The FAPRI-University of Pretoria Collaboration

Report for the University of Missouri South African Education Program

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FAPRI-University of Missouri
Contact: Julian Binfield
(573) 882-1460
binfieldj@missouri.edu

Food and Agricultural
Policy Research Institute

FAPRI
University of Missouri
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Introduction

The FAPRI-University of Pretoria Collaboration

The aim of the collaboration is to facilitate academic exchange between the University of Pretoria (UP) and the University of Missouri (UM) in the area of agricultural economics and the development of econometric modeling capacity for Southern Africa. The collaboration was initiated through exchange between 2002 and 2004 funded through the University of Missouri South African Education Program (UMSAEP). The work has helped to establish the BFAP (the Bureau for Food and Agricultural Policy) at UP, which has used the FAPRI style models to produce a series of important analyses (visit http://www.bfap.co.za/ for details).

BFAP has served a variety of end users including policy makers, industry and the region’s farmers. UP benefits from the collaboration through the input from the FAPRI team which has experience and a worldwide reputation in this kind of modeling. FAPRI benefits by gaining insight into the Southern African region from the South African experts.

The latest funding from UMSAEP came at a particularly beneficial time with world commodity prices booming, and many concerned about the contribution of biofuels to this. The implications of higher commodity prices, especially maize, have enormous consequences for countries like South Africa where the impact on peoples incomes is much more pronounced.

Academic exchange undertaken previously as part of the project

FAPRI has been able to provide the modeling team from Pretoria with assistance in building the econometric model of the agricultural sector as well as the development of a farm level model that is linked to the sector model.¹ There have been numerous visits by UP staff between 2002 and 2007 including PG Strauss, Ferdinand Meyer, Jacky Mampana, Jeanette de Beer and Sanri Reynolds. In addition to interaction with FAPRI staff regarding the construction and simulation of the models, visitors to UMC have taken classes and given seminars. Topics covered have included price formation in South Africa, farm level modeling, and the fruit and wine sectors.

Members of FAPRI staff (Patrick Westhoff, Julian Binfield, Brent Carpenter, Willi Meyers and Peter Zimmel) have also been to South Africa in order to interact with the modeling group there. While FAPRI members were in South Africa they taught part of the LEK 810 (Econometrics) course to postgraduate students attending the University of Pretoria. Topics included: supply response, risk and uncertainty, modeling demand, trade, and model closure. UMSAEP funding has also previously contributed towards the presentation of a paper to the International Association of Agricultural Economists in Durban.

The modeling project at Pretoria - BFAP

The Bureau for Food and Agricultural Policy (BFAP) was founded in 2004 with the purpose of facilitating decision-making in the South African agricultural sector as well as training of individuals in order to increase the amount of analytical and research skills available to the sector. BFAP is housed as an independent program within the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria, the Department of Agricultural Economics at the University of Stellenbosch, and the Department of Agricultural Economics at the Provincial Department of Agriculture, Western Cape. From the time of inception, BFAP has facilitated informed decision making

¹ More information regarding the modeling methodology, and the output of the collaboration thus far can be found in the final report produced for previous UMSAEP funding.
by SA agribusinesses, policy makers, trade negotiators and farmers through the development and operation of comprehensive analytical systems.

The analysis of world and domestic markets consists of baseline projections and scenario analyses of possible market and policy changes and the possible impacts of these changes on domestic markets and farm profitability and survivability. The baselines and scenarios are constructed in such a way that the decision maker can form a picture of possible future changes and what their likely effects could be. Proactive actions can thus flow from the use of these baselines and scenarios. BFAP is the first of its kind in South Africa and has become a valuable resource to government, agribusiness and farmers by providing analysis of future policy and market scenarios and measuring their impact on farm and firm profitability. BFAP recently published its fourth baseline of the agricultural sector in South Africa consisting of five-year baseline projections for twenty six agricultural commodities. Core funding for this initiative is provided by: National Agricultural Marketing Council, ABSA bank, THRIP programme of the Department of Trade and Industry (DTI), WineTech and Eskort.

**The aim of this research project – Development of biofuels sector modelling capability**
Recent years have seen an explosion in interest in biofuels such as ethanol and biodiesel, both with agriculture and in the wider community as concerns regarding greenhouse gas emissions and global warming. In the US ethanol production has expanded rapidly due to demand as a replacement for MTBE and as a fuel in its own right as a result of subsidies. In the EU, biofuels policy has been enacted to encourage production and use. Increasingly, other countries are introducing biofuels policies.

In South Africa, surplus maize production has led to prices trading at export parity levels with large carry-over stocks. The 2004/05 production season serves as a typical example, where maize prices decreased to export parity levels due to a large surplus. In this specific season, the strong exchange rate, together with average world prices, led to low export parity prices. In fact, the price of yellow and white maize decreased to levels where the majority of SA maize farmers could not produce economically. These large carry-over stocks have fuelled the debate to find alternative uses for the surplus maize.

Other drivers, such as the government’s commitment to comply with the framework of the Renewable Energy White Paper, in order to produce renewable energy of 10 000 GWh by 2013, of which a certain percentage needs to come from the production of biofuels, have automatically involved the government in the debate on biofuels. The preliminary target which the government aims to achieve is to replace 4.5 percent of the local petrol and diesel supply with biofuels by 2013. The prospect that a successful biofuels industry could create improved market access for black emerging farmers that produce suitable crops under contractual arrangements has also been much debated in government circles. In 2005, the Bureau for Food and Agricultural Policy (BFAP) released a report that discussed the different means of producing bioethanol and weighed up the impact which a range of critical elements could have on bioethanol production plants in South Africa. The report (available on the BFAP website) made use of a scenario planning exercise to point out the critical factors that determine the economical feasibility of bioethanol production.

Over the past year, BFAP has developed the capacity to model the biofuels industry in a system of equations which interact directly with the relevant crop and livestock industries. The new BFAP sector model now has the ability to simulate the impact of various policy scenarios and macro-economic factors on the potential biofuels industry in South Africa.
In these simulations, the BFAP model takes the dynamic interaction between the field crops, livestock and government policy into account. The field crops are the source of supply and, as a result, their prices will influence the competitiveness and feasibility of the biofuels industry. The livestock sector acts as the uptake market for the byproduct, which implies that the price at which the by-product sells is determined in the livestock market. Depending on how government structures the policy and incentive programme, the price of bioethanol and biodiesel can be mainly a function of the retail price of fuel.

In FAPRI there has been a parallel development of global models of biofuels. In FAPRI-Iowa State a model of the world market for ethanol has been developed. It includes the main markets for ethanol including Brazil, the USA and Europe. In FAPRI-Missouri extensive work has been carried out to incorporate the ethanol and biodiesel markets into the models of the agricultural sectors. The ethanol industry is represented through the projection of production capacity and utilization of this capacity. The market for fuel is modeled along with gas prices. Care is taken to incorporate the by-products from the production of biofuels as these are largely utilized by the livestock industry.

FAPRI is also developing a detailed model of the biofuels sector in the EU. The EU has set an indicative target of 5.75 percent of transport fuel use to be from biofuels by 2010. Individual member states set their own targets based on this and the policy choice to achieve this varies between member states. This makes the modeling of the EU biofuels sector complicated. In the EU the transport sector's use of fuel must be modeled. The model will be integrated with FAPRI's EU modeling system in order to assess the impact of policies on the agricultural sector.

Research undertaken
The project involved three staff exchanges:

i) Patrick Westhoff, responsible at FAPRI for US biofuels models, visited South Africa in September 2007 to work with UP colleagues and to present a paper on biofuels at a conference. The presentation is included in section 2.

ii) Julian Binfield visited South Africa to attend the BFAP annual baseline presentation in June 2008. The presentation is included in section 3.

iii) Thomas Funke, responsible at UP for the South African biofuels model, travelled to FAPRI in Columbia in 2008 and worked with staff here on the models. The paper on biofuels that Thomas wrote as part of one of his classes is included in section 4.

The expenses that are outlined in the budget below involved UP paying for the first of these visits, that of Westhoff to Pretoria for two weeks. FAPRI funded the visit of Binfield to UP in June 2008. FAPRI also shared some of the costs of the visit of Funke to Missouri.

FAPRI's role in this project can be split into three parts. The first role was that FAPRI could offer advice and guidance from their experience in the construction of biofuel models for the US. This was the focus of Westhoff's visit and the presentation that it reproduced below. Not only is the US ethanol industry one of the world major producers, but the ethanol market here has the potential to drive developments on the maize markets, depending on the levels of maize and oil prices, and government intervention. Some of the model structure and FAPRI's experience in modeling is transferable to the South African situation.

FAPRI provides the world prices to BFAP for their outlook process. Usually these prices are taken from the simulation of the FAPRI global system that occurs in January. However, the BFAP outlook comes out in June, and in 2008 there were significant changes in world market conditions during that time,
specifically, a strengthening in the price of oil. As has been noted, the size of the ethanol industry in the US means that under some conditions, and increase in the price of oil results in an equivalent increase in the price of maize (and this is transmitted to other commodities). Given the importance of maize in the South African economy it was essential that this issue was addressed. This was the focus of Binfield’s visit. Prior to the visit Julian produced a new set of world prices that were consistent with a higher oil price which were then used in the outlook. Binfield’s presentation at the conference in South Africa was concerned with the factors that were moving world markets and the oil price’s role in this. While in South Africa, Binfield worked with BFAP and Holger Matthey from the FAO on the BFAP outlook.

