Federal Ethanol Policies and Chain Restaurant Food Costs

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pwc

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Executive Summary

The federal government has implemented various policies to encourage the use of ethanol from domestic producers as an alternative fuel. First, between 1978 and 2011, petroleum refiners and gasoline wholesalers could claim the Volumetric Ethanol Excise Tax Credit ("VEETC") and its predecessor against federal excise taxes providing a cost advantage for the utilization of ethanol. Second, between 1980 and 2011, the federal government imposed a tariff on imported ethanol of 54 cents per gallon. Third, energy legislation enacted in 2005 and modified in 2007 implemented the Renewable Fuel Standard ("RFS"), which mandates minimum levels of biofuels that must be blended with gasoline through 2022.

Use of corn-based ethanol as a blending agent for gasoline has increased significantly since the enactment of these provisions. As recently as 2004, the U.S. Energy Information Administration was projecting that total corn ethanol used for gasoline would only reach 3.5 billion gallons by 2012. The most recent projections show ethanol use reaching 14.5 billion gallons in 2012, an increase of 300 percent.[1]

In addition to the RFS, VEETC, and the additional import duty, other government policies such as federal oxygenation requirements and state government mandates have encouraged new ethanol refining capacity and blending over the past decade. These policies and rising oil prices have combined to drive up the use of ethanol.

Policies encouraging the use of ethanol not only impact the corn market, but have unintended consequences for other parts of the economy. Corn is an input into the production of a wide variety of food products, from baked goods to meat production. Moreover, by increasing the demand for ethanol, these policies can increase the price of other agricultural and food commodities that are substitutes for corn production or consumption:

- An increase in the price of corn causes farmers to shift production away from other crops to corn. These shifts help ease the increase in corn prices but put pressure on the price of other crops.
- An increase in the price of corn causes businesses that use agricultural commodities to substitute other crops for corn. Again, the price increase of corn is lessened, but other crop prices rise.

The National Council of Chain Restaurants engaged PwC to estimate the impact of the RFS mandate on the input costs of chain restaurants.

To conduct this study, we reviewed existing private sector, academic, and government studies on the impacts of the RFS mandate on ethanol production and the price of corn and other agricultural commodities. We then combined these estimates with survey information on commodity purchases by chain restaurants to estimate the overall impact of the RFS mandate on chain restaurant input costs.

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[1] Energy Information Administration, *Annual Energy Outlook 2004* and *2012*.

Researchers have used a variety of approaches to estimate the impact of federal ethanol policies, including large-scale models that evaluate the impact of changes across the entire agricultural sector and more focused models that isolate the impacts on particular segments of the market. Although results differ, the following results emerge regardless of the approach:

- **Gasoline prices:** The price of gasoline helps to determine demand for ethanol independent of government policies. Higher gasoline prices make ethanol a relatively less costly form of energy for use in gasoline and diminish the impacts of the RFS mandate.
- **Corn yields:** Low corn yields raise the price of ethanol and make it less attractive. Under these conditions, RFS mandates are more likely to boost ethanol production relative to market-determined levels.

In addition, the RFS mandate has provided an incentive to boost ethanol production by creating a market in the future. Investors developed new ethanol refining capacity based in part on this demand. The VEETC and additional import duty reinforced this incentive by lowering the effective price of ethanol and limiting foreign competition.

Our review of existing research finds that while the VEETC and additional duty provided incentives that reinforced industry development, the RFS mandates have been the key policy encouraging increased ethanol production over the past decade.

We estimate the impact of the 2015 RFS mandates at 2011 levels of food purchases under two scenarios, based on the range of results in the literature.

Scenario I: Based on separate studies by Bento, Klotz, and Landry (2011) and Elam (2008), the RFS mandate is estimated to increase ethanol production by 6 billion gallons. We estimate that this would increase corn prices by 27 percent.

Scenario II: Based on a study by Babcock, Carr, and Carriquiry (2010), the RFS mandate is estimated to increase ethanol production by 1 billion gallons. We estimate this would raise corn prices by 4 percent.

We also conducted a survey of chain restaurants and estimated the dollar amount of their purchases of major food commodities. In 2011, we estimate quick service chain restaurants and full service chain restaurants spent $24.7 billion and $7.7 billion, respectively, on major food commodities.

Based on chain restaurant purchases in 2011, the 2015 RFS mandate is estimated to increase total costs for chain restaurants by $3.2 billion under the first scenario and $503 million under the second scenario. For quick service restaurants, total costs increase by $2.5 billion and $393 million, respectively. Full

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The 2012 Drought

The current drought is devastating the corn crop and will impose volatility in the ethanol market. While gasoline blenders and wholesalers are able to use past credits to meet RFS mandates, the current episode demonstrates a risk associated with fixed mandates. A mandate that requires certain quantities of ethanol to be utilized overrides the price signal that markets use to allocate resources. Corn is effectively required to be used in ethanol production even if the market places a higher value on its use as a food commodity. If another unseasonable weather pattern emerges in the next several years, it is unlikely that a sufficient pool of credits would exist to allow blenders and wholesalers to adjust ethanol production. As a result, in the absence of a waiver, they would be forced to boost ethanol production to comply with the RFS mandate when corn yields are low and corn prices are high.

The current episode demonstrates another aspect of the RFS mandates: in periods of supply shocks, they can increase price volatility of underlying agricultural commodities. If quantities cannot adjust during supply shocks, prices must change by larger amounts to restore market equilibrium.

service restaurants costs are estimated to increase by $691 million and $110 million, respectively (see **Table E-1**).

Table E-1. Impact of 2015 RFS Under Alternative Scenarios, 2011 Levels[a]

	Scenario I	Scenario II
Impact on Ethanol Production and Corn Prices		
Ethanol Production	6 billion gallons	1 billion gallons
Corn Price	+27%	+4%
Impact on Annual Chain Restaurant Input Costs (millions of dollars)		
All Types	**$3,163**	**$503**
Quick Service	2,472	393
Full Service	691	110
Average Restaurant Impact (dollars)		
All Types	**$17,963**	**$2,858**
Quick Service	18,190	2,894
Full Service	17,195	2,736

Source: PwC calculations. Detail may not add to totals due to rounding.

[a] Results assume the RFS corn ethanol mandates are fully phased-in (2015 levels) and are evaluated using 2011 levels of food purchases.

For the average quick service restaurant, these input cost increases are equivalent to $18,190 per restaurant in the first scenario and $2,894 per restaurant in the second scenario. For the average full service restaurant, the cost increases are $17,195 and $2,736 per restaurant, respectively.

These estimates reflect the increase in costs attributable to a single year. Chain restaurants would generally face similar increases each year the RFS is in place, although the specific impacts would depend on the RFS mandate for the year and other market factors. In periods of market disruption, such as that associated with the current drought, the impact is likely to be larger.

The impact of the corn ethanol RFS mandates will depend on market conditions underlying the ethanol market. Unexpectedly high or low gas prices or unexpectedly high or low corn yields would result in the RFS mandate having different effects on ethanol production and on agricultural prices. Chain restaurants and other consumers of agricultural products must incorporate this uncertainty into their planning processes.

Federal Ethanol Policies and Chain Restaurant Food Costs

The federal government has implemented various policies to encourage the use of ethanol from domestic producers as an alternative fuel. These policies have provided tax incentives to gasoline blenders and wholesalers to lower the cost of ethanol, restricted imports of competing ethanol through additional duties, and imposed mandated levels of ethanol that must be used.

Corn remains the primary source used to produce ethanol in the United States. By promoting ethanol production, the federal policies have certain side effects in corn and other agricultural markets. Using more corn in ethanol production will increase overall demand for corn and increase its price.   An increase in the price of corn will affect other parts of the agricultural sector and the overall economy. First, if the price of corn increases, farmers have an incentive to shift production away from other crops to corn. These shifts help ease the increase in corn prices but increase the price of other crops. Second, businesses that use agricultural commodities as inputs face increased costs, a portion of which are passed along the supply chain. For example, increased feed costs for livestock result in higher costs for beef. As purchasers of a wide range of agricultural commodities, chain restaurants face these higher input costs on their food purchases.

The National Council of Chain Restaurants engaged PwC to estimate the impact of the Renewable Fuel Standards ("RFS") mandates on the input costs of chain restaurants. In developing these estimates, we have combined information from a sample of chain restaurants with estimates from a variety of researchers.

The first section of the report provides an overview of federal ethanol policy and the corn market; the second section summarizes the existing research on the impact of the primary federal policies; the third section describes the survey administered to NCCR members and the results; the fourth section provides the estimated impact of the RFS mandates; and the final section describes the impact on illustrative restaurants. Appendices provide more detail on the survey, methodology, and supplemental estimates.

