

2010

# Biofuel policy and stock price in imperfectly competitive markets

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**Biofuel policy and stock price in imperfectly competitive markets**

by

**Fatma Sine Tepe**

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

**MASTER OF SCIENCE**

Major: Economics

Program of Study Committee:  
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Rick Dark  
Dermot J. Hayes

Iowa State University

Ames, Iowa

2010

*I dedicate this thesis to my family for all the love and encouragement.*

*I love you.*

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## **ACKNOWLEDGEMENTS**

First of all, I would like to thank my major advisor, Dr. David Hennessy, for his encouragement and constructive criticism throughout this research. I also would like to thank the other committee members Dr. Dark, and Dr. Hayes for sharing their deep knowledge with me.

I am so much grateful to my Mom, Dad, and Brother who have always stimulated me to stay open-minded and to keep on doing the best I could. I love them so much that I would not have made it this far without their support.

## **ABSTRACT**

The increase in demand for corn as a biofuel feedstock has had a significant impact on the agricultural markets in the United States. These include seed, fertilizer and livestock markets all of which have become more concentrated with mergers and acquisitions over time. Oligopoly theory suggests that corn input suppliers likely benefit from policies that support corn markets, while meat companies likely lose. This study investigates, in particular, the effect of increased corn-ethanol production on agribusiness stock prices. A two-factor capital asset pricing model (CAPM) is developed and estimated by OLS and FGLS. The results indicate that increases in corn price have positive effect on excess stock returns of seed and fertilizer companies, while the impact is negative for meat companies.

## CHAPTER 1

### INTRODUCTION

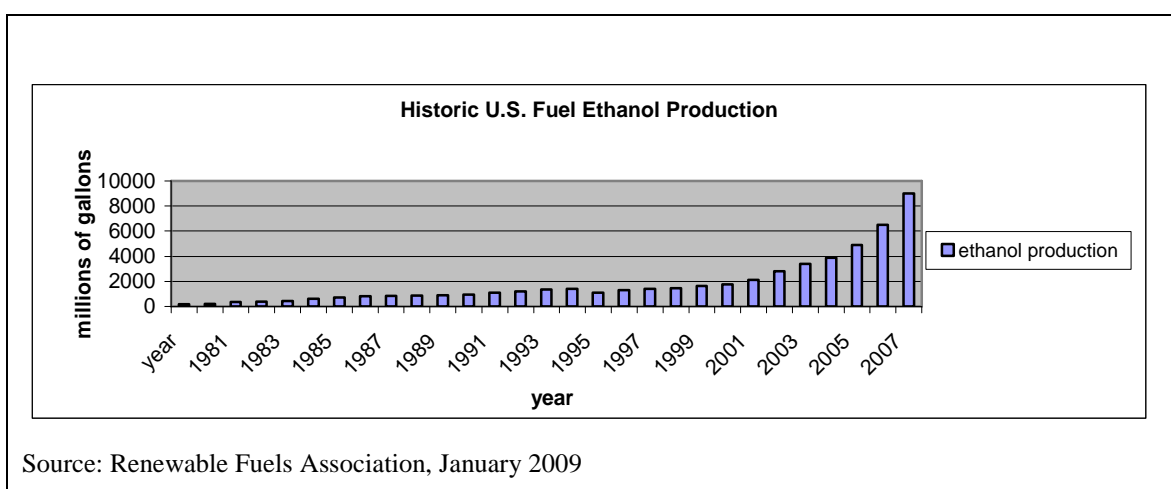
Renewable energy-especially biofuels- is a hot topic in the United States and in many other countries worldwide. The production of biofuels—a subgroup of biomass which can either be in a liquid form such as bioethanol or biodiesel, or in a gaseous form such as biogas —is growing rapidly in response to changing needs of the industry and consumers. Countries are beginning to realize the need for more sustainable energy sources. There have been developments in terms of biofuels in the past as well, the most notable one was during the 1970s afterwards the energy crisis, but most of these developments were somehow short-lived. However, this time it seems like these trends will persist for much longer (Rajagopal and Zilberman, 2007). One reason is that supply of oil is not expected to keep up with demand in future (King Jr. and Schwartz, 2008). This is not the only reason though; the biofuel industry owes much of its success to government policies and regulations.

The common rationales for governments to promote biofuels are; 1) Biofuels provide renewable energy which is less carbon intensive than oil, thus environmentally friendly with lower emissions of toxic and ozone-forming pollutants, and greenhouse gases, decreasing the devastating effects of global warming, 2) Biofuels can be produced domestically by most countries, decreasing reliance on foreign oil and ensuring energy security and 3) Biofuels bolster agriculture. However, biofuels also raise a variety of concerns and draw attention from critics. The main arguments are; 1) Growth in biofuel production increases world food prices which affects everyone, especially the poor and 2) More growth in biofuel production could result in agricultural land use expansion (e.g. cultivating land in rain forests) and increased use of agrichemicals like fertilizers that would be harmful for the environment.

Biofuels are not created equally, thus one would expect the economic and the environmental impact of biofuels to be heterogeneous varying with space and time. Globally, first generation biofuel production (chiefly, ethanol made from corn or sugar cane and biodiesel made from vegetable oil) is dominated by few players. In 2005, Brazil

and the United States together accounted for 99 percent of global ethanol production, whereas Germany and France accounted for 69 percent of global biodiesel production (Msangi et al., 2007).

Ethanol production capacity, the most widely used biofuel, has grown over time in the U.S. (Seelke and Yacobucci, 2007). In 2008, America's annual operating capacity increased by 2.7 billion gallons, a 34% increase over 2007 (RFA 2009 Annual Report). Figure 1.1 illustrates the historical chart for the production of ethanol in the U.S.



**Figure 1.1. Historical U.S. Fuel Ethanol Production**

Cellulosic sources of feedstock for ethanol production hold some promise for the future; however the current primary feedstock in the United States is corn. Corn prices have created a great deal of concern in the agricultural markets; particularly seed, fertilizer and livestock. Market power is mentioned frequently in debates regarding the impact of biofuel policies. Because seed, fertilizer and livestock market have become more concentrated with mergers and acquisitions over time, the outcome of government support to biofuels might be huge, varying with their industry link to corn markets. In other words, some of the large suppliers might capture significant shares of the benefits that come along with biofuel regulations, while some others might suffer because of the unfavorable effect of ethanol on their businesses.



The objective of this thesis is threefold: The first objective is to analyze U.S biofuel policies and their motives. The second objective is to establish a relationship between corn prices and share prices by analyzing seed, fertilizer and livestock market environment. The final objective is to construct both theoretical and econometric models in a way that would reveal the effects of biofuel policy, through corn future prices, on share prices of eight leading companies in seed, fertilizer and livestock industries; and answer the primary research question, “What is the effect of biofuel policies on stock prices in imperfect market?”

In the next section, a review of literature is presented. The third section provides a historical perspective on biofuels while describing various types of biofuels and the drivers for the growth in biofuel production. The fourth section addresses the seed, fertilizer and livestock market environment, and corporate history of selected companies in those sectors. The fifth section discusses economic theories and models that relate to impacts of biofuel policies. Then the methodology for developing the econometric model is discussed and the empirical model is estimated. Final thoughts are provided in the conclusion of this thesis.

## **CHAPTER 2**

### **REVIEW OF LITERATURE**

This chapter is a review of previous studies related to the link between biofuel policy and agricultural markets and assessment of the regulation influence on stock markets. This chapter will be organized into 2 subsections: Market implications of biofuel policy and policy implications for stock market.

#### 2.1. Market Implications of Biofuel Policy

Several models have been augmented to study the market implications of biofuel policies in various aspects.

Hamm et al. (2008) discussed the effectiveness of broiler corn (B: C) ratio to identify profit opportunities in the poultry industry. The objective of their study was to determine the relationship among input and output prices, various supply indicators and stock share price for four major broiler producers across the period 1989-2005. Because corn accounts for greater portion of poultry feed, upwards of 70 percent, they argued that B: C ratio would be highly likely to be useful as a profit indicator to account for the volatility of poultry profits due to increasingly volatile corn prices stemming from increased ethanol production. They developed a model to determine the magnitude and importance of the B: C ratio and other supply indicators, such as total chicken in cold storage, number of eggs set and chicks placed, broiler exports, prices per pound of whole broiler without giblets, boneless skinless breast and leg quarters corn price per bushel and total ready-to-cook broiler production on stock share price of four major broiler producers. Hamm et al. did not include any financial variables, like Standard and Poor's index into their models. Three sets of modeling procedures were employed: Ordinary Least Squares, Maximum Likelihood and Polynomial Distributed Lag. They also compared and contrasted the results of three model estimation techniques with results obtained from utilizing VAR modeling of the B: C ratio to estimate share price given shocks to the B: C ratio. Empirical results indicated that industry structure could be a factor in the ability to respond to input and output price changes given the rapid concentration and diversified production. They also concluded that the broiler-corn ratio is of interest for firms because

decision makers may be able to anticipate the price changes and predict the magnitude and the direction of profitability for the firm.

Bhattacharya, et al. (2009) developed a multi market equilibrium displacement model (EDM) to account for the demand and supply interdependence between corn, ethanol, ethanol byproducts and different types of meat. Bhattacharya et al. studied 6 markets: beef, pork, poultry, corn, ethanol, ethanol byproducts. Bhattacharya et al. did not discuss the linkage between ethanol and meat markets at firm-level. From the EDM solution they derived own- and cross elasticities of interest by simply dividing the percentage changes in quantities by the pertinent percentage changes in prices. They found that a 10% percent shift in ethanol demand raises the corn price by 4.48% leading to a decline in corn demand by 4.05% for cattle, 2.38% for hogs, and 8.55% for chicken. They also provided total elasticities of prices and quantities in the meat marketing channel with respect to changes in the price of ethanol, the price of corn, and the price ethanol by products. In all cases they found the poultry sector to be most sensitive, followed by beef and pork.

Muhammad et al. (2007) examined the poultry supply response to changes in feed costs, particularly corn prices. The objective of this study was to determine sensitivity of U.S. broiler production to changes in corn prices. Muhammed et al. represented the model by the following two equations:

$$(2.1) \Delta Q_t = \Pi_0 + \Pi_1 \Delta p_{t-1} + \Pi_2 \Delta fp_{t-1} + \Pi_3 \Delta w_{t-1} + \Pi_4 \Delta h_{t-1} + \varepsilon_t$$

$Q$  is total U.S. broiler production in thousands of pounds. Broiler prices in cents per pound are represented by  $p$ , and  $fp$  is the broiler feed-price ratio. The variable  $w$  represents farm wages and  $h$  is the number of chicks hatched which measures the number live chicks taken from incubators.  $\varepsilon_t$  is a random disturbance term. For any  $x$  variable,  $\Delta x_t = \log(x_t) - \log(x_{t-4})$ . This equation stated that the log change in broiler production is a function of the log change in output prices, feed-price ratio, wages, and chicks hatched the pervious quarter. The derived demand for hatched chicks was estimated as well. The derived demand equation is;

$$(2.2) \Delta h_t = \beta_0 + \beta_1 \Delta fp_t + \beta_2 \Delta w_t + u_t$$

Equation (2.2) states that the number of chicks hatched in period  $t$  is a function of the feed-price ratio and farm wages. All variables in equation (2.2) are log changes and  $u_t$  is a random disturbance term. Muhammad et al. estimates equations (2.1) and (2.2) using quarterly data from 1987 to 2004. They found that 1 percentage increase in feed cost decreased U.S. broiler production by 0.06 percent and 1 percentage increase in corn cost decreased U.S. broiler production by 0.042 percent.

Taheripour and Tyner (2007) used general and partial equilibrium models to analyze how the benefits of the ethanol subsidy are allocated among farmers, ethanol producers, fuel blenders, and land owners. They showed that farmers will capture an increasing portion of the benefits associated with the ethanol subsidy as the market for ethanol grows and accounts for a larger share of the corn market purchases. They also showed that in the presence of a fuel standard and a limited production capacity of ethanol, the ethanol industry has the potential to capture the whole ethanol subsidy.

Saitone et al. (2008) developed an analytical model for determining the production and price impacts and distribution of benefits from the ethanol subsidy when market power may be exercised by upstream sellers in the seed sector and downstream buyers in the corn-processing sector. Analytical results from their general model demonstrated that market power, whether exercised by oligopsony corn processors or oligopoly seed manufacturers, would reduce the expansion in corn output due to the subsidy. They found that upstream oligopoly power exercised by seed producers is as important in influencing the positive and distributional impacts of the subsidy as downstream corn processors buyer power.

## 2.2. Policy Implications for Stock Market and Modeling Expected Returns

Economists have always been interested in the impact of economic events on the value of firms. This is a difficult task as it requires a detailed analysis of the impact. It is important to identify when the market first anticipates the effects of the event on future

profitability. An event study measures the impact of a specific event on the value of a firm using financial market data.

MacKinlay (1997) described the procedure to conduct an event study in three steps; 1) Defining the event and identifying the period over which the security prices of the firms involved will be examined--the event window, 2) After identification of the event, determining the selection criterion or criteria to select the firms for the event study, and 3) Measuring the abnormal return to estimate the event's impact. The abnormal return is the difference between the actual ex post return of the security over the event window and the normal return of the firm over the event window. The normal return is defined as the expected return that would take place in the absence of the event.

Biofuel regulations have been enacted in various forms over time. Because there are a vast number of policies in the biofuel historical context, it is difficult to define the event and to anticipate the event window for this study.

MacKinlay (1997) mentioned different approaches to model the return of a given security. He grouped the approaches into two categories: statistical and economic. The statistical approach follows statistical assumptions to model the behavior of stock returns without any economic intuition. However, the economic approach relies not only on statistical assumptions but also on investor's action and behavior. Hence; the potential advantage of economic models over statistical models is the opportunity to calculate more precise measures of the normal return using economic restrictions. In order to correctly specify the statistical methods, the assumption that asset returns are jointly multivariate normal and independently and identically distributed through time is imposed.

The main statistical methods mentioned by MacKinlay (1997) are

1) *Constant Mean Return Model*: The constant mean return model is specified as;

$R_{i,t} = \mu_{i,t} + \varepsilon_{i,t}$  where  $\mu_{i,t}$  is the mean return for asset  $i$ ,  $R_{i,t}$  is the period  $t$  return on security  $i$  and  $\varepsilon_{i,t}$  is the period  $t$  disturbance term for security  $i$ .

2) *Market Model*: The market model relates the return of any given security to the return of the market portfolio. The model's linear specification follows from the assumed joint

normality of asset returns. The model is specified as;  $R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}$ , where  $R_{i,t}$  and  $R_{m,t}$  are period  $t$  returns for the security  $i$  and market portfolio respectively.  $\varepsilon_{i,t}$  is zero mean disturbance term.

As the market return is added into the model, the portion of the return that is related to variation in the market's return is removed. There are also other statistical models that are used in order to measure the return of the stocks beyond constant return model and market model. A general such type of statistical model is the factor model. The reasoning behind factor models is to benefit from additional factors which explain more of the variation in the return. The market model is an example of a one-factor model.

Two common economic models which provide economic restrictions on the statistical assumptions to model the behavior of the stock returns are the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). Broadly speaking, CAPM emphasizes the role of covariance between asset returns and an endogenous preference-based aggregate, while APT is an asset pricing paradigm which focuses on the covariance between asset returns and factors in the return generating process.

There are several capital asset pricing models (CAPM) in the literature helping us to describe how investors assess the risk and value risky cash flows. Among them, the Sharpe-Lintner-Mossin-Black model (CAPM) is the one that is most widely used. Harry Markowitz (1991)'s work on portfolio theory considers how an optimizing investor would behave, whereas the work by Sharpe (1964) and Lintner (1965) on CAPM is concerned with economic equilibrium assuming all investors optimize in the particular manner Markowitz proposed. In Markowitz's model, an investor chooses a portfolio at time  $t-1$  that produces a stochastic return at  $t$ . Markowitz assumes that the investors are risk averse and, their choice for the portfolio is based only on the mean and variance of their one-period investment return. Thus, investors choose "mean-variance-efficient" portfolios, in the sense that the portfolios minimize the variance of portfolio return, given expected return. Sharpe (1964) and Lintner (1965) add two key assumptions to the Markowitz model to identify a portfolio that must be mean-variance-efficient; 1) *Complete Agreement*: Given market clearing asset prices at  $t-1$ , investors agree on the

joint distribution of asset returns from  $t-1$  to  $t$ ; in other words, investors make the same forecasts of expected returns, variances and covariances, and 2) *Borrowing and Lending at a risk-free rate*: The level of borrowing and lending is the same for all investors and does not depend on the amount borrowed or lent.

The portfolio model provides us with an algebraic condition on asset weights in mean-variance-efficient portfolios. With CAPM, this algebraic statement could be turned into a testable prediction about the relation between risk and expected return.

Jensen (1968) was the first to note that the Sharpe-Lintner version of the relation between expected return and market beta also implies a time-series regression test. The Sharpe-Lintner CAPM says that the expected value of an asset's excess return is completely explained by its expected CAPM risk premium. This implies that the intercept term in the time-series regression is zero for each asset. In Black, Jensen, and Scholes' (1972) study, the intercept of their regression line was significantly different from its theoretical value- zero. Black et al. used all of the stocks on the New York Stock Exchange during 1926–66 to form ten portfolios with different historical beta estimates. They found that high-beta securities had significantly negative intercepts and low-beta securities had significantly positive intercepts, contrary to the predictions of the traditional form of the model.

Traditional CAPM approach has only “one systematic risk factor” which is referred as market risk; hence the familiar CAPM equation is just an application of the relation between expected return and portfolio beta to the market portfolio. In the late 1970s, research began to uncover variables like size, various price ratios and momentum that add to the explanation of average returns provided by beta (Fama and French, 2004). Fama and French (1992) found that, for 1963-1990 period, beta has no ability in explaining cross-sectional variation in equity returns, but variables such as size and the book-to-market value of equity (BE/ME) do.

Chen, Roll, and Ross (1986) explored a set of economic state variables as systematic influences on stock market returns and examined their influence on asset pricing. The variables they included are the growth rate of industrial production, the difference

between the returns on high and low-grade bonds, the difference between the returns on long and short-term bonds and unexpected inflation. They concluded that stock returns are exposed to systematic economic news, that they are priced in accordance with their exposures, and that the news can be measured as innovations in state variables whose identification can be accomplished through simple and intuitive financial theory. There are a number of studies which use macro-economic variables as factors in order to examine the stock performance during good or bad macroeconomic times determining average returns. These variables include investment-capital ratio and consumption wealth ratio (Javid and Eatzaz, 2009).



## **CHAPTER 3**

### **BACKGROUND**

Globally, biofuels, like all the other alternative energy technologies, have relied heavily on government support to compete with fossil fuels. The evolution of biofuels have been influenced by both explicit policies such as excise tax exemptions, mandatory blending requirements, renewable fuel standards, and indirect policies such as carbon policies, agriculture and trade policies, vehicle policies, etc. (Rajagopal and Zilberman, 2007). Biofuel policies are motivated not only by the potential for short-term gains but also by a will to act on climate change related problems expected to appear in the longer term (Charles et al., 2007). The U.S. biofuel policies enacted in the 1970s encouraged only limited growth in biofuels at that time; however there is no question that they played an important role in setting the stage for the recent significant growth in the production and use of biofuel. It is very likely that the government support will continue in the future to support biofuels (Rajagopal and Zilberman, 2007).

Before getting into the details of biofuel policies in the U.S., it would be appropriate to outline various types of biofuels and to analyze the drivers for the biofuel promotion policies at this point. In the first instance, it is worth noting that despite the existence of a wide variety of biofuels being produced from agricultural resources, the focus of this thesis is mainly on ethanol.

### **3.1 Major types of Biofuel**

A variety of biofuels can be derived from biomass. Biofuels can be grouped into two categories; 1) first generation biofuels 2) second generation biofuels

#### **3.1.1. First generation biofuels**

The first generation biofuels refer to the fuels that are derived from agricultural crops traditionally grown for food and animal feed purposes using conventional methods. Ethanol, along with biodiesel, is the current chief candidate as a petroleum replacement in internal combustion engines (Charles et al., 2007).