The final role for FAPRI that was funded in part by the UMSAEP money was in hosting Funke, a post graduate student from Pretoria who took several classes. For one of the classes he prepared the paper that is reproduced here on a wheat ethanol model. During his visit, Funke had access to FAPRI staff experienced in modeling and specifically in biofuels.

It is hoped that this project will help stimulate further collaborative research between FAPRI and BFAP. Both sides benefit from the program, with FAPRI providing modeling expertise and projections for world commodity markets, and BFAP providing market intelligence and experience in working in Africa, an environment that is significantly different from the US.
1. Patrick Westhoff's presentation to the Conference of the Agricultural Economics Association of South Africa

South Africa's bioenergy policy and the economics of biofuels:
Lessons from the US experience

Agenda
- Basic economics of biofuel markets
- US experience and impact on global markets
- Lessons from the US experience

Biofuel markets
- Biofuel markets in US and elsewhere are very distorted by policies
- In spite of distortions, basic market principles apply
  - Producers respond to output and input prices
  - Biofuel use responds to changes in prices of biofuels and petroleum-based fuels
  - Traders look for arbitrage possibilities

US biofuel supply economics
- Biofuel producers seek to maximize profits
- In 2006 and 2007, ethanol prices have been well above historical levels
- As a result, the profitability of ethanol production has been very high
- Response: much plant investment, high rates of capacity utilization
- Situation now appears to be changing; abnormal profits do not persist

US ethanol wholesale price

US ethanol plant net returns

Source: Calculations based on data from www.ethanolbusiness.com
So let's back up a little

- Characteristics of US biofuel industry
- What policies support the industry?
- Why is it primarily based on maize?
- Interaction of US biofuel markets with other markets
**Incentives supporting US biofuel industry**

- Most important: tax credits to those who blend ethanol or biodiesel with other fuels
  - $0.54 per gallon ($0.135 per liter) for ethanol
  - $1.00 per gallon ($0.264 per liter) for biodiesel from "virgin" vegetable oil
- Various state subsidies
  - Lower state taxes on ethanol-blended fuels
  - Investment incentives
    - These are generally much smaller than federal tax credit

**Mandates and regulations supporting US biofuel industry**

- Renewable fuel standard
  - Requires growing share of US fuel to meet standards of biofuel
- Will probably become passed in 2007—existing mandates add to biofuel market impact in future
- Further regulations must be passed to expand the market
- Clean air rules
  - Regulations once again focus on oxygenate content and on reducing certain pollutants
  - MTBE no longer available—ethanol-only mandate now attractive
- State mandates
  - For example, 10% ethanol-blend requirement in Iowa

**Trade policies affecting US biofuel industry**

- Tariff on imported ethanol
  - 23% plus $0.54 per gallon ($0.143 per liter) on ethanol imported directly from Brazil
  - Exemption for ethanol imported from Caribbean (up to 7% of US consumption)
- Restrictions on sugar imports
  - Make US sugar price much higher than price on world market
  - Main reason US makes ethanol from maize, not sugar—given US policies, maize is a cheaper feedstock

**US ethanol production and tax credits**

**US ethanol production and mandates**

**Biofuel and related markets**

- Biofuel markets have strong interactions with other commodity markets
  - Petroleum, gasoline and diesel markets have major impacts on biofuel use and prices
  - Markets for maize, sugar, vegetable oils affect feedstock costs for biofuel producers
  - Biofuel demand for feedstocks affects markets for grains, oilseeds, sugar, meats, dairy products...
West TX interim. petroleum prices

US ethanol demand
- Portion of demand results from mandates and regulations
- Accounted for most ethanol use in 2006
- Explains ethanol prices well above energy value relative to gasoline in 2006
- Without new laws or regulations, only modest growth in this category (given with total gasoline use)
- Rest of demand reflects voluntary decisions to blend ethanol, but ethanol blended gasoline
- Growing share of total demand, mostly in 10% blends
- Uncertainty at what price?

Price of ethanol in US market
- Energy equivalent approximately 2.3 that of gasoline on volume basis
- All else equal, might expect retail ethanol price to be 2.3 that of gasoline
- Ethanol program allows for ethanol with lower charge
- Higher prices will result in consumers valuing gasoline more than ethanol
- Actual ethanol demand at prices are actually below 2.3 that of gasoline consumption for tax credits, marks up, etc.
- As supplies exceed quantities needed to satisfy mandates and regulations, what will be the price of ethanol?

US retail gasoline and ethanol prices

US wholesale gasoline, ethanol prices

US ethanol use/gasoline use

Source: EIA baseline update August 2007
Other effects of biofuel expansion

- Incentives to expand crop production, change crop mix, and limit crop use around the world
- Increased feed costs eventually translate into higher meat and dairy prices
- But lots of “noise” means people can argue about magnitude of effects
- For example: What is the effect of biofuel expansion on US consumer food prices?

Annual change in US farm cash receipts and food expenditures

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm cash receipts</th>
<th>Food expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>1998</td>
<td>300</td>
<td>350</td>
</tr>
<tr>
<td>1999</td>
<td>325</td>
<td>400</td>
</tr>
<tr>
<td>2000</td>
<td>350</td>
<td>450</td>
</tr>
<tr>
<td>2001</td>
<td>375</td>
<td>500</td>
</tr>
<tr>
<td>2002</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>2003</td>
<td>425</td>
<td>600</td>
</tr>
<tr>
<td>2004</td>
<td>450</td>
<td>650</td>
</tr>
<tr>
<td>2005</td>
<td>475</td>
<td>700</td>
</tr>
<tr>
<td>2006</td>
<td>500</td>
<td>750</td>
</tr>
</tbody>
</table>

So has expanded biofuel production increased consumer food prices in the US?

- Yes:
  - Higher grain and vegetable oil prices mean higher costs of items from breakfast cereals to soft drinks
  - Higher feed costs mean higher meat and dairy product prices

- But:
  - Don’t attribute changes in food prices to biofuels—many other factors are at play
  - For example, dairy prices are much more volatile than feed costs because of strong global demand and limited supply
  - And most of the costs of food happen after the farming in the US

Lessons from the US experience (1)

- Even in a distorted market, basic economics is still important
  - Producers must expect to make money to invest and must cover marginal costs to stay in business
  - Unless mandates get in the way, users will look at relative prices in deciding what to buy
  - Markets are interconnected because of trade and substitution effects
Lessons from the US experience (2)
- Policies can strongly influence the market
  - Subsidies can raise returns to biofuel producers and/or lower costs to biofuel consumers
  - Mandates can raise prices to consumers and producers
  - Tariffs and other trade policies will affect where biofuels are produced

Lessons from the US experience (3)
- Biofuels have impacts on other markets
  - More biofuel production means higher global prices for feedstocks, with spillover effects on other markets
  - Equilibrium will occur when rate of return to biofuel production similar to other enterprises

An important distinction
- South Africa is a (relatively) small country
- South African biofuel production unlikely to have major impacts on world prices for biofuels, grains, oilseeds, or sugar
- Impacts on South African maize and sugar prices
  - Small if South Africa still a net exporter of maize sugarcane
  - But if South Africa becomes an importer, prices will rise to import parity (world price + transportation costs) from export parity (world price - transportation costs)

Concluding comments
- Biofuels have had and will have major impacts on global markets
- We all have a lot to learn, and much of what we think we know today will prove to be wrong
- But in analyzing impacts of biofuels, don’t overlook basic economic principles
2. Julian Binfield's presentation to the BFAP Baseline Outlook Conference, Pretoria, June 2008

<table>
<thead>
<tr>
<th>Why a baseline is not a forecast</th>
<th>Oil markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Markets are inherently uncertain</td>
<td>• Agriculture increasingly integrated with energy markets</td>
</tr>
<tr>
<td>• Unprecedented level of price volatility in recent years</td>
<td>• Determines input price</td>
</tr>
<tr>
<td>• Impossible to predict even next month with great accuracy</td>
<td>• Through biofuels demand</td>
</tr>
<tr>
<td>• Need to determine underlying trends and which ones will persist</td>
<td>• But the link varies across different commodities</td>
</tr>
</tbody>
</table>

Generating the world price projections for the baseline

• FAPRI finalises prices for the global outlook in January
• This year market movements are extreme
• Plus, oil price much higher than in January's baseline
• So, we adjusted 2008 and 2009 based on what has happened since June and futures markets
• Adjusted prices to reflect a $100 oil price

What is driving world markets?

• Poor weather in Australia, EU and Ukraine
• Solid growth in India and China
• Much of the blame is attributed to biofuels, account for much of growth but <5% of total
• Weaker dollar exaggerates climb in commodity prices
• Ratcheting up impact of policy response
• Higher oil prices

Maize

• Maize main feedstock for ethanol in US
• Policy a mixture of mandates, tax incentives
• In some range of prices can trade close to or above gasoline price
• Now trading on basis of energy value
• Price therefore now determined by oil price

Source: FAPRI 2009 Global Outlook

US policy environment

• US has just agreed Farm Bill
• Major change is "ACRE" program
• Likely to have only a small impact on production
• Conservation Reserve Program has 15mil ha in it, but not all is suitable for cereal production
• Energy Bill impacts dwarf those of Farm Bill in terms of production impacts
**Sunflowers**

- Sunflower prices have been more volatile than other oilseeds
- Reflects the smaller number of producing regions
- Biodiesel is a major driver, likely to be driven by mandates
- Sunflower price therefore less linked to oil price

**But people will say it is**

![Graph showing price of crude sunflower oil](image)


**EU policy environment**

- Most EU support decoupled from production
- "Health Check" reform de-couples more, also shifts more money into rural development
- Currently no import tariffs on cereals, export subsidies are virtually zero, world prices are above intervention price
- As in US, biofuels policy is the biggest factor

**And what about supply?**

- Little reaction in area planted to higher prices
- In the long run would expect reaction to be larger with more area and yields
- But, higher oil prices have offsetting effect
- How much production potential is out there?

