Social Economic Aspects of Sugarcane Ethanol Production in Brazil

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Márcia Azinha-Fernandez de Moraes
Professor at the Department of Economics, Business and Sociology
ESALQ - University of Sao Paulo

Topics

- Brazilian Ethanol Program: an overview
- Sustainability: social agenda
- Socioeconomic indicators
- Impacts of Sugarcane Ethanol Production

Brazilian Ethanol Program
an overview

- Brazilian National Ethanol Program – Proalcool – was launched in 1975 by the military government
- Since then we produce and use sugarcane ethanol as a fuel in a large scale
- Anhydrous (mixed to gasoline)
- Hydrous (automobiles powered by hydrous ethanol and on flex fuel cars)
- The main motivation of the Proalcool was economic
- At that time Brazil was still heavily depended on imported oil and was badly hit by the 1973 and 1979 oil shocks, with serious effects on the country’s trade balance and inflation
- Brazil adopted two strategies:
  - Increasing exploration and production of oil
  - Stimulating the production of anhydrous ethanol, to be mixture to gasoline (First Phase of Proalcool)
  - Replacing part of gasoline consumption with hydrous ethanol (Second Phase of Proalcool)
- The policy to replace oil was the main driver of Proálcool

National Ethanol Program
Historical aspects

Two main conditions enabled the creation of Proalcool

1) robust production of sugarcane and sugar tightly regulated by the government
- Since the 1930s, the government:
  - established production levels for sugar and alcohol for each plant
  - fixed the prices for sugarcane, sugar, and alcohol
  - controlled all sales and exports of sugar
  - Regulate the relationship between sugarcane suppliers and industrial units

2) military regime that was in place at the time
- whose decision-making and enforcement powers were quite broad, making it easier to coordinate the activities of the various stakeholders and sectors involved

Institutional Changes

- From the second half of the 80: the political system changed from military regime to a democratic one
- Federal government initiated an administrative reform aiming an economic liberalization in Brazil:
  - privatizations, deregulation of various agricultural productive chains – milk, coffee, wheat, sugarcane
- Deregulation on the sugarcane, sugar and ethanol sectors:
  - Strong Impacts on sugarcane, sugar and ethanol sectors
- Main changes:
  - on the system of pricing of sugarcane, sugar and ethanol
  - on production controls and crop plans previously issued by the government
  - on policies designed to support the production of sugarcane and ethanol
  - on the activities of the stakeholders themselves, including the government (at the federal and state level)
- Deregulation: affected the relationships among the actors along the entire production chain

The post-deregulation period

The free market: the profound changes and the new agenda
- Mergers and acquisitions process;
- International capital inflow;
- Expansion of electric energy co-generation;
- Investments in new process and products from sugarcane
- New social and environmental agenda
Social Economic Aspects: Motivation

- Brazilian experience with production and use of ethanol fuel from sugarcane has been widely discussed in the literature, and mostly, its positive contribution to reducing CO2 emissions compared to gasoline.
- Few works deal with social issues involved in the sugarcane sector, namely, job creation (agricultural and industrial sectors), working conditions and evolution in socioeconomic indicators.
- Motivation of our research: to better understand the social aspects and to assess the impacts of sugarcane industry (sugarcane, sugar and ethanol production) on the economy.

Sugarcane Production Chain: Main Agents

- Sugarcane processing plants in Brazil can produce sugar and/or ethanol. By products:
  - Vinasse: used as biofertilizer
  - Bagasse: electrical power generation
  - All plants are self-sufficient in electrical power
  - Most efficient sell the energy surplus to the market.