Ethanol is usually produced in the U.S. from the distillation of fermented simple sugars derived primarily from corn, but also from wheat, potatoes, or other vegetables. However in some other countries, for example Brazil, it is produced from sugarcane. The production process is similar to that of brewing beer; starch crops are converted into sugars; the sugars are fermented into ethanol, and finally the ethanol is distilled into its final form. Biodiesel, on the other hand, is produced from oilseed crops like soybean, rapeseed, and oil palm. The biggest use of fuel ethanol in the United States is as an additive in gasoline. Fuel ethanol is generally blended in gasoline to reduce emissions, increase octane, and extend gasoline stocks (Yacobucci, 2006). Ethanol, in purer forms, can also be used as an alternative to gasoline in automobiles specially designed for its use. Just like ethanol, biodiesel can be utilized on its pure form or as an additive as a renewable substitute fuel for diesel engines in order to lessen harmful vehicle emissions.

### 3.1.2 Second generation biofuels

It has been increasingly believed that first generation biofuels are limited in their ability to achieve targets for oil-product substitution, climate change mitigation and economic growth. Also, vast majority of first-generation biofuel feedstocks constitute edible materials, which has led to concerns about biomass traditionally used for human consumption being diverted to fuel production (van der Laak et al., 2007). Nevertheless, there are other more promising options, called second generation or advanced biofuels which are produced from non-food biomass. Second generation biofuels could offer greater benefits in the longer term (Sims et al., 2009).

Projections for when second generation biofuels are likely to be commercial are wide ranging, however often considered unlikely to occur before 2015 or 2020 (IEA 2008). The necessary conversion technologies are not technically proven at commercial scale and the cost of production seems to be significantly higher than that of first generation biofuels. Hence, second generation biofuels are not likely to be commercialized anytime soon (IEA 2008).

Two types of process are especially noteworthy. In the first process, enzymes are used to convert plant cellulose into bioethanol yielding lignocellulosic bioethanol. The second

process is anhydrous pyrolysis, i.e., the chemical breakdown of biomass by heating in the absence of oxygen to convert plant material into bio-oil or syngas (Charles et al., 2007).

### 3.2 Drivers for Biofuel Policies

Energy has increasingly become a buzzword in the news. President Barack Obama directed attention to energy problems once again in his April 22<sup>nd</sup> 2009 speech in Iowa with the following quote;

“...We must create the incentives for companies to develop the next generation of clean energy vehicles – and for Americans to drive them. ...administration has begun to put in place higher fuel economy standards for the first time since the mid-1980s – so our cars will get better mileage, saving drivers money and spurring companies to develop more innovative product. ...administration will be pursuing comprehensive legislation to move toward energy independence and prevent the worst consequences of climate change – while creating the incentives to make clean energy the profitable kind of energy in America. ...invests in advanced biofuels and ethanol, which, as I’ve said, is an important transitional fuel to help us end our dependence on foreign oil while moving toward clean, homegrown sources of energy.”

For a long time, there seemed to exist no alternative energy that could compete with oil in terms of cost and convenience for transportation. But today, fuels like ethanol and biodiesel seem to be emerging as serious alternatives (Rajagopal and Zilberman, 2007).

The main reasons for the popularity surrounding biofuels are;

- ***Biofuels can mitigate climate change and reduce carbon emissions.*** The use of biofuels is supported on the basis that it can provide a partial solution to reduce GHG emissions in the atmosphere. The direct carbon emission from combustion of biofuels is not that significant compared to fossil fuels. However, indirect carbon emissions from agriculture and processing can be significant (Rajagopal and Zilberman, 2007).
- ***Biofuels support agriculture and the economy.*** Diverting some agricultural resources to the production of bioenergy offers an attractive way of helping farmers, especially in developed countries. For instance, the diversion in the U.S. helps maintain maize prices, reducing the need for price compensation and export subsidies

(Hazell and Pachauri, 2006). Currently, the cultivation of biomass for first-generation biofuels benefits the agricultural sector. One should keep in mind that if there are increased moves towards the second generation biofuels, the farmers currently relying on crops used for first generation biofuels production would be affected adversely (Charles et al., 2007).

- ***Biofuels increase energy and national security.*** Hydrocarbon-based fuel sources are non-renewable. Hence, governments are investigating ways of developing alternative technologies to replace hydrocarbon-based fuels (Charles et al., 2007). Energy security is closely tied to national security. Domestic production and use of bioenergy decreases reliance on imported oil and increase the U.S.'s ability to control its own security and economic future by increasing the availability of domestic fuel supplies.
- ***Biofuels are replenishable and requires little infrastructural change.*** Biofuels are an inexhaustible resource since the stock can be replenished through agriculture (Rajagopal and Zilberman, 2007). Biofuels require little change to engines and motors already in use (Charles et al., 2007).

In the next section, I will try to discuss some widely used policies, the various forms in which they exist, and the implications of such policies for the biofuel industry in the United States.

### 3.3 Historical Perspective on Biofuel Policy

In the late 1970s, OPEC reduced crude oil supplies which led to a significant increase in fuel prices in the world market. The interest in liquid biofuels increased substantially during this period--both the U.S. and Brazil launched subsidized ethanol programs.

Subsidization of ethanol in the U.S. began with the Energy Policy Act of 1978. The Act reduced the motor fuels excise tax for ethanol-gasoline blends to initiate the industry. The motor fuels excise tax exemption was set at 4 cent per gallon of gasohol<sup>1</sup>—a blend of 10 percent ethanol and 90 percent gasoline, also called E10—equivalent to 40 cent per gallon of pure ethanol. The main arguments used to justify the subsidy were a) enhanced farm income and b) energy security. The Crude Oil Windfall Profits Tax Act of 1980

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<sup>1</sup> Technically, gasohol is any blend of ethanol and gasoline, but the term most often refers to the 10% blend.

extended the gasohol tax exemption<sup>2</sup> through the end of 1992. It also introduced a tax credit<sup>3</sup> available to alcohol fuel blenders, or to retailers in the case of sales of neat alcohol (E85 or higher) (Koplow 2006). The American Jobs Creation Act of 2004 changed the way taxes were collected on gasohol and other ethanol blends. Commonly referred to as the "blender's credit," the Volumetric Ethanol Excise Tax Credit (VEETC) was created in 2004 as part of the Act. VEETC is currently authorized through December 31, 2010. The Act provided greater flexibility by providing a new excise tax credit system for all ethanol blends and biodiesel. The Act provided blenders with reimbursement (from general tax revenues), deposited all taxes paid on gasohol and other ethanol blends into the Highway Trust Fund, and allowed farmer cooperatives to claim the small ethanol producer tax credit (Clean Fuels Development Coalition-CFDC). Prior to 2004, the Highway Trust Fund was losing funds from what otherwise would have been tax receipts from ethanol consumption (de Gorter and Just, 2008).

Between 1978 and today, the ethanol subsidy has ranged between 40 and 60 cents per gallon (Tyner 2008). As of January 1, 2009, the original tax credit totaling 51 cents per gallon on pure ethanol (5.1 cents per gallon for E10, and 43.35 cents per gallon on E85) was reduced to 45 cents per gallon.<sup>4</sup>

Government policies have also aimed to stimulate supply and demand for ethanol vehicles. In 1988, federal legislation began addressing the consumption side of the alternative fuels market. The Alternative Motor Fuels Act passed that year provided credits to automakers in meeting their Corporate Average Fuel Economy standards when they produced cars fueled by alternative fuels, including E85 (Leiby and Rubin 2000). Support on the consumption side continued in the Energy Policy Act of 1992 (EPACT92), which established E85 as an alternative transportation fuel. The EPACT92 also set a national goal of 30 percent penetration of alternative fuels in light-duty vehicles by 2010. It also required the federal government, alternative fuel providers, state and local

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<sup>2</sup> A **tax exemption** is an exemption from all or certain taxes of a state or nation in which part of the taxes that would normally be collected from an individual or an organization are instead foregone. Retrieved from [http://en.wikipedia.org/wiki/Tax\\_exemption](http://en.wikipedia.org/wiki/Tax_exemption)

<sup>3</sup> A **tax credit** reduces the amount of tax to be paid on dollar-for-dollar basis; it is not a deduction which reduces the income that is subject to taxation.

<sup>4</sup> Retrieved from <http://www.ethanol.org/index.php?id=78&parentid=26>

governments and private fleets to purchase vehicles that ran on alternative fuels (Koplow 2006).

Environmental concerns have also helped improve the market position of biofuels. The Clean Air Act in 1990, through which Congress acknowledged for the first time the contribution of motor fuels to air pollution, required vendors of gasoline to have a minimum oxygen percentage (by weight) in their product. Adding oxygen enables the fuel to burn cleaner than does the gasoline alone (Birur et al., 2007). The main sources of this added oxygen were methyl tertiary butyl ether (MTBE) and ethanol. Because oil industry already had more than a decade of experience using MTBE as an octane enhancer and MTBE was generally cheaper than ethanol, MTBE was more popular than ethanol before the turn of the century. However, the growth in MTBE use was short-lived, as it was found to contaminate the water supplies in several regions of the country. By 2005, it had been banned as an additive by 20 states. The oil companies sought legal exemption from prosecution regarding MTBE; however they lost that battle, although they did succeed in eliminating the percentage-oxygen requirement. In May 2006, when the changes in the clean air rules were implemented---blend of certain amount of oxygen is no longer a requirement--- many companies switched to ethanol since they feared legal prosecution if they continued to use MTBE (Tyner 2008). It was this enormous immediate demand that kick-started the growth of the ethanol industry.

Additional support for developing ethanol production facilities came through the small ethanol producer tax credit, first passed in the Omnibus Budget Reconciliation Act of 1990. This tax subsidy gave certain producers a 10 cents per gallon credit on their first 15 million gallons (\$1.5 million per plant) produced each year. Plants with a capacity in excess of 30 million gallons a year were not eligible. This capacity was doubled to 60 million gallons a year in the EPACT05. This tax credit is on the books through December 31, 2010 (Koplow 2006).

Other notable policies benefiting domestic ethanol industry have been supplemental import tariffs on foreign produced ethanol. The tariff has been criticized since the critics believed that it contradicts the goals of improving the environment, reducing reliance on oil and oil imports and diversifying energy sources. The argument behind the criticisms

go as follows; 1) The tariff affects imports from Brazil where sugar cane based ethanol is produced and 2) Sugar cane based ethanol contributes relatively more to reduction of green house gas (GHG) emission when compared with corn based ethanol produced in USA (de Gorter and Just, 2008)

Imports of ethanol in the U.S. have an ad valorem tariff of 2.5% and an import duty of 54 cents per gallon. The rationale for the import duty was to offset the value of the ethanol tax credit taken by the petroleum industry when both domestic and imported ethanol is blended with gasoline. However, there are exceptions to this rule. The U.S.-Israel Free Trade Agreement and the North American Free Trade Agreement allow ethanol that is fully produced with feedstocks from the countries that entered to the agreements, to enter the U.S. duty-free. Congress has also created some unilateral trade preference programs, such as the Caribbean Basin Initiative and the Andean Trade Preference Act that allow ethanol produced in those countries to enter the U.S. duty free. This means that ethanol producers in those countries avoid the secondary tariff as long as the ethanol is produced from within their own country (RFA).

Beside subsidizations and tariffs, the U.S. government has exerted more direct control over fuel markets by renewable fuel standards and mandatory blending requirements. The Energy Policy Act of 2005 (EPACT 2005) ensured gasoline sold in the U.S. contained a minimum volume of renewable fuel, called the Renewable Fuels Standard (RFS). The U.S. Congress gave the U.S. Environmental Protection Agency (EPA) the responsibility to coordinate with the U.S. Department of Energy, the U.S. Department of Agriculture, and stakeholders to design and implement this new program. The RFS mandated fixed minimum consumption per year of particular specified fuels, with the mandated level rising over time. The EPACT 2005 mandated the production of 7.5 billion gallons by 2012. The Energy Independence and Security Act of 2007 (EISA) extended the RFS signed into law in 2005, growing to 36 B gal to be blended into gasoline, diesel and jet fuel by 2022. The new RFS does not allow more than 15 B gal per year of starch-derived ethanol (e.g., corn ethanol) to satisfy the mandates; hence the new extended RFS essentially mandated second generation biofuels or biofuels with lower GHG emissions than corn ethanol (RFA).

On May 5, 2009, the EPA proposed regulations to implement significant changes to the RFS program, which is known as “RFS2”. The new proposal includes new registration, recordkeeping, and reporting requirements for biofuel producers, including possible on-site engineering reviews by a certified Professional Engineer.<sup>5</sup> As required by the EISA, changes under EPA’s new proposal to the existing RFS program include; 1) Significant expansion of the escalating volumes of renewable fuel required each year (to reach 36 B gal by 2022), 2) Separation of the volume requirements into four categories of renewable fuel (conventional biofuel, advanced biofuel, biomass-based diesel, and cellulosic biofuel), 3) Expansion of the scope of the program to include all transportation fuels, including gasoline and diesel intended for use in highway vehicles and engines, as well as non-road locomotives and marine engines, 4) Inclusion of specific types of waivers and EPA-generated credits for cellulosic biofuels, and 5) New definitions and criteria for both renewable fuels and the feedstocks used to produce them. These definitions affect feedstock use for production of renewable fuels and certain restrictions on the type of land that can be used to grow those feedstocks.

Figure 3.1 shows the annual volume requirements established by the EPA. There is a notable increase in the mandate for cellulosic biofuels in particular. The mandates will likely to provide a strong interest for investment in cellulosic production over the next decade.

Renewable Fuel Volume Requirements for RFS2 (billion gallons)				
YEAR	CELLULOSIC BIOFUEL REQUIREMENT	BIOMASS-BASED DIESEL REQUIREMENT	ADVANCED BIOFUEL REQUIREMENT	TOTAL RENEWABLE FUEL REQUIREMENT
2008	n/a	n/a	n/a	9.0
2009	n/a	0.5	0.6	11.1
2010	0.1	0.65	0.95	12.95
2011	0.25	0.80	1.35	13.95
2012	0.5	1.0	2.0	15.2
2013	1.0	a	2.75	16.55
2014	1.75	a	3.75	18.15
2015	3.0	a	5.5	20.5
2016	4.25	a	7.25	22.25
2017	5.5	a	9.0	24.0
2018	7.0	a	11.0	26.0
2019	8.5	a	13.0	28.0
2020	10.5	a	15.0	30.0
2021	13.5	a	18.0	33.0
2022	16.0	a	21.0	36.0
2023+	b	b	b	b

<sup>a</sup> To be determined by EPA through a future rulemaking, but no less than 1.0 billion gallons.  
<sup>b</sup> To be determined by EPA through a future rulemaking.

Source: EPA

**Figure 3.1. Renewable Fuel Volume Requirements for RFS2**

<sup>5</sup> Retrieved from <http://www.ethanolrfa.org/objects/documents/2435/june9rfshearing.pdf>



Along with RFS2, a fuel pathway is established for each fuel to trace back aggregate GHG emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes) produced over the fuel's full lifecycle. Each renewable fuel pathway has a unique lifecycle GHG emissions impact in grams/mmBtu. GHG thresholds are defined as the percent (%) reduction in lifecycle GHG emissions for a renewable fuel in comparison to the 2005 baseline (established by EISA) gasoline or diesel that it displaces. These lifecycle emissions are used to assign each pathway to one of the four renewable fuel categories by comparing it to the applicable threshold

EISA legislation requires that lifecycle GHG emissions for corn ethanol from plants constructed after December 2007 must be at least 20 percent less when compared to average emissions from petroleum fuels in order to qualify as a renewable fuel under the statute. Lifecycle GHG emissions must be at least 50 percent less than the 2005 baseline lifecycle GHG emissions to qualify as an advanced biofuel or biomass-based diesel. The advanced biofuel category can apply to a variety of fuels, including biomass-based diesel, biogas, butanol or other alcohols and fuels derived from cellulosic biomass (i.e. ethanol from cellulose, hemicelluloses, lignin, sugar or any starch other than corn starch). Lifecycle GHG emission must be at least 60 percent less than the 2005 baseline lifecycle GHG emissions to qualify as a cellulosic biofuel. Cellulosic biofuel is defined as any renewable fuel – not necessarily ethanol – that is derived from cellulose, hemicelluloses or lignin (EPA).

It has been estimated that indirect land use change associated with biofuels releases GHG emissions well in excess of gasoline emissions (Searchinger et al., 2008). Because there seems to be scientific uncertainty in measuring indirect emissions related to both biofuels and gasoline, the regulation itself is highly controversial, presenting regulators with a dilemma on whether and how to calculate them.<sup>6</sup> Tilman et al., 2009 note that if biofuels come from feedstocks produced with low life-cycle GHG emissions as well as minimal competition with food production, biofuels can be produced in large quantities and can have multiple benefits. In order to balance biofuel production, food security and emissions reduction, Tilman et al. conclude that the global biofuels industry must focus

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<sup>6</sup> See [http://www.ethanolrfa.org/objects/documents/2363/2009\\_liskaperrin\\_bbb.pdf](http://www.ethanolrfa.org/objects/documents/2363/2009_liskaperrin_bbb.pdf) for further discussion.

on five major sources of renewable biomass: 1) Perennial plants grown on degraded lands abandoned from agricultural use, 2) Crop residues, 3) Sustainably harvested wood and forest residues, 4) Double crops and mixed cropping systems, and 5) Municipal and industrial wastes.

The RFS2 proposal also discusses various legal, practical and economic issues associated with overcoming the E10 Blend Wall (RFA). The “blend wall” is the upper limit to the total amount of ethanol that can be blended into U.S. gasoline. Gasoline content is currently limited to 10 percent by volume by regulations. U.S. gasoline consumption is around 145 billion gallons each year and approximately 120 billion gallons are subject to the RFS ethanol blending formula. EPA has been petitioned by the ethanol industry to solve the "blend wall" dilemma by permitting ethanol blends up to 15 percent (E15) since ethanol industry is expected to hit the "blend wall" between 2011 and 2012, even if every gallon of gasoline included in the RFS were blended with 10 percent ethanol. It has been discussed that increasing gasoline blends from E10 to E15 could solve the blend wall issue, but it might create other problems that would need to be resolved (Petroleum Marketers Association of America, PMAA).

## **CHAPTER 4**

### **COMPANY REVIEW**

This chapter is a review of seed, fertilizer and livestock industries, as well as a discussion about the effects of the U.S. biofuel policies on those industries. It also reviews corporate history of several companies selected on the basis of their perceived market shares.

#### 4.1 Seed Industry

The sustainability of the biofuel industry depends on the capacity of agriculture to meet ever-increasing demand for energy crops. Corn is the most widely produced feed grain which accounts for more than 90 percent of total value and production of feed grains. The majority of the corn is grown in the Heartland region<sup>7</sup>. U.S. biofuel policies have promoted corn-based ethanol production since the early 1980s. Season average annual prices for corn and many other crops are not projected to reach the extreme highs seen in the first half of 2008, however the continued demand for corn-based ethanol, in combination with other long-term factors (i.e. future macroeconomic growth in U.S and worldwide, and increased livestock production) is expected to hold crop prices above their historical levels (Economics Research Service, USDA).

Growth in agricultural production is possible under two circumstances; either more land must be brought into production or more food must be produced on existing land. Bringing unfarmed land into production is not an eco-friendly solution and will not be sufficient to meet demand according to the Food and Agriculture Organization of the United Nations (FAO). The FAO expects only 20% of production growth to come from land expansion (FAO, 2002). The overwhelming majority of production growth will need to come from improved yields.

Companies have introduced hybrid seeds and then introduced biotech traits into them which offered opportunities to increase agricultural production without land expansion

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<sup>7</sup> The Heartland Region includes portions of South Dakota, Nebraska, Iowa, Missouri, Illinois, Indiana, Ohio, and Minnesota's Ag. Statistics Districts 4, 7, 8, and 9. Minnesota is also part of the Northern Crescent and Northern Great Plains Regions. See ERS/USDA website for further information.

and without intensive use of inputs. First generation of genetically modified (GM) staple crops either produce *Bacillus thuringiensis* (Bt), a naturally occurring chemical deadly to common agricultural pests, or offer protection to crops against the common herbicide Round-Up, or both (Sexton et al., 2009). Farmers believe that using GM crops will offer many benefits, such as higher crop yields, greater flexibility in crop practice and lower pest management costs (Fernandez-Cornejo and McBride, 2002). Since their commercial introduction in 1996, U.S. farmers have rapidly adopted soybean, cotton, and corn seeds with herbicide tolerance (HT) and/or insect resistance (Bt) traits (USDA).