![Table showing Romanian rapeseed production](image)


Future figures are as reported in simple avoidance of PAPRI projection.
Policy's role in increased supply

- For the EU and US, policy is about transferring money to farmers, not about security of supply.
- Little potential for policy to adjust to allow more production.
- For the EU, reform package acknowledges the increased role for risk management tools.
- WTO constrains the ability of countries to encourage production.
- How can countries like South Africa exploit the situation?

Change in production and net exports of five major grains for selected exporters

World consumption of five major grains, 2005/06 and 2007/08 marketing years.
3. Wheat ethanol model for integration in an already existing system of models

Project prepared as part of AgEcon 9220, Advanced Market and Price Analysis.

1. Background on the South African Biofuels industry – expected production and consumption

South Africa has not yet produced any large quantities of biofuels for commercial consumption. Small-scale producers are purchasing used sunflower oil and converting it to biodiesel for their private use. There are also a number of projects producing ethanol gel from maize, as this is aimed at a substitute for the use of paraffin in poor rural households. Large commercial operations are, however, still awaiting the finalisation and clarification of the government’s strategy before the high investment projects go ahead.

In South Africa, a range of commercial agricultural commodities have been selected to supply the biofuels industry. At present, first generation biofuels are expected to make up the majority of the fuels produced while in later years it is expected that second and third generation biofuels will make up more and more of the existing biofuels pool. The commercial commodities that have been selected include, sugarcane, a specific variety of wheat (Triticale), soybeans and to a certain extent sunflower. Non commercial commodities such as Cassava have been considered but as of yet no or very few commercial production facilities are in place. Presently, yellow maize and Jathropha have been excluded as a source of potential feedstock for biofuel production due to food security and environmental concerns.

As there is no local demand for biofuels, the analysis that will be conducted is based on what is expected to happen. The proposed model will, however, have the ability to determine demand based on the implementation of government policies.

The demand on the biofuels side, is directly dependent on the blending ratios that are implemented by the government. The higher the blending ratio in a country, the greater the forced demand for a commodity, and the results are higher prices. As this sector is still very new, only a number of assumptions can be made and used to predict how the South African market will react.

In other countries of the world, demand for biofuels is fuelled by various tax exemptions, mandatory blending ratios and import tariffs. A favourable combination of these policies leads to an increase in the amount of biofuels required to fulfill the mandate and as a result thereof, an artificial demand for biofuels exists. South Africans currently use approximately 12 billion litres of petrol and 8 billion litres of diesel per annum. At a 10% ethanol and a 5% biodiesel blend a large quantity of biofuels needs to be produced in order to satisfy local demand.

Important factors that will need to be taken into account when looking at the local demand for biofuels are:

- Pricing, sourcing and transporting of feedstock, by products and final products
- Blending rates of biofuels into the local fuel pool
- Tax rebates and exemptions allocated to stake holders within the industry
• Level of import tariffs in the industry
• Linkages of fuel prices to the raw material prices, for example, the maize price to the price of crude oil
• Biofuel utilization rate
• Profit margins of biofuel producers
• International trade and global trends in the production of biofuels
• Global crude oil prices

2. Literature review

2.1 The South African Wheat Industry

In South Africa wheat is produced in both winter and summer rainfall areas. Most wheat is produced under dryland conditions, i.e. no irrigation; but there are also a few areas where it is produced under irrigation. These provinces include Mpumalanga, the Northern Cape and KwaZulu Natal. The southwestern part of the Western Cape Province together with the Free State and the Northern Cape is the largest contributing region to wheat production in the country. The Free State and the Western Cape alone produce more than 80 percent of total wheat in South Africa (Meyer, 2002).

Table 1: Production statistics of wheat

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield (t/ha)</th>
<th>Area Harvested (1000 ha)</th>
<th>Production (1000 tons)</th>
<th>Net price (R/ton)</th>
<th>Producer price (R/ton)</th>
<th>Exchange rate (R/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996/97</td>
<td>2.1</td>
<td>1293</td>
<td>2760</td>
<td>909.4</td>
<td>4.29</td>
<td></td>
</tr>
<tr>
<td>1997/98</td>
<td>1.6</td>
<td>1382.3</td>
<td>2283.5</td>
<td>817.8</td>
<td>4.61</td>
<td></td>
</tr>
<tr>
<td>1998/99</td>
<td>2.0</td>
<td>748</td>
<td>1531</td>
<td>808.2</td>
<td>5.53</td>
<td></td>
</tr>
<tr>
<td>1999/2000</td>
<td>2.3</td>
<td>718</td>
<td>1725</td>
<td>960.6</td>
<td>6.11</td>
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<td>2000/01</td>
<td>2.4</td>
<td>934</td>
<td>2348.6</td>
<td>1044.7</td>
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<td>2001/02</td>
<td>2.4</td>
<td>973.5</td>
<td>2450</td>
<td>1437</td>
<td>9.77</td>
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<td>2002/03</td>
<td>2.6</td>
<td>941.1</td>
<td>2427.2</td>
<td>1889.8</td>
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<td>2003/04</td>
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<td>748</td>
<td>1540</td>
<td>1546</td>
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<td></td>
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<tr>
<td>2004/05</td>
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<td>830</td>
<td>1680</td>
<td>1486.6</td>
<td>6.22</td>
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<tr>
<td>2005/06</td>
<td>2.3</td>
<td>805</td>
<td>1905</td>
<td>1439.4</td>
<td>6.39</td>
<td></td>
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<td>2006/07</td>
<td>2.8</td>
<td>764.8</td>
<td>2162</td>
<td>1523</td>
<td>6.76</td>
<td></td>
</tr>
<tr>
<td>2007/08</td>
<td>3.0</td>
<td>632</td>
<td>1905</td>
<td>2267.2</td>
<td>7.10</td>
<td></td>
</tr>
</tbody>
</table>


In a normal weather year, at least 1.25 million hectares of wheat must be planted to meet the domestic needs. Although there has been an increase in the area under wheat up to about 1997, this has constantly decreased with the deregulation of the market and the abolishment of the Wheat Board in 1997. This resulted in South African wheat producers being faced with increasing competition from the international markets. In comparison, the SA wheat industry is a small player in the international arena and therefore the heavy influence from the international price and production trends is rather obvious (Meyer, 2002).
2.2 The Food Balance Sheet for Wheat

The South African wheat industry has always been a net importer of wheat, in some years less than in others, requiring a total of around 2.5 million tons for local consumption. The main consumption markets are also geographically split which makes the northern part of the country, also the bigger market, more prone to imports. The required quantity of wheat for consumption has been increasing steadily as the poorer South African consumers substitute corn meal consumption with bread and flour as their incomes increase. The table below presents this balance sheet.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (1000 tons)</th>
<th>Imports (1000 tons)</th>
<th>Exports (1000 tons)</th>
<th>Domestic consumption (1000 tons)</th>
<th>Ending stocks (1000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996/97</td>
<td>2700</td>
<td>508</td>
<td>360</td>
<td>2556</td>
<td>578</td>
</tr>
<tr>
<td>1997/98</td>
<td>2283.5</td>
<td>575</td>
<td>72</td>
<td>2290</td>
<td>1074</td>
</tr>
<tr>
<td>1998/99</td>
<td>1531</td>
<td>871</td>
<td>198</td>
<td>2631</td>
<td>647</td>
</tr>
<tr>
<td>1999/2000</td>
<td>1725</td>
<td>624</td>
<td>72</td>
<td>2441</td>
<td>483</td>
</tr>
<tr>
<td>2000/01</td>
<td>2348.6</td>
<td>304</td>
<td>103</td>
<td>2481</td>
<td>551</td>
</tr>
<tr>
<td>2001/02</td>
<td>2450</td>
<td>407</td>
<td>149</td>
<td>2679</td>
<td>580</td>
</tr>
<tr>
<td>2002/03</td>
<td>2427.2</td>
<td>747</td>
<td>179</td>
<td>2629</td>
<td>946.2</td>
</tr>
<tr>
<td>2003/04</td>
<td>1540</td>
<td>1042</td>
<td>158</td>
<td>2723</td>
<td>598</td>
</tr>
<tr>
<td>2004/05</td>
<td>1680</td>
<td>1227</td>
<td>158</td>
<td>2773</td>
<td>574</td>
</tr>
<tr>
<td>2005/06</td>
<td>1893</td>
<td>1055</td>
<td>111</td>
<td>2829</td>
<td>582</td>
</tr>
<tr>
<td>2006/07</td>
<td>2048</td>
<td>778</td>
<td>211</td>
<td>2817</td>
<td>380</td>
</tr>
<tr>
<td>2007/08</td>
<td>1905</td>
<td>1500</td>
<td>192</td>
<td>2910</td>
<td>683</td>
</tr>
</tbody>
</table>

Source: Grain SA and BFAP, 2008.

At present wheat is one of the top ten imported commodities into South Africa and these imports normally depend on the local production capacity and output. During the past 10 years, imports have averaged 800 000 tons per year as the total production of wheat has declined and consumption increased.

