Are Latin American and Caribbean Biofuel Policies Consistent with their Comparative Advantages?

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1. Introduction

Biofuels have been included in the energetic agendas of many economies. In general terms, the main reasons for biofuel promotion are: reduction on fossil fuel dependency, to encourage rural development, and to tackle climate change. Some Latin American and Caribbean (LAC) countries play a significant role in the biofuel dynamic. Pistonesi et al. (2008) mention that the biofuel production in LAC could be seen as a strategy to achieve environment, energy and agricultural development. In this sense, some countries in the region have been developing policies to promote biofuels production based on big countries experiences as a strategy to develop rural areas by the creation and retention of jobs.

Biofuels are alternative fuels from fossil energies made from biomass. In this context, bioethanol, biodiesel and biogas constitute these types of alternative energies. Furthermore, they can be divided in three categories according to their production source. First generation biofuels are those produced from edible crops, second generation biofuels are produced from non-edible crops, co-products from processes edible crops, or non-edible parts from edible crops. Third generation biofuel are those made from algae biomass (Francis and Virgin, 2010, p.178).

First generation ethanol is the largest scale produced biofuel. In 2011 the global fuel ethanol production was 22,742 million gallons (Earth Policy, 2012). Brazil and the US are leading the production of this type of bioenergy. Brazil produced 5,553 million gallons of ethanol from sugarcane sharing 24% of the global production, while the US produced 14,319 million gallons of corn based ethanol representing 62%. China, Canada, and the EU produced 9% of the total share. The rest 5% was produced by all the other countries. In all cases second and third generation ethanol production is marginal.

In 2011 world biodiesel production was 5,651 million gallons (Idem). The US shared 15% of the world production with 841 million gallons, followed by Germany which produced 835 million gallons, Argentina shared 13% of the biodiesel production with 729 million gallons, and Brazil produced 698 million gallons sharing 12%, France was the fifth leading producer of biodiesel sharing 7% of the total production with 420 million gallons. Soybeans and oil palm are the major crops from which first-generation biodiesel is produced.

In the Latin American and Caribbean Countries Brazil and Argentina are the leading producers of ethanol and biodiesel, respectively. In both cases governmental policies encouraged biofuel production (Sorda et al. 2010). Other countries in the region have developed a legal framework on biofuels promotion. In this sense, by 2011 seventeen LAC countries developed policies to encourage first-generation biofuel production.

Argentina, Brazil, Colombia, and Mexico are the four major producers of biofuel feedstock in LAC. In 2013 these countries reached a production of 859.02 million tons of sugarcane which represented 88% of the total amount of sugarcane produced in the region. Brazil lead the sugarcane production with 739.2 million tons of sugarcane, sharing 76% of the regional production. Mexico produced 61 million tons reaching 6% of the regional production. Colombia produced 34.87 million tons and Argentina 23.7, representing 4% and 2% of the production in Latin America and the Caribbean, respectively. Regarding the soybean production, the LAC countries produced 146.14 million tons in 2013. Brazil leads the production of this crop sharing 56% reaching a production of 81.69 million tons, Argentina produced 49.30 million tons representing 34% of the regional production, Mexico and Colombia's contribution was marginal, representing 0.2 and 0.1%, respectively.

The objective of this article is to evaluate in what extend the comparative advantages of the biofuel feedstock explain the biofuel policies in the LAC countries. With this aim the following section explains the comparative advantage concept from the Ricardian international trade theory. Additionally, the third section describes the biofuels policy context in the LAC countries giving special emphasis to Argentina, Brazil, Colombia, and Mexico. Furthermore, considering these economies there is specified an empirical model over the period 1991-2011 evaluating two different comparative advantage measures. Then the results are contrasted and discusses. The last section presents some concluding remarks.

2. Ricardian International Trade Theory

This section presents an overview of the international trade theory in which the article is based. First there are mentioned the conditions that should be met for two economies to trade according to the Ricardian theory. Additionally, there is included the concepts of absolute advantage and comparative advantage.

Ricardian theory states as a necessary condition for international trade to take place the presence of a comparative cost differential between countries. Considering two goods and two countries, these costs can be defined as the ratio between individual or absolute costs of both goods within the same country. Another way to define the relative costs is as the ratio of the unit cost of the same good in the two countries (Gandolfo, 1998).

The sufficient condition for international trade is that the international terms of trade are among the comparative costs. Thus, when the two conditions are satisfied, it will be beneficial for each country to specialize in the production of a good. More specifically, each country will specialize in the good in which it has the greatest comparative advantage or less relative disadvantage (Ibidem).

Furthermore, Reinert (2012) explains the concept of absolute advantage as the possibility that, due to differences in supply conditions, a country can produce a product at a lower price than other country. In this sense, the comparative advantage is defined as a "situation in which the autarkic relative price ratio in a country of a good in terms of another is rather lower than that of other countries in the world" (Reinert 2012, 33).

