties in Michigan and over 75 counties in the Midwest are likely to become non-attainment areas for ambient air quality under the new standards. The states have to develop implementation plans to meet the new

standards, which may include increased use of oxygenated fuels and ethanol.

5. The U.S. Department of Agriculture (USDA)'s Commodity Credit Corporation provides incentive payments to stimulate bioenergy production. Under this program, ethanol producers have already committed to expanding ethanol capacity to 3.75 billion gallons per year (RFA 2004). In Michigan, a new ethanol plant with a capacity 50 million gallons began operations in 2003 at Caro, and a couple of other plants are being planned.

Almost all of the projected increase in the ethanol production is from corn. Less capital-intensive dry milling process is likely to account for most of the new capacity. At the current yield level of 2.6 gallons of ethanol per bushel of corn, an increase in ethanol production of 1 to 3 billion gallons would consume 385 to 1153 million bushels of corn. Dry milling also yields about 17 pounds of DDGS per bushel of corn as a byproduct. DDGS can substitute soybean meal as a protein and energy supplement in livestock feed markets. A substantial increase in ethanol production will increase corn prices, which may cause prices of other crops to increase. But increased DDGS supply would tend to depress soybean meal prices. Vegetable oil prices are affected by increased ethanol production by wet mills. Question also arises whether large increases in DDGS can be readily absorbed in the feed markets. The effect on livestock producers is uncertain, since higher corn prices increase feed costs, while lower DDG and soybean meal prices reduce them. The economics of corn ethanol supply depends on the prevailing federal and state subsidies, and changes in prices of gasoline, corn and DDG. Net effect on retail prices of meat, poultry, milk and oils is uncertain.

We analyze the impacts increased ethanol demand on key agricultural variables both at the national level and at the level of Michigan using a multi-sector econometric model AGMOD developed at Michigan State University.

Federal Tax receipts, Highway funds and local Departments of Transportation funds

There has been some debate that increased ethanol sales will reduce the amount available for road construction, and maintenance from the Highway Trust Funds. As a result, many state departments of transportation and consumer groups oppose ethanol promotion. Federal motor fuels tax is 18.4 cents /gallon of gasoline, out of which $0.1544/g goes into the Highway Trust Fund and balance $0.0286/g goes to the Mass transit fund, and $0.01 goes to the Underground storage tank fund. Highway funds are in turn allocated to individual states by a complex formula defined under the Transportation Equity Act for the 21st Century (TEA-21). States are guaranteed 90.5% of state's contribution to the Highway trust fund. The state's share is then allocated to the state department of transportation (say MDOT) and other local bodies. The local share is 31.5% of the states' share under Act 51 of 1951. In the case of ethanol blend fuels, the partial exemptions for alcohol fuels and additional transfers to the general fund under the tax sharing formula reduce the excise tax revenues that are allocated to the Highway trust fund. Table 2 shows the distribution of motor fuel tax receipts [1]. As can be seen, the

[1] Source [26 USC 9503(b)(4)(E) & (b)(5)].

reduction in Highway funds when a gallon of gasohol (E10) is sold is $0.084 even though the difference in excise tax rates is only $0.053.

However, these tax rates are on the basis volume, and pure ethanol contains 2/3 energy of the same volume of gasoline. As a result, the volume of fuel purchases for equivalent travel increases with ethanol blends, which compensates for some of the tax revenue lost. Table 3 shows the net effect on tax receipts. It can be seen that ethanol sold as E85 has much lower tax exemption rate (6.41c/g) compared ethanol sold as E10 (54c/g). Federal tax revenue loss is only $0.0014/gasoline equivalent gallon for E85. Assuming marginally lower thermal efficiency of flex fuel vehicles, it is revenue neutral or even marginally tax revenue enhancing. Hence, the effect on Highway trust funds with E85 is purely the effect of the distribution formula since tax exemption is revenue neutral.

Table 2: Distribution of motor fuel excise tax receipts

Fuel	Excise tax rate c/gal	Transfer to Highway Trust fund	Transfer to Mass Transit fund	Transfer to UST fund	Transfer to General fund
Gasoline	18.4	15.44	2.86	1.0	-
E10	13.1	7.4	2.86	1.0	3.1
E85	12.95	6.49	2.86	0.5	3.1

Table 3: Net effects on motor fuel tax receipts

Fuel	Fed. Motor Fuels Tax rate c/g	Exemption /gal of fuel	Exemption rate per gal of ethanol in the blend	Energy content lhv btu/g (Ratio)	Tax revenue for Gas equi. c/gas eq	Tax revenue loss % for equivalent Travel
Gasoline	18.4	0	-	115,500	18.4	0
E10	13.0	5.4	54	111,550	13.46	26.84%
E85	12.95	5.45	6.41	81,925	18.26	0.76%
E100	12.95	5.45	5.45	76,000	19.68	-6.96%

Impact on State and local motor vehicle fuel tax revenues.