2.3 Biofuels Research in South Africa

2.3.1 Previous research reports and production costs

In South Africa, very little research has been done on the feasibility and the potential impacts of a biofuels industry on the local commodity market. Research institutions such as the Bureau for Food and Agricultural Policy are one of the only institutions that have developed models that can assist decision makers in analysing the impacts that their respective policies will have on the biofuels industry. BFAP has run a number of scenarios on the impact that various policies could have on the industry, and has found that biofuel production will be strongly influenced by the international price of brent crude oil, international commodity prices and local production conditions. Government renewable energy policies such as fuel tax exemptions and rebates, mandates as well as import tariff protection are just some of the variables that have been used to analyse the feasibility of the sector. The analysis has, however, been limited to feedstocks of yellow maize and sugar cane on the ethanol side and sunflower and soybeans on the biodiesel side.
BFAP has also reported a number of production costs for the industry in South Africa and according to them they are based on a standard 155 million litre ethanol plant (40 million gallon) and a return on investment of 14.5%. For the 2008 season, capital costs for maize and sorghum for ethanol production have been estimated at 70.97 SA cents/litre and variable costs at 125.34 SA cents /litre (BFAP, 2008). The Low Vehicle Carbon Partnership (Low CVP) also estimated the costs of producing ethanol from wheat in the United Kingdom, and they vary their costs according to the technology employed in the plant. Their Capex costs for a 100 kt / annum ethanol plant based on natural gas boiler and the national electricity grid are estimated at 40 MGBP with an estimated return of 2.5% thereon. The operational expenditure (OPEX) are estimated at 1 MGBP per annum, given that commodity prices are determined by an international market with no tax and subsidy schemes taken into account (Punter, Ricard, Larive, Edwards, Mortimer, Hornes, Bauken and Woods, 2004).

Lemmer, Richardson and Outlaw (2007) conducted research in order to quantify the risks and economic prospects of bioethanol production from wheat in South Africa. Their model was based on a 103 million litre per annum wheat ethanol plant and an expected rate of return of 19% per annum. Their research also examined costs of production estimates which were based on figures from a study done by Tiffany and Eidman (2003). Tiffany and Eidman (2003) estimated the total per litre cost of building an ethanol plant at an ethanol extraction rate of 360l per ton and a DDG extraction rate of 33% at R3.93 per litre. The finding by Lemmer et al indicate that under their base scenario, of little to no government support, bioethanol production from wheat in South Africa would not offer a reasonable chance of being economically viable, with an average ROI of -8.4% and a 97% chance that the NPV would be negative. The profitability of producing bioethanol from wheat does, however, improve with the implementation of a subsidy or by setting the plant price of bioethanol equal to that of fuel and adding a tax rebate. The authors reported that the % chance of the NPV being negative decreases from its previous level of 97% for the base scenario to 5% for when the subsidy is implemented and 0.5% when the price is set equal to the base price of fuel and the fuel levy exemption is included. In fact, the most feasible scenario, in terms of their stochastic efficiency ranking, was floor price of R3.325 per litre and a fuel levy reimbursement of 70%. In short, the authors find that bioethanol production from wheat in South Africa is not very likely without significant involvement by the government (Lemmer et al, 2007).

Findings indicate that government involvement is probably more important than macro economic factors and policies such as import tariff protection, tax exemptions, mandates, location of the biofuel production plants, the feedstock used for biofuel production can be implemented to make the industry more sustainable. (BFAP, 2007).

3. Policies

Policies that are expected to influence biofuel production in South Africa and that will be included in the model to simulate their impact are the following:

- Fuel tax exemptions on bio-ethanol - at present equal to 100% of the fuel levy tax component.
- Mandates on blending ratios, % mandates on the total gasoline supply.
- Import tariffs, % of total price, for the protection of the local industry from international competition.
4. Data availability

In an industry where there is very little activity due to political and policy uncertainty, data availability is bound to be a problem. That is also the case for the South African biofuels industry. The BFAP model has been developed by Dr. Ferdinand Meyer in conjunction with Dr. Patrick Westhoff at FAPRI and the University of Pretoria in South Africa and captures most of the South Africa’s agricultural sector. The model runs on an annual basis and has good time series with which it simulates most of the commodities grown in South Africa. Its results will be used primarily for this project’s projections of the wheat ethanol industry.

Other data sources include the South African grain producers’ organisation, Grain SA, and their balance sheets on grains as well as their knowledge of the ethanol production and extraction rates. The managing director of Silversandsethanol, an ethanol producer who uses different types of feedstock to produce grain based ethanol, is also on the list of trusted information sources.

It is proposed that projections on the domestic use of wheat as well as fuel and ethanol prices, the local wheat price, the bread price and the ending and beginning stocks of wheat will come from the data contained in the BFAP model. International prices such as the crude oil price, the international wheat price and prices such as the international ethanol price (Brazilian anhydrous) need to be sourced from the FAPRI baseline as well as other global models such as data from the Global Insight group. All other variables will be simulated in the wheat ethanol model by synthetic simulation, in the instances where data does not exist.
5. Representation of model

6. Empirical work

6.1 Introduction

The following section describes the variables and equations estimated, by either OLS or synthetically, that make up the model. The flow diagram in section 5 represents the interaction between the variables while section 6 attempts to cover the same model by explaining each one of the equations, as well as, the sources of, and reasons for, these equations, in the instances where there was no actual data, but only research from other institution and countries to back this up. Many of the estimations are synthetic, as the wheat ethanol industry does not yet exist in South Africa. A few simulations bring forward evidence, which indicates that under a specific set of policies, this industry could be competitive.

6.2 The Model Specifications

The model has been designed to include all possible variables that make up an industry. One important fact should be kept in mind, and that is that the model is to be included within a bigger framework of models and that the wheat ethanol section will form part of the larger ethanol production industry, i.e. sugarcane, maize and sorghum. A feedback mechanism is also included in the framework, as the use of wheat for ethanol could increase imports while its production of DDGs substitutes some of the raw material used for feed. In this instance the entire fuel industry is taken into perspective whereas, in reality, wheat ethanol alone could never fulfil a 10% mandate.
The following section represents these equations and there variables as well as the reasoning and research behind the assumption, especially if they have not been empirically estimated.

6.3 Exogenous variables – Price variables

- Real wheat producer price = f(Real wheat import parity Durban, wheat net imports)
- Real world wheat price = FAPRI projection (Wheat US No 2 HRW Gulf fob)

The real wheat producer price is simulated in the BFAP sector model as a function of the wheat import parity price and the net imports of wheat to South Africa. The import parity price of wheat is based on the US HRW No 2 Gulf fob price, in other words, linking the local price of wheat directly to the US HRW No 2 gulf price.

- Real soybean meal price = FAPRI forecast 2008 baseline
- Real sunflower cake price = FAPRI forecast 2008 baseline
- World oil price (US refiners acquisition) = Global Insight / FAPRI projection
- Ethanol world price (Brazilian anhydrous) = FAPRI baseline projection

6.4 Exogenous variables – Demand and technical factors

- Wheat for domestic use = Wheat human consumption + Wheat feed consumption + Wheat seed and on farm consumption

The wheat used for ethanol feeds back into the wheat domestic use function, once the model is integrated into the sector model. The wheat for domestic use function will then be an identity of wheat for human consumption, feed consumption, ethanol consumption and seed and on farm use.

- Exchange rate (South African Rand / US $) = Global Insight projection
- Ethanol extraction rate (l / ton) = 371 litres per ton of wheat (Tokgoz and Elobeid 2008, Punter et al 2004).
- DDGs extraction rate (kg/ton) = 250 kg per ton of wheat (Punter et al, 2004, Lemmer et al, 2007).

6.5 Endogenous variables - Price equations

Ethanol retail price
The model closes on the ethanol wholesale price (ETWPR) and therefore the ethanol retail price is a summation of different components. The fuel industry in South Africa is well regulated and therefore this can be done, as wholesale and retail margins, as well as taxes and other levies are known and documented. The equation of the identity for the ethanol retail price can be summed up by the following:

ETRTPR = ETWPR + ETCOAP + ETTARB
ETRTPR = Ethanol retail price
ETWPR = Ethanol wholesale price
ETCOAP = Ethanol costs after plant (including margins, transports costs and levies)
ETTARB = Ethanol tax after the fuel levy exemption (100% tax rebate so only a porting of the original tax costs remain)

**Basic fuel price of petrol (gasoline)**
The basic fuel price is the import parity price of refined gasoline for South Africa. The price is a measure at which refined gasoline can be landed in a port of South Africa. In this model an OLS regression has been run to estimate this price and it consisted of the following independent variables:

### Table 3: OLS output for the basic fuel price estimation

| OLS Regression Statistics for Basic fuel price 95 uId, 2008/11/07 03:33:21 PM |
|---------------------------------|-----------------|-----------------|-----------------|
| F-test                         | 884.100         | Prob(F)         | 0.000           |
| MSE                            | 5.636 CV Regr   | 2.630 F-test    | 884.100         |
| R²                             | 0.998 Durbin-Watson | 3.144 R²     | 0.998           |
| RBar²                          | 0.997 Rho       | -0.697 RBar²    | 0.997           |
| Akaike Inf.                    | 3.547 Goldfeld-Quandl | 112.249 Akaike Inf. | 3.547   |
| Schwarz Inf.                   | 3.638 Schwarz II |                 | 3.638           |

<table>
<thead>
<tr>
<th>95% Intercept</th>
<th>SA cents / US $</th>
<th>index</th>
<th>Oil price in SA cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>-66.348</td>
<td>0.031</td>
<td>0.650</td>
</tr>
<tr>
<td>S.E.</td>
<td>22.526</td>
<td>0.014</td>
<td>0.161</td>
</tr>
<tr>
<td>t-test</td>
<td>-2.945</td>
<td>2.206</td>
<td>4.040</td>
</tr>
<tr>
<td>Probit(t)</td>
<td>0.026</td>
<td>0.070</td>
<td>0.007</td>
</tr>
<tr>
<td>Elasticity at Mean</td>
<td>0.103</td>
<td>0.537</td>
<td>0.670</td>
</tr>
<tr>
<td>Variance Inflation Factor</td>
<td>1.081</td>
<td>9.394</td>
<td>9.558</td>
</tr>
<tr>
<td>Partial Correlation</td>
<td>0.669</td>
<td>0.855</td>
<td>0.982</td>
</tr>
<tr>
<td>Semipartial Correlation</td>
<td>0.04278363</td>
<td>0.0753652</td>
<td>0.246775</td>
</tr>
</tbody>
</table>

* SA cents/ US$ is the exchange rate, Index is the gross domestic product deflator (Global Insight) and the oil price in the country's local currency.

