FAO COMMODITY AND TRADE POLICY RESEARCH WORKING PAPER
No. 1

The Brazilian ethanol programme: impacts on world ethanol and sugar markets

Tatsuji Koizumi
Commodity Policy and Projections Service
Commodities and Trade Division
24 June 2003

FAO Commodity and Trade Policy Research Working Papers are published by the Commodities and Trade Division of the Food and Agriculture Organization of the United Nations (FAO). They are working documents and do not reflect the opinion of FAO or its member governments.

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ABSTRACT

The sugar market in Brazil has a strong relationship with the ethanol market. The Brazilian government has now abolished all the sugar market intervention measures except for the control on the ethanol-gasoline blend ratio. In this study, implications of a change in blend ratio to the sugar markets, particularly in its production resource use is investigated by applying a newly developed Ethanol-sugar market projection model. The model simulation result shows a moderately sized impact on the world ethanol and sugar markets.

RÉSUMÉ

Le marché du sucre au Brésil est étroitement lié au marché de l'éthanol. Le gouvernement brésilien a actuellement aboli toutes mesures d'intervention sur le marché du sucre, exception faite du contrôle sur le ratio du mélange éthanol-essence. Cette étude aborde les répercussions d'un changement du ratio de mélange sur les marchés du sucre, en particulier dans son utilisation comme ressource de production en appliquant un nouveau modèle de prévision du marché éthanol-sucre. Le résultat de la simulation indique que l'impact sur les marchés mondiaux de l'éthanol et du sucre serait modéré.

RESUMEN

Los mercados del azúcar y del etanol están íntimamente relacionados en Brasil. El gobierno brasileño acaba de erradicar toda medida de intervención al mercado azucarero, con excepción del control que ejerce respecto de las proporciones de la mezcla etanol-gasolina. El presente estudio analiza las consecuencias que tendría un cambio en la proporción de mezcla en los mercados del azúcar, en especial en lo que concierne a su uso como recurso productivo, mediante la aplicación de un modelo de proyección recientemente desarrollado para el mercado azucarero y del etanol. La simulación de este modelo arroja un impacto moderado sobre los mercados azucarero y del etanol.

CONTENTS

1. INTRODUCTION

The sugar market is operated under an extensive range of governmental interventions. Its production, trade and even consumption levels are subject to governmental controls in many countries. Strong governmental policy which influences sugar market activities has been deepening since the middle of the 1970s. The world sugar market is now operated under governmental programmes in three broad categories: agriculture, energy and environment. Air pollution and ground water pollution issues in the United States are one examples that make links between environmental and energy policies, while the energy policy decisions in Brazil and India are other examples that show links between agriculture and energy programmes.

World sugar and ethanol markets operate by having strong mutual influences because most of the sugarcane goes to ethanol production. At present, less than half of the sugarcane (between 35.0 and 47.2 percent)[1] goes to sugar production while the rest goes to the ethanol market. Among the major sugar producing countries, Brazil is the world's largest producer of sugarcane and sugarcane based ethanol. Hence, development in Brazil may have considerable implications on the situation of the world sugar and ethanol markets.

Over the last three decades, the government of Brazil has implemented powerful intervention programmes to its sugar market through its ethanol programme but had a clear change in its role in the late 1990s. With the de-regulation of its ethanol programme, which was implemented over the 1998-1999 period, the government no longer exercises direct control over sugar production and exports. Within the remaining range of permitted controls, the government can only set the ethanol to fuel blend ratio. The most likely foreseeable decision will be that on the planned compulsory usage of ethanol blend diesel fuel.

This study reports the evaluated results on the implications of the imposition of the ethanol blend diesel fuel usage for the world sugar and ethanol markets. The present analysis is based on world sugar-ethanol market modelling work. The link between the agricultural (sugarcane and sugar) and energy (ethanol) markets was analyzed and translated into the econometrically estimated structural equations of the model. The paper is organized as follows. In the next section a brief overview of the Brazilian ethanol programme is presented, followed by an explanation of the world sugar-ethanol model that is applied in evaluating the Brazilian program. Baseline projection figures are discussed in the fourth section, the fifth section reports the market situations when the programme is in force and the last section summarizes the findings.

2. A BRIEF HISTORY OF THE BRAZILIAN ETHANOL PROGRAMME

The government of Brazil inaugurated the national ethanol programme (PROALCOOL) in 1975. The major target of the programme was to reduce its oil import bill because, in the mid-1970s, Brazil was strongly dependent on imported oil. An important direct effect of the programme was the creation of a huge domestic demand for its sugarcane market. The creation of PROALCOOL provides the much needed cures to its sugar producers who are frequently faced with problems due to excess sugar production and huge fluctuations in its price. With the second oil-shock in 1979, the government decided to enlarge the programme by providing enhanced supports to the large-scale hydrated ethanol producers to supply the neat and cheaper prices fuel. Two institutes played vital roles in implementing the national ethanol program. The Institute of Sugar and Alcohol (IAA) controlled sugar and ethanol production and exports through implementing a production quota and fixed purchasing price of ethanol. Petrobas, being a monopolistic state oil company, controlled domestic ethanol sales and distribution. The government set the sugarcane price to independent growers. A wide range of

[1] These data are derived from the Ministry of Agriculture in Brazil.

governmental investment support programmes were implemented in the 1980s. The national ethanol production capacity expanded to produce over 16 billion litres of ethanol per year.