The seed industry can be viewed as comprising of four separate functions; 1) R&D in plant breeding, 2) Seed production 3) Seed conditioning and 4) Marketing/Distribution (Fernandez-Cornejo and Spielman, 2002).

Plant breeders contract out the production and multiplication processes to farmers, farmers' associations and private firms. Contract growers are provided with foundation seed<sup>8</sup> to produce either more foundation seed for R&D purposes or registered seed<sup>9</sup> for large scale production purposes. Registered seed is also contracted out to produce certified seed<sup>10</sup> (Fernandez-Cornejo and Spielman, 2002). In order to ensure that optimal growing conditions are maintained in production, the seed firm pays the contract grower a margin above the commodity market prices for the seed. (Agrawal et al., 1998). When corn is harvested, certified seed is conditioned for sale to farmers, a process that typically includes cleaning, sorting of the seed, treating it with insecticides and fungicides and packaging it for distribution and sale (Krull et al., 1998).

An important portion of the market price for seed incorporates R&D costs, particularly for hybrids or transgenic seeds over which private firms own exclusive proprietary rights. R&D costs vary among the different seed markets. For example, corn is extensively dependent on private sector R&D. Advertising, promotion, and distribution are other major costs varying with the stage of the product cycle (Fernandez-Cornejo, 2004).

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<sup>8</sup> high quality, pure parent seed stock produced from the original seed and used for multiplication purposes.

<sup>9</sup> grown from foundation seed to increase the scale of commercial multiplication and production.

<sup>10</sup> sold commercially to farmers and conforms to certain standards of genetic purity and quality established by state agencies.

A striking reorganization of firms and industry structure has taken place through time as the seed industry has adopted biotechnology. Large diversified firms, with backgrounds in agricultural chemicals (i.e. DuPont, Dow, Monsanto) or in pharmaceuticals (i.e. Novartis, Aventis) made large investments in the industry through several acquisitions of seed companies and small biotechnology research firms. Hence, seeds have become a concentrated market with a small set of large firms active across many crop categories (MacDonald, 2000).

The reasons for the reorganization of firms vary. Economies of scale might be a driver for the acquisitions since large firms may be more effective at developing and marketing new seeds. New traits developed during the research process must be combined with existing seed types that contain other desired characteristics. The knowledge and seed traits can be transferred among research firms and existing seed companies by market arrangements. However, there might be some potential problems with arrangements over time, therefore seed firms often ally or merge with research firms in order to reach smoother arrangements. Newly developed seeds may reduce the need for herbicides or pesticides, or may alter the mix of specific agricultural chemicals that a farmer needs. Because a farmer's chemical and seed decisions are often made jointly, and because agricultural chemical companies possess strong organizational skills in terms of marketing and research, there have been mergers and alliances among chemical firms, research firms, and seed firms.

The Action Group on Erosion, Technology and Concentration—the ETC Group—monitored concentration in the seed industry. Their data shows that the top ten multinational seed firms control more than half of the world's commercial seed sales (ETC Group, 2007). The top ten seed firms worldwide (by value of sales) are shown in Table 4.1 below.

**Table 4.1. World's Top Ten Seed Companies Based on 2006 Seed Revenues**

<i>Company</i>	<i>2006 seed sales</i>
	US \$ millions
1. Monsanto + Delta & Pine Land (US) pro forma	\$4,476
2. DuPont (US)	\$2,781
3. Syngenta (Switzerland)	\$1,743
4. Groupe Limagrain (France)	\$1,035
5. Land O' Lakes (US)	\$756
6. KWS AG (Germany)	\$615
7. Bayer Crop Science (Germany)	\$430
8. Takii (Japan) estimate	\$425
9. Sakata (Japan)	\$401
10. DLF-Trifolium (Denmark)	\$352

Source: ETC Group

Top ten seed corporations account for \$13,014 million or 57% of the commercial seed market worldwide based on their 2006 revenues. The top three seed companies account for \$9,000 million – or 39% of the commercial seed market worldwide. Monsanto, being at the top of the list, accounts for 20% of the world's commercial seed market. If we look at the proprietary seed market (that is, brand name, commercial seed – subject to intellectual property), the market share of the top ten seed companies is even greater. According to Context Network, the global proprietary seed market was worth \$19,600 million in 2006. In 2006, the top ten companies (all proprietary seed sellers) account for \$13,014 million – or 66% of the total proprietary seed market. Monsanto accounts for 23% - almost one-fourth of the global proprietary seed market. The top three companies – Monsanto, DuPont and Syngenta – account for 46% of the total proprietary seed market (ETC Group, 2007).

In this study, I will focus on the top three companies; Monsanto, DuPont-Pioneer Hi-Bred International and Syngenta. The next section is a brief description of corporate history and business units of those companies.

#### 4.1.1 Monsanto Company

The Monsanto Company (NYSE: MON) is a multinational agricultural biotechnology corporation. Monsanto is a relatively new company. The company shares the name and the history of a company that was founded in 1901, which mainly produced

and marketed agricultural chemicals. In 1997, Monsanto bought Asgrow, ELM, and Calgene; in 1998, it bought out DeKalb and Cargill's international seed business. Through the acquisition of biotechnology research companies, including Ecogen, Agracetus, and the Plant Breeding Institute, Monsanto also acquired the rights to seed technologies (Fernandez-Cornejo, 2004). Monsanto Company was first incorporated as a subsidiary of Pharmacia in 2000; the agricultural side of the merger retained the Monsanto name while the pharmaceutical and related side operated under the name of Pharmacia Corporation. Monsanto spun off as a separate company in 2002.<sup>11</sup>

Monsanto operates in two segments; Seeds and Genomics, and Agricultural Productivity.

The Seeds and Genomics segment sells corn, soybeans, canola, wheat and cotton seeds, as well as vegetable and fruit seeds through Asgrow, DEKALB, Deltapine, Genuity, Seminis, Vistive, YieldGard and YieldGard VT and organizational brands.<sup>12</sup> Monsanto aims to produce in-the-seed trait technologies for farmers to protect their yields, to increase the efficiency they derive from their land and to decrease their farm management costs. Monsanto also provides other seed companies with genetic material and biotechnology traits for their seed brands.

The Agricultural Productivity segment offers Roundup brand herbicides for agricultural, industrial, ornamental, and turf applications; lawn-and-garden herbicides for residential lawn-and-garden applications; and other selective herbicides for control of pre-emergent annual grass and small seeded broadleaf weeds in corn and other crops.<sup>13</sup>

Figure 4.1 and Figure 4.2 present net sales and gross profit for seeds and genomics, and agricultural productivity segments, respectively. As can be seen from the Figure 4.1, corn dominates Monsanto's seed sale. "Corn seed and traits" constitute approximately 35.2% of total gross profits in 2008, 40.6% of total gross profits in 2007 and 29.6% of total gross profits in 2006.

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<sup>11</sup> Retrieved from [http://www.monsanto.com/who\\_we\\_are/history.asp](http://www.monsanto.com/who_we_are/history.asp)

<sup>12</sup> Retrieved from <http://www.monsanto.com/products/brands.asp>

<sup>13</sup> Retrieved from <http://ca.finance.yahoo.com/q/pr?s=MON>

Monsanto has a higher stake in corn-based ethanol's success than any of its competitors, since it has both a great market share in US corn seed and a heavy focus on developing corn seeds. Monsanto's future is connected with that of ethanol, its future profitability lies on the anticipated success of ethanol and the resulting demand for Monsanto's Corn Seed.



**SEEDS AND GENOMICS SEGMENT**

	Year Ended Aug. 31,			Change
	2008	2007	2006	
(Dollars in millions)				
<b>Net Sales</b>				
Corn seed and traits	\$3,542	\$2,807	\$1,793	26%
Soybean seed and traits	1,174	901	960	30%
Cotton seed and traits	450	319	376	41%
Vegetable seeds	744	612	569	22%
All other crops seeds and traits	459	325	280	41%
<b>Total Net Sales</b>	<b>\$6,369</b>	<b>\$4,964</b>	<b>\$3,978</b>	<b>28%</b>
<b>Gross Profit</b>				
Corn seed and traits	\$2,174	\$1,721	\$1,019	26%
Soybean seed and traits	725	588	667	23%
Cotton seed and traits	313	267	305	17%
Vegetable seeds	394	267	296	48%
All other crops seeds and traits	251	171	146	47%
<b>Total Gross Profit</b>	<b>\$3,857</b>	<b>\$3,014</b>	<b>\$2,433</b>	<b>28%</b>
<b>EBIT<sup>(1)</sup></b>	<b>\$1,200</b>	<b>\$ 905</b>	<b>\$ 794</b>	<b>33%</b>

<sup>(1)</sup> EBIT is defined as earnings (loss) before interest and taxes. Interest and taxes are recorded on a total company basis. We do not record these items at the segment level. See Note 24 — Segment and Geographic Data and the "Overview — Non-GAAP Financial Measures" section of MD&A for further details.

**Figure 4.1 Net Sales and Gross Profit for Seeds and Genomics**

## AGRICULTURAL PRODUCTIVITY SEGMENT

	Year Ended Aug. 31,		Change 2008 vs. 2007	2007 vs. 2006
	2008	2007		
(Dollars in millions)				
<b>Net Sales</b>				
<i>Roundup</i> and other glyphosate-based herbicides	\$4,094	\$2,568	59%	14%
All other agricultural productivity products	902	817	10%	(1)%
<b>Total Net Sales</b>	<b>\$4,996</b>	<b>\$3,385</b>	<b>48%</b>	<b>10%</b>
<b>Gross Profit</b>				
<i>Roundup</i> and other glyphosate-based herbicides	\$1,976	\$ 854	131%	32%
All other agricultural productivity products	344	362	(5)%	NM
<b>Total Gross Profit</b>	<b>\$2,320</b>	<b>\$1,216</b>	<b>91%</b>	<b>20%</b>
<b>EBIT<sup>(1)</sup></b>	<b>\$1,691</b>	<b>\$ 470</b>	<b>260%</b>	<b>56%</b>

NM = Not Meaningful

<sup>(1)</sup> EBIT is defined as earnings (loss) before interest and taxes. Interest and taxes are recorded on a total company basis. We do not record these items at the segment level. See Note 24 — Segment and Geographic Data and the “Overview — Non-GAAP Financial Measures” section of MD&A for further details.

**Figure 4.2.**  
**Net Sales and Gross Profit for Agricultural Productivity**

#### 4.1.2 DuPont--Pioneer Hi-Bred Int'l

DuPont (NYSE: DD) is a global conglomerate that manufactures materials used in automotive manufacturing, construction, pharmaceuticals, agriculture, and electronics. E. I. du Pont de Nemours and Company was founded in July 1802 as a gunpowder mill by Eleuthère Irénée du Pont.<sup>14</sup> In 1802, DuPont was primarily an explosives company. In twenty first century, their focus turned to science-based solutions in areas such as food and nutrition, health care, apparel, safety and security, construction, electronics and transportation.<sup>15</sup> On August 8, 1997, DuPont acquired 20 percent of Pioneer Hi-Bred International--an Iowa based Seed Company. DuPont acquired the remaining 80 percent of Pioneer and announced the completion of the stock on October 1, 1999.<sup>16</sup> With complete ownership of Pioneer Hi-Bred, DuPont fully integrated biology into its science and technology base. Pioneer Hi-Bred International has become a powerful rival to Monsanto in the fast growing business of genetically engineered crops (Pekár Jr and Margulis, 2003).

The company has six reportable segments. Five of the segments constitute the company's growth segments: Agriculture & Nutrition, Coatings & Color Technologies, Electronic & Communication Technologies, Performance Materials and Safety & Protection. The sixth segment, Pharmaceuticals, is limited to income from the company's licensing interest in two drugs for the treatment of high blood pressure, Cozaar and Hyzaar. The company also includes embryonic businesses, such as applied biosciences and nonaligned businesses in Other. Applied biosciences aim to provide products for agricultural energy crops, feedstock processing, and advanced biofuels through commercializing non-food, cellulosic ethanol and biobutanol.<sup>17</sup>

Agriculture & Nutrition segment of DuPont delivers a broad portfolio of products and services that are specifically targeted to achieve gains in crop yields and productivity, including Pioneer brand seed products and well-established brands of insecticides,

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<sup>14</sup> Retrieved from <http://en.wikipedia.org/wiki/DuPont>

<sup>15</sup> Retrieved from [http://www2.dupont.com/Our\\_Company/en\\_US/glance/index.html](http://www2.dupont.com/Our_Company/en_US/glance/index.html)

<sup>16</sup> Retrieved from [http://www.biotech-info.net/merger\\_complete.html](http://www.biotech-info.net/merger_complete.html)

<sup>17</sup> Retrieved from [http://media.corporate-ir.net/media\\_files/irol/73/73320/BOP72619BOP005\\_BITS\\_N\\_1519.pdf](http://media.corporate-ir.net/media_files/irol/73/73320/BOP72619BOP005_BITS_N_1519.pdf)

fungicides and herbicides. The principal products of Pioneer are hybrid seed corn and soybean seed.

Figure 4.3 illustrates “Segment PRETAX Operating Income-Including Impact of Significant Items”. As can be seen from Figure 4.3, Agriculture & Nutrition Segment is gaining importance over the years. Agriculture & Nutrition Segment constitutes approximately 21.14% of pretax operating income in 2005, 18.33% of pretax operating income in 2006, 18.33% of pretax operating income in 2007 and 29.78% of pretax operating income in 2008.

Because DuPont's genetically modified seeds are perceived to increase efficiency of corn planting, increased demand for corn by ethanol refineries gave a push to DuPont's Agriculture & Nutrition segment, specifically Pioneer brand seed products. DuPont's profits will also be affected by any significant fluctuation in oil or natural gas prices, since the company uses oil as a raw material to make plastics and burns natural gas as a fuel to make its products.

E. I. DUPONT DE NEMOURS AND COMPANY AND CONSOLIDATED SUBSIDIARIES

SEGMENT PRETAX OPERATING INCOME - INCLUDING IMPACT OF SIGNIFICANT ITEMS	YTD 2009	Year				INCOME BEFORE INCOME TAXES (dollars in millions)				Year 2005									
		2009	2009	1Q09	2008	4Q08	3Q08	2Q08	1Q08		2007	4Q07	3Q07	2Q07	1Q07	2006	4Q06	3Q06	2Q06
Agriculture & Nutrition	1,432	580	852	1,087	(182)	(21)	504	786	894	(89)	(96)	428	651	604	(269)	(154)	430	597	875
Coatings & Color Technologies	87	106	(19)	326	(301)	190	247	190	840	216	204	226	194	817	287	281	228	21	536
Electronic & Communication Technologies	(89)	(35)	(54)	436	(46)	137	170	175	594	156	138	176	124	577	117	132	168	160	558
Performance Materials	(141)	5	(146)	128	(223)	(91)	223	219	626	53	196	227	150	559	44	189	191	155	515
Safety & Protection	59	(13)	72	829	4	251	302	272	1,199	277	313	318	291	1,080	211	293	308	268	994
Total Growth Platforms	1,348	643	705	2,806	(748)	466	1,446	1,642	4,153	613	755	1,375	1,410	3,637	380	721	1,325	1,201	3,478
Pharmaceuticals	524	272	252	1,025	265	260	265	235	949	246	237	241	225	819	240	210	200	169	751
Other	(87)	(43)	(44)	(181)	(112)	(44)	1	(26)	(224)	(55)	(76)	(37)	(56)	(173)	(54)	(31)	(32)	(56)	(90)
TOTAL SEGMENT PRETAX OPERATING INCOME	1,785	872	913	3,660	(595)	682	1,712	1,851	4,878	804	916	1,579	1,579	4,283	576	900	1,493	1,314	4,139
Exchange Gains and Losses	(74)	(144)	70	(255)	(116)	45	(29)	(155)	(85)	(35)	(30)	8	(28)	(4)	(9)	(3)	26	(18)	445
Corporate Expenses & Interest	(490)	(256)	(234)	(1,004)	(250)	(257)	(271)	(226)	(1,050)	(276)	(256)	(279)	(239)	(950)	(179)	(261)	(264)	(246)	(1,021)
INCOME BEFORE INCOME TAXES	1,221	472	749	2,391	(961)	470	1,412	1,470	3,743	493	630	1,308	1,312	3,329	388	636	1,255	1,050	3,563

Note: The data above provides a historical display of selected data included in our Quarterly Earnings Release financials. See Quarterly Earnings Release financials for full details, including details on "Significant Items".

Source: DuPont 2Q2009 Supplemental Financial Documents

Figure 4.3. Segment PRETAX Operating Income-Including Impact of Significant Items.

### 4.1.3 Syngenta AG

Syngenta AG (NYSE: SYT) is an agribusiness that is engaged in improving crop yields and food quality.<sup>18</sup> Syngenta is a young company founded in 2000. Novartis and AstraZeneca merged their agribusinesses to form Syngenta, the first global group focusing exclusively on agribusiness.<sup>19</sup> However, the industrial tradition goes back almost 250 years, when J.R. Geigy Ltd. began producing chemicals and dyes in Basel.

Syngenta has two main product lines, Crop Protection and Seeds. Syngenta is a global leader in Crop Protection; it ranks third in high value commercial Seeds.<sup>20</sup> Crop Protection chemicals include herbicides, insecticides and fungicides to control weeds, insect pests and diseases in crops. The Seeds segment develops, produces, and markets seeds and plants based on advanced genetics and related technologies.

Syngenta aims to provide high-performing seeds and crop protection products to enable more efficient biofuel production. Syngenta is also developing novel corn hybrids specifically tailored for this purpose.

Figure 4.4 illustrates Sales by Product Line: Crop Protection and Seed Sales. As can be seen from Figure 4.4, Syngenta's sales are dominated by Crop Protection products. In 2004, Syngenta began to transform its Seeds business into double and triple stack traits through novel technological advancements. In 2007, sales of Syngenta Corn seeds grew worldwide driven by crop prices and acreage expansion, particularly in the U.S.-due to ethanol production. AGRISURE double stack trait in corn received US EPA approval in 2007. The same trademark was launched as a triple stack trait in 2008. Syngenta developed marketing investments and research developments to ensure that its pipeline is able to capture a wide range of future biotech opportunities. The good corn sales performance was partly offset by lower soybean sales as a result of the decline in US soybean acreage.

Figure 4.5 demonstrates gross profit for each segment during 2006-2008. According to Figure 4.5, Seeds segment constitute approximately 20.9% of gross profits in 2006,

<sup>18</sup> Retrieved from <http://finance.yahoo.com/q/pr?s=SYT>

<sup>19</sup> Retrieved from [http://www.syngenta.com/en/about\\_syngenta/companyhistory.html](http://www.syngenta.com/en/about_syngenta/companyhistory.html)

<sup>20</sup> Retrieved from [http://www.syngenta.com/en/media/thisissyngenta\\_businessesandmarkets.html](http://www.syngenta.com/en/media/thisissyngenta_businessesandmarkets.html)

19.6% of gross profits in 2007 and 18.8% of gross profits in 2008, whereas Crop Protection constitute approximately 80% of gross profits in 2006, 80.5% of gross profits in 2007 and 81.3% of gross profits in 2008. Corn & Soybean Sales are 45.04% of seed sales in 2006 and 44.25% of seed sales in 2007.