The overall equation looks good with all of the statistical signs behaving as they should and the R-square and adjusted R – square showing a very good fit of 99.8% and 99.7%, respectively. The only concern is that the exchange rate variable is not completely significant, but this could be due to the data that has been used. Further simulations could be run to further improve this.

**Retail price of petrol (gasoline)**
In determining the retail price of gasoline a very similar procedure, as in the case of ethanol, was followed. The price has been calculated from the basic fuel price including measures such as the costs after the plant, taxes, levies and margins.

PRTPSA = BFPSA + PTCAP + PTTAX
PRTPSA = Retail price of petrol in SA (coastal)
BFPSA = Basic fuel price of petrol in SA
PTCAP = Petrol costs after plant
PTTAX = Petrol taxes and levies

**Dried distiller's grain price – wheat**
The dried distiller’s grain with solubles made from wheat is a by-product of the wheat to ethanol production process and is expected to have a value in the feed industry. Depending on the animal that it
is being fed to and the nutritional value of the product, it will fetch a certain price in the market. For this instance a proxy was used which incorporated the wheat producer price, the soybean meal price, the sunflower cake price and the domestic use of the product in the market. It is acknowledged that the maize producer price, as well as, the price of other DDGs products could eventually be included but as this product does not exist yet, a smaller scope of variables that could influence the price was decided upon. Research from the Prairie Swine Centre and the University of Saskatchewan suggest that DDGs from wheat has higher concentrations of nutrients, such as protein, fat, vitamins, minerals and fibre in comparison with its parent grain. The experiments did however show that despite its higher total nutrient content, nutrient digestibility was lower than in the case of wheat and it was found that DDGs inclusion, reduced growth performance of pigs, without affecting feed efficiency (Widyaratne and Zijlstra, 2008). The DDGs price equation therefore simulates a price that is lower than the producer price of wheat but moves together with the wheat producer price, the soybean meal price, the sunflower cake price and domestic use.

\[ DDGPRW = 0.65 \times WPPSA + 0.125 \times SBCPSA + 0.075 \times SCPSA - 0.1 \times DDGDUSSA \]

\[ DDGPRW = \text{DDGS wheat price} \]
\[ WPPSA = \text{Wheat producer price in South Africa – CAPE} \]
\[ SBCPSA = \text{Soybean cake price South Africa} \]
\[ SCPSA = \text{Sunflower cake price South Africa} \]
\[ DDGDUSSA = \text{DDGS domestic use South Africa} \]

**Wheat Producer Price, Soybean Cake Price and Sunflower Cake Price**

The wheat producer price is solved within the framework of the SA sector model and will be endogenous once the wheat ethanol model is added to the framework. At present and due to the location of the wheat surplus in South Africa, namely the Western Cape province, a transport differential has been calculated into the wheat producer price. After this has been done the price represents the regional Cape Province price, rather than the national average price, as traded on futures exchange. The reason for this is that the transport differential to the main market is extremely high, mostly due to the mode of transport, which in turn makes wheat produced in that are uncompetitive with wheat imports, seeing that the country is already trading at import parity.

The soybean cake price and the sunflower cake price are also solved within the framework of the sector model and for the purpose of this model are pasted as values.

**Ethanol wholesale price**

As mentioned previously the ethanol wholesale price is the closing identity of the model and solves by equating total supply and total demand. In addition to equating supply and demand an equilibrator of 0.003 (BFAP, 2006) is also used in order to simulate a wholesale price. The identity in the model is represented by:

\[ ETWPR = \text{Previous iteration, ETDUSSA, ETPRDSA + ETISA – ETESA, Previous iteration + equilibrator*difference (ETDUSSA – (ETPRDSA + ETISA – ETESA)} \]
\[ ETWPR = \text{Ethanol wholesale price} \]
\[ ETDUSSA = \text{Ethanol domestic use South Africa} \]
\[ ETPRDSA = \text{Ethanol production South Africa} \]
\[ ETISA = \text{Ethanol imports South Africa} \]
\[ ETESA = \text{Ethanol exports South Africa} \]
Equilibrator = 0.003

6.6 Endogenous variables - Supply and related equations

*Ethanol from wheat capacity*

The capacity that is to be established for ethanol production depends on two main factors. The first is the lagged capacity, in other words, the capacity that was established in the past and secondly the real lagged profit margin from wheat ethanol production. These variables are multiplied by factors that are the size of what one expects the expansion of the industry to be. For example, the sugarcane to ethanol industry would expand at a much greater capacity than wheat ethanol, and therefore the factors used in such a model would be a lot greater.

ETCAPW = 0.8*lag (ETCAPW) + 50*lag(ETWMAR/GDPD)

The model has also been adjusted so that the capacity can only grow positively, in other words if the sum of the above equation is negative, then the lagged capacity will automatically be selected.

ETCAPW = Ethanol from wheat capacity
ETWMAR = Ethanol from wheat margin
GDPD = Gross domestic product deflator (Global Insight)

*Ethanol wheat capacity utilisation rate*

The ethanol wheat capacity utilisation rate depends on the profitability of the wheat ethanol industry. If the industry is not profitable then it will not be utilised and if there is excess capacity it will be left standing. The capacity utilisation rate therefore is a function of real wheat ethanol margin.

ETCUSW = 2*(ETWMAR/GDPD)

ETCUSW = Ethanol capacity utilisation rate
ETWMAR = Ethanol from wheat margin
GDPD = Gross domestic product deflator

The model also has an estimate for an implied utilisation rate, in other words, the capacity that is actually being utilised is estimated in this function. This equation has been adapted from the BFAP Sector Model in order to make the eventual representation uniform.

Implied utilisation rate = e^{sum(adjustment ETWCUS, ETCUSW)}/(1 + e^{sum(adjustment ETWCUS, ETCUSW)})

where,

ETCUSW = Ethanol from wheat capacity utilisation rate, which in turn is a function of the real ethanol from wheat margin.

*Wheat used for Ethanol Production*

The wheat that is used for ethanol production is directly dependent on the actual capacity and the capacity utilisation rate that exists in the market. If this is zero, then no wheat will be used for ethanol production.

WETSA = ETCAPW*ETCUSW
WETSA = Wheat used for ethanol production
ETCAPW = Ethanol from wheat capacity
ETCUSW = Ethanol from wheat capacity utilisation rate

**Ethanol from Wheat Production**
The ethanol from wheat production equation is a representation of how much ethanol is actually produced from wheat given the current capacity and capacity utilisation rate.

\[ \text{ETPRDW} = \frac{\text{WETSA} \times \text{ETYLDW}}{1000} \]

ETPRDW = Ethanol produced from wheat
WETSA = Wheat used for ethanol production
ETYLDW = Ethanol yield from wheat, estimated at 371 litres per ton (Togkoz and El obeid, 2008)

**Ethanol Imports**
As South Africa is a relatively ‘marginal’ producer of agricultural commodities, relative to other countries, and as the country is a net importer of wheat, it can be expected that once a mandate is in place and depending on the structure at which the ethanol prices are determined locally, the country’s biofuels market will face increasing competition from other ethanol exporters. The coefficient of the ethanol import equation therefore carries a larger weight than those coefficients of the export equation due to the industry’s proneness to undersupply the local market.

\[ \text{ETISA} = \frac{2000 \times \text{ETWPR/GDPD} - 2000 \times (\text{ETPRWLD} + 0.95) \times \text{Exchange Rate} / 3.785 \times (1 + \text{ETTAR})}{\text{GDPD}} \]

ETISA = Ethanol imports to South Africa
GDPD = Gross domestic product deflator
ETPRWLD = Ethanol world price (Brazilian anhydrous) (FAPRI, 2008)
\((1 + \text{ETTAR}) = \text{Ad Valorem} \text{ import tariff mechanism (% tariff on value of good)}\)
ETPRWLD + 0.95 = proxy for additional costs such as transport, handling and insurance
Exchange Rate = SA cents / US Dollar
3.785 = Conversion of the world ethanol price to litres as it is quoted in US$ / gallon

**Dried Distillers Grain Production**
As dried distiller’s grain is a by product of ethanol production and it is directly dependent on the wheat that is being used for ethanol production. In the model it is being estimated by using the wheat, used for ethanol production, and the expected DDGS yield from a ton of wheat. This has been estimated to be slightly lower than in the case of corn, at 250 kg per ton of wheat used (Tokgoz and El obeid, 2008).

\[ \text{DDGWPRDSA} = \text{WETSA} \times \text{DDGWYLD} \]

DDGWPRDSA = DDGs wheat production in South Africa
WETSA = Wheat used for ethanol production
DDGWYLD = DDGs wheat yield per ton of wheat
6.7 Endogenous variables - Demand and related equations

**Petrol domestic use (gasoline)**
The domestic use of petrol (gasoline), is a function of the real basic price of gasoline and the real per capita income. The theory is that as the per capita income increases, so will the domestic consumption of petrol. The real basic price of petrol negatively affects the consumption thereof even though demand is relatively inelastic. The fit is good with a R square of 92.3% and an adjusted R square of 90%. The short run elasticity of the domestic use of petrol is relatively small with respect to the real basic fuel price, at -0.28 while it is a bit larger with respect to the real per capita income with a value of 0.83.