The state tax rates on motor fuels vary significantly from 4 to 39 cents/gallon. Five states (Connecticut, Florida, Idaho, Iowa, and South Dakota) have lower state tax rates for gasohol, but the exemptions range from 0.5 cents a gallon to a maximum of 2.5 cents per

gallon (Idaho). Similar to most other states, Michigan does not have any tax incentives for ethanol. Ethanol blends are included in the definition of gasoline and taxed at the same rate of 19-cents/ gallon. Based on energy content, ethanol use is effectively taxed at higher rates 19.67 cents per gal gasoline equivalent for E10 and 26.79 cents for E85. This will increase state motor fuel tax revenues by 3.5% for E10, and 41% for E85 for equivalent travel[2]. As a general case, if the state fuel excise tax rate is *x* cents /gallon, replacing it with ethanol will increase gallon sales and excise tax receipts to 1.52*x*. So long as the excise tax rate for the ethanol content is more than 2/3 the rate of gasoline, the state excise tax revenues will increase. Similarly, many states levy additional local taxes on motor fuels on a volume basis, which will increase tax revenues with increased sales volumes of alcohol blends. In conclusion, under the current tax structure, both Federal and State government revenues will likely increase with E85 sales. The Federal tax receipts will decline by 26% with E10 sales for equivalent travel. However, the impact on the Highway Trust Fund is more adverse because of the additional transfers to the General fund. The TEA-21 provisions need to be amended to increase the share of Highway Trust funds in ethanol blend tax receipts[3].

We estimate the net impacts these effects of increased ethanol sales on the revenues of the State of Michigan.

3. ETHANOL DEMAND SCENARIOS

We estimate the projected national fuel ethanol demands for the period 2003-2010 under the following scenarios, by drawing on earlier studies by USDA, and US Energy Information Administration (EIA), specifically, reports prepared in response to enquiries by the Congress about impacts of proposed legislation. (USDA 1999, USEIA 2002a, USEIA 2002b, USEIA 2002c)

1. Fourteen state MTBE ban (current situation and Reference case)
2. Fourteen state MTBE ban and Federal MTBE ban (Case A)
3. Fourteen state MTBE ban and Federal Renewable Fuel Standard (Case B)
4. Federal MTBE ban and Federal Renewable Fuel standard (Case C)
5. Fourteen State MTBE ban + Federal RFS + 8 hour ozone standards (CASE D)
6. Federal MTBE ban + Federal RFS + 8 hour ozone standards (CASE E)

The projections are summarized in Figure 1. We chose the fourteen state MTBE ban as the reference case because the ethanol and corn markets appear to have already incorporated this information as evidenced by the very rapid increase in ethanol output and capacity over the last couple of years. As discussed earlier in section 2, the other scenarios are likely outcomes of legislation under consideration.

[2] However, direct supplies from terminal to State, Fed, local governments, non-profit schools, colleges, and universities for student transportation are exempt from this tax.

[3] Transportation Bill (H.R.3119) currently under consideration in the Congress has provisions called VEETC, (volumetric ethanol excise tax credit) would change how the ethanol tax credit is used and reduce the burden on the Highway Trust Funds.

Banning MTBE through out the nation has been proposed under several bills in Congress (S. 1766, H.R. 6, H.R. 837, S. 385). For example S.1766 proposes complete phasing out MTBE use in four years as well as a renewable fuel standard. USEIA in response to a request from Senator Murkowski, analyzed the impacts of various provisions of S. 1766 on the US transportation fuels market (USEIA 2002a). Similarly, USEIA analyzed the impacts RFS and MTBE provisions of S. 517 at the request of Senators Daschle and Murkowski (USEIA 2002b).

In June 2002, Senator Jeff Bingaman, Chairman of the Senate Committee on Energy and Natural Resources, requested that the Energy Information Administration (EIA) provide an analysis of eight factors related to the Senate-passed fuels provisions of H.R. 4, the Energy Policy Act of 2002. In response, EIA prepared a series of analyses discussing the market impacts of each of these factors, one of which addressed the specific impacts of the proposed revision of the 8-hour ozone standards (USEIA 2002c). This new standard would change the ambient air standard for ozone from 0.12 parts per million (ppm) averaged over a 1-hour period to a new 0.08 ppm standard averaged over 8 hours. EPA identified approximately 329 counties that would fail to meet the new 8-hour standards according to1999-2000 data. Based on EPA projections for 2007, the number of counties failing the 8-hour NAAQS is expected to be cut in half as a result of low-sulfur gasoline requirements for light-duty highway vehicles (referred to as ``Tier 2'' standards) that become effective in 2004, and as a result of ozone control programs already in place such as those affecting power plants. Although the final rule on the implementation of these standards has not yet been promulgated, designation of the 8-hour nonattainment areas is expected to occur in 2004, States need to begin providing State Implementation Plans for attainment in 2006, and some States must meet the limit in 2007. EIA concluded that it is unlikely that the 8-hour ozone rule will lead to much of an increase in RFG consumption because RFG was a more expensive option for most states. However, at the request of Committee staff, an “upper bound” case was developed for increased RFG consumption as a result of the transition from the 1-hour to the 8-hour ozone rule. We base our ethanol demand projections for case D and E based these upper bound projections as our upper bound projections of ethanol demand.

However, it is easy to see from Figure 1 that, when they occur concurrently, the MTBE ban and 8 hour ozone rule effects will be dominated by the RFS effect, beginning from 2011. Hence scenarios B, C, D and E differ mainly in the intermediate period of 2005-2010.

We treat these ethanol demand projections as exogenous increases in demand corn for conversion to fuel use, and incorporate into the multi sector econometric model of US agriculture.