Product Line	(US\$ million, except growth %)		Growth				Actual %
	2007	2006	Volume %	Local price %	CER %	Currency %	
Selective Herbicides	2,019	1,813	8	-	8	3	11
Non-Selective Herbicides	902	725	19	2	21	3	24
Fungicides	2,004	1,716	12	-	12	5	17
Insecticides	1,205	1,093	8	(1)	7	3	10
Seed Care	604	531	12	(1)	11	3	14
Professional Products	475	427	13	(3)	10	1	11
Others	76	73	(9)	11	2	2	4
<b>Total</b>	<b>7,285</b>	<b>6,378</b>	<b>11</b>	<b>-</b>	<b>11</b>	<b>3</b>	<b>14</b>

Product Line			Growth				Actual %
	2007	2006	Volume %	Local price %	CER %	Currency %	
Corn & Soybean	893	785	8	4	12	2	14
Diverse Field Crops	351	309	5	2	7	6	13
Vegetables	502	421	13	1	14	6	20
Flowers	272	228	13	-	13	6	19
<b>Total</b>	<b>2,018</b>	<b>1,743</b>	<b>9</b>	<b>3</b>	<b>12</b>	<b>4</b>	<b>16</b>

CER stands for Constant Exchange Rate

**Figure 4.4 Sales by Product Line: Crop Protection and Seed Sales**

2008 (US\$ million)	Crop Protection	Seeds	Business Development	Unallocated	Total
Product sales	9,224	2,337	10	-	11,571
Royalty income	7	105	14	-	126
<b>Total segment sales</b>	<b>9,231</b>	<b>2,442</b>	<b>24</b>	<b>-</b>	<b>11,697</b>
Less sales to other segments	(73)	-	-	-	(73)
<b>Third party segment sales</b>	<b>9,158</b>	<b>2,442</b>	<b>24</b>	<b>-</b>	<b>11,624</b>
Cost of goods sold	(4,352)	(1,331)	(18)	(12)	(5,713)
<b>Gross profit</b>	<b>4,806</b>	<b>1,111</b>	<b>6</b>	<b>(12)<sup>1</sup></b>	<b>5,911</b>
Marketing and distribution	(1,474)	(555)	(10)	-	(2,039)
Research and development	(556)	(343)	(70)	-	(969)
General and administrative	(655)	(173)	(21)	-	(849)
Restructuring and impairment	(83)	(76)	(37)	-	(196)
<b>Operating income/(loss) – continuing operations</b>	<b>2,038</b>	<b>(36)</b>	<b>(132)</b>	<b>(12)</b>	<b>1,858</b>
2007 (US\$ million)	Crop Protection	Seeds	Business Development	Unallocated	Total
Product sales	7,281	1,954	5	-	9,240
Royalty income	4	64	-	-	68
<b>Total segment sales</b>	<b>7,285</b>	<b>2,018</b>	<b>5</b>	<b>-</b>	<b>9,308</b>
Less sales to other segments	(68)	-	-	-	(68)
<b>Third party segment sales</b>	<b>7,217</b>	<b>2,018</b>	<b>5</b>	<b>-</b>	<b>9,240</b>
Cost of goods sold	(3,537)	(1,123)	(6)	(3)	(4,669)
<b>Gross profit</b>	<b>3,680</b>	<b>895</b>	<b>(1)</b>	<b>(3)<sup>1</sup></b>	<b>4,571</b>
Marketing and distribution	(1,167)	(465)	(6)	-	(1,638)
Research and development	(496)	(283)	(51)	-	(830)
General and administrative	(516)	(125)	37	-	(604)
Restructuring and impairment	1	(38)	2	-	(35)
<b>Operating income/(loss) – continuing operations</b>	<b>1,502</b>	<b>(16)</b>	<b>(19)</b>	<b>(3)</b>	<b>1,464</b>

**Figure 4.5. Segment Gross Profit for the years 2006, 2007 and 2008.**



2006 (US\$ million)	Crop Protection	Seeds	Business Development	Unallocated	Total
Product sales	6,376	1,683	1	–	8,060
Royalty income	2	60	1	–	63
<b>Total segment sales</b>	<b>6,378</b>	<b>1,743</b>	<b>2</b>	<b>–</b>	<b>8,123</b>
Less sales to other segments	(77)	–	–	–	(77)
<b>Third party segment sales</b>	<b>6,301</b>	<b>1,743</b>	<b>2</b>	<b>–</b>	<b>8,046</b>
Cost of goods sold	(3,049)	(894)	(2)	(37)	(3,982)
<b>Gross profit</b>	<b>3,252</b>	<b>849</b>	<b>–</b>	<b>(37)<sup>1</sup></b>	<b>4,064</b>
Marketing and distribution	(1,037)	(429)	(4)	–	(1,470)
Research and development	(490)	(232)	(74)	–	(796)
General and administrative	(549)	(106)	(13)	–	(668)
Restructuring and impairment	(275)	(38)	12	–	(301)
<b>Operating income/(loss) – continuing operations</b>	<b>901</b>	<b>44</b>	<b>(79)</b>	<b>(37)</b>	<b>829</b>

Source: Syngenta Annual Report 2008. Available at [http://www.syngenta.com/en/investor\\_relations/pdf/Syngenta\\_FR2008\\_English.pdf](http://www.syngenta.com/en/investor_relations/pdf/Syngenta_FR2008_English.pdf).

**Figure 4.5. (continued)**

## 4.2 The Fertilizer Industry

Fertilizers are chemical compounds that are critical to the growth, development and health of plants and influence food quality that is important for human nutrition. Major crop nutrients are nitrogen, phosphorus and potash – all naturally occurring elements in the environment. Micronutrients are also required in smaller amounts by plants. Fertilizers are usually applied either through the soil, for uptake by plant roots, or by foliar feeding<sup>21</sup> for uptake through leaves. In each season, essential nutrients from the soil are removed by growing crops. Fertilizers help farmers to restore the nutrients removed to produce food and maintain the health of their soil (The Fertilizer Institute (IFT)).

Fertilizers can be organic or inorganic based on their content. Organic fertilization is accomplished through the addition of organic waste to the soil. Inorganic fertilizers, on the other hand, are manufactured to contain nutrient compositions and concentrations. Some inorganic fertilizers contain one main nutrient source, whereas others contain multiple sources. The main nutrients in mixed inorganic fertilizers are nitrogen, phosphorus, and potassium; however, they often contain micronutrients as well (Gelling and Parmenter, 2004).

Heavy application of fertilizers for some crops does not necessarily mean that fertilizer makes up the greatest share of their operating cost. For instance; sugar beet, rice, and peanut use high volumes of fertilizer; however fertilizer expenses amount to less than 20 percent of their operating costs. Among major U.S. crops, corn has the highest fertilizer costs per acre (\$93 at average 2007 prices), and has the highest fertilizer costs as a share of operating costs which is 41 percent (USDA). Figure 4.6, Figure 4.7 and Figure 4.8 display estimated U.S. fertilizer (nitrogen, phosphate and potash) use by selected crops: corn, wheat, cotton, soybeans and other. Figures indicate that corn is the most fertilizer intensive crop among all. Figure 4.9 illustrates estimated fertilizer use by corn for the time period 1964-2007 in the U.S. As can be seen from the figure, nitrogen fertilizer is very important for corn, followed by potash and phosphate in importance.

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<sup>21</sup> Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves.

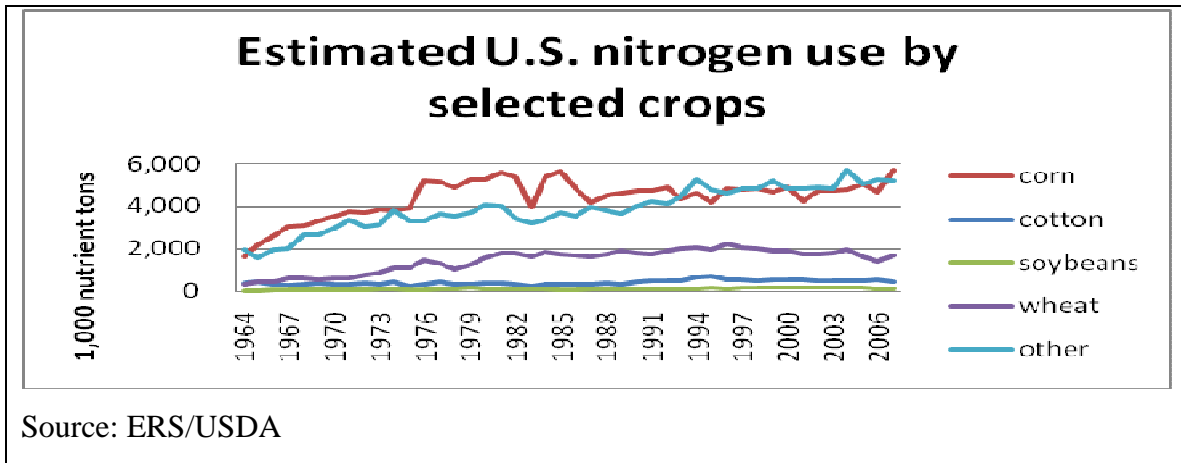


Figure 4.6. Estimated U.S. nitrogen use by selected crops

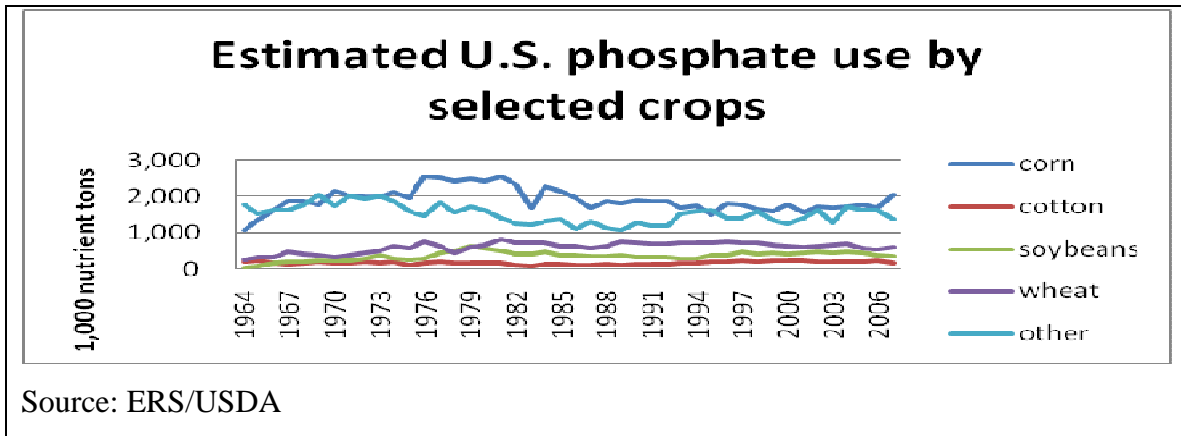


Figure 4.7. Estimated U.S. phosphate use by selected crops

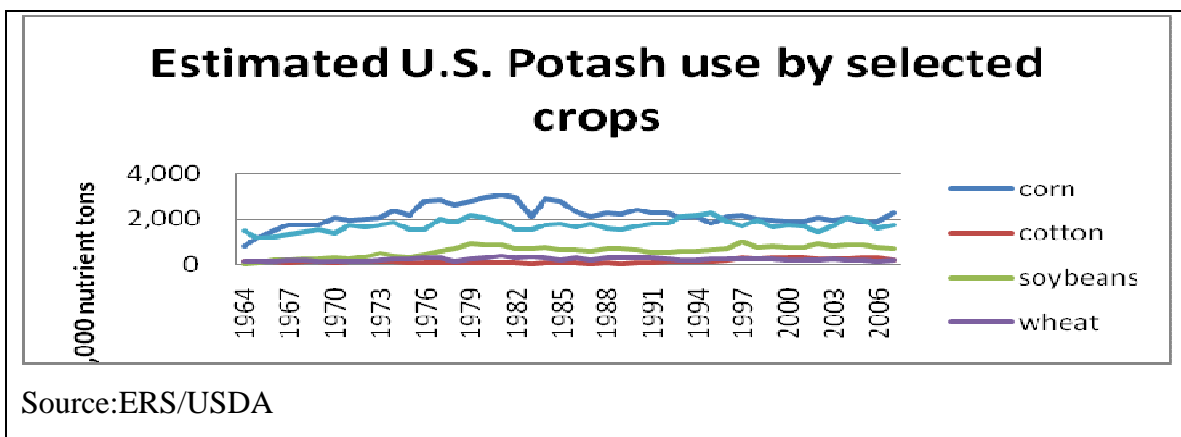
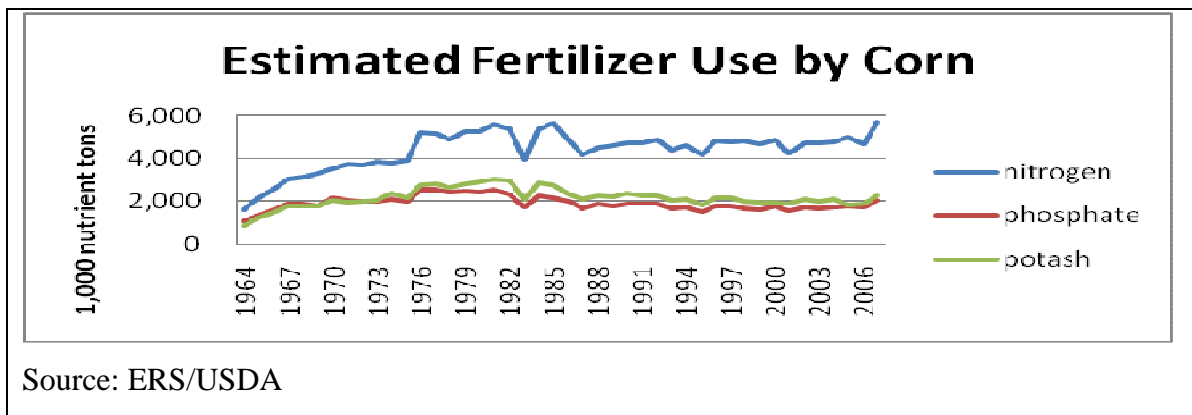


Figure 4.8. Estimated U.S. Potash use by selected crops



**Figure 4.9. Estimated U.S. Fertilizer use by corn**

U.S. nominal prices of nitrogen, phosphate, and potash fertilizers, among others, began trending upward in 2002, and they reached historic highs in mid-2008. With record crop prices and record demand for grain, farmers were both motivated and pressured to maximize the productivity of their soils. Hence, farmers invested in fertilizer to boost their output (Huang et al., 2009).

At this point, it is also worthwhile to mention cellulosic ethanol, currently at the R&D stage, for the future prospects of fertilizer use. If cellulosic ethanol production does become a commercial reality, the impact on the fertilizer industry and nutrient cycling could be large (Fixen, 2007). Once cellulosic ethanol production is commercialized, energy crops such as switchgrass or miscanthus (elephant grass) are bound to enter the scene in short order. These are often described as “low input” species, not requiring fertilization or at most, minimal fertilization (Tilman et al., 2006).

Having spoken of the positive role fertilizer usage plays in agricultural production and productivity, one should also pay attention to increasing environmental concerns linked with economic decisions regarding fertilizers. Misuse of fertilizers can degrade water and soil quality, harm wildlife, generate greenhouse gases and pollute drinking water supplies. When nitrogen is applied to crops, not all of it is taken up by the plants. The rest may be retained in the soil, or lost to the atmosphere, ground or surface waters. Elements such as nitrogen and phosphorus can get washed into surface waters and can cause algae blooms and excess plant growth. When excessive nutrients are carried through freshwater ways

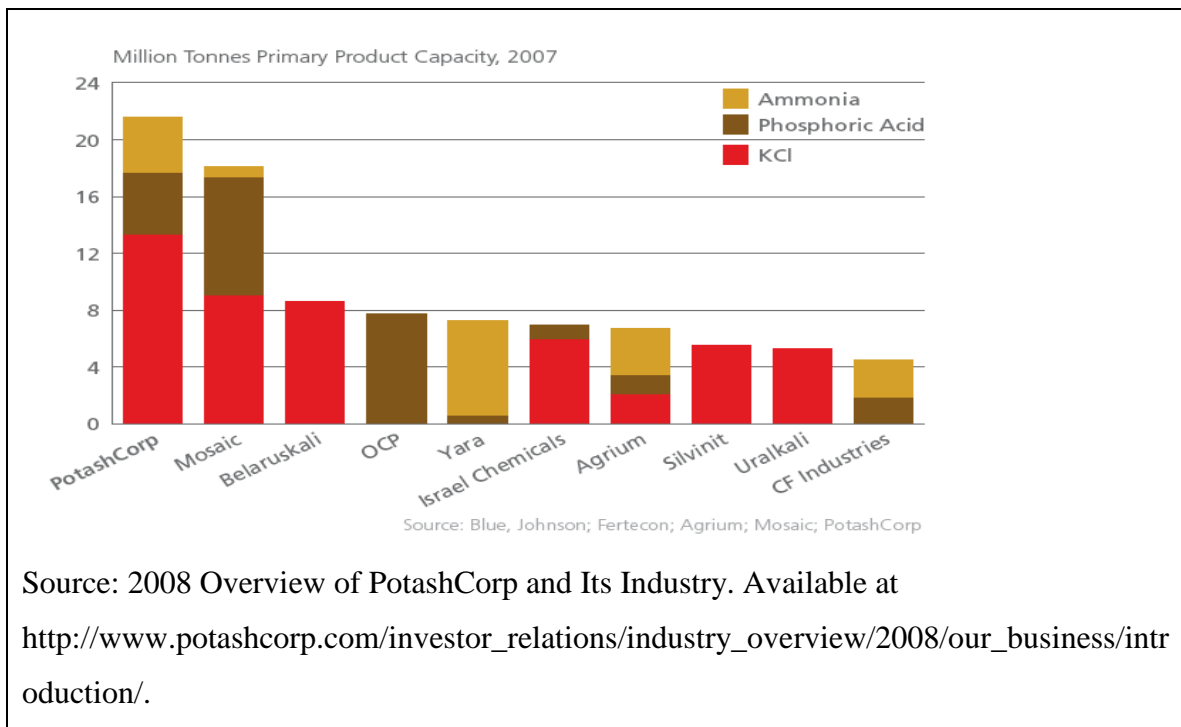
and then reach marine ecosystems, they accelerate plant growth. This excess growth in plant material can reduce the oxygen level in marine ecosystem, which can lead to fish kills (IPNI). High level of nitrogen in drinking water is a concern to human health, since it can contribute to the "blue baby" syndrome in infants less than one year of age. Fertilizer use and production also have the potential to contribute to GHG. Oxides of nitrogen can emanate from nitrogen fertilizer use and CO<sub>2</sub> from fertilizer production facilities. However, the contribution of fertilizer to GHG is likely to be negligible (Byrnes 1990). Excesses of minor elements in the soil, such as copper and zinc, can also cause problems in crop production.

The growth of U.S. fertilizer industry has been accompanied by big changes in the system of production and distribution of fertilizers. Globally, potash deposits are very limited. With high and rapidly increasing costs for a greenfield mine and a production lead-time of at least five to seven years, potash business is a formidable undertaking. Companies considering new mines face capital costs estimated at \$2.5 billion or more. On the other hand, the global supply of phosphate rock is adequate. However, high-quality ore bodies are relatively rare and processing facility construction costs are high.<sup>22</sup>

Figure 4.10 displays World's Ten Largest Fertilizer Companies by their production capacities. As seen from the figure, PotashCorp is the world's largest fertilizer enterprise, producer of the three primary crop nutrients: potash, nitrogen and phosphate. PotashCorp is followed by Mosaic Company.

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<sup>22</sup>Retrieved from <http://www.sec.gov/Archives/edgar/data/855931/000113031908000163/o39398exv13.htm>



**Figure 4.10. World's Ten Largest Fertilizer Companies by their production capacities**

In this study, I will focus on PotashCorp and Mosaic Company, because they together control the world market for potash and phosphate with their cumulative market share by their production capacities. A brief description for PotashCorp and Mosaic Company is provided in the next section.

#### 4.2.1 Mosaic Company

The Mosaic Company (NYSE: MOS) is engaged in production and marketing of concentrated phosphate and potash. Mosaic was formed on October 25, 2004 through the combination of leaders in crop nutrition industry; IMC Global Inc. and Cargill Inc. Crop Nutrition Division.

The company operates through three segments; phosphate, potash and offshore. The Phosphates segment produces phosphate fertilizer (out of ammonia<sup>23</sup> and sulfur) and feed

<sup>23</sup> Anhydrous ammonia (ammonia without water) consists of 82 percent nitrogen and 18 percent hydrogen. when ammonia (NH<sub>3</sub>) is manufactured, the nitrogen comes from the air and the hydrogen comes from natural gas. Natural gas also provides the energy required to combine nitrogen and hydrogen. Because

phosphate. The Mosaic Company is the world's largest producer of finished phosphate products, with an annual capacity of 10.3 million tones. The Potash segment mines and processes potash to be used in the manufacture of mixed crop nutrients, animal feed ingredients and industrial applications both in Canada and the United States, and sells potash worldwide. The Company's annual capacity of 10.4 million tones is the second largest in the world. The Offshore segment produces and markets fertilizer products and provides other supplementary services.<sup>24</sup>

The company's operations are vertically integrated, from the mining of resources to the production of crop nutrients, feed and industrial products for customers around the world. The Mosaic Company has key distribution facilities in 10 countries serving wholesalers, retail dealers and individual growers in over 30 countries.<sup>25</sup>

Demand for biofuels, demand for meat-calorie demand, and declining amounts of arable land due to urbanization and drought have benefited Mosaic Company during 2004-2008. However it is important to note that if food prices increase because of a serious collapse in the farming industry (a supply side shock), this is likely to hurt Mosaic Company more than it helps.<sup>26</sup>

#### 4.2.2 Potash Corporation

The Potash Corporation of Saskatchewan Inc. (NYSE: POT), also referred as PotashCorp, was launched by the Province of Saskatchewan in 1975 and became a publicly traded company in November 1989.