Table 4: OLS output for the domestic use of petrol in South Africa

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F-test</strong></td>
<td>41.667</td>
</tr>
<tr>
<td><strong>Prob(F)</strong></td>
<td>0.000</td>
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<tr>
<td><strong>MSE</strong></td>
<td>131.782</td>
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<tr>
<td><strong>CV Regr</strong></td>
<td>1.215</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td>0.923</td>
</tr>
<tr>
<td><strong>Durbin-Watson</strong></td>
<td>1.068</td>
</tr>
<tr>
<td><strong>R^2</strong></td>
<td>0.923</td>
</tr>
<tr>
<td><strong>Rho</strong></td>
<td>0.900</td>
</tr>
<tr>
<td><strong>RBar^2</strong></td>
<td>0.464</td>
</tr>
<tr>
<td><strong>Akaike Inf</strong></td>
<td>9.806</td>
</tr>
<tr>
<td><strong>Goldfeld-Quandt</strong></td>
<td>0.276</td>
</tr>
<tr>
<td><strong>Schwarz In</strong></td>
<td>9.866</td>
</tr>
<tr>
<td><strong>Schwarz ln</strong></td>
<td>9.866</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>95%</th>
<th>Intercept</th>
<th>Real per capita</th>
<th>GDP</th>
<th>Real BFP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beta</strong></td>
<td>3555.855</td>
<td>0.560</td>
<td>-11.576</td>
<td></td>
</tr>
<tr>
<td><strong>S.E.</strong></td>
<td>814.518</td>
<td>0.668</td>
<td>2.442</td>
<td></td>
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<tr>
<td><strong>t-test</strong></td>
<td>4.488</td>
<td>8.243</td>
<td>-4.740</td>
<td></td>
</tr>
<tr>
<td><strong>Prob(t)</strong></td>
<td>0.003</td>
<td>0.000</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td><strong>Elasticity at Mean</strong></td>
<td>0.787</td>
<td>-0.124</td>
<td></td>
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</tr>
<tr>
<td><strong>Variance Inflation Fac</strong></td>
<td>3.323</td>
<td>3.323</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Partial Correlation</strong></td>
<td>0.952</td>
<td>-0.873</td>
<td></td>
<td></td>
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<tr>
<td><strong>Semipartial Correlation</strong></td>
<td>0.867272388</td>
<td>-0.498682</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ethanol Exports**
As mentioned previously, ethanol exports are expected to be of lesser importance in the South African biofuels industry, than ethanol imports, and therefore the coefficients are a lot smaller. The export equation is made up of the real ethanol wholesale price and the real ethanol world price, in SA cents per litre.

\[
ETESA = -1000*ETWPR/GDP + 1000*(ETPRWLD-0.1)*Exchange Rate/3.785/GDPD
\]

ETESA = Ethanol exports from South Africa
ETWPR = Ethanol wholesale price
GDPD = Gross domestic product deflator
ETPRWLD = Ethanol world price (Brazilian anhydrous) (FAPRI, 2008)
Exchange Rate = South African cents per US Dollar
3.785 = Litres per gallon
(ETPRWLD-0.1) = Ethanol world price less a handling fee that needs to be paid by the exporter

**Ethanol domestic use**
The domestic use of ethanol is modelled as a function of the difference between the petrol retail price and the ethanol retail price. The opinion of the fuel industry is that ethanol will be used as an octane
enhancer for gasoline, rather than a fuel substitute. The model has been adopted for that and models the difference between these at 95% or zero, choosing the one that is higher. The domestic ethanol use also needs to take a mandate, if one has been implemented, into consideration. The theory is that the mandate will be binding if ethanol production is below a certain quantity, and it has been modelled such that, either the domestic use due to the ethanol price takes effect or if this is smaller than the mandate, then that comes into effect, making it binding.

\[ \text{ETDUSSA} = 5000 \times \text{maximum}(0.95 \times \text{PRTPSA} - \text{ERTPR})/\text{GDPD} \text{ or max } (95\% \times \text{PRTPSA} - \text{ERTPR}, \text{ETMANPER} \times \text{PTDUSSA}) \]

\[ \text{ETDUSSA} = \text{Ethanol domestic use in South Africa} \]
\[ \text{PRTPSA} = \text{Retail price of Petrol in South Africa} \]
\[ \text{ERTPR} = \text{Ethanol retail price in South Africa} \]
\[ \text{GDPD} = \text{Gross Domestic Product Deflator} \]
\[ \text{ETMANPER} = \text{Ethanol mandate as a percentage of total petrol use} \]
\[ \text{PTDUSSA} = \text{Petrol domestic use in South Africa} \]
\[ 5000 \times \text{maximum}(...) = \text{a figure that ensures that the model reacts accurately if the difference between the petrol price and the ethanol price is positive, if this is not the case the it will be 0.} \]

**DDGs Domestic use**
At present there is not a separate function for the domestic use of DDGs. The reason for this is that the amounts produced are expected to be relatively small and therefore an amount can be estimated, by adding DDGs production to DDGs imports and subtracting DDGs exports from this. What is left is the demand for DDGs and in this case it is the domestic use.

\[ \text{DDGUSSA} = \text{DDGPRDSA} + \text{DDGISA} - \text{DDGESA} \]
\[ \text{DDGUSSA} = \text{Domestic use of DDGs in South Africa} \]
\[ \text{DDGPRDSA} = \text{Production of DDGs in South Africa} \]
\[ \text{DDGISA} = \text{Imports of DDGS} \]
\[ \text{DDGESA} = \text{Exports of DDGS} \]

**7. Impact analysis**

**7.1 The Baseline**

The baseline is a projection based on a set of assumptions that have been gathered from a number of alternative sources, in this instance, these include Global Insight, FAPRI and BFAP. The aim of the baseline is to establish a mean at which prices and production quantities could move given the macroeconomic assumptions that have been made within the framework of the model. In the case of biofuels, the assumption of oil prices, economic growth, the exchange rate and feedstock prices, would, for example be of high importance in order to establish a relevant and realistic trend of production. The only policy variable that is in place within the framework of the baseline is a tax rebate already officially available for ethanol. No other policies have been included as this will be done in the scenario analysis section of this document.
The Macroeconomic Assumptions
A number of macroeconomic assumptions that have been used for the purpose of this exercise have been taken from the 2008 baseline of the Bureau for Food and Agricultural Policy. These assumptions were published during June 2008 and are based on an oil price, the US refiner’s acquisition price, with an average of $105.62 per barrel over the baseline period. The assumption for the exchange rate, the South African Rand to the US Dollar, is as it had appeared in the baseline, but was simulated by the research institute, Global Insight. It focuses on a relatively strong rate, 766.99 SA cents per US dollar during 2008 but this weakens throughout the baseline’s period and in 2017 reached an annual average of 1105.85 per dollar. A full set of assumptions of the macroeconomic and exogenous variables are represented in Table 5, below:

Table 5: Macroeconomic and exogenous assumptions

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</thead>
<tbody>
<tr>
<td>Oil price</td>
<td>99.43</td>
<td>112.65</td>
<td>94.23</td>
<td>104.16</td>
<td>104.67</td>
<td>111.46</td>
<td>115.06</td>
<td>111.65</td>
<td>105.10</td>
<td>97.80</td>
</tr>
<tr>
<td>SAC/US$</td>
<td>766.99</td>
<td>814.06</td>
<td>857.66</td>
<td>899.56</td>
<td>938.79</td>
<td>976.91</td>
<td>1015.05</td>
<td>1045.83</td>
<td>1075.42</td>
<td>1105.85</td>
</tr>
<tr>
<td>GDP</td>
<td>256.48</td>
<td>271.10</td>
<td>286.68</td>
<td>300.38</td>
<td>314.75</td>
<td>329.08</td>
<td>344.08</td>
<td>359.46</td>
<td>375.38</td>
<td>392.16</td>
</tr>
<tr>
<td>GDP/cap</td>
<td>1620.66</td>
<td>1855.47</td>
<td>1929.73</td>
<td>2028.71</td>
<td>2140.20</td>
<td>2265.41</td>
<td>2403.16</td>
<td>2552.93</td>
<td>2706.62</td>
<td>2866.30</td>
</tr>
<tr>
<td>Eth WP</td>
<td>1.84</td>
<td>1.92</td>
<td>1.74</td>
<td>1.65</td>
<td>1.63</td>
<td>1.67</td>
<td>1.76</td>
<td>1.83</td>
<td>1.88</td>
<td>1.97</td>
</tr>
<tr>
<td>Wheat WP</td>
<td>371.36</td>
<td>311.48</td>
<td>272.83</td>
<td>264.82</td>
<td>276.82</td>
<td>286.51</td>
<td>299.96</td>
<td>263.83</td>
<td>273.71</td>
<td>275.76</td>
</tr>
<tr>
<td>Wheat SA</td>
<td>3788.37</td>
<td>3643.67</td>
<td>3462.20</td>
<td>3773.61</td>
<td>3878.69</td>
<td>4159.45</td>
<td>4384.82</td>
<td>4442.75</td>
<td>4446.11</td>
<td>4561.43</td>
</tr>
<tr>
<td>SBM SA</td>
<td>3668.53</td>
<td>3444.87</td>
<td>3501.32</td>
<td>3306.65</td>
<td>3824.42</td>
<td>3667.62</td>
<td>3625.23</td>
<td>3830.97</td>
<td>3555.30</td>
<td>3967.96</td>
</tr>
<tr>
<td>SCSA</td>
<td>2386.61</td>
<td>2290.27</td>
<td>2338.68</td>
<td>2294.46</td>
<td>2563.58</td>
<td>2497.28</td>
<td>2503.84</td>
<td>2642.83</td>
<td>2507.32</td>
<td>2705.34</td>
</tr>
</tbody>
</table>

Source: Global Insight, the Bureau for Food and Agricultural Policy, FAPRI, 2008.