Despite this achievement, the programme has faced criticism since the middle of the 1980s. Changes in the macro economic conditions were the first source of criticism. The 1982 the Brazilian debt crisis dried up the sources of finance, followed by the declining international oil prices that started from 1986. Inadequate ethanol supply and demand management raised serious market disruptions in the early 1990s and resulted in losing consumer credibility in ethanol fuel. The production of ethanol powered cars has been declining since then. Now only 1 percent of cars are ethanol powered. To forestall that trend, the government set the anhydrous ethanol blend to gasoline between 20 and 25 percent of the product, with a variation of plus or minus 1 percent as a means of balancing the relationship between supply and demand of sugar and ethanol. The government took radical programme reforms over the 1997-1999 period. In 1997, the price of hydrated ethanol was liberalized, followed by the 1999 price liberalization decision of anhydrous ethanol and the abolition of the distribution monopoly given to Petrobas, and the reduction in the subsidies to the ethanol blend gasoline producers. Currently, there are no restrictions on ethanol production, the only tool that is left to the government is setting the anhydrous blend ratio to gasoline. The actual percentage of the blend ratio is determined by the Ministry of Agriculture, as a means of balancing the relationship between supply and demand of sugar and ethanol. A blend ratio of 26 percent is set as the legal maximum blend ratio level. As of April 2003, the blend ratio was set at 20 percent and it will be increased back to 25 percent from July 2003.

Table 1 shows the history of the Brazilian ethanol and sugar programmes.

3. WORLD ETHANOL-SUGAR MODEL

A world sugar and ethanol model has been developed in order to analyze how an ethanol, energy or environmental policy in major producing countries will affect not only the ethanol market but also the domestic and world sugar markets. The model is developed as a dynamic partial equilibrium model. The world sugar market consists of 14 major producing countries while there are 11 major country markets in the world ethanol market. In the model, two markets are linked together through the Brazilian sugar and ethanol markets. In the Brazilian market, a "sugarcane allocation ratio variable" is defined. This allocation ratio of sugarcane determines what portion of sugarcane goes to ethanol production or sugar production. In recent years, mills have become more flexible, producing both sugar and ethanol. The main driving factor that determines the level of sugar and ethanol production is the relationship between the domestic sugar and ethanol price. The reaction of producers to a change in market price is replicated in the model through the introduced allocation ratio variable to allow the instantaneous ethanol and sugar production adjustment to change the relative sugar-ethanol price ratio.

Each country market consists of the production, consumption, export, import and ending stock activities. The sugar market activities are defined on a raw sugar equivalent basis. Because several country markets are operated under strong governmental intervention, country market clearing prices are solved from the country market clearing identities, while the trade market price is found as a trade market clearing price. Among the 14 sugar country markets, two country and regional market prices are near perfectly isolated from the trade market price movements. The exogenously specified market intervention prices are guiding the market supply and consumption activities while trade is taking place to fill the resulting supply-consumption gaps in these cases. Among the EU's sugar production and trade programmes, the model takes into account the sugar production quotas, intervention price, export subsidies and preferential treatments for specified countries.

Sugarcane is not the only source of ethanol production. The United States' ethanol production, for example, is based mostly on maize. Ideally, the model specification should be extended to cover those related agricultural commodity markets. However, at this stage of model development, relevant

markets are approximated by the exogenously provided market prices. Ethanol consumption is specified as the sum of transportation use and other uses. Transportation use is defined as a function of ethanol and gasoline prices, which is further explained by the exogenously provided crude oil price, and the number of vehicles. Data for the sugar and ethanol markets are taken from FAOSTAT. Brazilian ethanol and automobile data have been collected from publications from the government of Brazil.

Figure1 illustrates the concept of the World Ethanol and Sugar Model

4. MARKET PERSPECTIVES

4.1 Assumptions

The baseline simulation is grounded in a series of assumptions about the general economy, agricultural policies, and technological changes in exporting and importing countries for the projection period. The exogenous assumptions on the projected demand for gasoline and diesel in Brazil and India are taken from the World Energy Outlook 2002 (International Energy Agency, 2002). Another set of exogenous assumptions, the projected United States ethanol consumption and crude oil price, is derived from the Annual Energy Outlook 2003 (United States Department of Energy, 2003). In this USDE baseline scenario, the world crude oil price will decrease by 1.5 percent per year from 2000 to 2010. Gasoline consumption data in four major Indian cities is derived from the government of India. Population data for each country is taken from UN population estimates. GDP and growth assumptions are mainly based on the economic forecasts of the World Bank.

It is generally assumed that current agricultural policy will be continued in all countries over the projection period in accordance with the baseline market situations. Normal weather and historical rates of technological innovation are assumed in this projection. New WTO agricultural agreements are not taken into account in the models. Reduction commitments for market access and export subsidies will be frozen at levels prevailing in the year 2000 for developed countries and 2004 for developing countries. Regional free trade areas are not assumed to expand. WTO entries of China and Taiwan Province are taken into account in calibrating the baseline estimates. The Russian Federation is not assumed to be a member of WTO. Brazil will maintain PROALCOOL and the ethanol blend ratio is assumed to remain with a maximum level at 25 percent throughout the projection period. The government of India is implementing its E-5 programme (5 percent ethanol, 95 percent unleaded gasoline) from 2003 in four major cities.[2]

4.2 World and Brazilian ethanol markets perspectives to the year 2010

World ethanol consumption is projected to increase by 3.0 percent per annum from 2000 to 2010. As a result of the alternation from MTBE to ethanol in the United States fuel market, US ethanol consumption is projected to show a step-shaped increase. The projected world ethanol price is reported on a basis of an artificially created price index (2000=1). The world ethanol price is predicted to increase in a fluctuating manner during the 2000-2010 projected period and is estimated to reach 1.05 in 2010. Most ethanol producing countries are expected to give priority to domestic markets in supplying their products, the world ethanol trade share to production and consumption is not projected to expand. The trade share to production will remain at 9.9 percent in 2010. World ethanol export is projected to increase by 1.1 percent per annum during this period. Since the relatively high domestic and international prices of ethanol stimulate its production, world ethanol production is projected to grow by 3 percent per year.

