The Ethanol Trade Development Between China and Brazil

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Abstract

The rapid growth of its GDP and the air pollution it generates have forced China to consider the use of alternative, renewable and greener fuels for its transportation needs. Since they are made from plants which absorb CO_2 during their growth, biofuels seem to be a partial solution to that problem. This remains true even if China doesn't have enough agricultural land to produce the quantity its own future consumption targets would require.

Because the Brazilian sugarcane based ethanol is cheaper and generates less greenhouse gases during its production than the corn based ethanol produced in other countries, it stands as the best alternative if China was to decide to import ethanol. It is even more so if we consider that Brazil, apart from having a homegrown technology in the sector, possesses the necessary manpower, water resources and unused agricultural land to produce the additional 8.5 billion liters of ethanol that China will need in 2020.

The ethanol trade between China and Brazil would be interesting for both countries. By importing the Brazilian biofuels, China could meet its ethanol consumption target, reduce its emissions of greenhouse gases and strengthen its political alliance with Brazil, the most populous country of Latin America. For Brazil, an important surge of its ethanol exports would require an increase of the agricultural area planted with sugarcane but it would also create jobs and help its rural development.

Key Words: China, Brazil, Biofuels, Ethanol

1. The Biofuels supply and demand in China

With an average annual GDP growth of about 10% for the last thirty years, China has become one of the largest fuel consumers of the world and the first air polluter. Since most of its energy comes from fossil fuels, China is now struggling with problems like the rapid depletion of its oil and natural gas reserves, an ever growing dependence on imported oil which satisfies half of its actual demand (Martinot and Li Junfeng) and an obvious air pollution problem. According to the World Bank, 16 of the 20 world most polluted cities are Chinese.

To improve the situation, China has decided to diversify its energy sources, notably by promoting the use of fuels which are renewable and produce less greenhouse gases. Biofuels like ethanol or biodiesel are being considered. One of the reasons for it is that biofuels are made from agricultural products like corn, cassava or soybeans; which have the positive effect of improving the revenues and the welfare of the Chinese rural population.

Apart from giving subsidies to the ethanol producers, the Chinese government has made compulsory the blending of 10% of ethanol in the gasoline sold in ten Chinese provinces in the recent years. As a result, the Chinese ethanol production has surged to 1.46 billion liters in 2008 - the third largest in the world after USA and Brazil - and is supposed to reach 2.15 billion liters in 2010. If China was to increase its ethanol production at the same pace as in the years 2003-2008, it would still produce less than 3 billion liters of ethanol in 2020.

If that hypothesis was correct, the country would end up with an ethanol production deficit of more than 7 billion liters by the year 2020 since the official goal of the NDRC (National Development and Reform Commission) is to increase China annual ethanol consumption to 2 billion liters by 2010 and to 10 billion by 2020. In fact, the deficit will inevitably be much larger due to the moratorium that has been declared in 2007 on the expansion of the national corn based ethanol production. That moratorium showed that the Chinese government was concerned about a possible competition with the food production, the limited amount of the available arable land in the country and the national mounting water supply problem. As a consequence, importing ethanol is the only solution.

2. Two scenarios for importing ethanol

Despite the moratorium, it can be shown through two different scenarios that ethanol imports could help China to reach its consumption target of 10 billion liters for 2020.

In the first scenario, the country would import 5 billion liters of ethanol per year, which would represent 50% of the Chinese demand in 2020. In this case, China, which produced only 1.46 billion liters in 2008, would import enough raw materials to produce locally a total of 5 billion liters of ethanol.

In the second scenario, China would maintain its 2008 ethanol production and would import 8.5 billion liters of ethanol per year in 2020.

3. The reasons why China should import ethanol from Brazil

3.1. Economic Reason

Compared to the gasoline, the cost of imported ethanol is competitive. If the production cost per liter of ethanol is US$ 0.47 in China[1], it is US$ 0.32 in USA[2] and only US$ 0.25 in Brazil[3].