PotashCorp is a large enterprise producing three primary plant nutrients: potash, phosphate and nitrogen. Among these three nutrients, potash is the company's main priority. The Company's phosphate operations is responsible for the manufacture and sale of solid and liquid phosphate fertilizers, animal feed supplements and industrial acid, which is used in food products and industrial processes. Under its nitrogen operations

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natural gas is such an important feedstock in producing ammonia, low cost natural gas provides a powerful economic advantage for ammonia production.

<sup>24</sup> Retrieved from [http://www.mosaicco.com/about/company\\_overview.htm](http://www.mosaicco.com/about/company_overview.htm)

<sup>25</sup> For further information see : [http://www.mosaicco.com/resources/global\\_presence\\_map.htm](http://www.mosaicco.com/resources/global_presence_map.htm)

<sup>26</sup> Retrieved from [http://www.wikinvest.com/wiki/Mosaic\\_Company\\_\(MOS\)](http://www.wikinvest.com/wiki/Mosaic_Company_(MOS))

segment; nitrogen fertilizers, nitrogen feed and industrial products including ammonia, urea, ammonium nitrate and nitric acid are produced.<sup>27</sup>

Having greatest strength in potash, PotashCorp is the world's largest potash producer by capacity. The Company is the second largest nitrogen producer by ammonia capacity and the third largest phosphate company, with large, low-cost reserves and the most diverse product line in the industry.<sup>28</sup>

PotashCorp benefits from demand for biofuels (specifically, corn-based ethanol) just like its competitor Mosaic Company. Increasing demand for corn is not the sole factor that affects PotashCorp's profitability though. The decline in natural gas prices during 2009 served company profits to be higher, since cheaper natural gas means lower production cost and higher margins for the company.<sup>29</sup>

#### 4.3 The Poultry and Pork Industry

The U.S. is the world's largest producer and the second largest exporter of poultry meat according to the Economic Research Service (ERS) of USDA. Of the combined total of U.S. poultry production in 2007, 67 percent was broiler meat, 21 percent was eggs, 12 percent was turkey meat and less than 1 percent was other chicken meat (ERS). The U.S. consumption of poultry meat (broilers, other chicken, and turkey) is considerably higher than beef or pork, but it is less than total red meat consumption (Oryango et al., 2009).

Over the past three decades, the steady increase in the consumption of chicken products has led to the rise of the chicken industry. Red meat was the big player in the American diet in the 1970s (Watts, 2007). There are several market innovations contributing to the poultry market expansion. First, in the 1960-70s, the chicken price declined from one-half that of beef to about one-sixth, stimulating chicken consumption. Second, chicken has benefited from the fact that it is low in fat compared to competitive

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<sup>27</sup> Retrieved from <http://www.reuters.com/finance/stocks/companyProfile?symbol=POT.N&rpc=66>

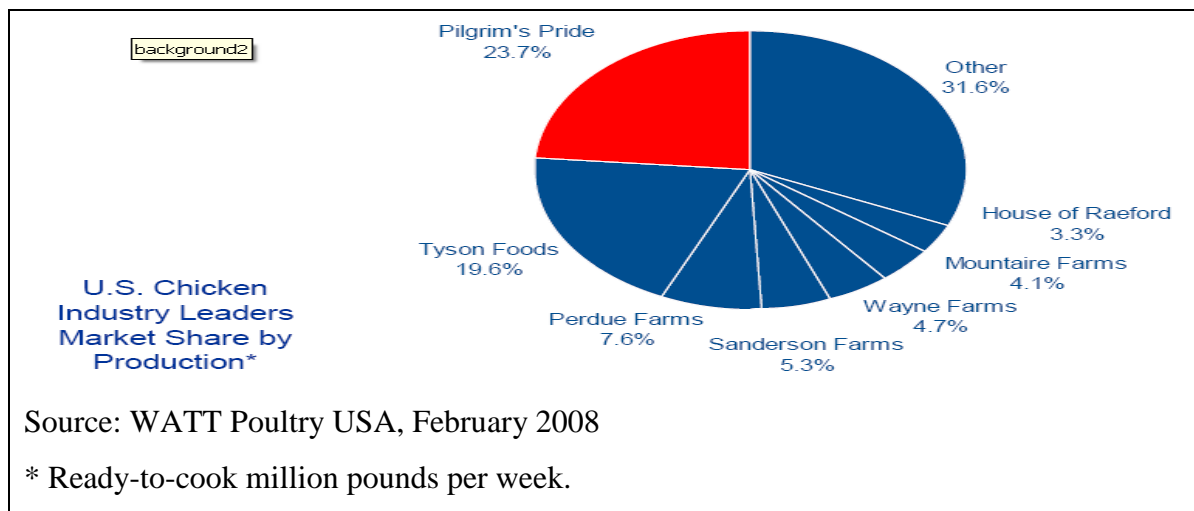
<sup>28</sup> Retrieved from [http://www.potashcorp.com/media/pdf/investor\\_relations/industry\\_overview/2008/POT\\_OverviewBook\\_08.pdf](http://www.potashcorp.com/media/pdf/investor_relations/industry_overview/2008/POT_OverviewBook_08.pdf)

<sup>29</sup> Retrieved from [http://www.wikinest.com/stock/Potash\\_Corporation\\_of\\_Saskatchewan\\_\(POT\)](http://www.wikinest.com/stock/Potash_Corporation_of_Saskatchewan_(POT))



meats, in other words, health concerns have fueled increases in poultry meat (Moschini and Meilke, 1989). That, however, doesn't tell the whole story. The introduction of the chicken products to nontraditional vendors, such as fast food restaurants and frozen food sections at grocery stores also contributed to the market expansion of poultry (Oryango et al., 2009).

Poultry production is mostly concentrated in the eastern half of the U.S. A small number of large companies vertically integrated in all aspects from hatchery to processing dominate the industry (Onyango et al., 2009). The 1950s saw expansion of vertical integration and by 1977, 85 percent of broilers, turkeys and eggs were in vertically integrated systems. More than 90 percent of the poultry in the U.S. was vertically integrated in 2003. The vertical integration has resulted in improved production efficiencies in the poultry industry, increased brand name and processed products. Market shares (by production) of U.S. Chicken Industry Leaders are illustrated in Figure 4.11

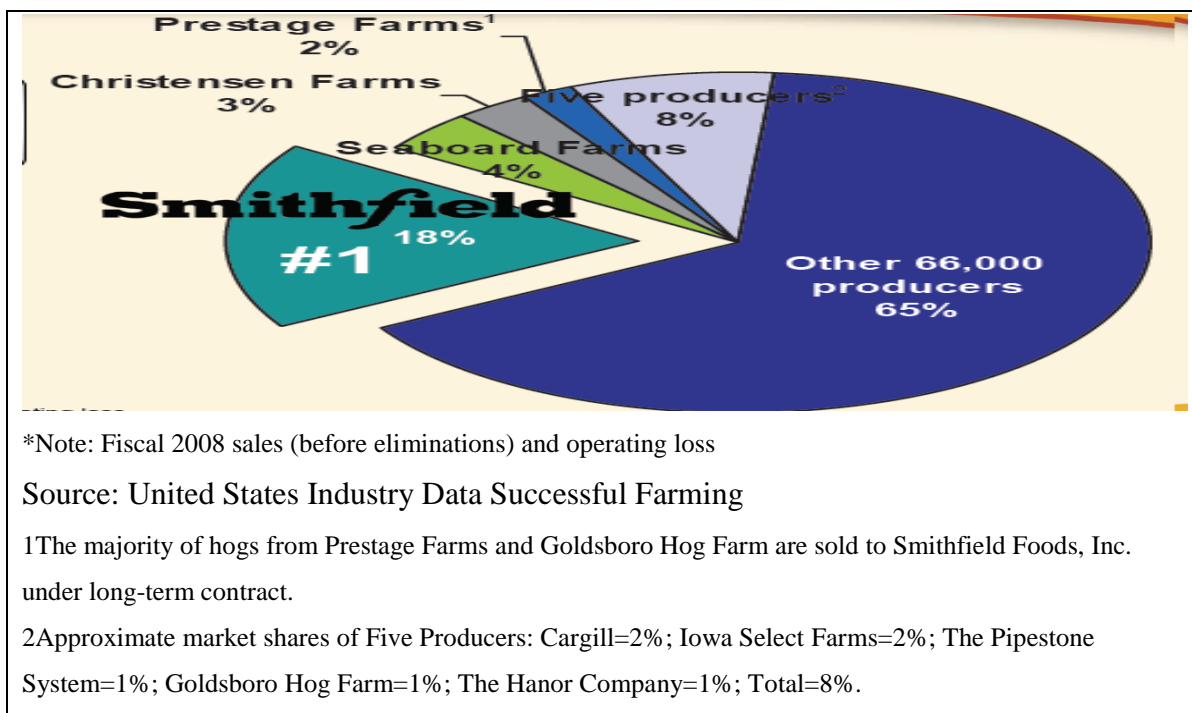


**Figure 4.11. Market Shares (by production) of U.S. Chicken Industry Leaders**

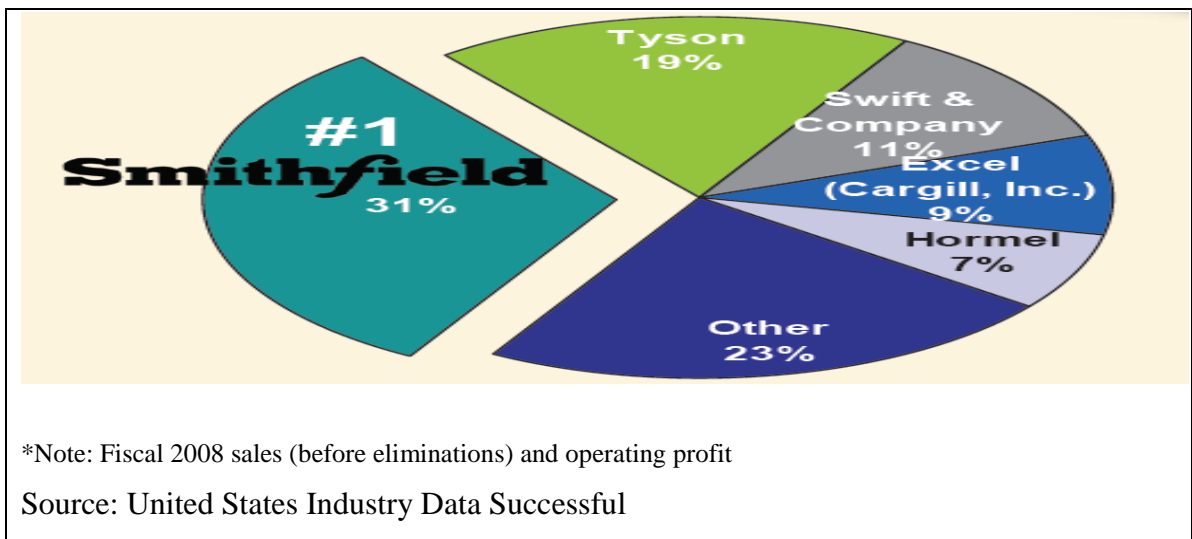
The U.S. pork production sector has also changed dramatically in recent years. In the late 1980's the sector was made up of hundreds of thousands hog enterprises often part of diversified farming operations. The sector has become more concentrated with fewer firms over time (Lawrence and Grimes, 2007). The production of the pork is carried out in two ways; 1) Very large pork producers contract their production of hogs out to

independent growers and 2) Production is carried out on company-owned farms with hired management, which is called “full integration”. Large pork producers generally maintain some mixture of these two approaches. However, many family farmers view large pork producers as a threat since a scenario in which contract growers will be superseded by fully integrated large pork producers, is considered to be likely to occur in the future (Reimer, 2006).

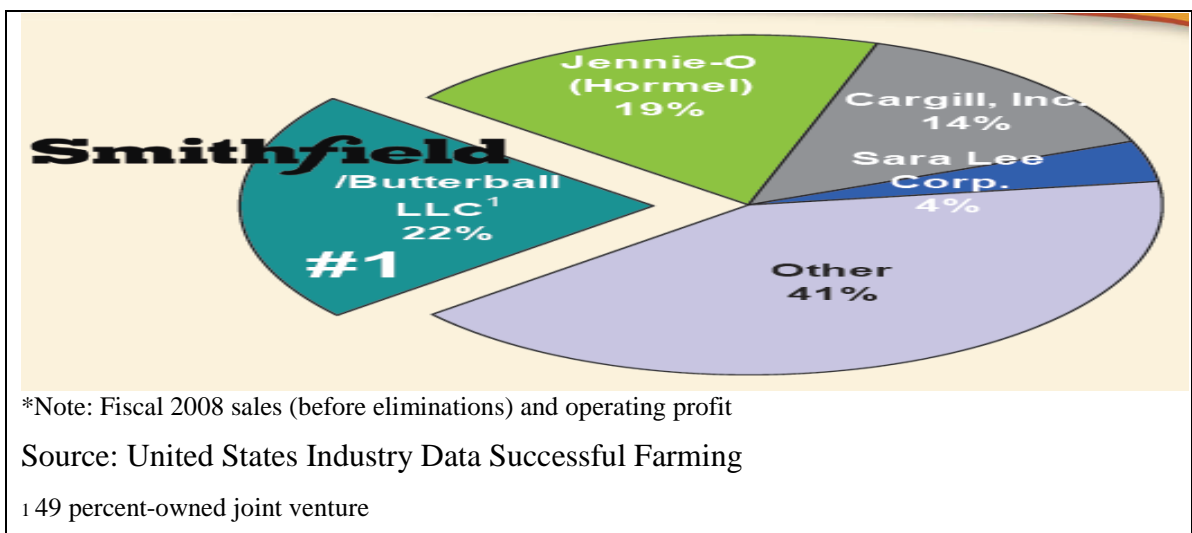
Figure 4.12, Figure 4.13 and Figure 4.14, collected from Smithfield’s public presentation, demonstrate the company’s market share in hog production, pork processing and turkey processing, respectively. According to the figures, Smithfield is the world’s largest hog producer, pork processor and the U.S.’s largest turkey processor.



**Figure 4.12. Market Share: Hog Production**



**Figure 4.13. Market Share: Pork Processing**



**Figure 4.14. Market Share: Turkey Processing**

The input structure of livestock production—the very existence of biology, prevents livestock producers from instantly responding to price changes. The timeline for meat production from farm to retail ranges from 2 months for poultry meat to 2 years for beef. Livestock production’s varying timeframes make the decision making process more difficult because producers make production decisions before feed and product prices are known. The production and marketing costs of the livestock industry increased between 2006 and 2008 due to record-high grain, oilseed, and energy prices (Stillman et al., 2009, USDA).

Poultry firms have experienced considerable difficulties due to oversupply of meat, high prices for inputs, and weak domestic and international demand as a result of global conjuncture. On December 1, 2008, Pilgrim's Pride-the largest chicken producer in the U.S., along with several of its wholly owned subsidiaries, announced that, in an effort to address certain short-term operational and liquidity challenges, it was filing a voluntary petition for relief under Chapter 11 of the U.S Bankruptcy Code.<sup>30</sup> It went bankrupt because of too much debt and bad bets made on corn prices.

I will discuss Sanderson Farms, Smithfield Foods and Tyson Foods in this study. All three have great market shares in their fields. Perdue Farms and Pilgrim's Pride are not taken into consideration, since Perdue Farms is privately owned-no stock data and Pilgrim's Pride went into bankruptcy in October, 2008-difficult to assess the implication of biofuel policies together with the repercussions of bankruptcy.

The next section discusses corporate histories of the selected firms in livestock industry.

#### 4.3.1 Sanderson Farms

Sanderson Farms, Inc. (Sanderson Farms) (NASDAQ:SAFM), incorporated in 1955, is a fully integrated poultry processing company engaged in the production, processing, marketing and distribution of fresh and frozen, processed and prepared chicken products. The company stock became publicly traded in May 1987 and is listed on NASDAQ under the symbol SAFM.<sup>31</sup> Sanderson Farms is the fourth largest chicken producer in the U.S with 5.3% market share in production.

Sanderson Farms is a vertically integrated poultry manufacturer. The Company conducts its chicken operations through Sanderson Farms, Inc. (Production Division) - encompasses all steps in chicken production- and Sanderson Farms, Inc. (Processing Division) both of which are the wholly owned subsidiaries of Sanderson Farms. The Company sells its fresh chicken products primarily under its brand name to retailers,

<sup>30</sup>Retrieved from [http://archive.gipsa.usda.gov/pubs/2008\\_psp\\_annual\\_report.pdf](http://archive.gipsa.usda.gov/pubs/2008_psp_annual_report.pdf)

<sup>31</sup> Retrieved from <http://phx.corporate-ir.net/phoenix.zhtml?c=68801&p=irol-IRHome>

distributors and casual dining operators located principally in the southeastern, southwestern, northeastern and western United States. Foods Division is the unit responsible for conducting its prepared chicken business. Through its foods division, the Company also sells, under its brand name, further processed and partially cooked chicken to distributors and food service establishments.<sup>32</sup>

Sanderson Farm's profitability is highly dependent on feed costs, as they make up a significant share of the total cost of sales. Any fluctuation in corn price spurred by ethanol production will be reflected in the company's profit margins.

#### 4.3.2 Smithfield Foods

Smithfield Foods, Inc. (NYSE:SFD) is engaged in the production of a variety of fresh meat and packaged meat in the U.S. and internationally. It offers fresh pork to retail customers as well as ready-to-eat, prepared foods. The company also engages in turkey production and hatchery operations.<sup>33</sup>

The origins of Smithfield Foods date back to 1936 when Joseph W. Luter, Sr. and his son, Joseph W. Luter, Jr., opened their Smithfield Packing plant in Smithfield, Virginia. By late 1980's, Smithfield had to deal with severe fluctuations in hog prices and high transportation costs. The company overcame this problem through a joint venture with Carroll's Foods. In 1990, Smithfield Foods made a difference in the marketplace, managing its supply of hogs from conception to processing to produce higher-quality and leaner meat products. The company acquired exclusive U.S. rights to the genetic lines of exceptionally lean hogs developed by Britain's National Pig Development Company. Working closely with its hog production partners, the company launched Smithfield Lean Generation Pork™ in 1994. It revolutionized the industry and gained enormous success.<sup>34</sup> Smithfield has many familiar brands including Butterball, John Morrell, Gwaltney, Patrick Cudahy, Krakus, Cook's Ham, Weight Watchers' and Stefano's.

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<sup>32</sup> Retrieved from [http://media.corporate-ir.net/media\\_files/irol/68/68801/SAFM08ARFINALweb.pdf](http://media.corporate-ir.net/media_files/irol/68/68801/SAFM08ARFINALweb.pdf)

<sup>33</sup> Retrieved from <http://ca.finance.yahoo.com/q/pr?s=SFD>

<sup>34</sup> Retrieved from [http://www.r-calfusa.com/industry\\_info/2008\\_JBS\\_merger/080409-Exhibit18\\_HistoryofSmithfieldFoods.pdf](http://www.r-calfusa.com/industry_info/2008_JBS_merger/080409-Exhibit18_HistoryofSmithfieldFoods.pdf)

The Company conducts its business through five segments: Pork, International, Hog Production (HP), Other and Corporate, each comprises of a bunch of subsidiaries. The Pork segment produces a variety of fresh pork and packaged meats products in the U.S. and markets them nationwide and to a number of foreign markets. The International segment includes the Company's international meat processing operations that produce a variety of fresh and packaged meats products. The HP segment consists of hog production operations located in the States and foreign plants. The Other segment is comprised of its turkey production operations and its interest in Butterball, LLC. The Corporate segment provides management and administrative services to support our other segments<sup>35</sup> In October 2008, the company completed the previously announced sale of Smithfield Beef Group, Inc., its beef processing and cattle feeding operation.<sup>36</sup>

The market price of live hogs and the cost of feed grains such as corn and soybean meal directly affect the profitability of hog production. Higher profits are generated when hog prices are high and feed grain prices are low, and lower profits (or losses) incurred when hog prices are low and feed grain prices are high. The Company's strategic initiative of vertical integration is believed to reduce its exposure to fluctuations. The vertical integration also increases traceability from conception of livestock to consumption of the pork product.