I. Overview of Federal Ethanol Policies and the Corn Market

Over the past 40 years, the federal government has enacted a series of policies that promote the use of ethanol. In 1978 Congress first enacted an excise tax credit for ethanol blends. To encourage the domestic development of the ethanol industry, since 1980 a supplemental tariff applied to all ethanol imports. In 2005 the Renewable Fuel Standard was enacted, which mandated certain levels of renewable sources of fuel.

The government has enacted certain other provisions to encourage ethanol and other biofuels. Under the Clean Air Act of 1990, jurisdictions failing to meet clean air standards must use oxygenated fuel, and ethanol is an important oxygenate. There are tax credits and mandates that apply to other types of renewable energy. Also, the federal government has other programs that offer direct and indirect support to ethanol research and development efforts. While such provisions also have impacts on biofuel use and the broader economy, this report only examines the impact of the provisions that directly target corn ethanol.

a. Federal Policies Promoting the Use of Corn Ethanol

i. Description of the Renewable Fuel Standard

The Renewable Fuel Standards (RFS), initially enacted in the Energy Policy Act of 2005 and subsequently modified in the Energy Independence and Security Act of 2007 ("EISA"), mandates specified amounts of biofuels be blended into gasoline. The RFS requires that by 2022, a total of 36 billion gallons of renewable biofuels be consumed annually, with conventional ethanol such as corn ethanol accounting for no more than 15 billion gallons. The EISA allows the EPA to lower the mandate if, after consultation with the Departments of Agriculture and Energy, it determines that implementation of the mandate would severely harm the domestic economy or environment or if there is insufficient domestic supply. The mandate for cellulosic ethanol has been waived through 2012 based on the technological challenges associated with cellulosic ethanol production.[2] **Table 1** below summarizes the expected mandated levels through 2021.

Table 1. RFS Levels, 2011-2021 (Billions of Gallons)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total RFS											
Statutory Level	13.95	15.20	16.55	18.15	20.50	22.25	24.00	26.00	28.00	30.00	33.00
Net of Assumed Adjustments [a]	13.71	14.71	15.88	16.98	18.14	18.71	19.45	20.22	21.44	22.25	22.89
Conventional (e.g., corn) ethanol	12.60	13.20	13.80	14.40	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Advanced Ethanol											
Statutory Level	1.35	2.00	2.75	3.75	5.50	7.25	9.00	11.00	13.00	15.00	18.00
Net of Assumed Adjustments [a]	1.11	1.51	2.08	2.58	3.14	3.71	4.45	5.22	6.44	6.25	7.89

Source: Food and Agricultural Policy Research Institute, University of Missouri, "U.S. Baseline Briefing Book," FAPRI-MU Report #01-12, March 2012.
[a] FAPRI assumes the EPA will extend current waivers for advanced ethanol (e.g., cellulosic ethanol) and the biodiesel mandate will be 1.28 billion gallons each year in 2013 and beyond.

Gasoline producers must provide documentation to the EPA on the amount of ethanol blended into gasoline through the use of renewable identification numbers (RINs), which are assigned to each gallon of ethanol produced. Each year the EPA sets a percentage that represents the share

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[2] The EPA is expected to announce whether it will waive the 2013 mandates in December 2012.

of the mandated biofuels relative to the entire gasoline market. Each producer must provide RINs to the EPA to demonstrate that it complied with the required percentage on its gasoline production. Producers who accumulate excess RINs can hold them and use them in future years or sell them to other producers who have not used sufficient amounts of biofuels. Producers can also borrow from future years to comply with the current year requirement.

ii.   Volumetric Ethanol Excise Tax Credit

The Volumetric Ethanol Excise Tax Credit ("VEETC") was enacted in 2005 to replace earlier credits to encourage the use of ethanol in gasoline. Before its expiration in 2011, the credit was available to crude oil refiners or gas wholesalers and equaled $0.45 per gallon of ethanol blended with gasoline. The credit was available for both domestic and imported ethanol and offset federal gasoline excise taxes. In 2011, when ethanol blended with gasoline amounted to 13.2 billion gallons[3], the value of the credit would have amounted to $5.9 billion.

iii.   Tariffs on Imports of Ethanol

Through 2011, imported ethanol faced two separate tariffs: an ad valorem tariff equal to 2.5 percent of the value of the imports, and a $0.54 per gallon additional duty. After 2011, only the ad valorem tariff applies. The tariffs are waived on imports from countries eligible for the Caribbean Basin Economic Recovery Act ("CBERA") as long as the ethanol is produced in those countries. There is a separate provision that allows ethanol from other countries such as Brazil to be routed through CBERA countries and U.S. insular possessions and enter the U.S. duty-free, subject to certain limits. Up to 7 percent of the U.S. market can enter without any local content, and more can enter if the beneficiary country supplements with at least 30 percent local content. In the past, imports from the Caribbean countries have not exceeded the 7 percent cap.

b. Overview of Corn Markets

Most corn grown in the United States is used as inputs in the production of other commodities rather than consumed directly. Livestock and poultry operations use corn to feed their animals. Sugars derived from corn are used as a sweetener in soft drinks and other food products. And corn is used to produce ethanol. Overall, the U.S. agricultural sector devotes slightly more acreage to the production of corn than to the other main crops, as shown in **Figure 1**.

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[3] Production from U.S. Energy Information Administration, *Annual Energy Outlook*, 2012.

Figure 1. Acreage Devoted to Major Crops, 2010-2011
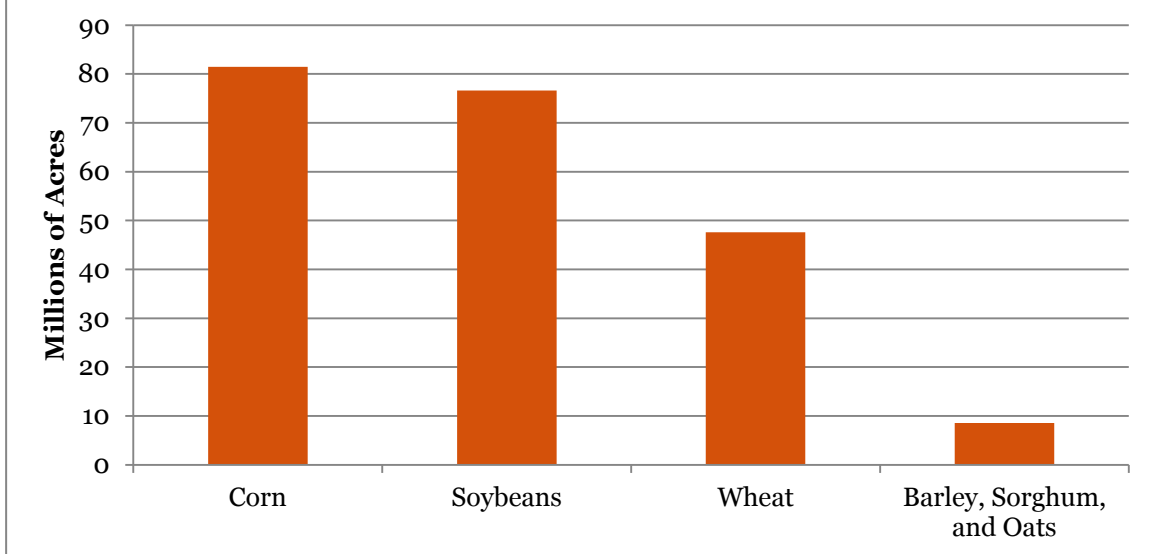
Source: USDA Field Grains Database, accessed August 2012; Wheat Outlook, August 2012; and Soybean Oil Crops Yearbook, March 2012.

While domestic uses of corn generally have grown over the past several decades, there have been significant changes more recently. The utilization of corn for ethanol production experienced modest increases through the 1980s and 1990s. However, in the early 2000s utilization accelerated significantly. In 2010-11, the production of ethanol and its byproducts became the largest use of U.S. corn production (see **Figure 2**). As of the marketing year 2011-2012, corn used for ethanol represented 45 percent of total use.