[1] GSI, Global Subsidies Initiative. 2008. *Biofuels – At What Cost? Government support for ethanol and biodiesel in China.* Geneva, Switzerland. International Institute for Sustainable Development.

[2] EMBRAPA (2009).

By far, Brazil is the most efficient ethanol producer of the world and is the country with the best conditions to increase its output. It has a lot of unused agricultural land to expand its sugarcane plantations. Over the last decades, it has also acquired a vast experience and has developed its own technology in the field.

3.2. Environmental Reasons

The Chinese government is well aware that the environmental degradation of the air, water and agricultural land poses a threat to the country's future economic growth. This was one of the reasons why it set a 10 billion liters ethanol consumption target for 2020.

If reached, that target would help to reduce the quantity of greenhouse gases generated by the country. That effect would be even more important if Brazilian ethanol was imported because the ethanol made from sugarcane produces significantly less greenhouse gases than the ethanol made in Europe or USA by using corn and wheat. (The main reason for it is that the sugarcane production process uses much less external energy than its competitors.)

The reduction in the greenhouse gases production that can be expected if ethanol was used as a fuel can easily be calculated.

Greenhouse gases are gases that trap heat in the atmosphere. Some greenhouse gases such as carbon dioxide occur naturally and are rejected into the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O) and Fluorinated Gases.[4] Those gases are mainly emitted by the use of fossil fuels.

To calculate the reduction in greenhouse gases emission obtained by using ethanol, we must first estimate the quantity of carbon dioxide which would be emitted if gasoline was burned. In the literature, we find the following data for the gasoline. (Esparta et al.)

The pollution created by the gasoline[5]

- 100 ml of gasoline corresponds to 74.9 g of gasoline (100 ml × 0.749 g / ml).
- In 74.9 g of gasoline, we have 64.79 g of carbon (74.9 g × 86.5%).
- In 64.79 g of the carbon burned, 64.14 g is oxidized (64.79 g × 0.99).
- 64.14 g carbon black produces 235 g of CO_2 (64.14 g × 44/12).

It will be assumed here that the ethanol (made from any raw material) which is used to replace the gasoline is a form of perfectly renewable and sustainable energy in order to make it neutral in GHG emissions.[6] By using this hypothesis and the above mentioned values, we obtain for every liter of gasoline substituted by ethanol a GHG emission reduction of 2,35 kg CO_2.

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[3] EMBRAPA (2009).

[4] EPA Climate Change Site. http://www.epa.gov/climatechange/emissions/index.html. January 17th, 2010.

[5] Esparta's calculation.

[6] In that hypothesis, any carbon dioxide emitted by vehicles running on ethanol is reabsorbed during the growth of sugarcane.

Since the quantity of ethanol used in China by 2020 will be 10 billion liters in the two above mentioned scenarios, they will be studied together. To make our calculations, we will use a constant annual increase of 17.5% in the Chinese consumption of ethanol between 2010 and 2020.

Table 1: Reduction of CO_2 emissions by substituting ethanol to gasoline from 2010 to 2020

Year	**Billion liters of ethanol 1st and 2nd scenario**	**Reduction CO_2 emissions (million of tons)**
2010	2	4,70
2011	2,35	5,53
2012	2,76	6,49
2013	3,24	7,62
2014	3,81	8,96
2015	4,48	10,53
2016	5,26	12,37
2017	6,18	14,53
2018	7,27	17,10
2019	8,54	20,08
2020	10	23,51
Total	55,89	131,42

Source: Author's calculation.

This reduction, 131, 42 million tons of CO_2, would be equivalent to the carbon sequestered by 41 million twenty years old Brazilian trees.[7]

Limitations of those calculations: The life cycle of the ethanol has not been taken into account in our evaluation of the pollution it generates. For example, the transport process from Brazil to China can be significant. Also, the emission of Methane (CH_4) and Nitrous Oxide (N_2O) produced by the gasoline and the ethanol life cycle have not been taken into account in our calculations.