#### 4.3.3 Tyson Foods

Tyson Foods, Inc. (NYSE: TSN) is engaged in the production, distribution, and marketing of chicken, beef, pork, prepared foods, and related products worldwide.<sup>37</sup> The company is based in Springdale, Arkansas.

The history of Tyson Foods started with an Arkansas farmer, John Tyson, who hauled about 50 chickens to sell in Chicago to earn some profit during 1935. Two years later he named his business Tyson Feed & Hatchery and the next 13 years (including postwar

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<sup>35</sup> **Butterball** brand of turkey and other poultry products produced by Butterball LLC, a joint venture of Smithfield Foods and Maxwell Farms

<sup>36</sup> Retrieved from [http://files.shareholder.com/downloads/SFD/697187344x0x308064/2D89F0A0-6B0C-4D98-A3F7-C30723C951FE/smi\\_ar\\_09.pdf](http://files.shareholder.com/downloads/SFD/697187344x0x308064/2D89F0A0-6B0C-4D98-A3F7-C30723C951FE/smi_ar_09.pdf)

<sup>37</sup> The company is the world's largest processor and marketer of chicken, beef and pork, the second-largest food production company in the Fortune 500 and a member of the S&P 500

period) the company substantially increased its revenues by trading chicken. In 1947 the company was incorporated. In 1963 the company went public and changed its name to Tyson's Foods, Incorporated. It also made its first acquisition, the Garrett Poultry Company based in Arkansas. Technological improvements in the 1960s affected the poultry industry to a great extent. Broiler production had become one of the most industrialized, automated parts of U.S. agriculture. During the 1970s, Tyson continued to grow and diversify. In 1971, the company's name was changed from Tyson's Foods to Tyson Foods. In 1977 Tyson purchased hog-production facilities in North Carolina. Later on, diversification continued with the purchase of Mexican Original in Fayetteville, Arkansas and the purchase of Arctic Alaska Fisheries, Inc., and Louis Kemp Seafood. In 2001, Tyson acquired of beef and pork powerhouse, IBP, Inc.<sup>38</sup>

The Company operates through four segments: Chicken, Beef, Pork and Prepared Foods. The chicken segment, vertically integrated, is involved in breeding, raising and processing chickens. The beef segment is involved in processing of live cattle and fabricating beef. The pork segment is involved in the processing of live market hogs and fabricating pork. The Prepared Foods segment manufactures and markets frozen and refrigerated food products. Tyson provides products and service to customers throughout the United States and more than 90 countries.

Tyson holds 22% share of the domestic beef market. Excel and JBS are the firm's closest competitors, both have 22% market share, respectively.<sup>39</sup> Tyson is the second-largest domestic chicken processor, with 19.6% share of the U.S. market, trailing only Pilgrim's Pride, which holds 23.7%. Tyson is also the second-largest domestic producer of pork, with 19% share of the market. Smithfield Foods holds 31% of the pork market share.

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<sup>38</sup> Retrieved from <http://www.tyson.com/Corporate/AboutTyson/History/Timeline.aspx>

<sup>39</sup> Retrieved from <http://www.scribd.com/doc/16530689/Tyson-Foods-TSN-June-2009-Presentation>

## **CHAPTER 5**

### **THEORETICAL FOUNDATIONS**

This section explores the principles and mechanisms that affect the profit margins of companies reflected in shareholder wealth. All of the industries aforementioned have experienced structural changes in the concentration of market power and in size due to merging and acquisitions. Looking at the historical context, these industries can be characterized as oligopolies.

Oligopoly analysis is the study of market interactions with a small number of firms. Because there are few participants in this type of market, each oligopolist is aware of the actions of the others. The decisions of one firm influences, and is influenced by, the decisions of other firms. Strategic planning by oligopolists always involves taking into account the likely responses of the other market participants.

The related papers are Dixit (1986) and Quirnbach (1988). Dixit examines the general comparative statics of an oligopoly. Quirnbach uses a conjectural variations model of oligopoly and shows how the effect of a demand shift varies with the degree of competition.

As mentioned earlier, the ethanol industry has created an enormous new market for corn, giving corn prices the kind of lift that has not been seen in years, thus enhancing farm-level profitability. Farmers, desperate for income after years of low corn prices, are increasingly adopting GM seeds to increase their yields per acreage.

In this chapter, I will try to examine shareholder welfare by analyzing the effect of demand shift on company profits. In order to do this, I will apply the theoretical framework to the seed industry in the Cournot duopoly context. Standard comparative statics techniques are used. In each case, necessary and sufficient conditions are derived for the signs of the output and price effects. The focus of this theoretical application is the seed market; however the results can be extended to livestock and fertilizer markets.



### 5.1. Demand Shifts and Oligopoly

The main focus is on the impact of a demand shift on oligopoly profits. A standard symmetric Cournot duopoly model is used with homogeneous product facing a demand curve  $P(Q, \theta)$  where  $Q$  is the industry output characterized by

$$(5.1) \quad Q = q_1 + q_2$$

Let the demand curve be a linear function in quantity

$$(5.2) \quad P(Q, \theta) = \theta_1 + \theta_2 \cdot Q$$

where  $\theta_1$  and  $\theta_2$  are demand shift parameters. Assume that biofuel policies affect  $\theta_1$  and an increase in  $\theta_1$  will shift the demand curve outward, that is to say  $P_{\theta_1}(Q, \theta) > 0$  at all  $Q$  levels leading to a parallel shift in the demand curve.

Let the companies have the same cost structure (thus cost functions) which is constant marginal cost  $c$ . Therefore we expect both of the firms to set their profit functions as follows

$$(5.3) \quad \Pi_i = (P(Q, \theta) - c) \cdot q_i$$

Firm  $i$  maximizes its profit by choosing  $q_i$  so that for both firms

$$\begin{aligned} (5.4) \quad \partial \Pi_i / \partial q_i &= P(Q, \theta) + P_Q(Q, \theta) \cdot (\partial Q / \partial q_i) \cdot q_i - c \\ &= P(Q, \theta) + \phi_i \cdot Q \cdot P_Q(Q, \theta) - c \\ &= (1 - \phi_i) \cdot P(Q, \theta) + \phi_i \cdot MR(Q, \theta) - c = 0 \end{aligned}$$

where subscripts (except  $i$ ) indicate partial derivatives and  $\phi_i = (q_i / Q) \cdot (\partial Q / \partial q_i)$  is firm  $i$ 's conjecture about the elasticity of industry supply with respect to  $q_i$ .<sup>40</sup>

Marginal revenue is derived from industry total revenue, therefore it will depend on  $\theta$  as well;  $MR(Q, \theta) = P(Q, \theta) + Q \cdot P_Q(Q, \theta)$  is the industry marginal revenue.

Assume that both of the companies have identical conjectures  $\phi_1 = \phi_2 = \phi$  and these conjectures are independent of that particular firm's output level; that is  $d\phi / dq_i = 0$  for  $i = 1, 2$ .  $\phi$  can be interpreted as an index of industry collusion, with higher  $\phi$  meaning a greater industrial collusion and  $\phi \in [0, 1]$  being the reasonable range. There are three important values of  $\phi$ ;  $\phi = 0$ , which corresponds to perfect competition;  $\phi = 1$ , which corresponds to perfect collusion; and  $\phi = 1/n$ , which gives the symmetric Cournot solution.

In order to guarantee the second order conditions for the firm's profit maximization problem, assume that  $P_Q(Q, \theta)$  and  $MR_Q(Q, \theta)$  are negative at equilibrium and both functions are finite. Assume a symmetric Cournot solution, so that  $\phi = 1/2$ . Let  $Q^*$  (total industry output),  $q_1^* = q_2^* = Q^*/2$ , and  $P^* = P(Q^*, \theta)$  be equilibrium levels for output and market price. If the first order condition is evaluated at  $Q^*$  and  $P^*$ , then (5.4) becomes

$$(5.5) \quad (1 - \phi) \cdot P(Q^*, \theta) + \phi \cdot MR(Q^*, \theta) = c$$

The left side of the equation is a convex combination of demand and marginal revenue. Quirmbach (1988) interprets this expression as the firm's "conjectural" marginal revenue curve, denoted by  $CMR(Q, \theta, \phi)$ . The profit of any firm is

$$(5.6) \quad \Pi_i^* = (P(Q^*, \theta) - c) \cdot (Q^*/2)$$

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<sup>40</sup> Most authors represent conjectural variations as firm  $i$ 's conjectures about its individual rivals' outputs ( $dq_i / dq_j$  for  $i \neq j$ ) or its conjecture about the total output of all rivals ( $d\{\sum_{i \neq j} q_j\} / q_i$ ).

## 5.2. Comparative Statics

One could expect an increase in equilibrium quantities of output, price and profit as a result of an outward shift in demand curve for competitive industry. However, the outcome for imperfect competition could be different than that of perfect competition.

The effect of  $\theta_1$  on  $Q^*$  is found by totally differentiating first order condition (5.5), yielding

$$(5.7) \quad (1-\phi) \cdot A + \phi \cdot B = 0$$

where  $A = P_Q(Q^*, \theta) \cdot (dQ^*/d\theta_1) + P_{\theta_1}(Q^*, \theta)$

$$B = MR_Q(Q^*, \theta) \cdot (dQ^*/d\theta_1) + MR_{\theta_1}(Q^*, \theta)$$

Equation (5.7) can be reexpressed as such

$$(5.8) \quad -K = (dQ^*/d\theta_1) \cdot N$$

where  $K = (1-\phi) \cdot P_{\theta_1}(Q^*, \theta) + \phi \cdot MR_{\theta_1}(Q^*, \theta)$

$$N = (1-\phi) \cdot P_Q(Q^*, \theta) + \phi \cdot MR_Q(Q^*, \theta)$$

One can notice that, by the definition of  $CMR(Q, \theta, \phi)$ , the left side is just the negative of the partial derivative of  $CMR(Q^*, \theta, \phi)$  with respect to  $\theta_1$ .<sup>41</sup> Thus by (5.8) and the definition of  $CMR(Q^*, \theta, \phi)$

$$(5.9) \quad -CMR_{\theta_1}(Q^*, \theta, \phi) = (dQ^*/d\theta_1) \cdot N$$

and

$$(5.10) \quad \frac{dQ^*}{d\theta_1} = -CMR_{\theta_1}(Q^*, \theta, \phi) / N$$

where  $N = (1-\phi) \cdot P_Q(Q^*, \theta) + \phi \cdot MR_Q(Q^*, \theta) < 0$  since  $P_Q(Q, \theta)$  and  $MR_Q(Q, \theta)$  have been assumed to be negative to ensure that firm's second order conditions for the

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<sup>41</sup> The conjectures were assumed to be independent of the shift parameter; i.e., that  $d\phi/d\theta_1 = 0$ .

profit maximization problem are satisfied. The sign of  $dQ^*/d\theta_1$  depends on the sign of  $CMR_{\theta_1}(Q^*, \theta, \phi)$  which is denoted by  $(1-\phi) \cdot P_{\theta_1}(Q^*, \theta) + \phi \cdot MR_{\theta_1}(Q^*, \theta)$ , yielding

$$(5.11) \quad CMR_{\theta_1} < 0 \Leftrightarrow MR_{\theta_1}(Q^*, \theta) < -[(1-\phi)/\phi] \cdot P_{\theta_1}(Q^*, \theta)$$

Recall that  $MR(Q^*, \theta) = P(Q^*, \theta) + Q \cdot P_Q(Q^*, \theta)$ ; then the partial derivative of  $MR(Q^*, \theta)$  with respect to  $\theta_1$  is

$$(5.12) \quad MR_{\theta_1}(Q^*, \theta) = P_{\theta_1}(Q^*, \theta) + Q \cdot P_{Q\theta_1}(Q^*, \theta)$$

Using (5.11) and (5.12) gives

$$(5.13) \quad CMR_{\theta_1} < 0 \Leftrightarrow P_{\theta_1}(Q^*, \theta) + Q \cdot P_{Q\theta_1}(Q^*, \theta) < -[(1-\phi)/\phi] \cdot P_{\theta_1}(Q^*, \theta)$$

or equivalently

$$(5.14) \quad CMR_{\theta_1} < 0 \Leftrightarrow P_{Q\theta_1}(Q^*, \theta) < -P_{\theta_1}(Q^*, \theta) / (\phi \cdot Q^*)$$

The effect of demand shift on equilibrium quantity can be summarized as follows

$$(5.15) \quad \frac{dQ^*}{d\theta_1} < 0 \Leftrightarrow P_{Q\theta_1}(Q^*, \theta) < -P_{\theta_1}(Q^*, \theta) / (\phi \cdot Q^*)$$

The price effect is

$$(5.16) \quad \frac{dP^*}{d\theta_1} = P_{\theta_1}(Q^*, \theta) + P_Q(Q^*, \theta) \cdot \frac{dQ^*}{d\theta_1}$$

Using (5.10) and the expressions for  $CMR_{\theta_1}$  and  $N$ , we get

$$(5.17) \quad \begin{aligned} \frac{dP^*}{d\theta_1} &= P_{\theta_1}(Q^*, \theta) + P_Q(Q^*, \theta) \cdot (-CMR_{\theta_1} / N) \\ &= P_{\theta_1}(Q^*, \theta) + P_Q(Q^*, \theta) \cdot \frac{-(1-\phi) \cdot P_{\theta_1}(Q^*, \theta) - \phi \cdot MR_{\theta_1}(Q^*, \theta)}{N} \end{aligned}$$

A sufficient condition for  $dP^*/d\theta_1$  to be positive is that  $dQ^*/d\theta_1$  must be negative. Conversely, for  $dP^*/d\theta_1$  to be negative,  $dQ^*/d\theta_1$  must be positive.

Finally, the effect of  $\theta_1$  on seed-firm profits is

$$(5.18) \quad \frac{d\Pi_i^*}{d\theta_1} = \Sigma + \Lambda$$

$$\text{where } \Sigma = (P(Q^*, \theta) - c) \cdot \frac{dQ^*}{d\theta_1} \cdot (1/2)$$

$$\Lambda = [P_{\theta_1}(Q^*, \theta) + P_Q(Q^*, \theta) \cdot \frac{dQ^*}{d\theta_1}] \cdot (Q^*/2)$$

In simpler form

$$(5.19) \quad \frac{d\Pi_i^*}{d\theta_1} = P_{\theta_1}(Q^*, \theta) \cdot (Q^*/2) + (1/2) \cdot (MR(Q^*, \theta) - c) \cdot (dQ^*/d\theta_1)$$

Using  $MR(Q^*, \theta) - c = (1 - \phi) \cdot Q^* \cdot P_Q(Q^*, \theta)$  and (5.16) yields

$$(5.20)$$

$$\frac{d\Pi_i^*}{d\theta_1} = P_{\theta_1}(Q, \theta) \cdot (Q^*/2) + [(1/2) \cdot (1 - \phi) \cdot Q^* \cdot P_Q(Q^*, \theta)] \cdot \frac{\frac{dP^*}{d\theta_1} - P_{\theta_1}(Q^*, \theta)}{P_Q(Q^*, \theta)}$$

$$P_{\theta_1}(Q, \theta) > 0$$

$$= \frac{Q^*}{2} \cdot [\phi \cdot P_{\theta_1}(Q^*, \theta) + (1 - \phi) \cdot \frac{dP^*}{d\theta_1}]$$

As seen from (5.20); the negative profit effects can only occur when  $0 < \phi < 1$ .

Hence, for oligopoly, perverse profit effects can arise even if there is an outward shift in demand. Since  $MR \leq c$  from (5.5), (5.19) indicates that  $dQ^*/d\theta_1 > 0$  is necessary for  $d\Pi_i^*/d\theta_1 < 0$ . Also (5.20) implies that the more stringent condition,  $dP^*/d\theta_1 < 0$ , is also necessary for  $d\Pi_i^*/d\theta_1 < 0$ . The main results are summarized in Figure 5.1.

$$d\Pi_i^*/d\theta_1 < 0 \implies dP^*/d\theta_1 < 0 \implies dQ^*/d\theta_1 > 0 \iff CMR_{\theta_1} > 0$$

Source: Quirmbach (1988)

**Figure 5.1. Demand Shift Comparative Statics; Sufficient and Necessary Conditions when  $P_{\theta_1} > 0$**

Now, consider the demand curve,  $P(Q, \theta) = \theta_1 + \theta_2 \cdot Q$ , and symmetric Cournot duopoly solution with  $\phi = 1/2$ . By (5.14), we have  $CMR_{\theta_1} > 0$  since  $P_{Q\theta_1}(Q^*, \theta) = 0$  and  $-P_{\theta_1}(Q^*, \theta)/(\phi \cdot Q^*) < 0$ . By equations (5.8) and (5.17), the price effect is  $dP^*/d\theta_1 = 1/3 > 0$ ; and by (5.20),  $d\Pi_i^*/d\theta_1 > 0$ .

When demand shifts, the qualitative possibilities are richer in an imperfectly competitive industry than in a competitive one. Output might fall, the price might fall and oligopoly profits can fall. However, with the inverse demand generated within our model, both the price and the profit have increased due to increased demand for corn. Under competitive markets, the output choice depends on the demand curve only. However, the output choice in an imperfectly competitive industry depends on both the demand and marginal curves (Quirmbach, 1988).

The effect of demand shift on oligopolist firm profit can be linked to shareholder wealth via the discounted present value model of company valuation. The effect of the demand shock on asset value (i.e. stock price) depends on the future cash flows and discount rate. For example, let  $P_{i,t}$ , the price of stock of company  $i$  at time  $t$ , be the discounted value of the future cash flows which are expected to accrue to the asset:

$$(5.21) \quad P_{i,t} = \sum \frac{\Pi_{i,t+k}}{(1+r)^k}$$

where  $\Pi_{i,t+k}$ , the profit of the firm, is the cash flow to asset, which is expected to occur in period  $t+k$ . The discount rate,  $r$ , is the opportunity cost of the cash flow given its perceived riskiness (which is assumed to be constant over time for convenience). Any change in demand shock, assuming a constant discount rate, will be passed onto the shareholder wealth through company profits.

Within our generated duopoly model, the shareholders of seed companies will benefit from biofuel policies, the impact of which is reflected at corn seed demand. Because farmers are increasingly adopting either hybrid or GM corn seeds for their lands, seed firms which offer a broad product line (i.e. Monsanto, DuPont—Pioneer Hi-Bred Int'l) will experience increased demand for their products. Increased demand will eventually result in higher stock prices through higher profits.

## CHAPTER 6

### METHODOLOGY

This chapter presents the methods used to solve the research objectives.

#### 6.1. Empirical Model Formulation

The primary objective of this research is to develop a method to evaluate the impact of biofuel policy on stock value of agribusiness market leaders in seed, fertilizer or livestock industry. A capital asset pricing model (CAPM) approach will be used to analyze the link between biofuel policy and stock performance.

##### 6.1.1 CAPM and Multi Factor CAPM: a general description

The CAPM was developed, at least in part, to explain the differences in risk premium across assets. According to CAPM, these differences are due to differences in the riskiness of the returns on the assets. The general idea behind CAPM is that investors need to be compensated in two ways: time value of money and risk. The time value of money is represented by the risk-free rate in the formula and compensates the investors for placing money in any investment over a period of time. The other half of the formula represents risk and calculates the amount of compensation the investor needs for taking on additional risk.<sup>42</sup>

The expected return on any risky asset can be written as

$$(6.1) \quad E(R_i) = R_f + \frac{E(R_m) - R_f}{\sigma_m^2} \text{Cov}(R_m, R_i)$$

or alternatively

$$(6.2) \quad E(R_i) = R_f + (E(R_m) - R_f) \beta_i$$

and

$$(6.3) \quad \beta_i = \frac{\text{Cov}(R_m, R_i)}{\sigma_m^2}$$

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<sup>42</sup> Retrieved from <http://www.investopedia.com/terms/c/capm.asp>



where  $E(R_i)$  is the expected return on asset  $i$ ,  $R_f$  is the risk free rate,  $E(R_m)$  is the expected return on the market portfolio and  $\beta_i$  is the sensitivity of the asset return to market returns.