Figure 2. Uses of U.S. Corn Production
(by marketing year, in millions of bushels)
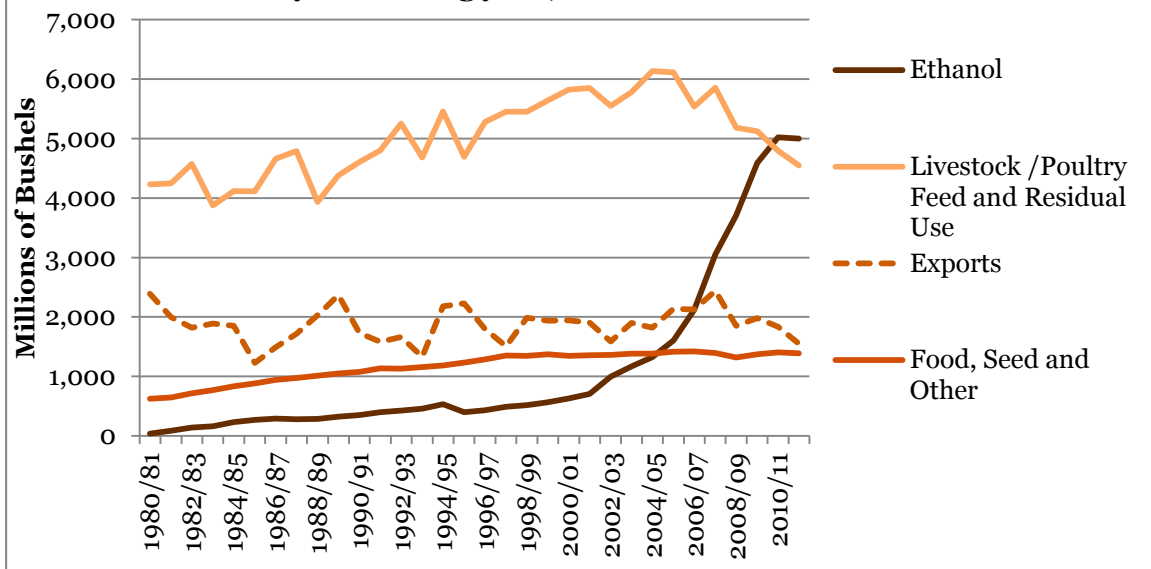
Source: USDA, Economic Research Service Feed Grains Database, accessed August 2012.

Note: Marketing runs from September to October.

Corn prices have exhibited significant volatility over the past several years, as have prices of similar agricultural commodities. In the middle of 2006, the prices of corn, soybeans, and wheat climbed significantly and have remained at elevated levels compared to the early 2000s. In the middle of 2010 these prices began to climb again. By the beginning of 2012, average annual prices of corn, wheat, and soybeans were 161 percent, 116 percent, and 81 percent, respectively, above the level from January 2003. **Figure 3** illustrates the price paths over time.

Figure 3. Corn, Soybean, and Wheat Prices
(dollars per bushel)
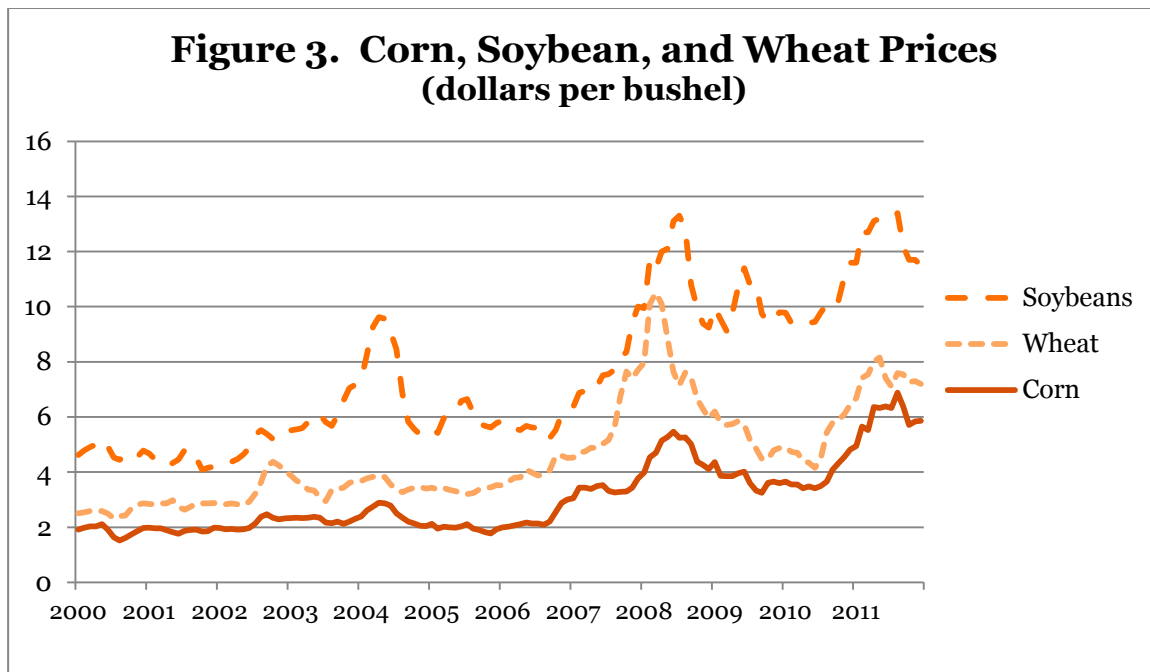
Source: USDA National Agricultural Statistics Service, accessed August 2012.

c. Corn-based Ethanol

Over the last decade, projections of the use of corn-based ethanol as a blending agent for gasoline have increased significantly. In 2004, the U.S. Energy Information Administration projected that total corn-based ethanol blended with gasoline would reach 3.5 billion gallons by 2012. The most recent projections show ethanol use reaching 14.5 billion gallons in 2012 (see **Figure 4**).

Figure 4. Corn Ethanol Used in Gasoline Blending, U.S. Energy Information Administration Projections
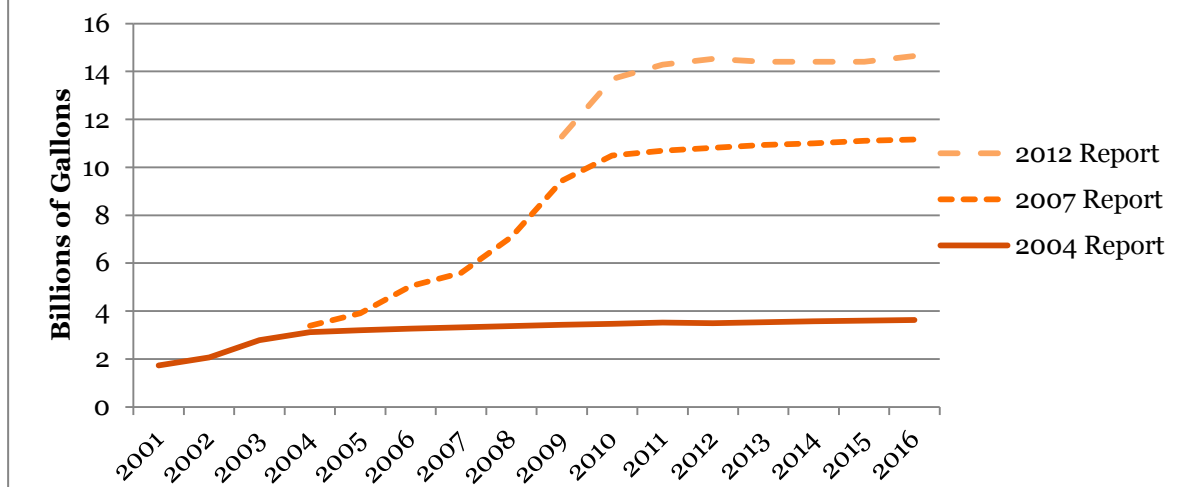
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2004* (Table 18); *2007* (Table 17); and *2012* (Table 17). Energy content (in quadrillion Btu) of ethanol converted to volume (in gallons) assuming 1 quadrillion Btu per 12 billion gallons of ethanol.

Projections for 2012 increased by 7.3 billion gallons between 2004 and 2007, and by another 3.7 billion gallons between 2007 and 2012. Federal government policies played a role in promoting the ethanol industry during this period. The VEETC and its predecessor credits boosted demand for ethanol as an alternative source of energy in gasoline. After 2007, the revised RFS mandates provided investors in ethanol refining plants a growing market that would reach at least 15 billion gallons per year in 2015 and beyond, leading to increased refining capacity even before the mandated volumes took effect.

Increasing gasoline prices also increased the attractiveness of ethanol. In its 2004 *Annual Energy Outlook*, EIA was projecting a 2012 crude oil price of approximately $30 per barrel (in 2012 dollars); in the 2007 report, the 2012 oil price projection had risen to $53 per barrel, and in its 2012 report, $103 per barrel. Higher prices for gasoline increase the incentive to adopt alternative sources of energy such as ethanol.