4. ANALYSIS METHOD

A Brief description of AGMOD

Since, increased ethanol production affects many agricultural sectors we use a multi-

sector econometric modeling approach. For this purpose, AGMOD, an econometric model of U.S. agriculture developed at Michigan State University beginning in 1986, was modified to include an ethanol sector (Ferris 1989, Ferris 1991). AGMOD is an econometric/simulation model of U.S. agriculture with an international component. Based on annual data since 1960, the model is designed to generate year-by-year agricultural commodity production and price forecasts 10 years into the future. The model covers major commodities in the livestock, dairy, poultry and field crop sectors. The commodities with international linkages include coarse grain, wheat and oilseeds. Also, the high protein feed industry is analyzed.

The model can be described as mainly recursive in that the supply equations incorporate distributed lag forms. The key variables in the supply sector are gross margins over variable costs. In the crop sector, the expected gross margins over variable costs per acre include returns from government programs as well as returns from the market. The resulting production levels then are the major determinants of prices in combination with the usual demand factors of consumer income per capita, availability of substitute products, and trends in tastes and preferences. The prices so determined are major influences on subsequent production.

The model uses micro-TSP software and the current version has over 400 equations and 700 variables. About 100 statistically derived equations are updated every year. The core AGMOD model supports additional satellite models for forecasting effects on Michigan agriculture, farm income and retail prices. The output of the model has been extensively used for examining the impact of alternative farm policies as they affect individual enterprises, total farm income, government cost and consumer prices. (Ferris 1989, Ferris 1990, Ferris 1998, Ferris 2000)

AGMOD was employed to estimate the impact of alternative levels of ethanol production on major farm and agri-business variables for the period of 2003 to 2010. The outputs of these solutions to AGMOD, which are national projections, were then transferred to an econometric model of Michigan agriculture called MIAGMOD. MIAGMOD focuses on the major enterprises in the state in terms of production, prices, costs of production and profit margins. The output from MIAGMOD, in turn, was transferred to another model, which is designed to aggregate data into total cash receipts from marketing, government payments, and other sources; into total cash expenditures; and then to net cash income. This econometric model, called MIINMOD, is also designed to generate financial statements for Michigan agriculture in the aggregate.

5. RESULTS

In the reference case, ethanol production was projected from 2,500 million gallons per year in 2003 to 2,880 million gallons in 2010. In the other five scenarios, the projections to 2010 ranged from 3,250 million gallons to 4,300 million gallons to 4,670 million gallons. While the conclusions vary somewhat on the direction and timing of differences between the reference case and the alternative higher production levels of ethanol, the major conclusions can be described by comparing the impacts of the high (4,670 million

gallons) case with the reference case. For expository purposes, the high scenario will be labeled "E" and the reference scenario "R".

We assume in this analysis that all the increased ethanol production will have corn as a feedstock. By 2010, production of ethanol under E will be 62 percent above ethanol production under R. In terms of the relative importance in corn production, corn used in ethanol production would increase from 9.0 percent of corn production in 2003 to 9.5 percent in 2010 under R and to 14.8 percent under E.

Crucial in this analysis is what proportion of the increased ethanol production will be by the wet mill process relative to the dry mill process. We repeatedly sought the judgment of authorities in the ethanol industry about the past distribution since no official data are available. However, the answers have been vague. By indirect methods, the following estimates were made of the present allocation and assumptions were as follows about the future. For the year 2003, the estimate is that wet milling provided 60 percent of ethanol production and will decline to 56 percent by the year 2010. By-products of wet milling of ethanol are corn gluten feeds with a protein content of about 21 percent and corn gluten meals with a protein content of about 60 percent. Most of the feed and meal output is corn gluten feed. Another by-product is corn oil. Wet millers also have the option of shifting between production of ethanol and the production of high fructose corn syrup, which is a direct competitor to sugar.

The major by-product of the dry mill process is distillers dry grain and solubles (DDGS). This feed has a protein content of about 30 percent protein. In dry milling, distillers dry grain and solubles is produced in both ethanol and beverage production. While nearly all of the feed production from the dry milling process is fed to the domestic livestock industry, a high proportion of the production of the corn gluten feeds and meal has been exported, mostly to the European Union. In the decade of the 1990s, 80 percent of the production of these feeds was exported. The pricing structure of the EU, which favored the importation of high protein feeds, was the basis for the attractive export market for the U.S. Because of the concern about GMOs, the EU has discriminated against the importation of these feeds. In the analysis, projections of exports of corn gluten feeds and meal were based on production of these feeds, production of coarse grain in the EU (which needs high protein feeds as a supplement) and an assumed detraction in the amount of 3 million MT because of the GMO problem. For the period of 2003 to 2010, the exports of corn gluten feed and meal amounted to an annual average of 4.3 million MT under R and 5.5 million MT under E, 35 and 40 percent of the production of corn gluten feeds respectively.

Impact at the National Level

As would be expected, the utilization of corn as a part of the coarse grain complex (containing also sorghum, barley, and oats in a very minor role) increased significantly between 2003 and 2010 in R compared with E. This increased corn prices received by U.S. farmers by 18 percent in 2007 in E over the R case and by 7 percent in 2010 [See Figure 2]. As would be expected in dynamic models such as AGMOD, farmers respond

to higher prices and eventually the price advantage declined. Corn acreage increased by 4 percent in H over R by 2010 [Figure 3]. Because of the increased availability of high protein feeds from ethanol production, the utilization of soybean meal for feed was 3.6 percent lower in 2010 under E than under R. However, the higher prices on corn offset the increased availability of high protein feeds, and soybean meal prices were actually higher under E than under R until 2010[Figure 4]. Also, prices on corn gluten feed and distillers dried grain and solubles with their higher energy content were higher based on the corn market [Figure 5]. The prices on corn gluten meal were lower under E by 2009 and 2010 but prices of both corn gluten feed and meal depended on the assumption about exports. If exports of these feeds were much higher than forecast, prices on both would be above R under the E scenario.