The empirical counterpart for this model is the excess returns market model;

$$(6.4) R_{i,t} - R_{f,t} = \alpha_i + \beta_i (R_{m,t} - R_{f,t}) + \varepsilon_{i,t}$$

where  $\alpha_i$  is the intercept term,  $R_{i,t} - R_{f,t}$  is excess stock return,  $R_{m,t} - R_{f,t}$  is excess market return and  $\varepsilon_{i,t}$  is the error term.

A factor is a variable that explains why a group of stocks have returns that tend to move together. To put it another way; it helps explain common components of the variance of security returns. A priced factor is a variable which helps explain the expected asset returns. In other words, it helps explain common components of the variance of security returns and expected returns. The excess return on the market is the only priced factor in the CAPM. However, it has been usually debated that one factor is not enough. The major problem, here, is the identification of possible factors that explain cross section of expected returns. A multiple factor CAPM allows for different sensitivities to different financial factors. These financial factors can be tradable portfolios and/or non tradable variables such as macroeconomic variables; business cycles, inflation, etc.

Mathematically it is represented as follows;

$$(6.5) E(R_i) - R_f = \beta_{i,1} (E(R_m) - R_f) + \beta_{i,2} f_1 + \dots + \beta_{i,n} f_n$$

where

$f_1$ : Financial factor 1

.....

$f_n$ : Financial factor  $n$

$\beta_{i,2}$ : Sensitivity of asset  $i$  return to the financial factor 1.

.....

$\beta_{i,n}$ : Sensitivity of asset  $i$  return to financial factor  $n$ .

and the counterpart time-series regression model for multiple-beta CAPM;

$$(6.6) \quad R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,1} (R_{m,t} - R_{f,t}) + \beta_{i,2} f_1 + \dots + \beta_{i,n} f_n + \varepsilon_{i,t}$$

where  $R_{i,t} - R_{f,t}$  is excess stock return,  $R_{m,t} - R_{f,t}$  is excess market return and  $\varepsilon_{i,t}$  is the error term.

### 6.1.2 Model Specification

A single factor CAPM is limited with one priced factor and can not account for the impact of biofuel policy; however a multifactor valuation model can come over the limitation and enhance our understanding in terms of deriving economic implications of biofuel policies. Hence; in order to address the research objective of this study, a multifactor CAPM will be estimated.

The research model is based on the same assumptions as those of simple CAPM: 1) Markets are highly efficient so that expected returns quickly and fully reflect available information; no transaction costs, tax obligations, or indivisibilities exist, 2) For risk-free financial assets, lending and borrowing rates are equal, and 3) Investors are assumed to be risk averse, well-diversified and to hold homogenous expectations that are fully characterized by means and variances over single-period horizons.

The econometric model consists of two explanatory variables and one dependent variable. The new approach to CAPM specifies a stable linear relationship between excess market return  $R_{m,t} - R_{f,t}$ , corn futures return  $R_t^c$  and excess stock return  $R_{i,t} - R_{f,t}$ . The return on corn futures was entered as a proxy to capture the effect of biofuels policy. The regression is presented in equation (6.7).

$$(6.7) \quad R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,1} (R_{m,t} - R_{f,t}) + \beta_{i,2} R_t^c + \varepsilon_{i,t}$$

## 6.2 Hypothesis Testing

The following hypotheses and sub-hypothesis are generated for the multifactor CAPM regression.

*H1*: There will be a positive relationship between return on corn futures and return on seed company stock.

$$H_0^S : \beta_{i,2}^S > 0$$

*Sub-hypothesis*:  $\beta_{i,2}^S$  will increase with the share of corn seed in company profits.

*H2*: There will be a positive relationship between return on corn futures and return on fertilizer company stock.

$$H_0^F : \beta_{i,2}^F > 0$$

*H3*: There will be a negative relationship between return on corn futures and return on livestock company stock.

$$H_0^L : \beta_{i,2}^L < 0$$

## 6.3 Description and Computation of Variables

### 6.3.1 The return series for stock and market index

The total return to holding stock is the sum of capital gains and any dividends paid during the holding period. The return to stock,  $R_{i,t}$ , is usually described as follows

$$(6.8) \quad R_{i,t} = \frac{p_{i,t} + d_{i,t} - p_{i,t-1}}{p_{i,t-1}}$$

where  $p_{i,t}$  is the price of security  $i$  at the end of day  $t$ ;  $d_{i,t}$  is the dividends for firm  $i$  during period  $t$ ;  $p_{i,t-1}$  is the price of security  $i$  at the end of the day  $t-1$ .

The regression analysis in this study is conducted with log returns. Log returns have the nice property that they can be interpreted as continuously compounded returns-so that frequency of the compounding of the return does not matter. Because the access to dividend data is out of reach, adjusted closing prices will be used for the stock return series. Adjusted closing price is a useful tool when examining historical returns because it gives a more accurate representation of the firm's equity value beyond the simple market price. It accounts for all corporate actions such as stock splits, dividends/distributions and rights offerings.

The continuously compounded returns were obtained for stock and market returns on daily basis.

$$R_{i,t} = \ln\left(\frac{P_{i,t}^a}{P_{i,t-1}^a}\right)$$

$$R_{m,t} = \ln\left(\frac{SPCI_t}{SPCI_{t-1}}\right)$$

$P_{i,t}^a$  = adjusted closing price per share of firm  $i$  at the end of the day  $t$ .

$P_{i,t-1}^a$  = adjusted closing price per share of the firm  $i$  at the end of day  $t-1$ .

$SPCI_t$  = closing value of Standard & Poor 500 Composite Price Index at the end of day  $t$ .

$SPCI_{t-1}$  = closing value of Standard & Poor 500 Composite Price Index at the end of day  $t-1$ .

The corn market follows a fixed cycle of production. The corn cycle goes from planting, to pollination, and finally to harvest. During these key stages of corn production, the corn futures prices are very sensitive to any potential supply disruption. In other words, the futures are generally supply driven. However, the increase in ethanol production has created a demand driven market for corn (Muhammad et al, 2007). Most U.S. grain buyers do monitor the futures market continuously before offering cash prices to corn producers. Because cash prices are directly linked to future prices, any volatility that appears in the futures market is generally transferred directly into the cash grain

market. When future prices increase/decrease, cash prices generally tend to increase/decrease as well. Biofuel policies have created swings in the commodity market, particularly for corn. Since biofuel production in the U.S. is mainly associated with corn-based ethanol, corn futures are perceived to be an appropriate tool to capture market implications of biofuel in this study. December Corn futures will be used for the analysis.

The corn future return series is calculated in the following manner:

Between time period  $1/1/x - 11/30/x$ , the log return series for year  $x$  December contract is calculated as

$$R_t^c = \ln\left(\frac{p_t^c}{p_{t-1}^c}\right)$$

$p_t^c$  = closing future price for corn at the end of the day  $t$ .

$p_{t-1}^c$  = closing future price for corn at the end of the day  $t-1$ .

After  $11/30/x$ , year  $x+1$  December contract is used to calculate log returns instead of year  $x$ . However, the change-over date when calculating percent changes is ignored. That is,  $11/30/x$  data for year  $x$  contract and  $12/1/x$  data for year  $x+1$  contract are not used to calculate a percent change on  $12/1/x$  for year  $x+1$  contract. Instead  $11/30/x$  and  $12/1/x$  data for year  $x+1$  contract is used to calculate a percent change on  $12/1/x$  for year  $x+1$  contract. In other words, the day before contract price is always used, even when switching to a contract that has more distant maturity.

## CHAPTER 7

### DATA

This chapter presents data sources and descriptive statistics.

#### 7.1 Data Sources and Descriptive Statistics

All of the data used in this study are secondary data gathered on daily basis from a variety of sources. Data were collected from Yahoo! Finance, Federal Reserve (Fed) and Chicago Board of Trade (CBOT). Because we have return series for the stocks, it is usually assumed to be free from any concern about nonstationarity or time trend. However, the time series nature of the data set makes it necessary to test for unit roots so that an appropriate model formulation can be implemented. Using Phillips-Perron and Augmented Dickey Fuller unit root test, the hypothesis of non stationarity was rejected at 5% significance level for all the return series except the risk free rate. The most important criticism against the unit root tests is that their power is low if the process is stationary but with a root that is close to the boundary. Hence; in order to provide additional evidence for stationarity of the return series, the Kwiatkowski et al. (1992) (KPSS)<sup>43</sup> test was used. Under KPSS, the test statistic did not exceed the critical value for all the return series except the risk free rate, so that the null hypothesis of stationarity was not rejected, thus confirming the results of the unit root tests conducted on the same series.

As mentioned earlier, sectors being studied in this thesis include seed, fertilizer and livestock (specifically, poultry and pork). The selection of firms is based on the perceived market share. Because each company has a different publicly available dataset, this study covers different time period for each selected company. The final date is the same for all stocks, but the initial date varies from Jan, 1990 to October, 2004. The stocks of selected firms are traded daily on NYSE and NASDAQ. Selected firms and time periods are displayed in Table 7.1. The adjusted closing prices will be used to calculate return series.

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<sup>43</sup> Stationary tests have stationarity under null hypothesis, thus reversing the null hypothesis under unit root test approach.

The S&P 500 index will be used for market returns in the model. It covers the period between Jan 2, 1990 and June 2, 2009. The S&P 500 is a stock market index containing the stocks of 500 American Large-Cap<sup>44</sup> corporations. Although the S&P 500 focuses on the large cap segment of the market, with approximately 75% coverage of U.S. equity value, it is also an ideal proxy for the total market. The index is owned and maintained by Standard & Poor's, a division of McGraw-Hill. All of the stocks in the index trade on the two largest US stock markets, the NYSE and NASDAQ. The S&P Index Committee follows a set of published guidelines which provide more transparency for investors to replicate the index and achieve the same performance as the S&P 500.<sup>45</sup>

**Table 7.1 Selected Firms in the U.S. Stock Market**

Company	Ticker	Time Period
<i>Seed Industry</i>		
DuPont	DD	01/03/00-06/02/09
Monsanto Co.	MON	10/24/00-06/02/09
Syngenta AG	SYT	11/15/00-06/02/09
<i>Fertilizer Industry</i>		
Mosaic Co.	MOS	10/25/04-06/02/09
Potash Corp.	POT	01/12/90-06/02/09
<i>Livestock Industry</i>		
Sanderson Farms	SAFM	01/02/90-06/02/09
Smithfield Foods	SFD	03/26/90-06/02/09
Tyson Foods	TSN	01/02/90-06/02/09

The risk free rate is market yield on U.S. Treasury Securities at 3-month secondary market rate on discount basis.<sup>46</sup> The data cover the period from Jan 2, 1990 to June 2, 2009.

<sup>44</sup> Large-Cap is a term used to refer to companies with a market capitalization value of more than \$10 billion. Large-Cap is an abbreviation of the term "large market capitalization". Market capitalization is calculated by multiplying the number of a company's shares outstanding by its stock price per share. The dollar amounts used for the classifications "large cap", "mid cap", or "small cap" are approximations that change over time. Retrieved from <http://www.investopedia.com/terms/l/large-cap.asp>

<sup>45</sup> For further information on the index, see [http://www2.standardandpoors.com/spf/pdf/index/SP\\_500\\_Factsheet.pdf](http://www2.standardandpoors.com/spf/pdf/index/SP_500_Factsheet.pdf)

<sup>46</sup> The data was retrieved from

This analysis uses closing prices of December Corn futures from Jan 2, 1990 to June 2, 2009.<sup>47</sup> The corn futures trade at CBOT in 5000 bushel units. A futures exchange is a central marketplace with established rules and regulations where buyers and sellers trade contracts for delivery in some future time period. Although most future contracts are offset and grain is not delivered, there are five delivery months for corn: March, May, July, September and December.

Descriptive statistics and missing data for all the variables are given in Table 7.2.

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<https://www.federalreserve.gov/datadownload/Download.aspx?rel=H15&series=bd891f9aa455467f8e6d0abbd14eda18&from=01/02/1990&to=06/02/2009&lastObs=&filetype=sheetml&label=include&layout=seriescolumn>

<sup>47</sup> The data were generously supplied by Virgil Robinson, Marketing Manager at Pioneer Hi-Bred International.



**Table 7.2 Summary Statistics of the stock returns, the corn future return and the S&P 500 return**

<i>Return Series</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Max</i>	<i>Min</i>	<i>Number of Observations</i>	<i>Number of Missing Observations</i>
Corn Future	-0.000217	0.0140	0.0740	-0.0767	4777	8
DuPont	0.000215	0.0184	0.1050	-0.1166	4777	-
Monsanto Co.	0.001040	0.0251	0.1628	-0.1765	2136	-
Mosaic Co.	0.001320	0.0397	0.1455	-0.5321	1146	-
Potash Corp.	0.000965	0.0225	0.1387	-0.3143	4769	59
Sanderson Farms	0.000548	0.0279	0.2259	-0.2766	4777	-
Smithfield Foods	0.000533	0.0271	0.2923	-0.2166	4721	-
Syngenta AG	0.000915	0.0213	0.1526	-0.1070	2120	-
Tyson Foods	0.000175	0.0230	0.1577	-0.1947	4777	6
S&P 500	0.000180	0.0116	0.1025	-0.0947	4777	-

## CHAPTER 8

### Results and Discussion

This chapter presents and explains the estimation procedures, the econometric results obtained from model estimation, the implications for shareholder wealth. The results presented here are those obtained when the Standard and Poor's market index (S&P 500) represents the stock market.

#### 8.1 Estimation Results

Corn futures were included as a proxy in the test of CAPM to see whether biofuel policy has pricing significance together with the market index. Asset returns were linked to the economic variable (corn futures) and market return; in other words, a time series regression of the excess returns of each asset was run on the corn futures return and excess market return. The benchmark model was estimated by Ordinary Least Squares (OLS). The results are given in Table 8.1.

**Table 8.1 Results of OLS estimation for CAPM**

Company	Intercept			F-statistic	
<b>Seed Industry</b>					
DuPont	-0.0003 (-0.767)	0.990*** (99.809)	0.022 (1.480)	49991.707*** (0.00)	0.677
Monsanto Co.	-0.0013* (-1.697)	0.905*** (40.325)	0.117*** (4.015)	832.616*** (0.00)	0.438
Syngenta AG	-0.0021*** (-3.315)	0.875*** (44.997)	0.082*** (3.262)	1029.201*** (0.00)	0.493
<b>Fertilizer Industry</b>					
Mosaic Co.	0.0060*** (3.6350)	1.152*** (26.112)	0.485*** (9.433)	407.084*** (0.00)	0.416
Potash Corp.	-0.0020*** (-3.185)	0.928*** (66.532)	0.197*** (9.234)	2278.235*** (0.00)	0.489

Note: The values in parentheses in the first second and third column are *t*-statistics and the values in the fourth column are *p*-values.

\*Indicates statistical significance at the 10% level.

\*\* Indicates statistical significance at the 5% level.

\*\*\* Indicates statistical significance at the 1% level.

**Table 8.1 (continued)**

Livestock Industry					
Sanderson Farms	-0.0035*** (-4.244)	0.900*** (48.068)	-0.063** (-2.186)	1155.481*** (0.00)	0.326
Smithfield Foods	-0.0033*** (-4.305)	0.903*** (50.585)	0.009 (0.338)	1281.559*** (0.00)	0.352
Tyson Foods	-0.0031*** (-4.800)	0.919*** (62.115)	-0.001 (-0.658)	1930.010*** (0.00)	0.447

Regarding the OLS results in Table 8,  $R^2$  ranged from 0.326 to 0.677 for the eight companies. Results suggest that model predicts best for DuPont with 0.01 observed significance level for the parameter estimate for market index. Neither intercept nor corn estimate for DuPont was, not even at 0.1 significance level, significant. Results for Syngenta AG were next best with observed significance level of 0.01 for intercept, market index and corn. The coefficient estimates were jointly significant at 0.1 significance level for each company.

Because this study deals with time series data, the observations follow a natural ordering over time, so that successive observations are likely to exhibit intercorrelations, especially if the time period between successive observations is short (Gujarati, Basic Econometrics, 2003). Serial correlation was tested by Durbin-Watson (D-W). The results are displayed on Table 8.2. The null hypothesis was not rejected for any model, implying that there is no statistical evidence for first order serial correlation in the model.

**Table 8.2 Results of Durbin-Watson**

Company	D-W	Null Hypothesis	Decision
<i>Seed Industry</i>			
DuPont	2.031	No first order autocorrelation, positive or negative	DNR
Monsanto Co.	1.944	No first order autocorrelation, positive or negative	DNR
Syngenta AG	2.079	No first order autocorrelation, positive or negative	DNR
<i>Fertilizer Industry</i>			
Mosaic Co.	2.000	No first order autocorrelation, positive or negative	DNR
Potash Corp.	1.917	No first order autocorrelation, positive or negative	DNR
<i>Livestock Industry</i>			
Sanderson Farms	2.209	No first order autocorrelation, positive or negative	DNR
Smithfield Foods	1.937	No first order autocorrelation, positive or negative	DNR
Tyson Foods	2.029	No first order autocorrelation, positive or negative	DNR

Note: For the given sample size and given number of explanatory variables, the critical values are:  $d_u = 1.789$  and  $d_l = 1.748$ . DNR stands for “do not reject”.

The models were tested for heteroscedasticity using White’s General Heteroscedasticity Test (White, 1980). The White test can be a test of (pure) heteroscedasticity or specification error or both. It has been argued that if no cross-product terms are present in the White test procedure, then it is a test of pure heteroscedasticity. If cross-product terms are present, then it is a test of both heteroscedasticity and specification bias.<sup>48</sup> The test was performed in both ways, with and without cross product terms. The results are given in Table 8.3.