Profile of independent suppliers and rural partners in the 2011–12 harvest season, registered in the TRS System database maintained by the CONSECANA-SP

Source: Consecana SP

The Social Agenda

- From 2005 onward, there were improvements in the environmental and social indicators, as well as in working conditions in the national sugarcane, sugar and ethanol sectors.
- There was also greater compliance with the existing labor standards.
- Several factors can explain the better working conditions nowadays:
  (i) Banning the practice of pre-harvest burning of sugarcane fields
  - The harvest process of green cane is done mechanically, which improved the working conditions and demanded employees with higher education.
  - Also with the adoption of mechanical harvesting decreased the migration of workers from poorer states of Brazil, which used to come to harvest sugarcane by hand in the state of São Paulo.

(ii) Improving compliance with environmental and labor standards

- As of 2007, given the prospects for increased biofuel production in several countries, fuels made from agricultural raw materials began to receive criticism.
  - There has been a considerable increase in the importance of the socio-environmental agenda, and the increasing need to comply with internationally environmental and social standards.
  - Multinational and national companies of the food and beverage sectors, big sugar consumers, increased certification requirements of the supply chain, which also had a positive impact on social indicators of the sugarcane sector.
  - Compliance with environmental and social requirements has begun to influence the strategies and investments in the ethanol sector, which seeks to export ethanol to the United States and the European Union.

(Moraes & Zilberman, 2014)
(iii) Increase in exports of sugar in the international market

- Competitors of Brazil in the international sugar market (especially the EU countries) began to question the competitiveness of domestic production, claiming that Brazil had lower production costs because it degraded the environment and had inadequate working conditions.

- Although these were not the factors of lower cost of Brazil, certainly influenced companies to adopt best practices and certify production.

(iv) Opening of the Brazilian economy and foreign capital inflows

- Foreign capital entered in the sugar and ethanol sectors in 2000

- 2000: French groups Louis Dreyfus, Tereos, and Sucden having acquired ethanol plants in Brazil that year

- After 2007 there was a greater influx of foreign investment

  - largely came not only from sugar-producing companies in other countries (such as Shree Renuka Sugars, India’s largest sugar refiner), but also from companies with extensive experience in the production and trading of agricultural commodities, such as Bunge Limited, Cargill, Louis Dreyfus, Tereos, Abengoa, Glencore, and the Noble Group

  - large oil companies (Shell, British Petroleum, Petrobras)

- Adoption of better environmental and social practices

(iv) Mergers and acquisitions

- It was observed a process of consolidation and there were profound changes in the organization of production

- Intense process of professionalization of management, which can be attributed in part to the new players in the industry

- New technologies and new forms of coordination of the production chain, as well as production management systems that are economically and environmentally more efficient, have been adopted, in order to meet the growing list of sustainability criteria required by the market.

- There is an extensive legal and regulatory apparatus governing the Brazilian labor market, covering all sectors of the economic activity, including workers in the sugarcane, sugar and ethanol sectors

- The main regulations for the labor market in Brazil are:
  (i) The Federal Constitution;
  (ii) Consolidation of Labor Laws (CLT),
  (iii) Rural Workers’ Law (5889/73);
  (iv) Law No. 10.192/2001 that establishes the wage policy.

- The organization of workers’ unions is covered in article 5 of the Federal Constitution

Production of Ethanol from Sugarcane in Brazil: from State Intervention to a Free Market

Book co-authored with Prof David Ziberman (UC Berkeley)

- Origin of Proacool, the role of the military government, and the deep state intervention existing on the sugarcane, sugar and ethanol sectors at that time

- The process of deregulation occurred from the late 90s, and the challenges and changes faced by the stakeholders in a free market environment

- The new rules and changes since 2000, the international interest in alternatives to oil, the new environmental and social agendas, the financial constraints, and ultimately how we see the future of biofuels in Brazil.
The average schooling of agriculture workers is 4 years of study
- Sugarcane: 3.3 years of study is the average, considering both regions
- NNE region has lower education level
- The state of São Paulo has the highest level: 6.5 years of school, which still is very low
- 28.8% (about 90k workers) are illiterate