Federal government policies combined with increasing oil prices to provide a strong incentive to increase ethanol refining capacity and promote its use in gasoline.

II. Ethanol and Impacts on Agricultural Markets

Given the role of corn as the primary input in the production of ethanol, increased ethanol production will have a significant impact on corn markets. Increased demand for corn for use in ethanol will cause corn prices to increase, in the absence of adjustments to the supply of corn. As corn prices increase, other users of corn will have an immediate incentive to shift to alternatives. For example, livestock producers could keep livestock on grazing lands for longer periods or try to substitute other grains. Shifting demand away from corn and to other grains will ease the pressure on the price of corn but will increase the price of those grains.

a. Ethanol Supply and Demand

There are several key factors that drive the supply and demand for ethanol and therefore influence the price of agricultural commodities.

Gasoline prices. The demand for ethanol depends on gasoline prices. Increases in gas prices will make ethanol a more attractive energy source for gasoline. Although the energy content of corn ethanol is only about two-thirds of the energy content of gasoline, as long as ethanol prices are less than two-thirds of the price of gasoline, refiners and wholesalers will generate positive margins on each gallon of blended gas.

Corn yields. Given that corn is the key ingredient for U.S. ethanol, high corn yields will lower production costs for ethanol refiners and enable them to generate higher margins for a given price of ethanol. Low corn yields will result in lower margins for ethanol refiners. Current drought conditions in the United States are having a significant impact on ethanol markets.

Imports. Ethanol imports from countries such as Brazil can be used in place of domestic ethanol in gasoline blending. If imported ethanol is used instead of domestic ethanol, less corn will be used for ethanol with fewer impacts in the corn market. The competitiveness of foreign ethanol will depend on factors such as foreign refining costs, exchange rates, foreign demand for ethanol, and trade policy.

Refining capacity. The production of ethanol requires dedicated refineries to convert corn into ethanol. The amount of corn used in ethanol production is limited by available refinery capacity. If the margins earned by ethanol producers are insufficient to cover both fixed (capital costs associated with the refinery) and variable costs (input costs such as corn), additional capacity would not be developed for future production.

Other government policies. The federal government has certain policies that affect the use of ethanol in addition to the RFS, the VEETC, and the import duty. For example, the EPA sets requirements on the blending ratios between gasoline and ethanol that are allowable. Before 2010, gas producers could only blend up to 10 percent ethanol in standard gasoline. The EPA now allows gasoline with up to 15 percent ethanol to be used in cars built after 2001. This policy will increase the market for ethanol. In the absence of this liberalization, there were doubts that the RFS mandate for 15 billion gallons in 2015 and beyond would be met.[4] Additionally, federal oxygenation policies have increased the use of ethanol in gasoline in certain jurisdictions. State governments have set their own ethanol mandates. These other policies have encouraged ethanol use and the development of the industry independent of these federal policies.

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[4] Babcock, Carr, and Carriquiry, 2010.

b. Impact of Federal Policies on Ethanol and Corn Markets

The three federal policies identified above impact ethanol and corn markets by altering the interplay of supply and demand in the ethanol market.

i. Renewable Fuel Standard

The RFS mandates require that a certain level of ethanol is used in gasoline. The impact of the RFS mandate depends entirely on the amount of ethanol utilization that would occur in the absence of the mandate. If the mandated ethanol use always exceeds the amount that would occur in the absence of the mandate ("equilibrium utilization"), increased ethanol blending will require either the use of more corn for domestic ethanol production or increased ethanol imports to meet the mandate. Increased use of corn for ethanol production would increase corn prices. Increased imports of ethanol could affect specific commodity prices given global agriculture markets, depending on the product used for the ethanol. If alternatively the mandate is always below the equilibrium level of ethanol utilization, there would be no impact on ethanol or corn prices. Because the market for ethanol depends importantly on uncertain corn yields and variable gasoline prices, markets can be impacted by the RFS as long as there is a positive probability that the mandates may require increased production at some point. Markets would reflect that probability in setting prices.

By mandating a specific level of ethanol that must be used in gasoline, the RFS uses a quantity-based policy to encourage ethanol utilization. Such policies can be problematic in the face of uncertainty: in periods of adverse market conditions, such as the current drought, the mandate requires ethanol production even if there are more highly valued uses for the corn that will be used for the ethanol. The mandate overrides the price signal that generally would allocate the corn to its most highly valued use.

Estimates of the impact of the RFS on the ethanol and corn market vary depending on the underlying assumptions and the modeling approach. Most models measure the impact by assessing the probability that the mandate will be binding and adjusting the impact of binding mandates for that probability. Key variables in evaluating the impact of the mandate are the assumed gasoline price and corn yield. Higher assumed gasoline prices and higher corn yields lead to smaller impacts of the RFS because the higher demand and lower supply costs will encourage ethanol utilization, even without the mandate.

Table 2 summarizes the impacts of the RFS mandate and proposed alternative mandates on ethanol production determined by other researchers under a range of assumptions. The studies presented below find that eliminating the RFS could lower ethanol production by a wide range, from as little as 0.5 billion gallons to as much as 6.7 billion gallons. The wide range reflects a variety of different assumptions by the researchers and time periods analyzed.

The estimates provided below focus on the impact of the RFS. As described above, other federal policies have encouraged the development of the ethanol industry. Disentangling the impact of these policies is difficult, as well as the impact of other economic developments such as rising oil prices. These studies estimate ethanol use with and without the RFS mandates, but dynamic responses in other parts of the economy could offset or reinforce the changes associated with the policy.[5]

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[5] For example, increased use of alternatives to oil, such as ethanol, could cause oil producers to change their pricing strategies. Such changes would have broad impacts on the overall economy, which would impact ethanol utilization.

Table 2. Summary of Findings on Impact of RFS

Source	Model	Corn Yield (bu / planted acre)	Wholesale Gas Price (cents / gallon)	Change in Ethanol Production (billions of gallons)	% Change in Ethanol Production
Anderson (2008)	FAPRI				
Quarter-waiver of RFS		153.5	NA	1.4	7%
Half-waiver or RFS		153.5	NA	2.4	12%
Babcock, Barr, and Carriquiry (2010)	CARD				
Elimination of mandate in 2011		150.4	230	1.7	13%
Elimination of mandate in 2014		150.4	230	1.0	7%
Babcock (2012)	CARD				
Full mandate to flexible, 2012		112	278	1.3	10%
Flexible mandate to none, 2012		112	278	0.5	4%
Bento, Klotz, and Landry (2011) [a]	General Equilibrium	142	178	6.7	80%
Elam (2008a): 50% relief (2008/9)	FarmEcon	140	350	2.1	19%
Elam (2012)	FarmEcon				
15% Reduction in RFS in 2012		135	338	0.6	4%
Elam (2008b): eliminate RFS in 2008/9	FarmEcon	155	240	6.1	55%
EPA Analysis of RFS (2010), 2022 Impact [a]	FASOM/FAPRI	185	335	2.7	22%
USDA (Feb 2007): 2015 Mandate [a]	FAPSIM	155	215[b]	3.0	25%
USDA (2009): 2015 RFS [a]	REAP	156	240[c]	1.7	13%

[a] These studies evaluated the impact of imposing the 15 billion gallon ethanol mandate rather than eliminating it.
[b] Estimated wholesale price; based on crude oil of $70 per barrel.
[c] Estimated wholesale price; based on crude oil of $80 per barrel.
Note: See References for sources. FAPRI = Food and Agricultural Policy Research Institute model (Missouri University and Iowa State), CARD = Center for Agricultural and Rural Development model (Iowa State), REAP = Regional Environment and Agricultural Programming model, FASOM=Forest and Agricultural Sector Optimization model, FAPSIM = Food and Agricultural Policy Simulation model.

Most of these reports relied on economic models that link supply and demand in different segments of the agricultural sector, incorporating decisions on acreage, crop selection, and imports and exports. The FAPRI, CARD, and FAPSIM models have stochastic components that allow researchers to simulate the impact of policy changes using a distribution of values for key variables such as gasoline prices and corn yields. Other models rely on deterministic projections to evaluate the impact.