3.3. Political Reasons

The Brazilian ethanol imports would increase substantially the trade relations between China and Brazil, the two largest developing countries in the eastern and western hemispheres. This is

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[7] That number of trees has been calculated by considering that, in the Brazilian regions where most of the sugarcane is planted, 3.2 trees extract an average of one ton of CO_2 from the atmosphere over a twenty years period. This data comes from the planting experience of native trees in the Atlantic region by the NGO SOS Atlantic Forest in São Paulo. The measurement was made by the SOS Mata Atlantica, with support from the *Escola Superior de Agricultura Luiz de Queiroz* (ESALQ / USP) and the Key Consulting Associates.

important since the bilateral trade between China and Brazil has been growing steadily in recent years. In 2009, China has even become the largest trade partner of Brazil, surpassing USA which used to occupy that rank since 1930. (Manfrini, 2010.)

For Brazil, this change was welcome since, in 2009, the country had a US$ 4.28 billion trade surplus with China (exports of US$ 20.191 billion and imports of US$ 15.911 billion). For comparison, Brazil had a US$ 4.443 billion trade deficit with USA in 2009 (exports of US$ 15.74 billion and imports of US$ 20.183 billion).

4. The effects of an eventual ethanol exports expansion on Brazil

4.1. The effect on the Brazilian agricultural land

In 2008, Brazil has produced more than 22.5 billion liters of ethanol on about 3.8 million hectares. Considering the technology presently available, Brazil would have to increase by approximately 833 000 hectares the surface of its sugarcane plantations if it wanted to produce the 5 billion liters of ethanol required in our first scenario. That would double its current ethanol exports. To produce the 8.5 billion liters of ethanol required in the second proposed scenario, the increase in the surface of sugarcane plantations would be 1.4 million hectares.

Since Brazil still has about 90 million hectares of unused agricultural land, such increases would be possible without affecting important environmental conservation areas such as the Pantanal, the Amazon basin, the Cerrado and the Atlantic forest.

4.2. The effects on the Brazilian environment

A study by Embrapa has shown that, despite the deforestation of the last 30 years, Brazil is one of the best countries of the world when it comes to maintaining its forest cover. Today, Africa has 7.8% of its original forests, Asia has 5.6%, Central America has 9.7% and Europe – the worst case in the world - has only 0.3%!!! In this area, Brazil is clearly in a class of its own since it has kept 69.4% of its original forests.

Because Brazil holds such a large proportion of the world forest patrimony, many fear that an eventual increase of the Brazilian biofuels production could raise the level of deforestation.

In the parts of Brazil where the sugarcane does grow, any expansion of the cultures could cause the partial destruction of native forests, especially if the Brazilian environmental laws were not respected, as it was often the case in the past.[8] However, it would be possible, with good supervision, to encourage the expansion of the sugarcane culture on degraded agricultural land and on unoccupied areas by using long-term incentives.

If there is no doubt that the expansion of a monoculture like the sugarcane over larger areas could affect the biodiversity (flora and fauna), it is important to note that this would not affect the Amazon basin where the climate is too hot and humid to permit sugarcane cultivation.

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[8] WWF – Brasil. May/2008. *Análise da expansão do complexo agroindustrial canavieiro no Brasil programa de agricultura e meio ambiente.*

(Brazilian Sugarcane Industry Association - UNICA). It is also worth mentioning here that a popular technique to harvest sugarcane is to set it afire in order to get rid of all the foliage; a technique that gives the impression that the illegal burning of the Brazilian forests is more important than it actually is.

Another potential problem to consider is the possibility that the expansion of the sugarcane plantations could provoke the displacement of other economic activities like cattle raising or grain production towards environmentally sensitive regions.

4.3. The effect on the Brazilian employment

It is possible to use the employment multiplier of an I-O model to evaluate the increase in the number of jobs generated by an eventual increase in the quantities of exported ethanol.