The total impact of E versus R was to increase total area in the U.S. to the major crops by about 2 to 3 percent with corn and wheat acreage up and soybean acreage down, corn acreage up by 4 percent and soybean acreage down by 3 percent in E relative to R. [Figure 3, and Figure 6] Wheat acreage is enhanced by the higher prices prompted by the fact that higher corn to wheat price ratios encouraged more feeding of wheat.

The net effect of higher feed prices reduced livestock production, which, in turn, generated higher livestock prices under E. Because of increased production of corn oil in wet milling, vegetable oil prices including soybean oil was lower under E relative to R, with soybean oil prices two percent lower in 2007 and five percent lower in 2010. However, the combination of higher livestock and wheat prices more than offset lower vegetable oil prices pushing up retail food prices in the E scenario but by nominal degrees.

In the past, the impacts of such policy decisions relative to enhancement of ethanol production would have had less noticeable effects on market prices because of comfortable U.S. and world carryover levels of grain stocks. In the decade of the 1990s, the world ending stocks of coarse grain (corn, sorghum, barley and oats) and wheat averaged 26 percent of utilization. For the period of 2003 to 2010, the projected percent of ending stocks of these grains averaged 16 percent under both R and E forecasts. It should be emphasized that the price impacts of increased ethanol production in the U.S. will be *much less* should the projections of world grain stocks be *underestimated*.

Since summer of 2003, when these projections were completed, world production estimates of grains and oilseeds have been lowered to slightly below the first forecasts of the World Agricultural Outlook Board of U.S. Department of Agriculture. In comparing their report of May 12, 2004 with their reports in June and July 2003, world production of coarse grain and wheat was down 1.2 percent and production of oilseeds was down 4.6 percent. This reduced the ending stock-use ratio from 17.1 percent to 16.4 percent on grains and from 15.2 percent to 12.5 percent on oilseeds. Even with these modest changes due to weather abnormalities, estimates of U.S. farm prices were revised substantially upward- by nearly 30 percent on soybeans, 20 percent on corn and 5 percent on wheat. This reflects the sensitivity of prices to relatively low stock levels and the demand inelasticity for food and feedstuffs. These events, of course, materially modify the

patterns shown in the figures, but not necessarily the basic conclusions relative to alternative scenarios on ethanol production.

Implications to Michigan Agricultural Enterprises

Under E, higher prices on corn, soybeans and wheat generate total acreages of major crops in Michigan of one percent above the R scenario by 2010. Gross margins over variable costs were significantly higher on corn; also somewhat higher on soybeans and wheat until late in the 2003 to 2010 period. The higher feed prices generated by the expanded production of ethanol tended to reduced gross margins over variable costs on milk production, beef cows, and cattle feeding even though the market prices on the sales from these enterprises were higher. Higher feed prices also reduced prices on feeder cattle but not enough to increase feeding margins. Gross margins in hog production were also reduced under E versus R but the short biological cycle in hogs resulted in higher margins toward the end of 2003 to 2010 as swine operators cut back farrowings, both nationally and in Michigan.

Expanded ethanol production will be positive for crop production in Michigan with somewhat higher output early on with production of corn and soybeans up by 4-5 percent in 2010 in E over R [Figure 7]. Wheat production could be as much as 10 percent higher in 2010. On the other hand, livestock production would be slightly lower in 2010 comparing E to R, but not more than one or two percent.

Implications to Michigan Agriculture Financial Situation

Because of the diversity of Michigan's agriculture, summarizing the impact of expanded ethanol production is difficult. Also, an enterprise-by-enterprise tabulation serves to illustrate the broad impact of a policy decision on this multi-dimensional sector, with the important fruit, vegetable and ornamental sections excluded. Also, since the impacts are not linear over time because of farmer's reactions to changing profit levels, the following Table 4 displays the percentage differences from R to E for a selected year 2007 and the end point 2010.

The effect of the different scenarios on net cash income on Michigan farms is illustrated in Figure 8. Note that the major impact is not registered until 2007 under the different scenarios. This is because of the biological lag in agricultural production responding to a change in profit levels.

A more refined procedure to evaluate the impact of the alternative scenarios on net cash income is to calculate the net present value in terms of the base year 2003. For the entire period of 2003 to 2010, the annual average net cash income for Michigan farmers was $976 million under the R scenario and $1016 million under the E alternative, 4.1 percent higher. Calculating the net present value using projected interest rates for short term and intermediate term loans, the net present value of net cash income for the R alternative was $581 million and $625 million for the E assumption an 8 percent increase.

Note that the expanded production of ethanol would have a small positive effect on farmland prices in Michigan. While small, such an impact is of major proportions because of the total value of farmland in the state and the importance in farmers' equity.