3. Biofuels Context in the LAC Countries

This section presents the biofuel policy factors found in previous studies for developing countries, in particular for the LAC countries. Additionally, there is described the implemented policy instruments or the biofuel targets proposed in those economies. Argentina, Brazil, Colombia, and Mexico receive special emphasis in this description since these countries constitute the largest economies of the region.

3.1. Biofuel Policy Drivers in the LAC Economies

In general terms, economies promote biofuel policies to decrease fossil fuels dependency, capture rural development opportunities in terms of agricultural employment and poverty reduction, and to tackle climate change reducing GHG emissions (Doku and Di Falco 2012; Duffey and Stange 2011; Sorda et al. 2010). Furthermore, UNCTAD (2013) identify technology as a crucial factor for a successful biofuel policy in terms of join efforts between research centers and universities, private and governmental sector.

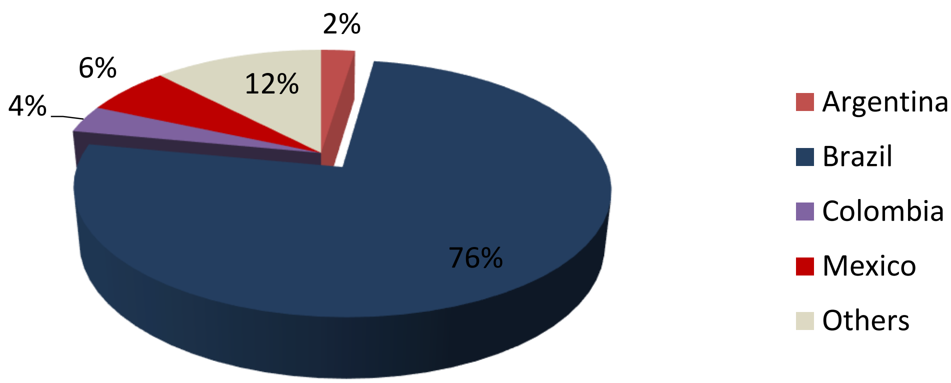
In contrast with the developed economies which major objective for biofuel policies implementation is GHG emission reduction, developing countries, particularly the LAC economies, promote biofuel policies to generate agricultural employments and to reduce oil imports (Pistonesi et al. 2008; Doku and Di Falco 2012; Sorda et al. 2010). Additionally, Doku and Di Falco mention that "when one focuses on large agricultural developing countries… comparative advantage such as fertile land and an appropriate weather should be key drivers behind biofuel adoption (2012, 101)". In this sense, similarly than Doku and Di Falco (2012), this article focuses on comparative advantages, agricultural employment, technology, and ability to protect their market.

3.2. Policy Instruments and Biofuel Crops in LAC

Within the LAC countries, Brazil and Argentina are the leading producers of ethanol and biodiesel, respectively. In both cases governmental policies have promoted biofuel production (Sorda et al. 2010). Moreover, other countries in the region have developed a legal framework on biofuels promotion consisting in grants, guaranteed loans and tax incentives for the production of biofuels, and consumer excise taxes exemption for biofuels to help achieve targets on biofuel production and consumption (UNCTAD 2006; Valdes 2011). In this sense, by 2011 seventeen LAC countries developed policies to encourage biofuel production. These countries were: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, and Uruguay (Pistonesi et al. 2008).

Argentina, Brazil, Colombia, and Mexico are the four major producers of ethanol feedstock in the LAC region. In 2013 these countries reached a production of 859.02 million tons of sugarcane which represented 88% of the total amount of sugarcane produced in the region (FAO 2013). Brazil lead the sugarcane production with 739.2 million tons of sugarcane, sharing 76% of the regional production. Mexico produced 61 million tons reaching 6% of the regional production. Colombia produced 34.87 million tons and Argentina 23.7, representing 4% and 2% of the production in the LAC region, respectively. Figure 1 shows the sugarcane production's share in the LAC countries.

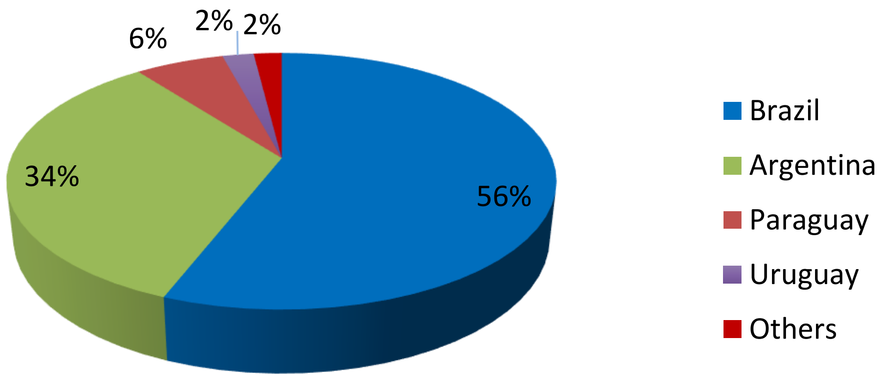
Figure 1. Share of Sugarcane Production in LAC, 2013