Brazil's ethanol consumption is projected to increase by 2.3 percent per annum, and its ethanol consumption is predicted to dominate 51.5 percent of world ethanol demand in 2010 with the assumed

[2] These are Delhi, Calcutta, Mumbai and Bangalore.

anhydrous ethanol blend ratio of 25 percent. Since gasoline demand in Brazil is predicted to increase by 2.7 percent per year, ethanol consumption of anhydrous ethanol is predicted to increase proportionately, while hydrated ethanol and anhydrous ethanol for other uses are estimated to decrease by 0.9 percent per annum. Ethanol production in Brazil is projected to increase by 2.3 percent during this term. It is assumed that, because of the purpose of PROALCOOL, the government of Brazil will give priority to meeting domestic demand rather than joining international markets. Brazil's ethanol exports are predicted to increase by 3.9 percent per annum during this period.

In India, the E-5 programme will be promoted in four major cities. Ethanol consumption and production in India is projected to increase by 1.9 percent per annum during this period. In the United States, the use of Methyl Tertiary Butyl Ether (MTBE) is expected to be regulated in 14 States[3] which passed relevant legislation. However, in the baseline projection it is assumed that the federal ban will not be adopted. As a consequence of the regulations on MTBE, it is expected that, in those States, MTBE will be replaced by ethanol. United States ethanol consumption is projected to expand by 5.7 percent per annum over the projection period. Owing to the estimated higher ethanol demand, the domestic ethanol producer price is projected to increase from 140.0 to 147.2 (Index; 1982=100) during this period. United States ethanol production is projected to increase by 5.7 percent by annum, and its ethanol export to decrease by 3.0 percent. The total ethanol consumption by OECD countries[4] is projected to increase by 4.7 percent per annum during this period, and their production to increase by 5.0 percent per annum during this period. United States market developments greatly influence the market situation of OECD countries.

4.3 World and Brazilian sugar markets perspectives to the year 2010

World sugar production (in raw sugar equivalent) is projected to expand by 1.7 percent per annum from 2000 to 2010. The country which contributes most to the increase in the world sugar production is Brazil. World sugar consumption is projected to expand by 1.9 percent during this period. The country which contributes most to the increase in world sugar consumption is India. World sugar exports (raw sugar equivalent) are projected to increase by 1.5 percent per annum and world sugar imports are projected to expand by 2.6 percent per annum during this period. The world raw sugar price[5] was 8.18 US cents/lb in 2000 and is projected to observe the cyclic fluctuations in the world sugar market price during the projection period because of the biologically required time-lag in sugarcane production. Because of this the world price in the year 2010 is estimated at 6.96 US cents/lb.

Brazil's sugarcane production is predicted to increase by 3.2 percent over the 2000-2010 period, supported by the projected steady growth in area harvested and yield. Brazilian sugarcane area harvested is projected to increase by 1.4 percent. The sugarcane area harvested in Brazil amounts to about 10.6 percent of the total crop area harvested. Sugarcane yield is predicted to increase by 1.8 percent.

The sugarcane allocation ratio of sugar production over ethanol production is determined by the relative price ratio between domestic sugar and ethanol prices. The sugar-ethanol price ratio6 is the crucial factor in deciding the allocation ratio. From 2009 to 2010, domestic crystal sugar price is projected to decrease from 1.074 to 1.064 (Index; 2000=1)7 and domestic anhydrous ethanol price to decrease from 1.137 to 1.1048. The price ratio, which is calculated as a ratio of normalized sugar price

[3] These are Arizona, California, Colorado, Connecticut, Indiana, Iowa, Illinois, Kansas, Michigan, Minnesota, Nebraska, New York, South Dakota and Washington.

[4] In this paper, OECD total is calculated as a sum of United States, Mexico, EU15, Australia, Japan and Republic of Korea.

[5] In terms of the ISA average price.

[6] This price ratio is calculated as: (domestic crystal sugar price) / (domestic anhydrous ethanol price).

[7] Domestic crystal sugar price is projected to decrease from 22.74 to 22.53 R$/50 kg.

[8] Domestic anhydrous ethanol price is projected to decrease from 646.75 to 628.23 R$/1 000 litres.

over normalized ethanol price, is projected to increase from 0.944 to 0.963. It means that there is expected to be an incentive for sugar production. With this change in the producer price ratio, the sugarcane allocation ratio for sugar is projected to increase from 50.77 to 51.19 in 2010.

Brazil's sugar production is predicted to increase by 3.8 percent per annum during this period. Exports are predicted to grow by 5.8 percent. In 2010, Brazil is expected to be the greatest sugar exporter in the world.

EU15's sugar production is derived from sugar beet and sugarcane. Its production is projected to increase by 0.5 percent per annum. Exports are projected to decrease by 0.9 percent per annum during this period. The total OECD sugar production is projected to increase by 0.6 percent and their export to decrease by 0.4 percent per annum during this period.

5. IMPACTS OF THE BLEND RATIO CONTROL

5.1 Scenario-imposition

Since the end of the 1970s, the hypothesis of substituting diesel by ethanol in diesel cycle engines has been considered. At the experimental level, anhydrous ethanol is blended into diesel engines at a level of 8 percent in Brazil. The same experiment was conducted in Sweden and the United States (each adopted the blend rate at 15 percent). The repercussion effects of increasing ethanol demand are vast, although the government does not adopt anhydrous ethanol blend to diesel oil. Because the upper limit of the anhydrous ethanol blend ratio is set at 26 percent, there seems to be little room to expand anhydrous ethanol within the current ethanol policy. To increase domestic ethanol consumption and control the sugar market more effectively, setting the anhydrous ethanol blend ratio to domestic diesel oil seems to be required.