Key findings from the papers are below:

- The Anderson (2008) paper measured the impact of waiving a portion of the RFS mandate, but certain details of the projection were not available in the paper. Ethanol production was estimated to fall by 7 percent if the RFS mandate in 2008 had been lowered by 25 percent and 12 percent if it had been lowered by 50 percent.
- The Babcock, Barr, and Carriquiry (2010) paper assumed a significant increase in ethanol demand between 2011 and 2014 apart from the mandate and assumed relatively low corn yields and low gas prices. Because of the increase in underlying ethanol demand, the impact in 2014 is smaller than the impact in 2011, even though the RFS mandate amount is larger.
- The Babcock (2012) paper looked at current market conditions and evaluated the change from waiving the current RFS mandate. Current market conditions are significantly worse than long-term expectations for the ethanol market, and the paper only measures waiving the current mandate. A permanent waiver of the policy would have a larger impact. The impacts differ based on whether blenders are able to utilize credits for past production (as allowed under the RFS).
- The Bento, Klotz, and Landry (2011) paper is based on numerical simulations using a general equilibrium model. The paper derives the equilibrium level of ethanol production without any policy interventions, then recalculates the equilibrium level assuming the mandate exists. The paper estimates that the 15 billion gallon RFS mandate would increase ethanol production by 6.7 billion gallons in 2015.
- Two of the Elam papers (2008a, 2012) pair relatively low corn yields with relatively high gas prices and estimate the impacts of partially waiving the RFS mandates. A third Elam paper (2008b) combines higher corn yields with a low gas price.
- The EPA (2010) analysis compared biofuel production in the absence of the RFS mandate based on a 2007 projection to production under the mandate, but partially updated fuel costs in the analysis. As a result, it states that the impact measured combines the impact of RFS with other market developments, and RFS alone would be smaller.
- The USDA (2007) paper adopts relatively low corn yields and low gasoline prices and estimates that a 15 billion gallon corn ethanol mandate would have a large impact on ethanol production.
- The USDA (2009) paper relies on a regional model that simulates policy, demand, and supply issues and utilizes assumptions relatively close to current projections. The model estimates the impact of the 15 billion gallon mandate reflecting the development of the ethanol market over the past decade.

These studies demonstrate the importance of the underlying assumptions and modeling approach. As the current drought demonstrates, these variables can change significantly from year to year. While some of the key variables in the studies differ widely, they could prove appropriate in a future year.

To evaluate the impact of federal policies on corn prices, we have adopted two alternative assumptions on the impact of RFS on ethanol utilization based on the findings in the literature. We have provided results under each of these scenarios:

- Scenario I: The results from the Bento, Klotz, and Landry (2011) and Elam (2008b) papers suggest that the RFS could cause ethanol utilization to increase by over 6 billion gallons. These estimates suggest that the RFS was responsible for approximately 60 percent of the increase in ethanol utilization between the Energy Information Administration's 2004 and 2012 forecasts. For the first scenario, we adopt this impact to evaluate the effect on commodity prices.

- Scenario II: The Babcock, Barr, and Carriquiry (2010) paper assumes that eliminating the current RFS mandate would lower ethanol production by 1.0 billion gallons. These results suggest that other market aspects, such as oil prices, have been responsible for much of the increase in ethanol utilization. We adopt this assumption for our second scenario.

To derive the impact on corn prices under each of these assumptions, we developed a model to estimate the change in corn prices attributable to changes in corn ethanol production based on supply and demand sensitivities to quantity and price. Specifically, the model first estimates the change in corn prices resulting from the increased corn ethanol production attributable to federal policies, as estimated in the literature. Increased amounts of corn used in ethanol production translate into less corn for the non-ethanol market, which will cause corn prices to rise given its relative scarcity. The magnitude of the increase in price is calculated based on price elasticities of supply and demand.[6] This approach is based on the Biofuels Impact Model developed by economists at the Federal Reserve.[7]

We use the impact of RFS on ethanol production under the two assumptions (6 billion gallons and 1.0 billion gallons) to estimate the potential impact on corn prices. The model estimates that corn prices would increase under the two alternatives by 27 percent and 4 percent, respectively.

As described above, corn is an important input to livestock producers so an increase in the price of corn will affect livestock producers as well. To the degree farmers shift away from growing other corps and into growing corn, or livestock producers substitute other feed crops for corn, prices of those alternatives will increase. The impact on other commodity prices was estimated based on estimated relationships between changes in corn prices and changes in closely linked food commodities using a similar approach as that used by the Federal Reserve researchers. For these crops, the change in the commodity price associated with the change in corn price is estimated based on historical relationships between changes in corn prices and changes in the commodity price. For example, based on annual changes in price between 1983 and 2011, we estimated that for each 10 percent change in the price of corn, soybean prices change by approximately 6 percent. Similar relationships were derived for wheat, barley, potatoes, beans, rice, and sugar.[8]

For livestock and poultry, we estimated the impact based on estimates of the amount of feed needed to produce a pound of product. For a given increase in the price of livestock and poultry feed, we can estimate the associated increase in the production cost of meat products (including eggs and milk). Because the price of alternatives to corn such as soybean meal and other grains also increase, the ability of producers to avoid increased input costs is limited. While the production of ethanol generates distillers grains, their prices closely follow corn prices and cannot be substituted on a pound-for-pound basis with corn.

Table 3 below summarizes the price impacts under each alternative. More detail is provided in the appendix on these estimates.

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[6] Specifically, the model assumes a price elasticity of demand of 0.2 and a price elasticity of supply of 0.2, based on average values determined by the Food and Agricultural Policy Research Institute (FAPRI).
[7] See Baier, Clements, Griffiths, and Ihrig (2009).
[8] Relationships were estimated based on current and lagged price changes, controlling for temperature and precipitation. For potatoes, beans, rice, and sugar, current prices were not used because these products typically are not substitutes for corn (in livestock and poultry feed, for example).

**Table 3. Price Impacts on Other Food Commodities
from Eliminating RFS**

	Impact of Increase in Ethanol Use:	
	Scenario I	Scenario II
Corn	26.8%	4.3%
Wheat	12.1%	1.9%
Barley	14.4%	2.3%
Soybeans	15.7%	2.5%
Potatoes	13.0%	2.1%
Beans	4.4%	0.7%
Rice	5.7%	0.9%
Sugar	0.5%	0.1%
Beef	7.5%	1.2%
Poultry	7.7%	1.2%
Pork	15.0%	2.4%
Eggs	11.2%	1.8%
Milk	2.4%	0.4%

Source: PwC estimates. Impacts are for 2015 policy evaluated at 2011 levels
of food purchases.

ii.   Volumetric Ethanol Excise Tax Credit

When it was in place, the blending tax credit effectively lowered the price of ethanol for gasoline blenders and wholesalers, increasing the demand for ethanol. Both domestic and imported ethanol were eligible for the VEETC so demand for each would increase under the policy. While the VEETC is claimed by gasoline blenders or wholesalers, the ultimate beneficiary of the subsidy from the credit would depend on the characteristics of the corn, ethanol, and gasoline markets. Under different assumptions, consumers could pay less for gas, ethanol producers could receive higher relative prices, or corn growers could receive higher returns.[9]

For the VEETC, the gasoline price and corn yields play a less direct role in determining the effectiveness of the policy in encouraging additional ethanol use than for the RFS mandates. The credit will always provide a positive incentive to use more ethanol, in contrast to the impact on RFS, where high gas prices or high corn yields make it less likely that the mandates will have an impact.

The mandates established by the RFS could eliminate the incentive to boost ethanol production created by the VEETC. If the RFS mandate increased ethanol production above the level that it otherwise would have attained in the presence of the VEETC, the VEETC would have no impact on ethanol utilization. The VEETC would lower the ethanol price to blenders and wholesalers but would not promote additional utilization.

We have provided estimates of the VEETC in an appendix, but as long as the RFS mandates determine the level of ethanol utilization, the impact of the VEETC will be negligible.

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[9] See Taheripour and Tyner (2007).

iii. Additional Duty on Imports

When it was in place, the additional duty raised the price of foreign ethanol. The impact on the domestic ethanol and corn market would depend on the competitiveness of foreign ethanol. If imported ethanol would have been cheaper than domestic ethanol in the absence of the duty, the tariff would have caused the domestic ethanol price to be higher, which would have raised corn prices. However, if imported ethanol was already priced higher than domestic ethanol, the additional duty would have a minimal impact on the domestic market.

Capacity constraints in foreign countries that produce ethanol and the costs associated with transporting the foreign ethanol to the United States combined to limit the impact of the tariff. Research on its impact generally found that they were negligible.[10]

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[10] See, for example, Babcock, Barr, and Carriquiry (2010).