Table 4
Relative % differences between scenarios R and E
for financial indicators of the Michigan Farm Sector

	% Difference 2007	% Difference 2010
Cash receipts		
Corn	15	13
Soybeans	4	3
Wheat	14	10
All crops	3	4
Cattle	1	3
Hogs	2	10
Eggs	4	6
Turkeys	1	2
All livestock	1	3
Government payments	-12	3
Gross cash income	2	3
Cash expenses	1	2
Feed expenses	2	2
Net cash income	7	8
NPV in 2003 of net cash income	7	8
Price of farm land	NC	1

Implications for Michigan State revenues

We analyze impacts on Michigan State finances under the prevailing tax and revenue sharing arrangements outlined in section 2. We assume that all the incremental ethanol is sold as a 10% mixture with gasoline, and Michigan's share of national gasoline consumption remains unchanged. We assume that increase in ethanol consumption in Michigan under various scenarios is proportional to increase in national ethanol demand. We include the effects increased tax revenues because of increased volumetric sales of gasoline blends due to lower energy content of ethanol as well as the effects of reduced transfers to the Highway Trust Fund. Our estimates indicate that the state gasoline tax revenues will increase (due to lower energy content of ethanol) by $4.8 million in E compared to R. At the same time, transfers into the Highway Trust fund and hence Michigan's share of the Highway Trust fund will decline at the rate of about $0.751/gallon of ethanol sold in the state, i.e. by up to $51 million in 2010.

6. DISCUSSION AND CONCLUSIONS

Corn ethanol demand is likely to increase rapidly due to several proposed changes in energy policy (through various versions of the energy bill) and environmental policy. This will have significant ripple effects on US agriculture as well as state finances. Agricultural commodity prices will increase more sharply in the short run followed by more moderate increases due to expanded acreage under grain production. Increased use of ethanol fuel is likely to be beneficial to farmers, improve urban air quality and contribute to energy security by marginally reducing the dependence on imported oil. However, the net welfare benefits under the current tax incentive structure are uncertain and are not analyzed in this research.

The current tax structure treats ethanol used in different gasoline blends differently. As a result the current tax structure is very unfavorable to higher blends of ethanol. Paradoxically, the number of FFVs capable of using E85 and gas stations supplying E85 is growing as a result of alternative fuelled vehicle incentives under EPACT, but vehicle owners have little incentive to use E85 in these vehicles. For example, the number of FFVs capable of using up to 85% ethanol in 1999 was 726,000, however only 46,000 of them were being used as AFVs[4]. Similarly, the unequal treatment of gasoline and ethanol in determining the share of motor fuel taxes transferred to the Highway Trust funds creates adverse incentives by reducing state and transportation department revenues. If the national goal is promote alternative fuels, such contradictions amongst various policies need to be resolved.

[4] http://www.eia.doe.gov/cneaf/alternate/page/datatables/table1.html

7. REFERENCES

1. Environmental Protection Agency (EPA) *Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline*, EPA-420-R-99-021, Washington, DC, September 15, 1999.
2. Ferris J.N., *A description of "AGMOD,"- An econometric model of U.S. and World agriculture*, Staff paper #89-19. Department of Agricultural Economics, Michigan State University, East Lansing, 1989.
3. Ferris J.N., *Possible impacts of Clean Air Act on U.S. Agriculture*, Staff paper #90-59. Department of Agricultural Economics, Michigan State University, East Lansing, 1990.
4. Ferris J.N., *Understanding "AGMOD,"- An econometric model of U.S. and World agriculture*, Staff paper #91-5. Department of Agricultural Economics, Michigan State University, East Lansing, 1991
5. Ferris J.N., *Evaluation of the economic impact of a dry mill ethanol plant in Michigan using corn as a feedstock*, Staff paper #95-60. Department of Agricultural Economics, Michigan State University, East Lansing, 1995
6. Ferris J.N., *Market outlook and economics of producing and marketing Michigan Wheat*, Staff paper #98-8. Department of Agricultural Economics, Michigan State University, East Lansing, 1998.
7. Ferris J.N. *An analysis of the importance of agriculture and food sector to the Michigan economy*, Staff paper 00-11, MSU, 2000.
8. Gallagher, P.W., Otto, D.M. and Dikeman M., "Effects of an oxygen requirement for fuels in Midwest ethanol markets and local economies," *Review of Agricultural Economics*, v22, n2, pp 292-311, 2000.
9. RFA (Renewable Fuels Association) 2004. http://www.ethanolrfa.org/eth_prod_fac.html (accessed 5/5/2004)
10. Turner Mason& Company, *Costs of Potential Ban of MTBE in gasoline*, 1999. http://www.epa.gov/oms/consumer/fuels/oxypanel/mtbe-ban.pdf
11. US Department of Agriculture, *Economic Analysis of Replacing MTBE with Ethanol in the United States*, available at http://www.ethanolrfa.org/usda.html. 1999.
12. US Energy Information Administration (USEIA), *MTBE, Oxygenates and Motor Gasoline*, March 6, 2000, http://www.eia.doe.gov/ emeu/steo/pub/special/ mtbe.html#Revisions
13. US Energy Information Administration (USEIA)(2002a), Impact of Renewable Fuels Standard/MTBE Provisions of S. 1766, available at http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2002)06.pdf
14. US Energy Information Administration (USEIA)(2002b), Impact of Renewable Fuels Standard/MTBE Provisions of S. 517 Requested by Senators Daschle and Murkowski, available at http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2002)07.pdf
15. US Energy Information Administration (USEIA)(2002c), Reformulated Gasoline Use Under the 8-Hour Ozone Rule available at http://tonto.eia.doe.gov/FTPROOT/service/question6.pdf

Figure 1 : Estimated Demand for Ethanol (million gallons)