As an alternative scenario to this study, it is assumed that the government imposes a further restriction for setting the anhydrous ethanol blend ratio to domestic diesel oil, after the technology for practical use is completed. This programme is assumed to start from 2006 and the blend ratio will be set at a level of 8 percent.

5.2 Impacts on ethanol markets

Diesel oil consumption is projected to increase by 2.7 percent per annum from 2000 to 2010. In 2006, the consumption is projected to be 26.2 million tonnes. Owing to setting the anhydrous ethanol blend ratio to domestic diesel oil from 2006, Brazil's ethanol consumption in 2006 is predicted to increase by 15.3 percent. In 2010, its consumption is predicted to dominate 55.5 percent of world ethanol consumption. Because of the high consumption, the domestic anhydrous ethanol price in 2006 is predicted to increase by 6.49 percent. Ethanol production can be switched flexibly from sugarcane for sugar production without a time-lag. As a business practice, it was assumed that producers can adjust their ethanol-sugar production mix by allocating 22 percent of total sugarcane as adjustable input for a change in the sugar-ethanol price ratio. Brazil's ethanol production is predicted to increase by 14.98 percent in 2006. Similar to other ethanol producing countries, Brazil is expected to give priority to higher domestic ethanol prices than the international ethanol price. Brazil's ethanol exports are predicted to decrease by 4.23 percent in 2006.

The world ethanol market can be heavily influenced by Brazil's ethanol markets. World ethanol consumption and production is predicted to increase by 8.51 to 9.22 percent from 2006 to 2010. The volume of world ethanol trade is predicted to decrease by 0.10 to 0.12 percent. The world ethanol price is predicted to increase by 0.91 to 1.14 percent.

5.3 Impacts on sugar markets

As a result of a high domestic ethanol price, Brazilian sugar production is predicted to shift from sugar to ethanol production. In 2006, the domestic anhydrous ethanol price is predicted to be much higher than the crystal sugar price. The price ratio is predicted to be 0.687, although the ratio is projected to be 0.839 in the baseline-case. For this reason, the allocation ratio for sugar production is predicted to decrease from 48.46 to 45.12 percent in 2006. The price ratio is predicted to diminish from 2006 to 2010. The allocation ratio for sugarcane is predicted to be 47.92 percent in 2010, although the ratio is projected to be 51.19 percent in the baseline-case. As a result of the shift, Brazil's sugar production is predicted to decrease by 0.3 to 2.5 percent during this period, with exports predicted to decrease by 0.7 to 2.9 percent. Brazil's domestic crystal sugar price is predicted to increase by 3.82 to 5.44 percent. On account of this country's diminishing sugar production, world sugar production is predicted to decrease by 0 to 0.2 percent, compared with the baseline-case, and world sugar export is predicted to decrease by 0 to 0.3 percent. As a result of this, the world raw sugar price is predicted to increase by 0.34 to 2.23 percent.

Concerning sugarcane production, the area harvested for sugarcane is predicted to increase by 1.2 to 1.7 percent, compared with the baseline-case. In the scenario-case, the area harvested for sugarcane is predicted to reach 5.69 million ha in 2010. In Brazil, more than 80 percent of sugarcane harvested is cut by hand, burning off the sugarcane's dry leaves before cutting. Through the expansion of the sugarcane area harvested, the use of burning before cutting could have a negative impact on the environment.

6. CONCLUSION

As a result of the Brazilian energy programme's imposition of further 8 percent anhydrous ethanol blend diesel oil from 2006, world ethanol and sugar price are predicted to increase. The estimated results indicate that the magnitudes of world price hikes of both sugar and ethanol are moderate but will persist for years.

Although Brazil's sugar export is predicted to decrease, world sugar export is predicted to remain at the baseline predicted level because the higher world sugar price will stimulate major exporting countries to increase their exports from 2006. An increased raw sugar trade price will benefit sugar exporting countries. Benefited from the diminishing price differences between the domestic market price and world price, EU15 is predicted to increase its sugar export level by 0.9 percent. The other sugar-cane based sugar exporters are expected to materialize their benefits with a two-year time-lag, because of the biological condition of sugarcane production. The exports of ACP countries[9] are predicted to increase by 1.3 percent. Because most of the ACP countries' economies depend heavily on their sugar exports, the higher world sugar price could benefit their economies. The exports of Thailand and Australia are predicted to increase by 0.7 percent and 0.6 percent respectively.

The country which will benefit the most from the programme is Brazil itself. The government of Brazil can control not only domestic sugar and ethanol markets, but also the world sugar and ethanol price. The government of Brazil abolished most of the regulations for domestic sugar and ethanol markets in the 1990s. There is no regulation of their markets, except for setting the anhydrous ethanol blend ratio. The policy change of PROALCOOL can control sugar output and export. It will finally lead to the world sugar price being heavily influenced. Setting a further anhydrous ethanol blend ratio can be an effective policy tool to control domestic and world sugar markets, and moreover, this programme will contribute to expanding domestic ethanol markets. It will lead to reducing oil imports. From 23.2 to 25.8 million tonnes of oil imports are predicted to be saved. It will also lead to expanding job opportunities and to reducing air pollution.

[9] In this paper, the ACP countries are taken as 70 countries, excluding South Africa.