Such an input-output (I-O) model can be used to examine the interdependence of the different sectors of an economy.

An I-O model is created from actual data for a specific economic zone (e.g., a country, a region, a province, etc). The model uses flows of products which originate from each economic sector or activity - which is considered as a producer – to end up in the sectors where they are used – sectors which are considered as consumers.

The employment multiplier can be calculated by using the employment coefficients of all the sectors of the economy and the matrix of multipliers (Leontief inverse). Their calculation must follow the method described by Miller and Blair (1985). For each sector of the economy, the employment multipliers represent the capacity to generate jobs following the expansion of the production (and the demand) of its products. Those multipliers indicate which sectors of the economy have a relatively better capacity to generate employment for the labor force, in quantity as well as in quality (educational level). (Negri et al. 2009).

The employment coefficients, which represent the number of workers divided by the value of their production, are used in conjunction with an input-output model to obtain the employment multiplier for each sector which is analyzed. (Negri et al. 2009).

The employment multiplier for the ethanol sector is 47.6, which means that it has the capacity to generate a total of 48 jobs in the economy for each R$1 million of production in the sector. Among the jobs generated by that economic activity, 81% are occupied by workers with an elementary education level. This can be explained by the fact that the processes in the ethanol industry require a lot of unskilled labor and by the fact that the industry has always employed a lot of people with that education level. (Negri et al. 2009).

If we consider our first scenario (5 billion liters of ethanol exported in 2020), the increased value of the ethanol production would be R$ 2.15 billions[9] and would generate about 103,000 direct and indirect jobs.

[9] Cost of production US$ 0.25. Rate currency US$1 = R$1. 72.

If we consider our second scenario (8.5 billion liters of ethanol exported in 2020), the increased value of the ethanol production would be R$ 3.7 billions and would generate approximately 175,000 direct and indirect jobs.

Limitations: Those calculations have taken into account that the current technology would be used to produce the required quantity of ethanol. However, since Brazil plans to further mechanize the sugarcane harvesting and processing, it is possible that the whole sugarcane sector of the economy will eventually experience a gradual reduction of its employment numbers. Presently, the main obstacle to the mechanization of the Brazilian sugarcane harvesting process is the low cost of the Brazilian manual labor. With the actual demographic and economic trends in Brazil, this situation could evolve rapidly.

4.4. The effects on the Brazilian national income

Exporting ethanol to China would help to improve the Brazilian trade balance. In our first scenario, Brazil would double its ethanol exports. The sale of 5 billion liters of ethanol would generate revenues of US$ 2.3 billion (including the profits). In our second scenario, exports of 8.5 billion liters of ethanol would generate revenues of US$ 4 billion.

4.5. The effects on the Brazilian sugar supply

We can estimate the effects an eventual Brazilian ethanol production expansion would have on the domestic sugar supply by using historical data and a statistical model which will measure the effects different variables have had in the past.

The data used here came from UNICA, Ministry of Agriculture Livestock and Food Supply (MAPA), Center for Advanced Studies on Applied Economics (CEPEA), from University of São Paulo (USP) and *Estatísticas históricas do Brasil: séries econômicas, demográficas e sociais de 1550 a 1988. 2. ed. rev. e atual. do v. 3 de Séries estatísticas retrospectivas*. Rio de Janeiro: IBGE, 1990.

The model chosen is the Vector Auto Regression (VAR). “A Vector Autoregressive (VAR) Model is a model for two or more time series where each variable is modeled as a linear function of past values of all variables, plus the disturbances that have zero means given all past values of the observed variables.” (Wooldridge). It uses the basic supply function of a typical firm which uses the most relevant variables in determining the supply on a competitive market. That supply model is based on the microeconomic assumption that a firm always seeks to maximize its profits. That means that the sugar quantity offered on the market is directly related to its market price.