Rules and Norms
- Federal, state and municipal
  - Federal Decree # 11,241, July/1998
  - SP state
    - State Decree # 42.056, 1997
    - State Decree # 28.348, 1988
    - State Decree # 10.574, 2000:
      - State Law # 11.241, 2002: Deadlines for the end of Sugarcane Burning
    - Mechanized areas (flat): 2021
    - Non-mechanized areas: 2031

Environmental Protocol
- June, 2007: SP state and UNICA signed a cooperation Protocol
- Although non mandatory, producers’ adhesion was close to 100%

New deadlines for sugarcane burn halt are:
- June, 2007: SP state and UNICA signed a cooperation Protocol
- Federal Decree # 2.661, July/1998
- Brazilian Ministry of Labor
- Brazilian Institute of Geography and Statistics (IBGE)

Schooling of agriculture workers is
- Male workers: 6.8 years
- Female workers: 3.9 years
- São Paulo Center: 4.3
- São Paulo North: 4.3
- São Paulo South: 4.7

Source: Prepared based on data provided by PNAD 2012

### Sugarcane: Number of Workers, Age, Gender, Schooling, 2012

<table>
<thead>
<tr>
<th>Region</th>
<th>Average Age</th>
<th>Monthly Wage **</th>
<th>Male Share</th>
<th>Average Schooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>37.1</td>
<td>417.64</td>
<td>91%</td>
<td>5.3</td>
</tr>
<tr>
<td>North-Eastern</td>
<td>35.5</td>
<td>298.68</td>
<td>96%</td>
<td>5.9</td>
</tr>
<tr>
<td>Center-South</td>
<td>38.1</td>
<td>495.40</td>
<td>97%</td>
<td>6.2</td>
</tr>
<tr>
<td>São Paulo</td>
<td>35.2</td>
<td>534.95</td>
<td>98%</td>
<td>6.6</td>
</tr>
</tbody>
</table>

*Source: Moraes et al (2015). Prepared based on PNAD database*

- No large variations were observed in the average age of the workers in the different producing regions. The average age paid in São Paulo was the highest one. As expected, wages are positively correlated with the average schooling.
- Male workers prevailed in the different regions.
- The percentage of women is higher in the Center-South region (13%), what can be attributed to the mechanization of agricultural activities in this region.

### Sugarcane: Number of Workers by Producing Regions and Sector, 2012

<table>
<thead>
<tr>
<th>Region</th>
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<th>CS</th>
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<tr>
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<td>252,340</td>
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- Sugarcane, sugar, and ethanol sectors employed over one million people.

### Sugarcane Burning

- Burnt sugarcane (manual harvesting) vs green cane (mechanical)
- Prohibition of sugarcane burning: constitutes an advance in environmental terms
- Restrictions: no large variations were observed in the average age of the workers in the different producing regions.
- Male workers prevailed in the different regions.
  - The percentage of women is higher in the Center-South region (13%), what can be attributed to the mechanization of agricultural activities in this region.

### Database

- PNAD - National Household Sample Survey
  - Conducted by the Brazilian Institute of Geography and Statistics (IBGE) - (Federal Government)
  - Annual Surveys of socioeconomic information on formal and informal workers
  - Conducted by the Brazilian Ministry of Labor
  - Annual census on the formal labor market based on information provided by companies

### Variables

- Average Schooling: 4 years of study
- Schooling is still very low: 28.8% (about 90k workers) are illiterate

### Table

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3 recent studies:

1. Socio-Economic Impacts of Brazilian Sugarcane Industry
   - Published – Environmental Development Journal

   - Published – Biomass and Bioenergy

3. Sugarcane industry’s socioeconomic impact in São Paulo, Brazil: a spatial dynamic panel approach
   - Published – Energy Economics

What is new in this paper?