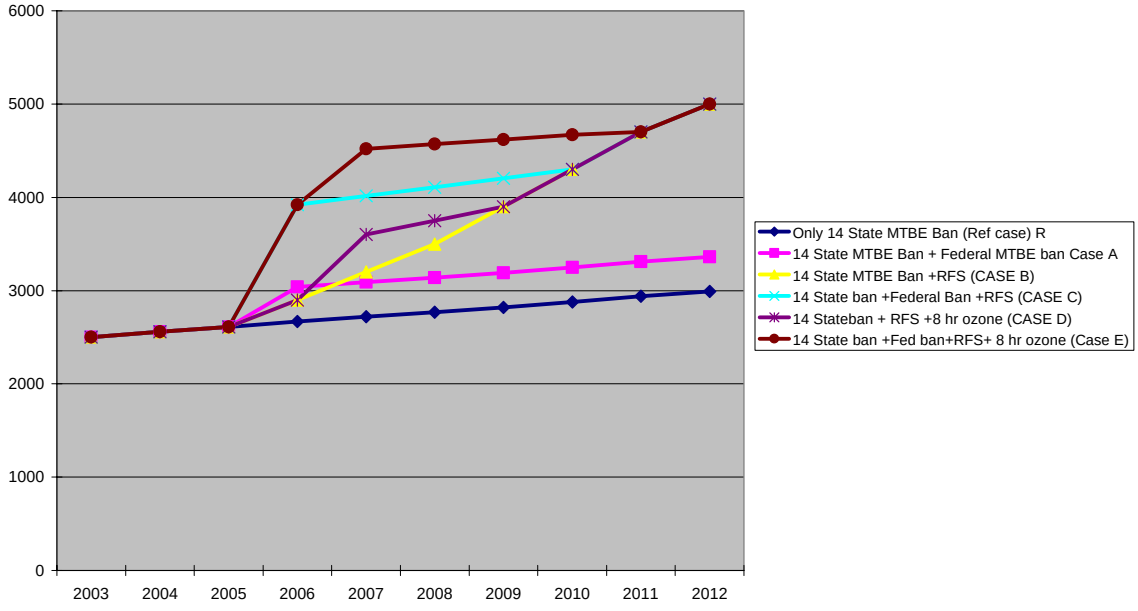

Figure 2: Corn Prices ($/bushel)

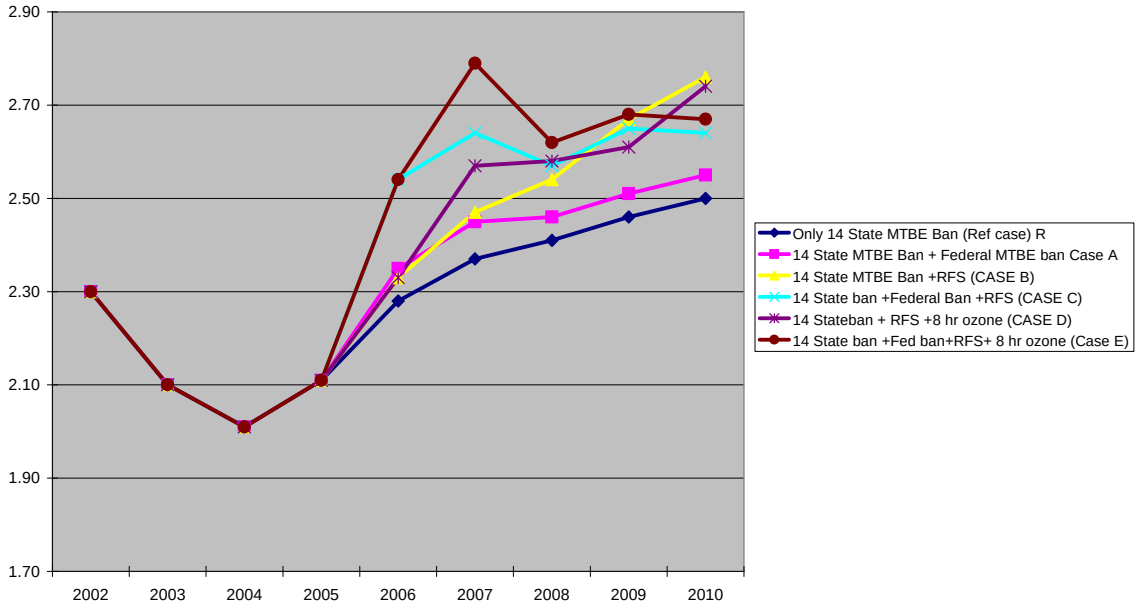

Figure 3: Harvested Acres of Corn,million acres (AHCNF)