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ANNEX - MODEL EQUATIONS

Production

$\Delta Ahis,t = f(\Delta PPis, t-1, \Delta PPia,t-1, \Delta Qis,t-1)$ or $\Delta Ahis,t = f(\Delta PPis, t-2, \Delta PPia,t-2, \Delta Qis,t-2)$

$\Delta Yis,t = f(\Delta Gis, t)$ -

$QPis, t = AHisc,t * Yisc,t * SUALt * ERisb,t + AHisb, t * Yisb, t * ERisb,t$

$SUALt = f((DPis,t / DPis,t\ 0)/(DPie,t / DPie, t\ 0))$

$\Delta QPie,t = f(\Delta PPie,t, \Delta Gie,t)$ or $\Delta QPie,t = f(\Delta PPie,t, \Delta PPim,t, \Delta Gie,t)$

Consumption

$QCi,t = PQCi,t * POPr, t$

$\Delta PQCi, t = f(\Delta DPi,t, \Delta DPia\ t, \Delta Ir, t)$

Exports

$\Delta EXi,t = f(\Delta WPi,t, \Delta DPi,t)$ or $EXi,t = QPi,t + IMi,t - QCi,t - (SSi,t - SSi,t-1)$

Imports

$\Delta IMi,t = f(\Delta MPi,t, \Delta DPi,t, \Delta Ir,t)$ or $IMt\ s = EXs + QCts + (SSst - SSst-1) - QPst$

Ending Stocks

$SSi,t = f(\Delta QPi,t, \Delta DPi,t)$ or $SSi,t = f(\Delta QCi,t, \Delta DPi, t)$

Market Equilibrium

$\Sigma_r EX\ i,r,t = \Sigma_r IM\ i,r,t$

Variable Definition

Ah = area harvested,
Q = production quota
Y = yield
G = exogenous growth rate
QP = production
ER = extraction rate
SUAL = sugarcane allocation ratio for sugar production
QC = consumption
PQC = per capita consumption
EX = export
IM = import
SS = ending stocks
I = per capita income
POP = population
DP = domestic price
PP = producer price
MP = import price
WP = world price

Index

i = all commodities
is = sugar
isc = sugarcane
isb = sugar beet
ie = ethanol
ia = alternative commodities
im = input for ethanol production
r = countries/ country groups
t = time

FIGURES

Figure 1 The concept of world ethanol and sugar model

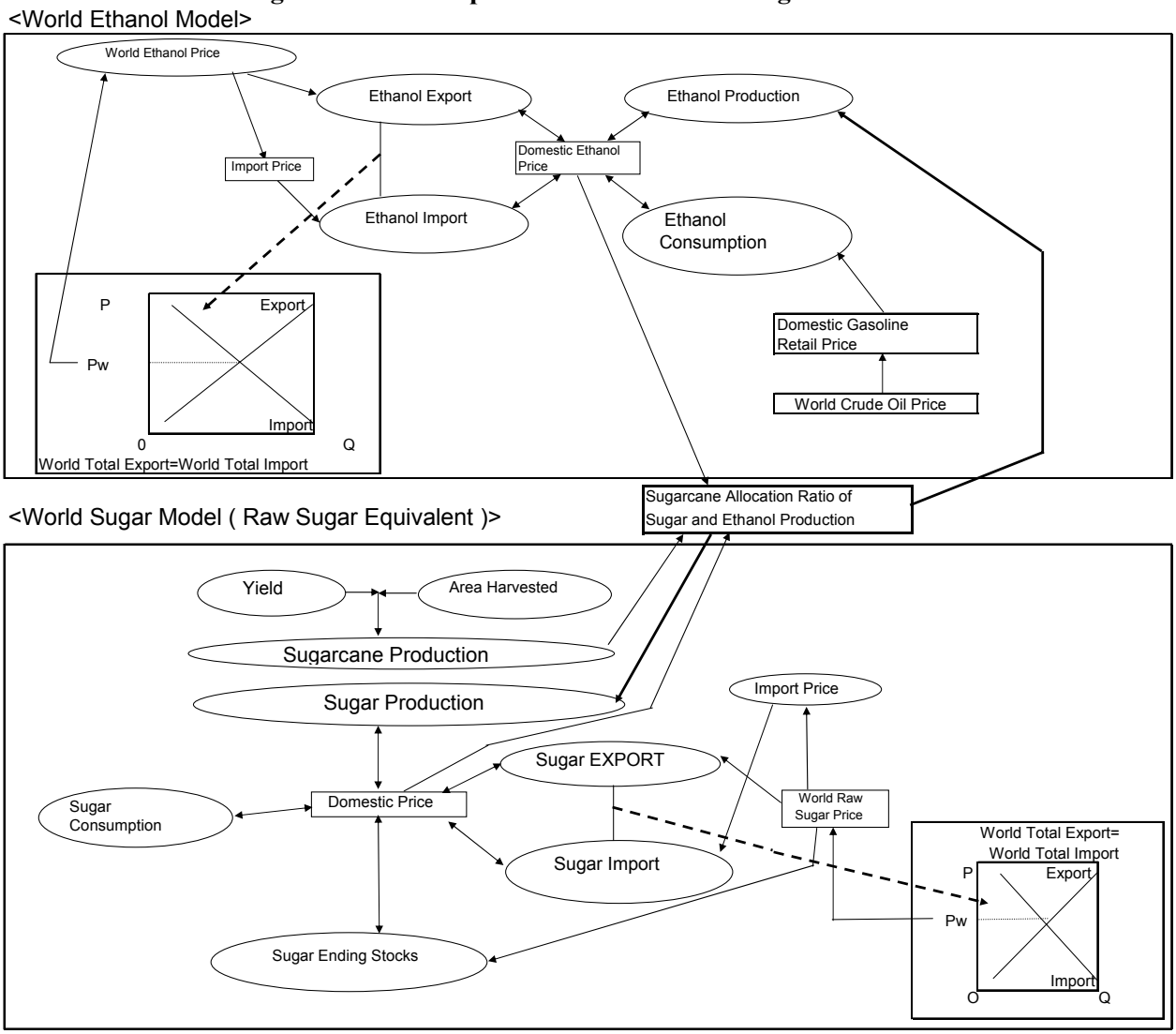
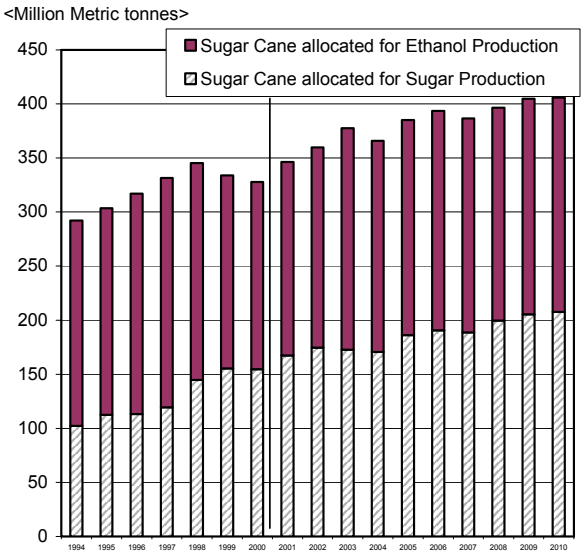
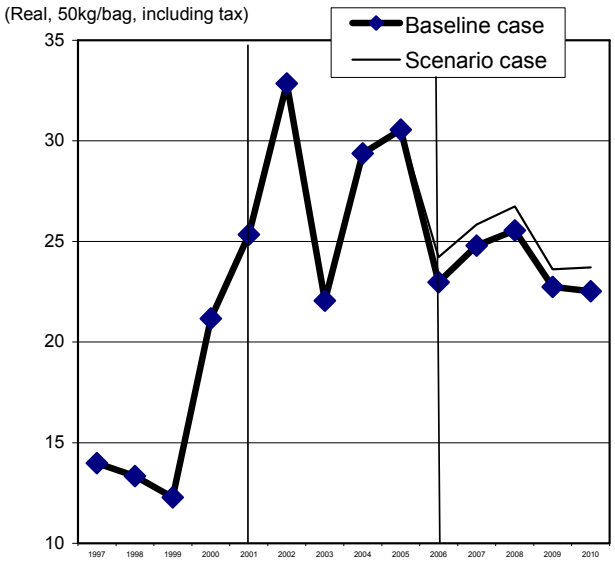