To understand the role of sugar and ethanol sectors not only in the generation of employment for the sugarcane workers themselves, but also in the intergenerational transmission of socio-economic conditions for their offspring, we compare:

- Socio-economic indicators of sugarcane workers (first generation) with the indicators of the workers (first generation) of the agriculture sector
- Socio-economic indicators of sugarcane workers (first generation) with those for the second generation of sugarcane workers (offspring)
- Socio-economic indicators of agriculture workers (first generation) with those for the second generation of agriculture workers (offspring)
- Results show that family background plays a role on the choices made by second generation workers
- The comparison between indicators for the sugar cane sector and the overall agricultural sector showed differences, with the sugar cane sector being better off than the agricultural sector
- The assessment of indicators for the second generation shows that they have face better choices and conditions than first-generation workers.
The analysis by sector of activity of the reference generation and the next generation also revealed an interesting new insight. An influence by the family background was observed in regards to the choices available to the next generation, which has an impact on the socio-economic indicators of employees’ offspring of the sectors analyzed. One possible reason is that a father who works under a formal contract of work and under better working conditions, exerts a positive influence on their offspring, encouraging them to follow in their steps. The same pattern was observed considering the mobility of offspring to other sectors of the economy: there is mobility for other sectors of activity, and this mobility is higher for the sugarcane’s employee’s offspring. Overall, the results preclude identifying a causality-link between the selected indicators and the sugar cane sector (as a whole). Although it was demonstrated that there are improvements, no statistical analysis was carried out to test correlation.
Accelerated growth in the sugarcane industry
In the late 1990s, the sugarcane industry of Brazil faced a profound transformation, including institutional changes related to:
- Decentralization of government intervention
- Mergers and acquisitions process
- Internationalization of assets
- There were external factors as well: countries seeking to mitigate greenhouse gas emissions by introducing ethanol into their energy mix began to pay close attention to the emergence of renewable energy sources and biofuel derived from sugarcane
This new structure ensured a dynamic of accelerated growth in the industry, in terms of production, processing (production units), and exports.

The socioeconomic impacts on GDP
- The objective of the study is to assess the effects that the sugarcane, sugar and ethanol sectors have on the municipal gross domestic product (GDP) per capita between 2000 and 2008, a period during which there was considerable growth of these sectors
- The focus was on the south-central region (states of São Paulo, Paraná, Minas Gerais, Mato Grosso do Sul, Mato Grosso, and Goiás)
- This region comprises about 90% of the national production of sugarcane, sugar and ethanol

Econometric Model
What is new in this paper?
1- Panel data: the technique of clustering time series data and cross-sectional data (panel data) allows econometric models to be estimated more efficiently
- We employed an econometric tool called dynamic panels with spatial control
  - It allows to quantify the effects of the existence of a sugar/ethanol plant and sugarcane area
    - For the host municipality of sugarcane crop and/or industrial unit
    - For the surrounding area
- Method of estimation: GMM-SYS – Generalized Method of Moments System
2 – Center-South region
- Data of 2,363 municipalities

Variables
Control variables:
- Proportion of adults in the municipal population
- Rate of labor force utilization (total and in farming)
- Average labor income (total and in farming)

Variables representing sugarcane sector (agriculture and industrial) expansion:
- Share of agriculture in municipal area
- Share of temporary crops within agriculture area
- Share of sugarcane within temporary crops area
- Districts and towns with an operational plant (dummy: 1 = yes; 0 = no)

Brownfields (mills operating before 2000) and greenfields (new units up to 2008)

Main results
Direct effect (on the cities where the expansion takes place): POSITIVE
Indirect effect (on the neighboring cities): POSITIVE
There was a direct contemporaneous effect in the municipalities:
- a 10 percentage point increase in the cane/temp raising the real municipal GDP per capita by an average of 76 $;
- For De variable, the real municipal GDP per capita increased, contemporaneously, by an average of:
  - 1098 $ in the host municipality
  - 457 $ in each of the 15 closest neighboring municipalities.
At 10 years after the installation of the plants and sugarcane areas:
- the average increase in the real municipal GDP per capita was
  - 1028 $ for the host municipality
  - 324 $ for each of the 15 closest neighboring municipalities

<table>
<thead>
<tr>
<th>Year</th>
<th>South-central region</th>
<th>Northern/northeastern region</th>
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<td>2020/21</td>
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Main Findings

On the basis of findings, we can conclude that the large-scale production of ethanol in Brazil has positive socioeconomic effects in the Center-South region, as evidenced by increases in the municipal GDP per capita;

The analysis reveals that the industry has made a positive contribution to the development of host municipalities and the neighboring municipalities due to the spatial and temporal effects.