The sugar supply model chosen uses five different variables.

$$SP = C(1)*CP + C(2)*P + C(3)*EE + C(4)*EP + C$$

Where: SP = Sugar production

CP = Sugarcane production

P = Domestic Sugar price

EE	=	Ethanol exports
EP	=	Ethanol production
C	=	Constant

Since there is a direct relationship between those five variables, our model, if valid, should show that the sugar supply is influenced by the increase in the sugarcane production (the raw material) and by the increase in the ethanol production and exports.

In the table presented below, it can be observed that, in the Durbin-Watson statistical test, the value of the sampling distribution is satisfactory at 2.63, which means that there is no autocorrelation effect in the model. The determination coefficient R-squared, which is 98%, shows that the behavior of the sugar production in Brazil is almost entirely explained by the variations of the four chosen variables. Moreover, the values which appear in the column "t-Statistic" show that the null hypothesis can be rejected and that any variation in the four chosen variables will cause a variation in the sugar production level.

The model shows that the variables "Sugarcane production" (CP), the "Domestic sugar price" (P) and the "Ethanol exports" (EE), are directly and positively related while the coefficient for the "Ethanol production" variable (EP), which appear in the table, is negative. This negative relationship seems due to the fact that the sugar and the ethanol productions compete for the same raw material, namely the sugarcane.

Table 2: Results of the Brazilian Sugar Supply Equation – 1997 – 2008

Variable	Coefficient	t-Statistic
CP	0.142712	7.464434
P	2.101474	0.414108
EE	0.395484	0.741327
EP	-1.741753	-5.986954
C	-2445.916	-5.986954
R-squared = 0.98		
Durbin-Watson = 2.63		

Source: Values calculated by the EVIEWS 3 computer software by using Brazilian government data.

By using the coefficients calculated by the EVIEWS 3 computer software, we obtain the following and final sugar supply function:

$$SP = 0.14*CP + 2.10*P + 0.40*EE - 1.74*EP - 2445.9$$

The coefficient of the sugarcane production variable (0.14) shows that the estimated sugar production (SP) is moderately related to the sugarcane production. This means that, in Brazil, a 10% increase in the sugarcane production causes an increase of only 1.4% in the sugar production.

The price coefficient (2.10) shows that the estimated sugar production (SP) is strongly related to the domestic sugar price (P). It indicates that an increase of 10% in the sugar price on the domestic market causes an increase of 21% in the sugar production. This shows the elasticity of the supply in relation to the price.

The ethanol production coefficient (-1.74) shows that a 10% increase in the ethanol production causes a strong 17.4 % decrease in the domestic sugar production. This was expected since the ethanol production competes with the sugar production for the same raw material.

We can then conclude that the sugar supply on the Brazilian market is mostly influenced in a positive way by the sugar price (P) variations and in a negative way by the Ethanol production (EP) variations. The sugarcane production (CP) and the Ethanol export (EE) have more moderate positive effects. It is probable that a doubling of the Brazilian ethanol exports would not affect those relations in a significant manner.

5. Conclusion

This paper showed that the entry of the Brazilian ethanol in the Chinese market would be beneficial for both countries. For China, the ethanol imports would help to reduce its contribution to the global emission of greenhouse gases. It would also be economically advantageous to import ethanol from the most efficient producer of the world. Politically, any trade increase would strengthen the relationship between the most important country of Asia and the most populous country of Latin America.

For Brazil, this development would also be interesting since an increase of its ethanol exports would generate income and employment for its population and would contribute to the development of its rural areas.

Based on historical data, the model used in this paper has shown that, because both products use the sugarcane as raw material, any increase in the ethanol production would have a negative impact on the sugar production. It has also shown that the sugarcane production and the ethanol exports would have a weak positive effect on the sugar production level, which is mostly driven by the Brazilian domestic sugar price variations.

Finally, the effect of an eventual ethanol production expansion would have limited effects on the Brazilian environment mainly because the country possesses a large reserve of unused and degraded agricultural land where sugarcane could be planted.

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