The SBM SA (soybean meal price in SA Rand / ton) and SFC SA (sunflower cake price in SA Rand per ton)) as well as the Wheat SA price (R/ton) are exogenous for the purpose of this exercise, but are solved endogenously within the framework of the South African sector model. Once the wheat ethanol model is integrated into the sector model it will provide feedback into the wheat feed and domestic use equations so that the impact of ethanol production from wheat is accurately represented throughout the system of equations. For the purpose of this exercise, a feedback link has been created within the wheat ethanol model, to show the impact of wheat ethanol production on the wheat market. The other variables are all exogenous to the system of equations in the sector model and are sourced from other research institutions such as FAPRI and Global Insight. As mentioned previously, relatively high oil price ($/bbl refiner’s acquisition price) was chosen for the purpose of this baseline together with a set of other prices and variables, such as the Brazilian anhydrous ethanol price ($/gallon), the world wheat price ($/t), the SA wheat price (R/t) and the per capita income (R’000), which were all simulated with this price range in mind. These together form the basis for this baseline and will also have an effect on the wheat ethanol model when running the impact analysis.

The Model Output
The set of macro economic assumptions that have been sourced for the simulation of this baseline feed into the model framework, exogenously. This means that they have been simulated by other models often from other institutions. These macro variables feed into the wheat ethanol model which is then solved within its own framework, establishing its own equilibrium.

Prices
In order to simulate this baseline, a number of assumptions had to be made with regard to the ethanol price, or the price at which ethanol is supposedly going to trade. South Africa’s potential for ethanol production is relatively limited, as is its potential for serious agricultural expansion. This is mostly due to the climatic conditions and agricultural resource potential of the country. It is due to this that the
government’s biofuels strategy has proposed, only marginal targets that it wants to achieve and hence ethanol could rather be seen as a octane enhancer, such as a replacement agent for MTBE, than an actual fuel substitute. Pricing policy by government therefore suggests that ethanol should trade relatively closely to the price of regular gasoline, which as mentioned previously, has been factored into the ethanol domestic use equation. The 100% fuel levy rebate also factors into this, as it gives blenders a credit, which in turn, they can use to promote ethanol production and create an additional demand. Table 6, below, depicts the ethanol and petrol (gasoline) prices as they have been simulated within the framework of the baseline.

**Table 6: Ethanol and Petrol prices, 2008 – 2017, (SA cents per litre).**

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</tr>
</thead>
<tbody>
<tr>
<td>Ethanol retail price</td>
<td>921.1</td>
<td>1029.0</td>
<td>1008.9</td>
<td>1092.3</td>
<td>1144.5</td>
<td>1227.2</td>
<td>1302.8</td>
<td>1343.6</td>
<td>1365.7</td>
<td>1392.6</td>
</tr>
<tr>
<td>Ethanol wholesale price</td>
<td>666.2</td>
<td>759.6</td>
<td>724.6</td>
<td>793.9</td>
<td>831.7</td>
<td>900.3</td>
<td>960.9</td>
<td>986.5</td>
<td>992.7</td>
<td>1003.0</td>
</tr>
<tr>
<td>Petrol retail price</td>
<td>963.5</td>
<td>1088.9</td>
<td>1057.0</td>
<td>1166.1</td>
<td>1225.5</td>
<td>1321.1</td>
<td>1401.7</td>
<td>1435.5</td>
<td>1448.0</td>
<td>1455.6</td>
</tr>
<tr>
<td>Petrol plant price</td>
<td>581.7</td>
<td>685.3</td>
<td>631.1</td>
<td>718.9</td>
<td>756.9</td>
<td>831.2</td>
<td>889.5</td>
<td>900.3</td>
<td>899.2</td>
<td>871.7</td>
</tr>
<tr>
<td>Ethanol profit margin</td>
<td>-954.5</td>
<td>-519.2</td>
<td>-541.1</td>
<td>-597.9</td>
<td>-569.4</td>
<td>-601.7</td>
<td>-612.4</td>
<td>-604.8</td>
<td>-644.8</td>
<td>-741.3</td>
</tr>
</tbody>
</table>

The ethanol retail price, in the baseline, is cheaper than the retail price of petrol whereas the wholesale price of ethanol is not cheaper than the plant price of petrol. This is mostly due to the tax rebate but the higher price of ethanol at wholesale level has the result that imports enter the country. In the baseline all of the domestic use of ethanol is made up of imports. This links back to the international price of ethanol (Brazilian anhydrous price) and its forecast, which, at an average of $1.79 per gallon (R4.49 per litre) is far cheaper than the price at which local ethanol could be produced. This, even though a transport factor of $0.95 per gallon has been included in the ethanol import equation. The profit margin is also negative making ethanol production economically impossible.

**Supply**

The higher local ethanol plant price causes cheaper imports to enter the country rather than local production taking place. This occurs even though there is no official mandate in place, but only a tax rebate, which the blenders of ethanol, are eligible for. The baseline shows that given the macro economic assumptions, ethanol production from wheat, is not viable and further policy intervention from government is required in order to start production in the industry.

**Table 7: Supply of ethanol to the industry (million litres)**

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</thead>
<tbody>
<tr>
<td>Ethanol from wheat</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>Ethanol imports</td>
<td>786.6</td>
<td>1090.1</td>
<td>1098.1</td>
<td>1166.8</td>
<td>1222.7</td>
<td>1355.0</td>
<td>1366.2</td>
<td>1213.8</td>
<td>1041.5</td>
<td>762.0</td>
</tr>
<tr>
<td>Ethanol from wheat capacity</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</table>

**Demand**

There is a slight demand for ethanol sourced on the international market, as it is so much cheaper than locally traded ethanol. As a result of this, all local ethanol demand, is fuelled by imports and local producers are simply priced out of the market. Apart from that there are also no exports of ethanol.

**Table 8: Demand of ethanol to the industry (‘000 tons)**

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<tbody>
<tr>
<td>Ethanol exports</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Total ethanol domestic use</td>
<td>786.6</td>
<td>1090.1</td>
<td>1098.1</td>
<td>1166.8</td>
<td>1222.7</td>
<td>1355.0</td>
<td>1366.2</td>
<td>1213.8</td>
<td>1041.5</td>
<td>762.0</td>
</tr>
<tr>
<td>Wheat used for ethanol</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</tbody>
</table>
By product
With no ethanol production, there is also no by product production. The production of wheat DDGs is directly linked to ethanol production and since there is no production in the baseline, the same is then true for DDGs. There is however a price for DDGs, as it is expected to have some value within the feed industry, based on a combination of other feedstock prices. As described in 7.3 the DDGs price is made up of the wheat producer price in the Cape, the soybean meal price, the sunflower cake price and the use of the product in the market. Table 9 presents the baseline for the by product.

Table 9: DDGs price, domestic use and production (*000 tons)

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</thead>
<tbody>
<tr>
<td>DDG domestic use</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>DDG production wheat</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>DDG price wheat</td>
<td>2807.50</td>
<td>2661.60</td>
<td>2554.80</td>
<td>2731.14</td>
<td>2884.98</td>
<td>3042.33</td>
<td>3185.26</td>
<td>3260.28</td>
<td>3216.98</td>
<td>3345.75</td>
</tr>
</tbody>
</table>

7.2 The Scenario
The scenario that has been simulated for the purpose of this exercise focuses specifically, on how the model reacts to policy variables and if it adheres to economic theory. The policy variables that have been shocked, for the purpose of this exercise, include a mandate for biofuels, as well as an import tariff protection mechanism. The idea is that in order to stimulate local production, in this instance, where the industry has a negative profit margin, a higher domestic price is needed. But a higher domestic price, as a result of the mandate, will encourage imports to enter the country, unless the country is protected from imports by means of an ad valorem import tariff.

The scenario that has been run is therefore a combination of a binding mandate of 10% and a measure of import tariff protection, equal to 20% of the entire value of ethanol imports entering the country. In order to see how the model responds, the binding mandate has been included as a 10% blend of the domestic gasoline use, with no phasing in period, which in the real world would seem to be unrealistic. The ethanol import tariff has also been implemented to its full potential and has also not been phased in over time. All other macro economic and exogenous variables have been held constant in order to show how the model responds to a pure policy shock.