What is new in this paper?

• Socioeconomic impacts were evaluated through use of the Federation of the State of Rio de Janeiro Industries’ (FIRJAN) Index of Município Development (IFDM) as a proxy for the Municipal Human Development Index (HDIM);

• This analysis evaluate both the effect of the expansion of sugarcane cultivation, as the presence of plants (sugar and / or ethanol plants).
Data and methodology

- The investigation undertaken in this study is based on panel models: system generalized method of moments (GMM).

- By incorporating spatial analysis, we were able to consider the geographic dimension of the analyzed socioeconomic impacts and eliminate the problem of spatial dependence, which is a specific case of cross-sectional dependence.

- An observation may be associated with another according to its spatial location due to the behavior of economic agents who define choice according to local market conditions, regional market conditions, or the distance between regions (Elhorst, 2014).

- To check the overflow effect, i.e. the effect on a given municipality on the other municipality, a matrix of spatial weights was taken. With this matrix was created new variables that gave greater weight to the nearest cities.

Main Findings

- A large number of jobs created in the three sectors (sugarcane crops, sugar and ethanol) surpass one million formal jobs.

- Several studies have associated increased sugarcane cultivation with positive effects on the local population when it takes place in the presence of a processing plant:
  - Presence of a sugarcane processing plant in a county (DPlant): was both significant and positive on the IFDM indicator value, with elasticity of 1.82% for the direct effect and 9% for the indirect effect.
  - Social and environmental certification programs adopted by companies had positive effects on the local population when they take place in the presence of a processing plant.

General Results and Conclusions

- The short term direct effect of an increase in the percentage of a county’s area represented by sugarcane is:
  - negative elasticity of 4.2% on the IFDM value;

- The negative result for the variable’s short term direct effect on socioeconomic development can be understood as the result job loss due to crop substitution as the relatively mechanized technologically advanced sugarcane culture replaced other, more labor intensive traditional cultures, as verified by Oliveira and Hoffmann (2011).

- The variable’s indirect effect:
  - was not significant

- The short term direct effect of an increase in the percentage of a county’s area represented by sugarcane processing plant are likely to extend beyond the borders of the county where the plant is located

Summary of variables used in the study

<table>
<thead>
<tr>
<th>Variable (abbreviation)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita (GDPcap)</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Literacy rate (%Lit)</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Urbanization rate (%Urb)</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Population Density (Den)</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Area occupied by sugarcane crops in relation to county’s total area (%AgroArea)</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Density (indicating the presence of a sugarcane processing plant in the city (DPlant))</td>
<td>IBGE (2014)</td>
</tr>
<tr>
<td>Percentage of a county’s total area represented by agriculture (%Agrozona)</td>
<td>IBGE (2006)</td>
</tr>
</tbody>
</table>

Sugarcane industry’s socioeconomic impact in São Paulo, Brazil: a spatial dynamic panel approach

- The plants stimulate growth in support segments, such as transportation, maintenance, and machinery sales outside their home county;

- Implementation of an industrial plant creates demand for many steel industry products, such as machinery, tractors and construction materials, further stimulating the regional economy;

- These estimates strongly suggest that the benefits gained from expansion of the sugarcane industry are for the most part derived from sector’s downstream segment and that the socioeconomic impacts of a sugarcane processing plant are likely to extend beyond the borders of the county where the plant is located.
http://www.esalq.usp.br/gemt

Thanks for your attention

Feel free to contact

mafdmora@usp.br