Figure 2 Brazilian Sugarcane Production (Baseline case)



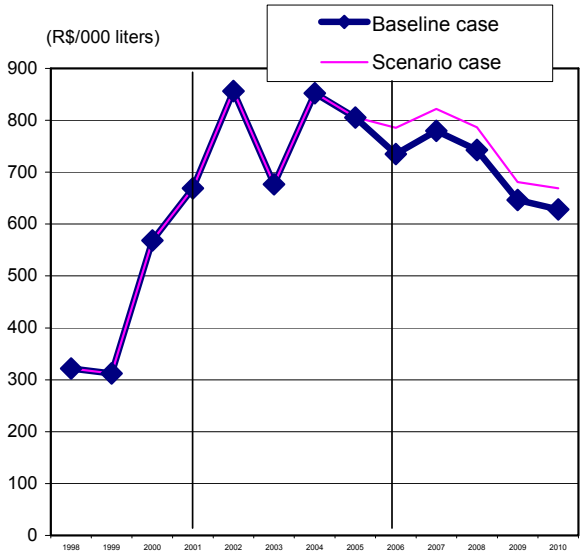
Source; FAOSTAT, ERS/USDA (From 1994 to 2000)

Figure 4 Brazil Crystal Sugar Price in the Domestic Marke



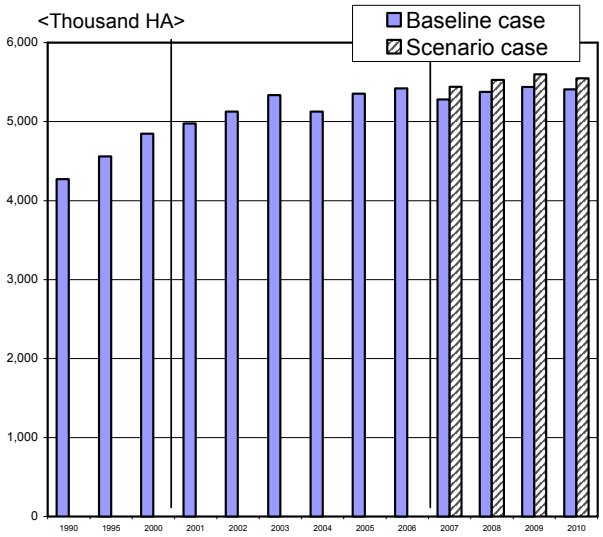
Source; ERS/USDA, USP/ESALQ/CEPEA (1997-2000)

Figure3 Brazil Fuel Anhydrous Ethanol Price (State of São Paulo)



Source; USP/ESALQ/CEPEA (1998-2000)

Figure 5 Brazil Sugarcane Area Harvested



Source: FAOSTAT (1990-2000)

TABLES

Table 1. The Brazilian Ethanol and Sugar Programmes

	Ethanol	**Sugar**
1975-1998	Creation of the Brazilian National Alcohol Programme (PROALCOOL) IAA: responsible for sugar and ethanol production and exports, through production quotas and fixed purchasing price of ethanol Petrobas: controls domestic ethanol sales and distribution as a monopolistic agent Subsidies to ethanol blend gasoline producers Tax incentives to ethanol blend gasoline car owners	Credit and subsidies for distillers' production facilities investments Set sugarcane price to independent growers
1998-99	Abolition of the monopolistic distributional arrangement given to Petrobas Liberalization of ethanol prices Reduced subsidies on ethanol blend gasoline producers	Removal of government set sugarcane producer price
1999-Present	Blend ratio of anhydrous ethanol-gasoline between 19 and 26 percent	

Table 2. World ethanol markets (baseline-projection)