III. Survey of Chain Restaurants

To estimate the impact on chain restaurants of federal ethanol policies, we administered a survey to a sample of chain restaurants to collect information on their purchases of food commodities.

a. Survey Overview

Each respondent was sent a questionnaire that asked for information on company revenues, number of establishments, type of restaurant (quick-service or full-service), and purchases by type of commodity for 2011. Companies provided detailed purchase volumes across several broad categories: corn products (such as high fructose corn syrup and corn oil), soybean products (such as soy and soybean oil), beef products, chicken products, pork products, wheat-based products, other food oil purchases, and other purchases. For processed products, companies were asked to provide the underlying components (e.g., amount of flour in rolls or high-fructose corn syrup in sauces). In cases where the companies were unable to provide such information for processed products, we estimated the components based on typical formulations. We focus on products likely to be impacted by the change in corn prices. The products included in the survey represent the most significant food commodities purchased by chain restaurants but exclude certain products that could represent significant purchases, such as alcoholic beverages.

A description of the survey is included in the appendix.

The sampled companies represent a cross-section of large chain restaurants identified by the National Council of Chain Restaurants. In total, 19 companies representing both the quick service and full service segments participated and provided information on their purchases. The respondents also reported total U.S. sales revenues for restaurants in their chains of $61.7 billion in 2011, $23.0 billion for full service restaurants and $38.7 billion for quick service restaurants.[11]

b. Valuation and Extrapolation of Survey Results to All Chain Restaurants

The volumes of primary purchases were converted into dollar amounts based on average prices for 2011 reported by the U.S. Department of Agriculture.

To extrapolate the survey results to the entire population of chain restaurants, we relied on U.S. sales revenues as reported by the sample and related that to our estimate of total national sales of chain restaurants by type. As described in the appendix, we estimated 2011 quick service chain restaurant sales of $170.2 billion and 2011 full service chain restaurant sales of $94.5 billion.[12] Thus, relative to the PwC survey responses, the U.S. quick service chain restaurant industry had sales in 2011 that were 4.4 times the sales reported by quick service survey respondents. For the U.S. full service chain restaurant industry, industry sales in 2011 were 4.1 times the sales reported by full service survey respondents.

Table 4 below provides estimates of the total value of primary food commodity purchases by chain restaurants in 2011. We estimate that the primary commodity purchases by quick service restaurants and full-service restaurants amounted to $24.7 billion dollars and $7.7 billion, respectively.

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[11] We did not receive sales revenues for several companies. In those cases we have relied on publicly available information on sales revenues by chain.

[12] Quick service restaurants were further stratified into pizza restaurants and all other types to adjust the sample results to more accurately represent the quick service restaurant sector.

On a per-restaurant basis, spending on primary food inputs amounted to $181,869 for the average quick-service restaurant and $192,552 for the average full-service restaurant.

Table 4. Estimated Value of Food Commodity Purchases by Chain Restaurants
(2011 totals in millions of dollars; 2011 average per restaurant in dollars)

	Quick Service Restaurants		Full Service Restaurants	
	Total 2011 ($ millions)	2011 Avg per Restaurant ($)	Total 2011 ($ millions)	2011 Avg per Restaurant ($)
Livestock and Poultry Products				
Beef	6,164	45,359	2,042	50,834
Butter	44	327	192	4,779
Cheese	2,703	19,890	909	22,637
Milk	68	499	89	2,224
Ice Cream	1,104	8,127	110	2,749
Cream	70	512	75	1,872
Pork	1,063	7,819	705	17,564
Chicken	4,607	33,900	1,320	32,876
Eggs	279	2,055	379	9,436
Turkey	47	349	8	194
Soybeans and Grains				
Wheat Flour	1,037	7,632	224	5,576
Rice	7	49	7	176
Soybean Oil	1,921	14,136	607	15,110
Oilseed Oil	1,183	8,705	50	1,257
Corn Products				
Corn	16	121	32	795
Other Corn Products	2,391	17,596	329	8,202
Other Products				
Potatoes	938	6,901	196	4,881
Beans	112	824	41.3	1,029
Sugar	227	1,669	46	1,139
Vegetables	734	5,399	370	9,220
Total	**$24,715**	**$181,869**	**$7,733**	**$192,552**

Note: Detail may not add to total due to rounding.

Source: PwC estimates.

IV. Impact of RFS Mandates on Chain Restaurants

We combine the estimated impact of the RFS mandates with the survey results to estimate the impact of the RFS on the prices paid by chain restaurant on their primary food purchases. The percentage increase in crop, livestock, and poultry prices are applied to the surveyed categories of spending to estimate the impact on chain restaurant costs.

Tables 5a and **5b** present the results associated with the impact of the RFS mandate on chain restaurant spending under each of the scenarios. Estimates assume that the RFS mandate is fully phased-in, and dollar values and volumes are at 2011 levels of food purchases.

Scenario I (6 billion gallon increase in ethanol utilization): In total, we estimate that the fully phased-in RFS mandate under this alternative would have increased spending by quick service restaurants by $2.5 billion (10 percent of major food commodity spending) and full service restaurants by $691 million (8.9 percent). Costs at a typical restaurant would have increased by $18,190 in quick service restaurants and by $17,195 in full service restaurants.

Scenario II (1 billion gallon increase in ethanol production): In total, we estimate that the fully phased-in RFS mandate under this scenario would have increased spending by quick service restaurants by $393 million (1.6 percent of major food commodity spending) and full service restaurants by $110 million (1.4 percent). Costs at a typical restaurant would have increased by $2,894 in quick service restaurants and by $2,736 in full service restaurants.

The impacts caused by the RFS mandates are recurring, although the specific impacts in any year will depend on the RFS mandate for the year and other market factors. In periods of market disruption, such as that associated with the current drought, the impact is likely to be larger.

Table 5a. Impact of RFS Mandate on Chain Restaurant Spending, Scenario I

	Quick Service Restaurants			Full Service Restaurants		
	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)
Livestock and Poultry Products						
Beef	460.3	7.5%	3,387	152.4	7.5%	3,796
Butter	1.1	2.4%	8	4.6	2.4%	115
Cheese	65.1	2.4%	479	21.9	2.4%	545
Milk	1.6	2.4%	12	2.2	2.4%	54
Ice Cream	26.6	2.4%	196	2.7	2.4%	66
Cream	1.7	2.4%	12	1.8	2.4%	45
Pork	159.8	15.0%	1,176	106.1	15.0%	2,641
Chicken	355.5	7.7%	2,616	101.9	7.7%	2,537
Eggs	31.4	11.2%	231	42.6	11.2%	1,061
Turkey	3.66	7.7%	27	0.6	7.7%	15
Soybeans and Grains						
Wheat Flour	125.7	12.1%	925	27.1	12.1%	676
Rice	0.4	5.7%	3	0.4	5.7%	10
Soybean Oil	300.8	15.7%	2,213	95.0	15.7%	2,366
Oilseed Oil	166.4	14.1%	1,224	7.1	14.1%	177
Corn Products						
Corn	4.4	26.8%	32	8.5	26.8%	213
Other Corn Products	640.1	26.8%	4,710	88.2	26.8%	2,196
Other Products						
Potatoes	121.5	13.0%	894	25.4	13.0%	632
Beans	5.0	4.4%	37	1.8	4.4%	46
Sugar	1.0	0.5%	8	0.2	0.5%	5
Vegetables	a	a	a	a	a	a
Total	**$2,471.9**	**10.0%**	**$18,190**	**$690.6**	**8.9%**	**$17,195**

a Estimates of the impact on these products are insignificant or indeterminate.
Note: Detail may not add to total due to rounding.   Impacts are for 2015 policy evaluated at 2011 levels of food purchases.
Source: PwC estimates.

Table 5b. Impact of RFS Mandate on Chain Restaurant Spending, Scenario II

	Quick Service Restaurants			Full Service Restaurants		
	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)
Livestock and Poultry Products						
Beef	73.2	1.2%	539	24.3	1.2%	604
Butter	0.2	0.4%	1	0.7	0.4%	18
Cheese	10.4	0.4%	76	3.5	0.4%	87
Milk	0.3	0.4%	2	0.3	0.4%	9
Ice Cream	4.2	0.4%	31	0.4	0.4%	11
Cream	0.3	0.4%	2	0.3	0.4%	7
Pork	25.4	2.4%	187	16.9	2.4%	420
Chicken	56.6	1.2%	416	16.2	1.2%	404
Eggs	5.0	1.8%	37	6.8	1.8%	169
Turkey	0.58	1.2%	4	0.1	1.2%	2
Soybeans and Grains						
Wheat Flour	20.0	1.9%	147	4.3	1.9%	107
Rice	0.1	0.9%	*	0.1	0.9%	2
Soybean Oil	47.8	2.5%	352	15.1	2.5%	376
Oilseed Oil	26.5	2.2%	195	1.1	2.2%	28
Corn Products						
Corn	0.7	4.3%	5	1.4	4.3%	34
Other Corn Products	101.8	4.3%	749	14.0	4.3%	349
Other Products						
Potatoes	19.3	2.1%	142	4.0	2.1%	101
Beans	0.8	0.7%	6	0.3	0.7%	7
Sugar	0.2	0.1%	1	*	0.1%	1
Vegetables	a	a	a	a	a	a
Total	**$393.3**	**1.6%**	**$2,894**	**$109.9**	**1.4%**	**$2,736**

a Estimates of the impact on these products are insignificant or indeterminate. An asterisk (*) denotes an impact less than $0.05 million for Total, 0.05% for Percent Change, or $0.50 for Average per Restaurant.
Note: Detail may not add to total due to rounding. Impacts are for 2015 policy evaluated at 2011 levels of food purchases.
Source: PwC estimates.