The Model Output
The implementation of a binding mandate for ethanol use as well as the import tariff on ethanol has had an increasing impact on the production of ethanol from wheat. In addition to this increase in production, prices have also increased together with imports and the profit margin of ethanol production.

Prices
The implementation of the mandate together with the implementation of the import tariff has had a strong impact on the wholesale price of ethanol.
Figure 1: Ethanol prices, wholesale versus scenario

The output of the model shows that the wholesale price of ethanol has increased by an average of 19.58% from its level in the baseline and by even more towards the end of the projected period, mostly due to the strong increase in local demand for ethanol. The ethanol retail price, on the other hand, only increased by an average of 14.24% from its baseline level. The world price of ethanol is not affected by the mandate and implementation of the import tariff but it has an impact in that the imports of ethanol increase.

Supply
The local production of ethanol increases with the implementation of a mandate and import tariff. The increase in the local ethanol price also improves the profit margin for ethanol producers and the result is an increase in production. In addition to the increase in local ethanol production from wheat, the imports of ethanol into South Africa, also increase. The difference in the local price, relative to the international price, makes it worthwhile for blenders to source ethanol from abroad, in order to fulfil the local mandate.

Table 10: Ethanol supply – scenario, 2008 – 2017 (million litres)

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</tr>
</thead>
<tbody>
<tr>
<td>Ethanol from wheat</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.56</td>
<td>3.83</td>
<td>3.63</td>
<td>3.92</td>
<td>4.41</td>
<td>8.95</td>
<td>21.16</td>
</tr>
<tr>
<td>Ethanol imports</td>
<td>1017.85</td>
<td>1018.95</td>
<td>1099.90</td>
<td>1130.67</td>
<td>1195.84</td>
<td>1254.46</td>
<td>1327.75</td>
<td>1423.78</td>
<td>1524.76</td>
<td>1624.03</td>
</tr>
<tr>
<td>Ethanol from wheat capacity</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>12.59</td>
<td>12.59</td>
<td>12.59</td>
<td>12.59</td>
<td>12.59</td>
<td>24.71</td>
<td>57.48</td>
</tr>
<tr>
<td>Ethanol profit margin</td>
<td>-425.0</td>
<td>-76.9</td>
<td>72.0</td>
<td>-159.1</td>
<td>-110.8</td>
<td>-160.6</td>
<td>-98.5</td>
<td>105.2</td>
<td>233.1</td>
<td>518.8</td>
</tr>
</tbody>
</table>

The model output indicates that ethanol produced from wheat, increased from zero to the amounts shown in Table 10, while ethanol imports were on average 22.55% higher than during the baseline projection. The changes in policy and ethanol profitability (in SA cents per litre) also had an increasing impact on the capacity of the ethanol industry, which in turn, increased to 57 000 tons of wheat in 2017.

Demand
An increase in the mandate for biofuels forces the demand for ethanol to increase. If the demand is not met then the price increases and imports enter the market, in order to make up for the shortfall. The
model output indicates that this is what has occurred in the scenario and that the shortfall is so severe that imports increase sharply as do prices.

![Ethanol imports, production and domestic use, 2008 – 2017.](image)

**Figure 2:** Ethanol imports, production and domestic use, 2008 – 2017.

As Figure 2 indicates, the increase in production, as a result of the mandate, is very small with respect to imports. It should, however, be mentioned that in reality ethanol production from wheat will be very area specific and that the fulfillment of the mandate will be substituted by the production of ethanol from other sources such as sugarcane and maize.

**By Product**

With an increase in ethanol production also comes an increase in the production of the by product, in this case DDGs from wheat. The amount of DDGs that is produced is also consumed locally.

**Table 11:** By product production and price under scenario conditions (‘000 tons)

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</tr>
</thead>
<tbody>
<tr>
<td>DDG domestic use</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>2.40</td>
<td>2.58</td>
<td>2.45</td>
<td>2.64</td>
<td>2.97</td>
<td>6.03</td>
</tr>
<tr>
<td>DDG production wheat</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>2.40</td>
<td>2.58</td>
<td>2.45</td>
<td>2.64</td>
<td>2.97</td>
<td>6.03</td>
</tr>
<tr>
<td>DDG price wheat</td>
<td>2607.50</td>
<td>2691.58</td>
<td>2554.63</td>
<td>2739.90</td>
<td>2684.72</td>
<td>3042.08</td>
<td>3184.98</td>
<td>3258.98</td>
<td>3216.98</td>
</tr>
</tbody>
</table>

The price of DDGs remains unchanged compared to the expected price of DDGs in the baseline as consumption and production increase to 14 260 tons in 2017 and the market for the product is far from reaching a saturation level, at which one can expect prices to change.

8. Theoretical discussion

8.1 Introduction

In an instance where a country is already a net importer of a good the price of that good is directly dependent on the international price, as the price of the product normally trades at import parity. It seems then interesting that there would be interest in ethanol production from wheat, seeing that there is, in most years and especially in the recent decade, a general shortage of wheat in South Africa. The model that has been developed has been tested by a scenario in order to establish, if it is capturing the theory correctly. The following section discusses the theoretical concept of employing a mandate and an
import tariff on an industry which is highly susceptible to imports as it faces competition from other low cost producers.

Previous research by Lemmer et al (2007) concluded that “The results of this analysis demonstrate that bio-ethanol production from wheat in the winter rainfall region of South Africa is not likely to be profitable without significant involvement by the government”, and it is the purpose of this theoretical discussion to see if the model results from the scenario as discussed in section 7, adhere to theoretical concepts.

8.2 Theory

An increase in the price of oil increases the price at which gasoline sells and with that the price at which ethanol can be competitively marketed, as a source of alternative energy. In a market where there is no mandate the production of ethanol should only take place if it makes economic sense to do so, in other words if there are positive profits to be made. In a market of voluntary blending ratios and high fuel prices, the price of ethanol is also expected to trade higher and as a result local ethanol production will compete with the international market as there is a chance the good economic rents can be made.

That is a short summary of the South African wheat ethanol industry as it has been simulated within the framework of the baseline. When simulating the scenario a mandate was implemented as was an import tariff in an attempt to curb competition from the international market as well as to stimulate local production. In theory, the implementation of a mandate, results in a higher ethanol price if and only if the domestic supply of ethanol is below the level of the mandate. If domestic supply is indeed higher than the mandate, prices could be expected to decline as domestic market is in oversupply. Figure 3 depicts this graphically:

![Figure 3: Impacts of a mandate on the price of biofuels](image)

Source: Ag Econ 9220, class notes.

The market equilibrium is at the point e without the mandate. That is the point where the market supply and demand curves intersect. The solid line M represents the binding mandate and is implemented at a certain percentage of the domestic gasoline consumption, which for the purpose of this exercise, is expected to remain relatively constant. As soon as the mandate comes into effect and becomes binding,
It is the new market demand curve and a new price is set at $P_{\text{new}}$, while the new market equilibrium is at $e_1$ and the quantity produced increases from $Q_{\text{old}}$ to $Q_{\text{new}}$. The demand curve remains constant as all macro economic variables remain unchanged but as theory dictates, an increase in price will eventually lead to an increase in supply or capacity.

In terms of the simulated example, the theory holds as the implementation of a 10% mandate did, indeed, increase the local ethanol price. As mentioned previously, an increase in the price of ethanol had an impact on imports, which in turn hampered the growth of the local industry. An import tariff would therefore have to be implemented, in conjunction with the mandate, in order stimulate local production of ethanol and to make it more competitive with international market.

An ad valorem import tariff is a percentage increase on the value of the imported goods. In the case of the ethanol industry and import tariff is added to the real import parity price of ethanol, in the local currency and local units. A 20% import tariff therefore increases the cost of importing ethanol by 20% and in so doing helps make local ethanol production more cost competitive.

The combined effect of a binding mandate and ethanol import tariff therefore have the desired result of increasing local production as well as raising the local price of ethanol and therefore creating a more profitable environment for ethanol production. Had the mandate been implemented without the import tariff, then ethanol production could still not take place as a higher price would further increase the amount of ethanol that is being imported. To receive a higher quantity of imports, defies the whole reason for alternative energy and hence this would not be sensible.

9. Conclusion

The production of wheat ethanol in South Africa needs to be considered very carefully as, from the data contained within the model and previous research done, it does not seem to be economically feasible without substantial support from government. The implementation of policies should also be considered carefully as one policy, such as a mandate, on its own might not be sufficient in stimulating local production but in conjunction with an import tariff this might well be the case.

What also becomes clear is that wheat ethanol on its own cannot supply the entire market let alone a part of the market and will only be successful is it is part of a pool of feedstock that can be utilised for ethanol production. In other words, its contribution to the national demand for ethanol, by supplying a region that produces a surplus of wheat, can indeed make a valued contribution. Wheat ethanol production would however be severely limited by the cost of the feedstock, as this plays a crucial role in its profitability. Production processes that increase yields, such as producing ethanol from wheat straw as well as more efficient production methods can also help the accomplishment of this goal.

The question that remains is if ethanol production from food sources in developing countries is actually a viable alternative? High food prices and low stock levels in many countries have been blamed largely on the production of biofuels although other variables have also been mentioned as having an impact. If this is truly the case the question that the South African government should ask themselves before making a decision on implementation of policies, is if the South African agricultural sector can first of all supply the required quantities and secondly, if it can respond to demand if such policies were implemented. Only time will tell.
10. References


Class Notes (2008). AgEcon 9220, class notes from the 13th November. Columbia, Missouri, USA.

FAPRI (2008), see Bureau for Food and Agricultural Policy (2008)