World ethanol production

	thousand tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**18 391**	**19 418**	**19 284**	**25 192**	**26 768**	**0.4**	**3.0**
Brazil	12 028	12 700	10 900	14 268	14 017	-0.9	2.3
OECD Countries Total	3 487	3 789	5 129	7 214	8 790	3.6	5.0
United States	2 216	2 540	3 999	5 905	7 359	5.5	5.7
EU 15	1 144	1 121	1 002	1 174	1 293	-1.2	2.3
Mexico	126	128	128	135	137	0.1	0.7
India	1 175	1 434	1 985	2 290	2 434	4.9	1.9
China, Mainland	43	125	200	212	220	15.1	0.9
ACP Countries	14	18	21	24	26	3.8	1.8
Thailand	77	86	90	94	97	1.4	0.7
Former USSR	191	393	263	286	302	2.9	1.3
Rest of World	1 377	873	697	803	881	-6.0	2.2

Source: FAOSTAT (1990,1995,2000)

World ethanol consumption

	thousand tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**18 509**	**19 873**	**19 269**	**25 192**	**26 768**	**0.4**	**3.0**
Brazil	12 676	13 575	10 769	14 083	13 779	-1.5	2.3
OECD Countries Total	3 311	3 968	5 923	8 160	9 851	5.4	4.7
United States	1 974	2 269	4 211	6 300	7 857	7.1	5.8
EU 15	814	1 009	879	969	1 032	0.7	1.5
Mexico	134	146	255	266	285	6.0	1.0
Japan	320	418	420	440	470	2.5	1.0
Korea Republic	69	127	158	186	207	7.8	2.5
India	1 152	1 434	1 916	2 219	2 360	4.7	1.9
China, Mainland	22	101	48	51	53	7.4	0.9
ACP Countries	18	14	46	53	58	8.9	2.1
Thailand	40	27	12	13	13	-10.1	0.6
Former USSR	61	187	227	249	264	12.6	1.4
Rest of World	1 229	567	327	363	389	-11.3	1.6

Source: FAOSTAT (1990,1995,2000)

World ethanol exports

	thousand tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**1 990**	**3 211**	**2 343**	**2 509**	**2 649**	**1.5**	**1.1**
Brazil	30	256	182	229	277	17.9	3.9
OECD Countries Total	1 369	1 813	1 155	1 181	1 209	-1.5	0.4
United States	648	909	414	333	295	-4.0	-3.0
EU 15	719	862	738	835	901	0.2	1.8
Mexico	0.1	35	0	10	10	-	-
Japan	0.1	1	-	-	-	-	-
Korea Republic	1	6	3	3	3	5.5	-0.1
India	23	2	69	71	74	10.4	0.7
China, Mainland	21	33	152	162	168	19.9	0.9
ACP Countries	0.17	8	29	32	35	59.4	1.8
Thailand	37	60	80	85	88	7.3	0.9
Former USSR	130	516	40	42	44	-10.2	0.8
Rest of World	381	523	637	707	754	4.8	1.6

Source: FAOSTAT (1990,1995,2000)

Table 3. World sugar markets (baseline-projection)

World sugar production (raw sugar equivalent)

	million tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**110.51**	**117.92**	**130.76**	**147.05**	**156.69**	**1.5**	**1.7**
Brazil	7.94	13.59	17.04	23.31	25.57	7.2	3.8
OECD countries Total	32.21	33.46	36.40	37.39	38.79	1.1	0.6
United States	6.34	6.69	7.88	8.02	8.34	2.0	0.5
EU 15	17.98	16.53	17.64	17.85	18.54	-0.2	0.5
Australia	3.68	5.06	5.45	5.38	5.77	3.6	0.5
Mexico	3.28	4.27	4.70	5.33	5.32	3.3	1.1
Japan	0.93	0.91	0.73	0.82	0.83	-2.2	1.2
Korea Republic	0	0	0	0	0	-	-
India	11.76	16.41	20.22	21.50	22.46	5.1	1.0
China, Mainland	6.88	6.77	6.74	8.25	8.99	-0.2	2.7
Cuba	8.04	3.26	4.06	4.01	4.08	-6.0	0.0
ACP Countries	5.86	6.03	6.73	7.62	8.14	1.3	1.7
South Africa	2.03	1.67	2.66	2.82	3.18	2.5	1.6
Thailand	3.51	5.20	6.45	7.74	8.03	5.7	2.0
Former USSR	9.43	6.61	4.15	4.81	5.07	-7.2	1.8
Rest of World	22.86	24.92	26.33	29.58	32.37	1.3	1.9

Source: FAOSTAT (1990, 1995, 2000)

World sugar consumption (raw sugar equivalent)

	million tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**109.35**	**113.17**	**127.89**	**146.16**	**156.94**	**1.4**	**1.9**
Brazil	6.95	8.25	9.59	11.45	12.93	3.0	2.8
OECD countries Total	29.82	31.10	32.06	33.95	35.58	0.7	1.0
United States	7.90	8.47	9.36	9.99	10.34	1.5	0.9
EU15	12.94	13.65	13.85	14.37	15.11	0.6	0.8
Australia	0.96	1.00	1.09	1.17	1.26	1.2	1.3
Mexico	4.43	4.46	4.48	4.85	5.05	0.1	1.1
Japan	2.78	2.54	2.23	2.38	2.50	-2.0	1.0
Korea Republic	0.82	0.99	1.04	1.19	1.32	2.2	2.2
India	10.99	13.33	17.23	21.12	22.24	4.2	2.3
China, Mainland	7.95	7.60	6.89	8.53	9.22	-1.3	2.7
Cuba	0.77	0.56	0.69	0.77	0.83	-1.0	1.6
ACP Countries	4.54	5.83	7.12	7.30	7.35	4.2	0.3
South Africa	1.35	1.36	1.55	1.57	1.56	1.3	0.05
Thailand	1.06	1.58	1.83	2.02	2.17	5.1	1.6
Former USSR	12.11	9.27	11.65	13.31	14.46	-0.4	2.0
Rest of World	33.80	34.29	39.28	46.14	50.60	1.4	2.3