V. Impact on Illustrative Restaurants

The estimates above present the potential impacts that the RFS mandate has on chain restaurants. Based on federal government data and the responses to the survey, we have estimated the impact on the average quick service restaurant and the average full service restaurant.

In 2011, the average quick service restaurant had total sales of approximately $1.3 million (see **Table 6a**). Food purchases of primary commodities by the average quick service restaurant amounted to $181,869, or 15 percent of sales.[13] The largest expenditures were for livestock and poultry products ($118,837 of the total, or two-thirds). The 2015 RFS mandates are estimated to increase the annual prices paid for these two products by $8,144 under the first scenario and $1,296 under the second. Overall, the RFS mandates are estimated to increase annual prices paid by the average quick service restaurant by $18,190 under the first scenario and $2,894 under the second.

Table 6a. Impact of RFS Mandate on Average Quick Service Restaurant

	Totals	Impact of RFS Mandate	
Revenues	$1,252,312		
Average Spending		Scenario I	Scenario II
Livestock and Poultry Products	$118,837	$8,144	$1,296
Soybeans and Grains	30,522	4,365	694
Corn Products	17,716	4,743	755
Other Products	14,794	938	149
Total	**$181,869**	**$18,190**	**$2,894**

Note: Detail may not add to total due to rounding. Impacts are for 2015 policy evaluated at 2011 levels of food purchases. Source: PwC estimates.

In 2011, the average full service restaurant had sales of approximately $2.4 million (see **Table 6b**). Food purchases of primary commodities by the average full service restaurant amounted to $192,552, or 8 percent of sales. The largest expenditures were for livestock and poultry products ($145,166 of the total, or three quarters). The 2015 RFS mandates are estimated to increase the annual prices paid for these two products by $10,876 under the first scenario and $1,730 under the second. Overall, the RFS mandates are estimated to increase annual prices paid by full service restaurants by $17,195 under the first scenario and $2,736 under the second.

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[13] Total sales include sales of non-food items such as alcohol. Measured costs of food purchases reflect the costs of the primary food commodities purchased and do not include additional processing costs, whether undertaken by the chain restaurant or its supplier. For example, the cost associated with a loaf of bread is the cost of the embedded flour rather than the purchase price of the loaf.

Table 6b. Impact of RFS Mandate on Average Full Service Restaurant

	Totals	Impact of RFS Mandate	
		Scenario I	Scenario III
Revenues	$2,352,104		
Average Spending		Scenario I	Scenario III
Livestock and Poultry Products	$145,166	$10,876	$1,730
Soybeans and Grains	22,119	3,228	514
Corn Products	8,996	2,408	383
Other Products	16,270	683	109
Total	**$192,552**	**$17,195**	**$2,736**

Note: Detail may not add to total due to rounding. Impacts are for 2015 policy evaluated at 2011 levels of food purchases.
Source: PwC estimates.

Appendix A: Survey of Chain Restaurants

a. Description of Survey

The survey provided to the chain restaurants requested general information on the company, such as whether it was a quick service or full service restaurant and its total U.S. sales by company-owned establishments and franchises. The survey next requested information on the volume of purchases of different types of food commodities potentially impacted by corn prices.

Companies were asked to provide the quantity of the component ingredients in each product. For example, if a company purchased breaded chicken, they were instructed to have separate entries for the chicken (poultry) and the breading (wheat).

We e-mailed the survey to 21 companies and received completed responses from 19 of them.

b. Survey Results

We tabulated and categorized the survey responses. The tabulations below represent the volumes of primary products for the base year, 2011, in terms of the overall volume of purchases and the average per restaurant for those reporting the number of establishments.

Table A-1. Volumes of Purchases Reported by Survey Respondents

	Quick Service Restaurants		Full Service Restaurants	
	2011	Average per Restaurant[a]	2011	Average per Restaurant[a]
Livestock and Poultry Products				
Pounds of Beef	846,818,609	26,304	251,815,194	28,004
Pounds of Butter	4,515,238	140	23,761,465	2,493
Pounds of Cheese	591,390,742	13,303	121,833,279	13,767
Gallons of Milk	7,830,452	243	12,572,232	1,886
Gallons of Ice Cream	39,962,615	1,241	4,871,787	449
Pounds of Cream	6,903,658	214	9,100,000	1,365
Pounds of Pork	269,273,282	7,332	160,700,002	16,183
Pounds of Chicken	880,407,995	19,534	264,165,236	28,956
Dozens of Eggs	58,177,204	1,807	96,278,574	2,728
Pounds of Turkey	4,633,429	144	926,764	139
Soybeans and Grains				
Pounds of Wheat Flour	1,432,187,699	30,789	251,573,205	31,980
Pounds of Rice	9,141,140	140	11,887,063	1,352
Gallons of Soybean Oil	108,820,435	3,273	34,949,036	3,959
Gallons of Oilseed Oil	52,362,030	1,626	2,724,028	409
Corn Products				
Pounds of Corn	36,706,540	1,140	65,048,490	9,254
Gallons of Other Corn Products	147,556,388	4,584	33,096,497	4,964
Other Products				
Pounds of Potatoes	1,861,467,405	55,168	474,510,221	47,317
Pounds of Beans	54,482,958	1,231	24,533,637	3,654
Pounds of Sugar	143,682,905	4,261	29,213,563	4,192
Pounds of Vegetables	824,180,172	25,242	330,620,762	39,645

[a] Average per restaurant for restaurants reporting number of establishments.
Source: PwC survey of chain restaurants, July 2012.

c. Extrapolation Factors for Survey

PwC received survey responses from 19 chain restaurant companies with 2011 U.S. sales totaling $38.7 billion for quick service restaurants and $23.0 billion for full service restaurants. In several cases, the companies did not provide total U.S. sales. In those cases, we relied on publicly available sources, such as financial filings or industry reports, to determine U.S. sales.

To estimate total chain restaurant sales in the United States, we relied on data from the Census Bureau and the D&B MarketPlace database. Although the Census Bureau does not report data on sales for chain restaurants, the Economic Census does provide data on restaurant sales categorized by single-unit and multi-unit firms. These data are available separately for both full service restaurants and quick service (or "limited service") restaurants under the North American Industry Classification System (NAICS) codes of 7221 and 7222, respectively. PwC classified all multi-unit firms with two or more establishments as chain restaurants.[14] In 2007, the most recent year for which Economic Census data are available, U.S. sales for quick service restaurants totaled $182.9 billion of which $112.5 billion, or 61 percent, was generated by chain restaurants. For full service restaurants, U.S. sales in 2007 totaled $192.3 billion of which $76.9 billion, or 40 percent, was generated by chain restaurants.

To identify single-location, franchisee-owned businesses, we used the D&B MarketPlace database, which captures over 10 million U.S. establishments, to measure the share of single location restaurant sales attributable to franchisee-owned businesses.[15] The April to June 2008 edition of D&B MarketPlace captures $87.1 billion in sales to single location restaurants, of which $19.8 billion were attributable to franchisee-owned single location restaurants, or 23 percent. These sales were across both quick service and full service restaurants.

PwC applied the 23 percent ratio to sales by single-unit firms as reported in the Economic Census to estimate total U.S. sales in single-location franchisee-owned establishments. Across both quick service and full service restaurants in 2007, sales by single-unit firms totaled $181.9 billion. Assuming 23 percent of those sales took place in single-location franchisee-owned establishments, we estimated total U.S. sales by single location franchisee-owned establishments of $41.4 billion. We split the $41.4 billion between quick service and full service restaurants based on the share of quick service restaurant sales and the share of full service restaurant sales attributable to franchisee-owned establishments in the 2007 Economic Census.[16] Under this method, we estimated additional quick service chain restaurant sales of $33.0 billion and additional full service chain restaurant sales of $8.4 billion, yielding total U.S. sales in 2007 for quick service chains of $145.5 billion and for full service chains of $85.3 billion.