<sup>48</sup> See Richard Harris, Using Cointegration Analysis in Econometrics Modelling, Prentice Hall&Harvester Wheatsheaf, UK., 1995, p.68

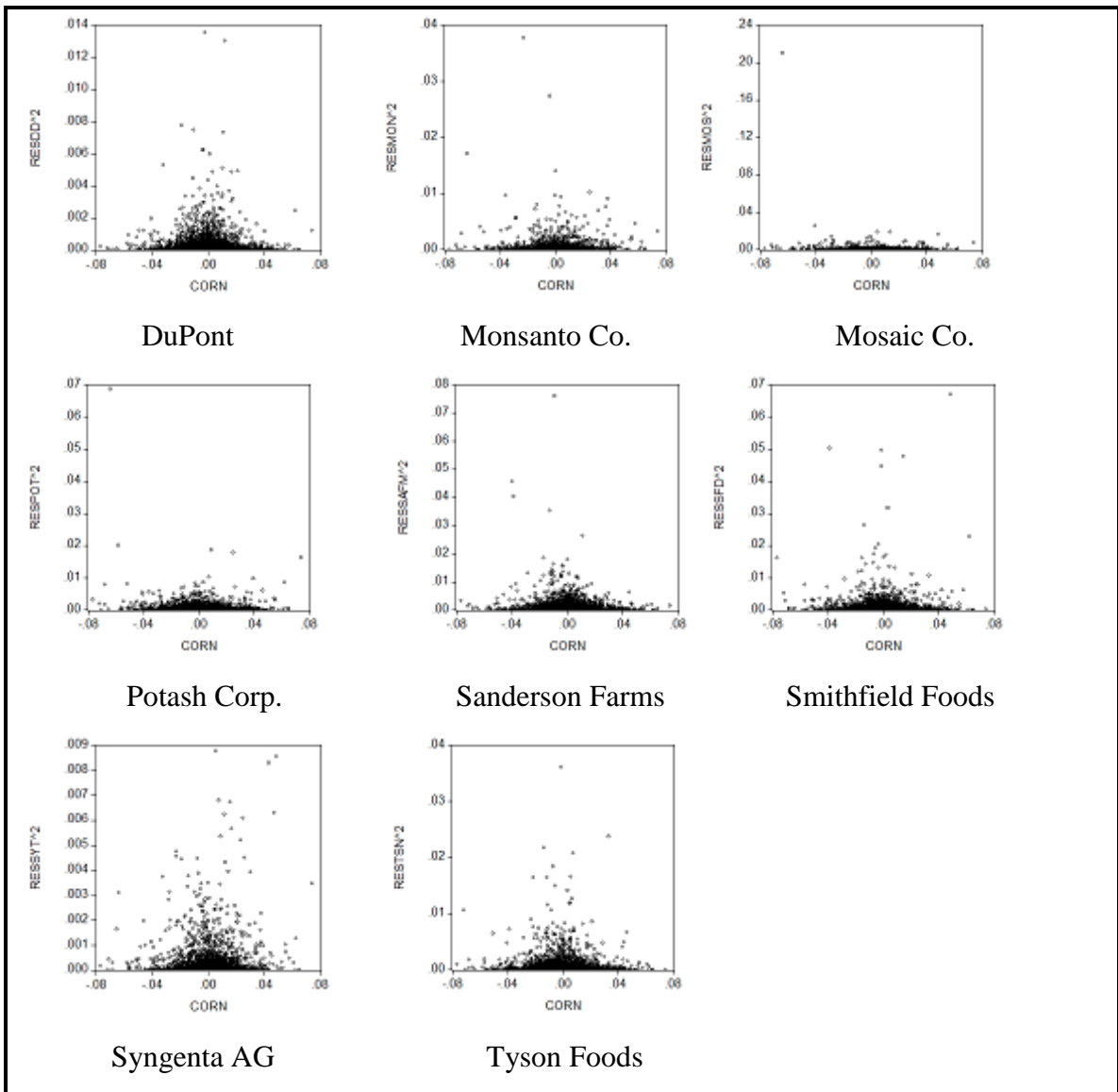
**Table 8.3 Results of White Test**

Company	White Test (no cross terms)	White Test (cross terms)
<i>Seed Industry</i>		
DuPont	23.576 (0.00)	25.777 (0.00)
Monsanto Co.	23.271 (0.00)	25.668 (0.00)
Syngenta AG	63.872 (0.00)	65.658 (0.00)
<i>Fertilizer Industry</i>		
Mosaic Co.	58.153 (0.00)	63.851 (0.00)
Potash Corp.	275.384 (0.00)	299.953 (0.00)
<i>Livestock Industry</i>		
Sanderson Farms	36.02 (0.00)	36.074 (0.00)
Smithfield Foods	263.145 (0.00)	279.341 (0.00)
Tyson Foods	68.788 (0.00)	72.17 (0.00)

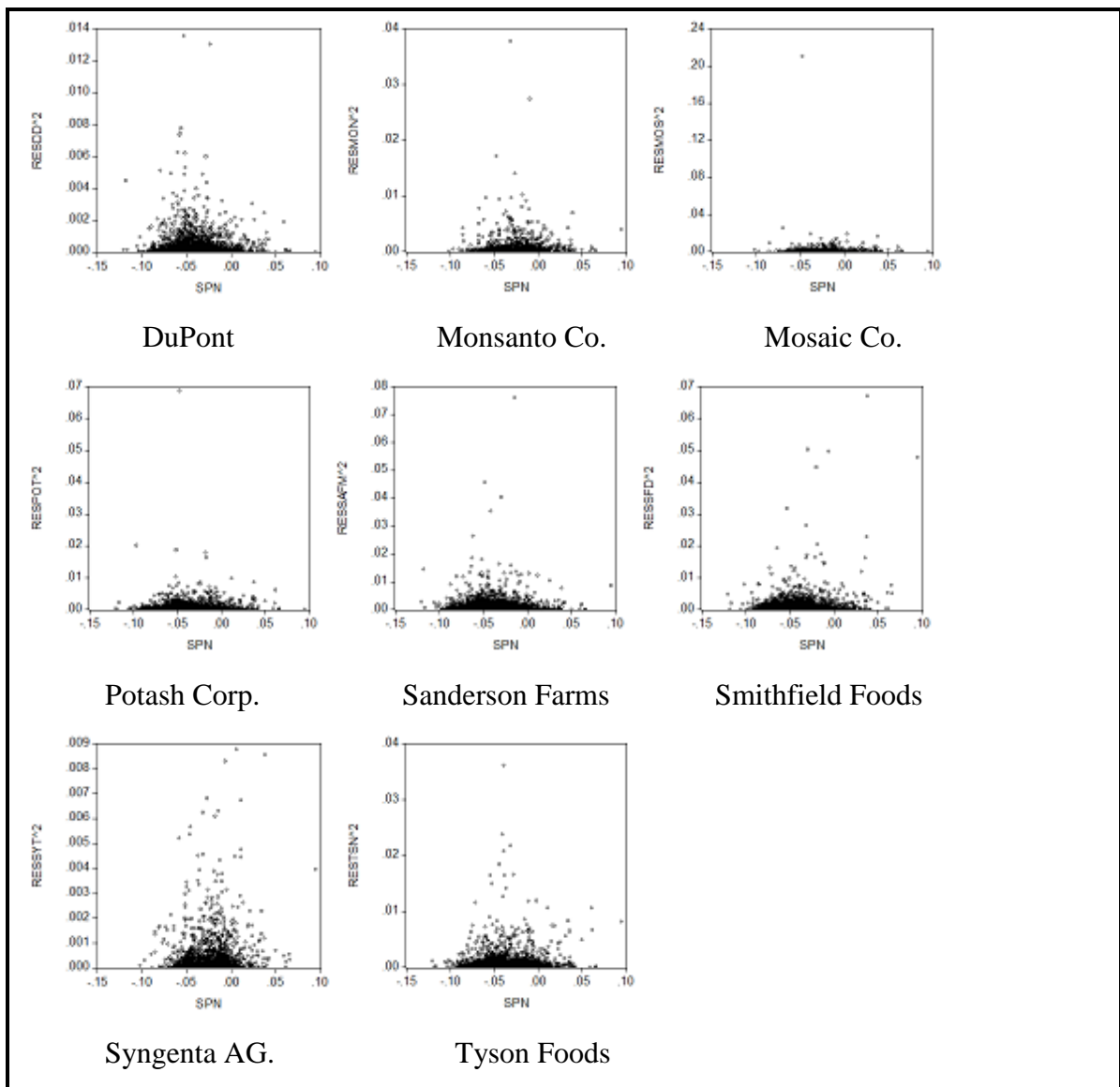
Note: The values in the parentheses are  $p$ -values.

The chi-square value obtained by White's test, with and without cross terms, exceeds the critical chi-square value at the conventional levels of significance for each model; the conclusion is that there is heteroscedasticity. OLS estimators are consistent but they are no longer efficient, not even asymptotically under the existence of heteroscedasticity. This lack of efficiency makes the usual hypothesis-testing procedure of dubious value. In order to overcome this problem, Feasible Generalized Least Squares was estimated.

Because there was no a priori or empirical information about the nature of the heteroscedasticity, a postmortem examination of the residual squared  $\hat{\epsilon}_{it}^2$  was done to make plausible assumptions about heteroscedasticity pattern. The squared residual was plotted against return on corn futures and excess return on S&P 500. The results are given in Figure 8.1 and Figure 8.2 respectively.



**Figure 8.1. Scattergram of estimated squared residuals against “Corn”**



**Figure 8.2. Scattergram of estimated squared residuals against “S&P 500”**

Both figures indicated a quadratic relationship between 1)  $\hat{\varepsilon}_{i,t}^2$  and corn, and 2)  $\hat{\varepsilon}_{i,t}^2$  and S&P market index. The correlation structure overall was not strong, specifically for Mosaic Company. The figures above were not significantly different from each other at the company level. Feasible/Two step weighted least squares method was performed in order to transform CAPM data.

The idea behind the method is a simple one. It has been assumed

$$(8.1) \quad \sigma_i^2 = \alpha_0 + \alpha_1(R_{m,t} - R_{f,t}) + \alpha_2(R_{m,t} - R_{f,t})^2 + \alpha_3 R_t^c + \alpha_4 (R_t^c)^2 + \alpha_5 R_t^c (R_{m,t} - R_{f,t})$$

Step 1. Replace  $\sigma_i^2$  by the squared OLS residual  $\hat{\varepsilon}_{i,t}^2$  and regress  $\hat{\varepsilon}_{i,t}^2$  on a constant,

$(R_{m,t} - R_{f,t})$ ,  $(R_{m,t} - R_{f,t})^2$ ,  $R_t^c$ ,  $(R_t^c)^2$  and  $R_t^c (R_{m,t} - R_{f,t})$  to obtain estimates of  $\alpha$ 's.

Step 2. Generate

$$(8.2) \quad \hat{\sigma}_i^2 = \hat{\alpha}_0 + \hat{\alpha}_1(R_{m,t} - R_{f,t}) + \hat{\alpha}_2(R_{m,t} - R_{f,t})^2 + \hat{\alpha}_3 R_t^c + \hat{\alpha}_4 (R_t^c)^2 + \hat{\alpha}_5 R_t^c (R_{m,t} - R_{f,t})$$

and  $\hat{\sigma}_i = \sqrt{\hat{\sigma}_i^2}$  using the  $\alpha$ 's and use OLS to estimate the transformed equation

$$(8.3) \quad \frac{R_{i,t} - R_{f,t}}{\hat{\sigma}_i} = \frac{\alpha_i}{\hat{\sigma}_i} + \beta_{i,1} \frac{(R_{m,t} - R_{f,t})}{\hat{\sigma}_i} + \beta_{i,2} \frac{R_t^c}{\hat{\sigma}_i} + \frac{\varepsilon_{it}}{\hat{\sigma}_i}$$

The problem with this simple model is that  $\hat{\sigma}_i^2$  is not necessarily positive for all values of the regressors; a negative variance makes no sense. To overcome this issue, the assumption about  $\sigma_i^2$  was modified as such

(8.4)

$$\sigma_i^2 = \exp \left[ \alpha_0 + \alpha_1(R_{m,t} - R_{f,t}) + \alpha_2(R_{m,t} - R_{f,t})^2 + \alpha_3 R_t^c + \alpha_4 (R_t^c)^2 + \alpha_5 R_t^c (R_{m,t} - R_{f,t}) \right]$$

or

$$\log(\sigma_i^2) = \alpha_0 + \alpha_1(R_{m,t} - R_{f,t}) + \alpha_2(R_{m,t} - R_{f,t})^2 + \alpha_3 R_t^c + \alpha_4 (R_t^c)^2 + \alpha_5 R_t^c (R_{m,t} - R_{f,t})$$

Then

$$\hat{\sigma}_i^2 = \exp \left[ \hat{\alpha}_0 + \hat{\alpha}_1(R_{m,t} - R_{f,t}) + \hat{\alpha}_2(R_{m,t} - R_{f,t})^2 + \hat{\alpha}_3 R_t^c + \hat{\alpha}_4 (R_t^c)^2 + \hat{\alpha}_5 R_t^c (R_{m,t} - R_{f,t}) \right]$$

was guaranteed to be positive. The results are displayed in Table 8.4.



**Table 8.4 Results of FGLS estimation for CAPM**

Company	Intercept	$\beta_1$	$\beta_2$	F-statistic	$R^2$
<i>Seed Industry</i>					
DuPont	-0.0001 (-0.268143)	0.998*** (96.014)	0.025* (1.735)	4665.931*** 0.00	0.616
Monsanto Co.	-0.001 (-1.262401)	0.909*** (37.709)	0.090*** (2.735)	717.721*** 0.000	0.423
Syngenta AG	-0.002** (-2.536)	0.883*** (42.263)	0.079*** (3.060)	904.939*** 0.00	0.513
<i>Fertilizer Industry</i>					
Mosaic Co.	0.006*** (3.081)	1.132*** (23.915)	0.385*** (7.045)	322.024*** 0.00	0.437
Potash Corp.	-0.002*** (-3.660)	0.923*** (63.010)	0.147*** (6.055)	1031.199*** 0.00	0.467
<i>Livestock Industry</i>					
Sanderson Farms	-0.003*** (-3.266)	0.922*** (45.412)	-0.047 (-1.596)	1031.199*** 0.00	0.264
Smithfield Foods	-0.003*** (-1.179)	0.771*** (45.535)	-0.009 (-0.323)	1037.034*** 0.00	0.284
Tyson Foods	-0.003*** (-4.616)	0.914*** (54.873)	-0.012 (-0.516)	1506.766*** 0.00	0.451

Note: The values in parentheses in the first second and third column are  $t$ -statistics and the values in the fourth column are  $p$ -values.

\*Indicates statistical significance at the 10% level.

\*\* Indicates statistical significance at the 5% level.

\*\*\* Indicates statistical significance at the 1% level.

The results of FGLS were somewhat similar to OLS with little difference in  $R^2$ ,  $F$ -statistics and  $t$ -statistic for most of the companies. The sign of the coefficient for corn showed a change from positive to negative for Smithfield Foods. The estimations were also tested for serial correlation and heteroscedasticity. The results are displayed in Table 8.5.

**Table 8.5 Results of Durbin-Watson and White's General Heteroscedasticity Test for FGLS**

Company	D-W	White Test (no cross terms)	White Test (cross terms)
<i>Seed Industry</i>			
DuPont	2.032	3.543 (-0.47)	14.849 (0.01)
Monsanto Co.	1.963	2.282 (-0.68)	2.567 (0.77)
Syngenta AG	2.100	6.298 (0.00)	6.300 (0.28)
<i>Fertilizer Industry</i>			
Mosaic Co.	1.966	16.014 (0.00)	18.616 (0.00)
Potash Corp.	1.920	4.324 (0.36)	4.334 (0.50)
<i>Livestock Industry</i>			
Sanderson Farms	2.192	9.536 (0.05)	9.636 (0.08)
Smithfield Foods	1.975	13.835 (0.01)	15.488 (0.28)
Tyson Foods	2.040	2.793 (0.59)	2.931 (0.71)

Note: For the given sample size and given number of explanatory variables, the critical values are:  $d_u = 1.789$  and  $d_l = 1.748$ . The values in the parentheses are  $p$ -values.

Durbin-Watson statistics implied that there was no statistical evidence for first order serial correlation in the model. The transformed model exhibited heteroscedasticity pattern for Mosaic Company, Sanderson Farms and Smithfield Foods. One explanation for the transformed models being heteroscedastic might be that apparent heteroscedasticity in the OLS residuals does not necessarily mean the random error terms in the model are actually heteroscedastic. Mankiw (1990)<sup>49</sup> contends that heteroscedasticity has never been a reason to throw out an otherwise good model.

<sup>49</sup> See N. Gregory Mankiw, "A quick Refresher Course in Macroeconomics", *Journal of Economic Literature*, vol. xxviii, December 1990, p.1648 for further discussion.

Three hypotheses and a sub-hypothesis were generated and tested using multifactor CAPM. The econometric estimations of market index and corn futures regressed on the share price of eight leading agribusiness companies affirm that the hypothesis signs are right. OLS and FGLS estimation procedures show statistical significance in market index and corn coefficient for most of the companies. The result for the signs of corn coefficient is consistent across all estimation methods for all companies except Smithfield Foods.

*H1*: There will be a positive relationship between return on corn futures and return on seed company stock.

$$H_0^S : \beta_{i,2}^S > 0$$

*Sub-hypothesis*:  $\beta_{i,2}^S$  will increase with the share of corn seed in company profits.

OLS results show that the impact of biofuel policy which has been investigated by using corn futures as a proxy, has the greatest positive significant wealth effect on the shareholders of Monsanto Company with a parameter estimate of 0.1171(t-statistic of 4.0148), followed by Syngenta AG with a parameter estimate of 0.081585(t-statistic of 3.2616) and DuPont with a parameter estimate of 0.02248(t-statistic of 1.4788).

FGLS results showed that corn coefficient estimates and t-statistics were 0.0898(t-statistic of 2.7346), 0.078572 (t-statistic of 3.0605), 0.02487(t-statistic of 1.735) for Monsanto Company, Syngenta AG and DuPont, respectively.

The results are not surprising at all; Monsanto has a heavy focus on developing corn seeds, and greater profit margin from corn sales than Syngenta AG and DuPont. DuPont is a conglomerate which specializes on not only agriculture, but also on automotive manufacturing, construction, pharmaceuticals, and electronics. Therefore, the corn coefficient is expected to be relatively smaller than those of Monsanto Company and Syngenta AG.

*H2*: There will be a positive relationship between return on corn futures and return on fertilizer company stock.

$$H_0^F : \beta_{i,2}^F > 0$$

OLS results showed that biofuels policies have the greatest positive significant wealth effect on shareholders of Mosaic Company, with a parameter estimate of 0.4847(t-statistic of 9.433) followed by Potash Corp. with a parameter estimate of 0.1966(t-statistic of 9.234).

FGLS results showed that corn coefficient estimates and t-statistics were 0.3852(t-statistic of 7.0451) and 0.147113(t-statistic of 6.05533) for Mosaic Company and Potash Corp., respectively.

*H3*: There will be a negative relationship between return on corn futures and return on livestock company stock.

$$H_0^L : \beta_{i,2}^L < 0$$

According to OLS results, swinging corn prices seem to have negative implications for the shareholders of Sanderson Farms and Tyson Foods with parameter estimates of -0.062689(t-statistic of -2.1856) and -0.0014924(t-statistic of -0.6584), respectively. The regression results for Smithfield Foods indicate a positive insignificant biofuel effect with a parameter estimate of 0.009041(t-statistic of 0.3375) for shareholders.

FGLS came up with a different result than OLS for Smithfield Foods, a negative impact on shareholder wealth, with a negative corn coefficient estimate of -0.008934(t-statistic of -0.322743). Results for Sanderson Farms and Tyson Foods were -0.0466(t-statistic of -1.5958) and -0.012328 (t-statistic of -0.5164), respectively.

The signs for corn coefficient in poultry/pork industries were as expected. However, significance of corn coefficient for Smithfield Foods and Tyson Foods is different from that of seed and fertilizer companies. The insignificant corn coefficient for Smithfield Foods and Tyson Foods could be partly due to the offsetting impact of ethanol byproducts which could be used as an alternative feedstock. Another explanation lies in the market share of the company. Sanderson Farms is a relatively small poultry company compared to Tyson Foods, which might be an explanation for the significance of corn coefficient at

approximately 11% and 5% according to FGLS and OLS results, respectively. Tyson Foods and Smithfield Foods are big companies with great market shares in their sectors. They are also vertically integrated so they might protect themselves from fluctuations in input prices and accommodate. Nevertheless, it is worth mentioning that if companies are highly leveraged, fluctuations in input prices (commodity and labor) might result in bankruptcy as in the case of Pilgrim's Pride.

## **CHAPTER 9**

### **CONCLUSIONS**

This chapter presents the summary and conclusions of this research. Also, the chapter proposes limitations and suggestions for further research. The chapter is organized into two sections. The first section concerns the summary of the study. The second section proposes suggestions for further research.

#### **9.1 Summary of the Study**

This study attempted to accomplish three objectives. The first objective was to provide a historical perspective on US biofuel policy, while describing various types of biofuels and the drivers for the growth in biofuel production. The second objective was to establish a relationship between corn prices and share prices by analyzing industry market environment and company corporate history. The final objective was to construct a model in a way that would reveal the effects of biofuel policy, through corn future prices, on share prices of eight leading companies in seed, fertilizer and livestock industries; and answer the primary research question, “What is the effect of biofuel policies on shareholder wealth?”

The principles and mechanisms that affect the profit margins of companies reflected in shareholder wealth were explored by a Cournot duopoly model. This analysis was done in order to establish the qualitative possibilities in an imperfectly competitive industry in case of a demand shift. The results for our specific duopoly model for seed market indicated that output, price and oligopoly profits rise for oligopolists.

Multifactor CAPM was used for the analysis in this study. Multifactor CAPM was chosen in order to derive economic implications of the biofuel policies. The models were estimated by both OLS and FGLS. The Durbin Watson test was used to test for serial correlation. The results revealed that serial correlation did not pose a serious problem. The White test, both with cross terms and without cross terms, was used to test for heteroscedasticity. The OLS residuals of all the companies showed a heteroscedastic

pattern, whereas the FGLS residuals of three companies only, Mosaic Company, Sanderson Farms and Smithfield Foods, showed a heteroscedastic pattern.

Given the fact that corn-ethanol production has different implications for companies in this study, empirical results thus far indicate that biofuel policy could be a factor of interest for decision makers, specifically for seed and fertilizer industries. This is because decision makers may be able to anticipate, and therefore accommodate, price changes in one market and to predict not only the magnitude, but also the direction of profitability for the firm.

## 9.2 Limitations and Suggestions for Further Research

The amount of data collected is a limitation of this research. Because the access to dividend data was out of reach, adjusted closing prices were used for the stock return series. Besides, there were missing data, specifically for Potash Corporation. Future research might utilize additional variables (i.e. natural gas prices, company specific financial ratios), additional companies from other agribusiness sectors (i.e. farm equipment) and extend the analysis (i.e. analysis for volatility in variance). This might add robustness to this analysis.

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