Source: FAOSTAT (1990, 1995, 2000)

World sugar exports (raw sugar equivalent)

	million tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**30.54**	**36.88**	**41.94**	**46.57**	**49.18**	**2.9**	**1.5**
Brazil	1.63	6.42	6.78	11.71	12.58	13.8	5.8
OECD countries Total	11.42	13.78	14.81	13.82	14.21	2.4	-0.4
United States	0.52	0.46	0.15	0.14	0.15	-10.4	-0.5
EU15	7.70	8.42	9.63	8.55	8.73	2.1	-0.9
Australia	2.86	4.04	4.19	4.16	4.55	3.5	0.7
Mexico	0.01	0.55	0.41	0.55	0.37	39.2	-0.8
Japan	0.01	0.002	0.003	0.003	0.003	-8.8	0.2
Korea Republic	0.33	0.31	0.41	0.40	0.41	2.1	-0.1
India	0.03	0.40	0.35	0.28	0.25	26.3	-3.1
China, Mainland	0.64	0.56	0.52	0.62	0.74	-1.8	3.2
Cuba	7.16	2.60	3.42	3.23	3.26	-6.5	-0.4
ACP Countries	2.79	2.54	3.40	3.49	4.03	1.8	1.6
South Africa	0.98	0.40	1.51	1.24	1.65	4.0	0.8
Thailand	2.43	3.88	4.29	5.64	5.86	5.3	2.9
Former USSR	0.15	2.57	0.68	0.65	0.66	14.9	-0.3
Rest of World	3.32	3.75	6.19	5.89	5.95	5.8	-0.37

Source: FAOSTAT (1990, 1995, 2000)

Table 3. World sugar markets (baseline-projection) (continued)

World sugar import (raw sugar equivalent)

	million tonnes					%	
Region	1990	1995	2000	2006	2010	Growth Rate 1990/2000	Growth Rate 2000/2010
World Total	**29.64**	**33.49**	**37.18**	**46.57**	**49.18**	**2.1**	**2.6**
Brazil	0.00	0.05	0.01	0.02	0.02	18.7	0.5
OECD countries Total	10.91	8.89	9.13	10.49	10.90	-1.6	1.6
United States	1.91	1.76	1.58	2.15	2.19	-1.7	3.0
EU15	4.22	3.98	4.43	5.08	5.22	0.4	1.5
Australia	0.02	0.02	0.02	0.03	0.03	1.2	2.3
Mexico	1.93	0.06	0.05	0.06	0.06	-27.7	0.2
Japan	1.72	1.75	1.57	1.57	1.68	-0.8	0.6
Korea Republic	1.10	1.32	1.48	1.61	1.73	2.7	1.4
India	0.01	0.16	0.03	0.04	0.04	9.0	1.5
China, Mainland	1.16	3.02	0.68	0.99	1.00	-4.8	3.6
Cuba	0	0	0	0	0	-	-
ACP Countries	1.51	2.56	2.99	3.24	3.22	6.4	0.7
South Africa	0.04	0.03	0.02	0.03	0.03	-4.2	1.0
Thailand	0.0001	0.002	0.004	0.005	0.005	35.6	2.5
Former USSR	4.10	5.09	7.06	9.16	9.98	5.1	3.2
Rest of World	11.92	13.69	17.24	22.60	23.99	3.4	3.0

Source: FAOSTAT (1990, 1995, 2000)

Table 4. Impacts on world ethanol markets

World Ethanol Production (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**9.22**	**8.51**
Brazil	17.26	14.98
OECD countries Total	0.09	0.07

World Ethanol Consumption (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**9.22**	**8.51**
Brazil	17.61	15.25
OECD countries Total	-0.03	-0.02

World Ethanol Export (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**-0.12**	**-0.10**
Brazil	-4.23	-3.28
OECD countries Total	0.42	0.33

World Ethanol Import (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**-0.12**	**-0.10**
Brazil	3.38	2.60
OECD countries Total	-0.21	-0.16

Ethanol Prices (Baseline/Scenario) (%)	Maximum	Minimum
World	**1.14**	**0.91**
Brazil Fuel Anhydrous Ethanol (State of São Paulo)	6.49	5.27

Table 5. Impacts on world sugar markets

World Sugar Production (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**-0.2**	**0.0**
Brazil	-2.5	-0.3
OECD countries Total	0.2	0.0
EU15	0.3	0.0
ACP Countries	0.7	0.0
Thailand	0.6	0.0
Australia	0.6	0.0

World Sugar Consumption (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**-0.2**	**0.0**
Brazil	-1.3	-0.9
OECD countries Total	-0.2	0.0
EU15	-0.3	-0.1

World Sugar Export (Scenario/Baseline) (%)	Maximum	Minimum
World Total	**-0.3**	**0.0**
Brazil	-2.9	-0.7
OECD countries Total	0.9	0.2
EU15	0.9	0.2
ACP Countries	1.3	0.1
Thailand	0.7	0.2
Australia	0.6	0.2

World Sugar Import (Scenario/Baseline) (%)	Maximum	Minimum
World	**-0.3**	**0.0**
Brazil	1.4	0.5
OECD countries Total	-0.1	0.0
EU15	-0.1	0.0

Raw Sugar Prices (Scenario/Baseline) (%)	Maximum	Minimum
World (ISA Average Price)	**2.23**	**0.34**
Brazilian Crystal Sugar	5.44	3.82

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