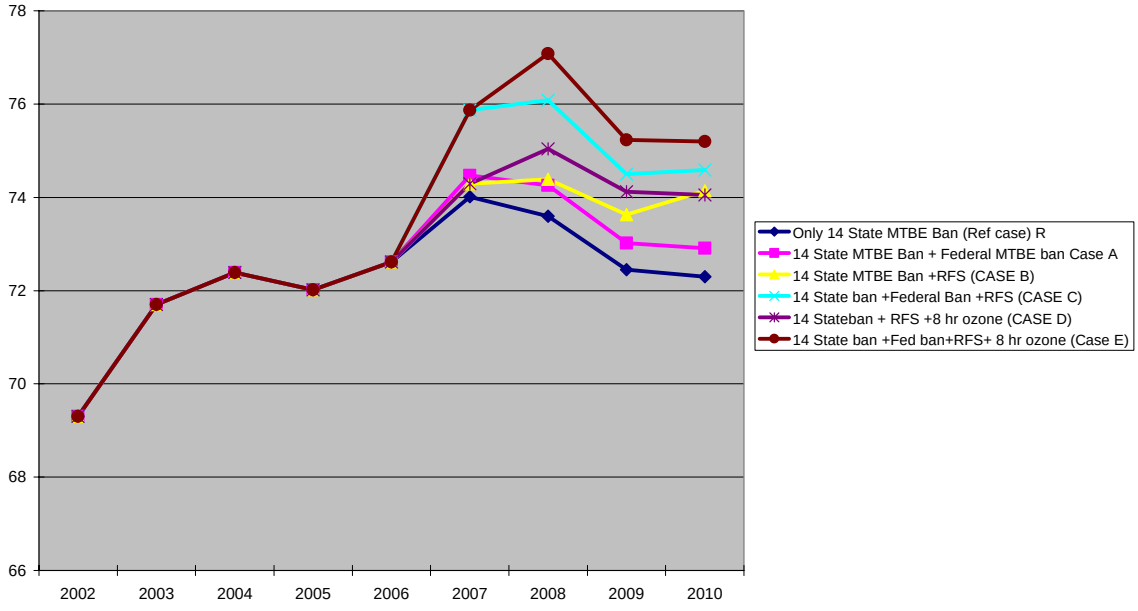

Figure 4: Price of Soymeal,$/ton (PSMF)

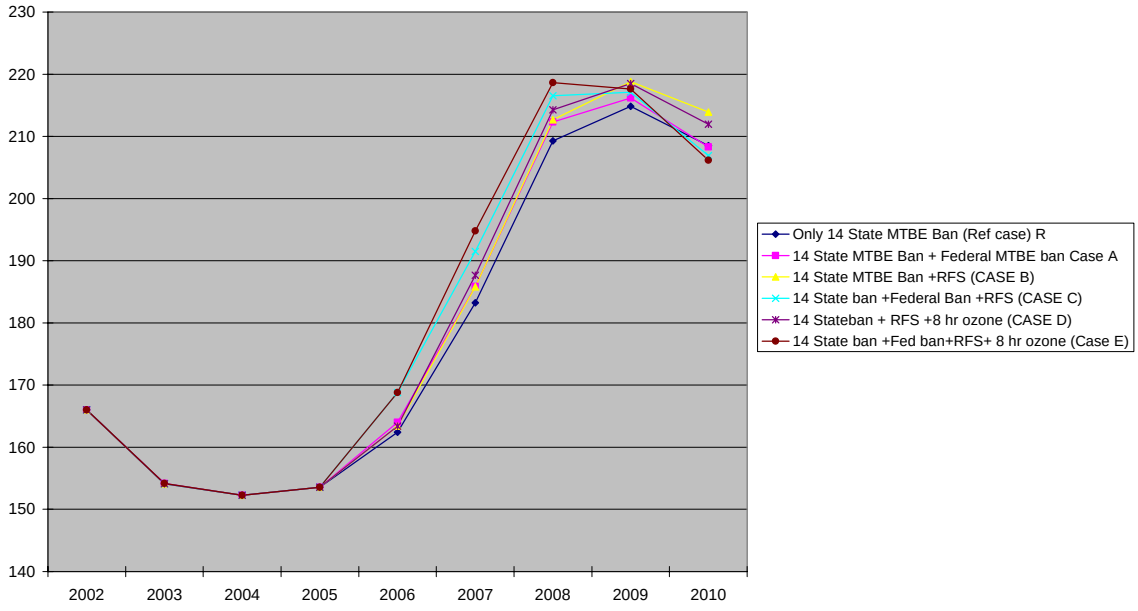

Figure 5: Price of Distillers Dried Grains and Solubles, $/shT (PDDGSF)