The U.S. Commerce Department releases the monthly Retail Trade and Food Services report which shows U.S. sales by quick service restaurants and full service restaurants. In 2011 they were $214.1 billion and $213 billion, respectively. We assumed that the share of revenues attributable to full service chain and quick service chain restaurants was the same in 2011 as it had been in the 2007 Economic Census. Applying this assumption, we estimated 2011 quick service chain restaurant sales of $170.2 billion and 2011 full service chain restaurant sales of $94.5 billion.

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[14] The Economic Census data also captures multi-unit firms with only one establishment in the industry. PwC excluded the sales from these firms as they did not meet our criteria for chain restaurants.

[15] Firms in the D&B Marketplace database are categorized by Standard Industrial Classification (SIC) codes. PwC identified restaurants using SIC code 5812, which closely related to NAICS codes 7221 and 7222.

[16] Data on sales by franchise status are available at the six-digit NAICS code level for codes 722110, 722211, 722212, and 722213, which are the subsets of NAICS codes 7221 and 7222.

Thus, relative to the PwC survey responses, the U.S. quick service chain restaurant industry had sales in 2011 that were 4.4 times larger than the sales reported by quick service survey respondents. Sales attributable to pizza restaurants in the sample were responsible for approximately 18 percent of total quick service sales. Based on sales information for the top 100 chains, pizza quick service restaurants were responsible for approximately 6 percent of total quick service sales. We used a weight of 1.5 for the pizza restaurants and 5.0 for all other restaurants to more accurately reflect the quick service restaurant industry. These values are consistent with the overall sales factor of 4.4.

For the U.S. full service chain restaurant industry, 2011 sales were 4.1 times larger than the sales reported by full service survey respondents. We have used this value for all full service restaurants.

We estimated the number of establishments in 2011 based on average annual growth rates in the U.S. Census Bureau's County Business Pattern data between 2007 and 2010 for quick service restaurants and full service restaurants. We estimate that the total number of quick service chain establishments was 40,160 and the total number of full service chain establishments was 135,895 in 2011.

d. Estimate of Indirect Price Impacts

We have used the approach used by the Federal Reserve researchers to estimate the impact of increased ethanol production on other segments of the agricultural sector. We estimated the relationship between percent changes in corn prices and percent changes in prices of agricultural commodities directly related to the corn market. Estimates were produced for food crops including soybeans, wheat, oats, barley, sorghum, rice, sugar, beans, and potatoes. Estimates were also produced for the livestock and poultry industry (beef, pork, chicken, turkey, milk, and eggs). While other agricultural sectors such as vegetables could be impacted through changes in demand for cropland, the relationships we observed were unreliable or indeterminate.

For each of the crops of interest, we performed regressions with the change in price as the dependent variable and the following independent variables: the contemporaneous change in the corn price and three lagged changes in annual corn prices, monthly dummy variables, temperature, and precipitation variables. We used annual price data from the International Monetary Fund. The indirect relationship represented the sum of the parameters on the corn price variables.

For the livestock and poultry sector, we collected information on feed ratios (corn, soybean meal, other grains, and other) and evaluated the increase in cost per pound of feed, based on the changes in crop prices estimated above. Taking relationships between feed inputs and livestock and poultry outputs, we estimated the increase in beef, chicken, turkey, eggs, and milk prices at 2011 levels. For example, each pound of chicken in the chain restaurant supply chain was estimated to require approximately 3.6 pounds of feed input. The percentage increase in the price of chicken depended on the relative price of chicken and feed, and the assumed impact of RFS.

Using these parameters, we updated the Federal Reserve spreadsheet model of the impact of biofuel utilization changes on commodity prices. The updated model was used to translate the change in ethanol utilization into the changes in prices.

Appendix B: Impact of the 2011 Volumetric Ethanol Excise Tax Credit

In this section, we estimate the impact of the 2011 VEETC on chain restaurants had the RFS mandates not been in place in 2011. The credit is not modeled in the estimates presented in the body of the report as it expired in 2011.

The table below summarizes illustrative findings from researchers on the impact of the VEETC. These studies were completed when the VEETC was still in place and estimated the impact of repeal.

As with the RFS estimates, there is wide variation in the impacts, depending on the underlying assumptions on the capacity constraints in the industry, the applicability of the RFS mandates, and other policy changes that impact demand. Estimates of repealing the VEETC tend to be smaller in later years as the RFS mandates are more likely to boost ethanol production. In this case, repeal of the credit would have a minimal impact as the RFS mandates determine the level of ethanol utilization.

Babcock, Carr, and Carriquiry (2010) assumed that the combined impact of the RFS and capacity constraints limited the effectiveness of the VEETC; as a result, the impacts of removing the credit were small. Taheripour and Tyner (2008) utilize a partial equilibrium model that allowed capacity expansions in response to changes in demand and did not include the RFS mandates; as a result the impact is larger. USDA's Office of the Chief Economist (2007) generated long-term projections of ethanol and commodity markets with and without the credit prior to the increased RFS mandates enacted in 2007. The FAPRI (2010) analysis is based on its model of the agricultural sector with and without the VEETC assuming that RFS remained in place.

Table B-1. Impact of the 2011 VEETC

Source	% Impact of Credit on Ethanol Production	Assumed Credit per Gallon
Babcock, Barr, and Carriquiry (2010)		
Elimination of credit in 2011	5%	0.45
Elimination of credit in 2014	1%	0.45
Taheripour and Tyner (2008)	30%	0.45
USDA, OCE (May 2007): 2011/12 impact	14%	0.51
FAPRI (2010): 2011 impact	10%	0.45

Source: See References.

To estimate the impact of the 2011 credit had the RFS mandates not been in place, we have adopted the FAPRI estimate that the credit would increase ethanol demand by 10 percent, or approximately 1.4 billion gallons. This estimate represents the median of the estimates analyzed. Using the price model described above, ethanol production of an additional 1.4 billion gallons would cause the price of corn to increase by 6 percent.

Table B-2 presents our estimates of the impact of the 2011 VEETC on chain restaurant input costs. The 6 percent increase in corn costs leads to increases in other agricultural products. In total, we estimate that the 2011 VEETC in the absence of the RFS mandates would have increased spending by quick service restaurants on average by $553 million (2.2 percent) and full service restaurants by $154.5 million (2.0 percent). Costs at a typical restaurant would have increased by $4,068 in quick service restaurants and by $3,846 in full service restaurants.

Table B-2. Impact of 2011 VEETC on Chain Restaurant Spending in Absence of RFS Mandates

	Quick Service Restaurants			Full Service Restaurants		
	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)	Total 2011 ($ millions)	Percent Change	Average per Restaurant ($)
Livestock and Poultry Products						
Beef	102.9	1.7%	758	34.1	1.7%	849
Butter	0.2	0.5%	2	1.0	0.5%	26
Cheese	14.6	0.5%	107	4.9	0.5%	122
Milk	0.4	0.5%	3	0.5	0.5%	12
Ice Cream	6.0	0.5%	44	0.6	0.5%	15
Cream	0.4	0.5%	3	0.4	0.5%	10
Pork	35.7	3.4%	263	23.7	3.4%	591
Chicken	79.5	1.7%	585	22.8	1.7%	567
Eggs	7.0	2.5%	52	9.5	2.5%	237
Turkey	0.82	1.7%	6	0.1	1.7%	3
Soybeans and Grains						
Wheat Flour	28.1	2.7%	207	6.1	2.7%	151
Rice	0.1	1.3%	1	0.1	1.3%	2
Soybean Oil	67.3	3.5%	495	21.2	3.5%	529
Oilseed Oil	37.2	3.1%	274	1.6	3.1%	40
Corn Products						
Corn	1.0	6.0%	7	1.9	6.0%	48
Other Corn Products	143.2	6.0%	1,054	19.7	6.0%	491
Other Products						
Potatoes	27.2	2.9%	200	5.7	2.9%	141
Beans	1.1	1.0%	8	0.4	1.0%	10
Sugar	0.2	0.1%	2	0.0	0.1%	1
Vegetables	a	a	a	a	a	a
Total	**$552.9**	**2.2%**	**$4,068**	**$154.5**	**2.0%**	**$3,846**

a Estimates of the impact on these products are insignificant or indeterminate. An asterisk (*) denotes an impact less than $0.05 million for Total, 0.05% for Percent Change, or $0.50 for Average per Restaurant.
Note: Detail may not add to total due to rounding. Impacts are evaluated at 2011 levels of food purchases.
Source: PwC estimates.

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