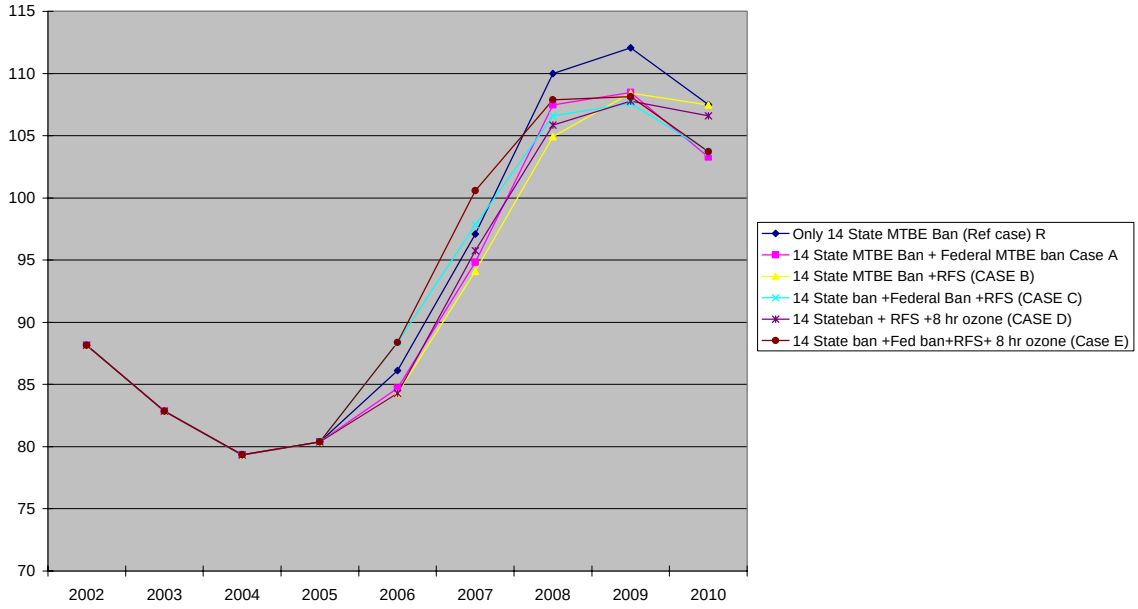

Figure 6: Total Area Harvested for Coarse Grain,Wheat and Soybeans plus Set-aside Acres,mil acres (TACGSWAF)

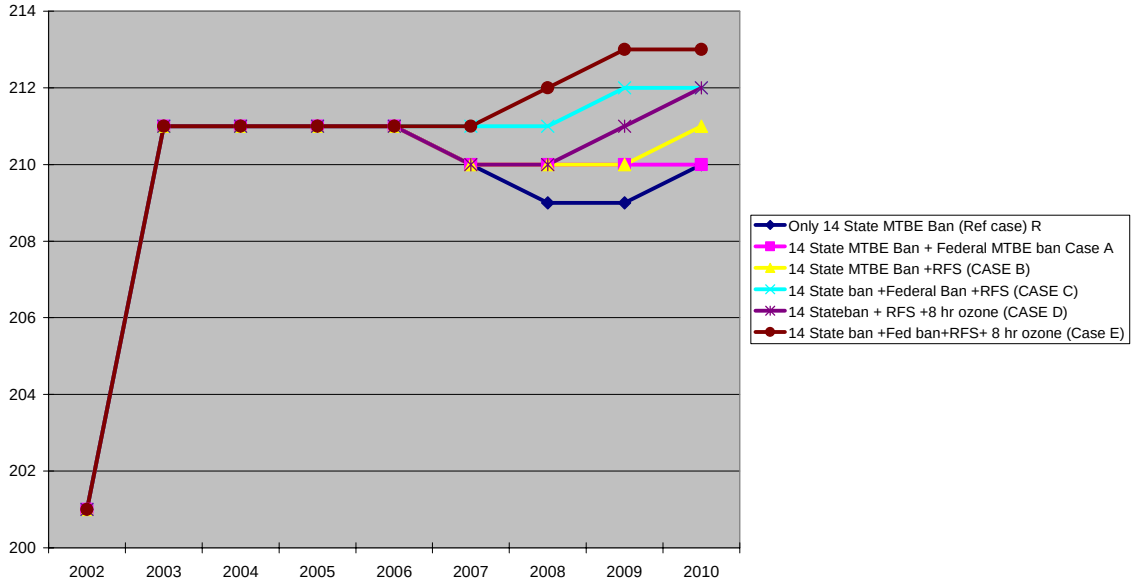

Figure 7 : Area Harvested for Corn for Grain, MI,1000 acres (AHCNMF)

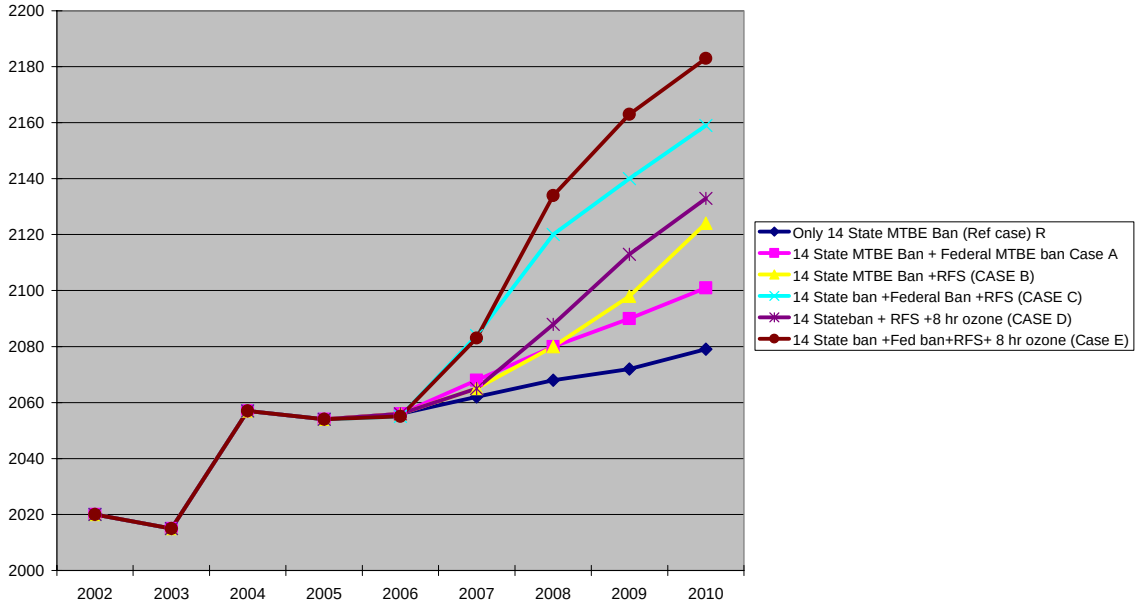

Figure 8: Net Cash Farm Income in MI,mil $ (INNRTM)