Source: Data from Faostats (2013)

Regarding the soybeans production, the LAC countries produced 146.14 million tons in 2013 (Idem). Brazil lead the production of this crop sharing 56% reaching a production of 81.69 million tons, Argentina produced 49.30 million tons representing 34% of the regional production, Paraguay produced 9 million tons and Uruguay 3.2 million tons sharing 6% and 2% of the total production in LAC, respectively.

Figure 2. Share of Soybeans Production in LAC, 2013



Source: Data from Faostats (2013)

3.2.1. Argentina

Biofuel legal framework in Argentina is regulated by the Argentine Biofuel Law 26.093 published in April 2006 and implemented in February 2007 under Decree 109/2007 (Sorda et al., 2010). Biofuel policy does not specifically focus on second generation or advanced biofuels (Joseph 2013). In terms of mandatory blends, gasoline and diesel are required to contain a 5% biofuel share starting in January 2010 (Argentine Biofuel Law 26.093 of April 2006, quoted in Sorda et al. 2010). In terms of international trade, biofuel exports are not granted direct financial incentives (Sorda et al. 2010).

3.2.2. Brazil

Brazil was the first economy in LAC producing biofuels. The required mandates have changed but it have been established a mix between 22% and 25% biofuel sharing (Pistonesi et al. 2008). National Petroleum Agency, through the Law 9478/97, defines the standards for gasoline and ethanol products. While Law 11.097/05 sets the specificities of biodiesel production, certification, and marketing (Tixeira 2011; Valdes 2011). In terms of biodiesel requirements, in 2005 it was implemented the National Program on Biodiesel Production and Usage which required a 2% blend of biodiesel (Sorda et al. 2010). Currently there is no a legal mandate to promote second generation biofuels. Even if in previous years there were protection barriers to international trade, in 2010 a tariff of 20% on imports of ethanol levied in 2001 was removed (Valdes 2011, 24).

3.2.3. Colombia

The Colombian government has promoted ethanol and biodiesel production through the Law 963 (Sorda et al. 2010). Currently, second and third generation biofuels are not required by law. In terms of mandatory blends, Law 963 mandates a 10% bioethanol-gasoline mix in cities which population is greater than 500,000 inhabitants (Sorda et al. 2010). Additionally, a mandatory blend for biodiesel was required. Both mandates were established by 2005 (Pistonesi et al. 2008).

3.2.4. Mexico

The Law of Promotion and Development of Biofuels states the legal framework of biofuel development in Mexico. This law encourages the promotion of second generation biofuels but it doesn't present any specificity regarding the source or a mandate in its consumption. In terms of international there is not a clear restriction in biofuels imports.

3.2.5. Other LAC countries

Bolivia has a legal framework for renewable fuels regulated by the law 3.152 which was promoted in 2005. This economy has stated a goal of 2.5% for 2007 reaching a 20% blend by 2015 (Pistonesi et al. 2008). The following biofuel countries' policy context were retrieved from (Biotop 2009, quoted in Duffey and Stange 2011). In this sense, Chile, has a non-mandatory required mix of 5% for biodiesel and ethanol. Costa Rica seeks to achieve an ethanol mix of 7.5% and between a 2% and 5% for biodiesel. Ecuador biofuel policy in 2006 stated a target ethanol mix of 5% and 10% for biodiesel. By 2009 Dominican Republic established a 5% ethanol mix intended to increase until 15% for 2015. El Salvador, had a goal of an ethanol mix of 10% in all the country's gasoline. DL-17-85 constitutes Guatemala's biofuel legal framework, this country has the government authorization of 5% of ethanol. In Honduras the Law 144 constitutes the biofuel major which established the interest of its government in biofuel research, production, and use. In Nicaragua the main biofuel policy is stated by the Law D-42-2006. Panama, by 2007 has proposed a goal of 10% ethanol mix. Paraguay, has stipulated a goal of a minimum 18% ethanol-gasoline mix for 2007. In terms of biodiesel this country has a target of 1% in 2007, 3% for 2008, and 5% in 2009 (Pistonesi et al. 2008). Peru, has a goal of 7.8% of ethanol and 2% for biodiesel by 2009 increasing to 5% by 2011 (idem). Finally, Uruguay has a biodiesel requirement stipulated in 2% by 2008 until 2012, and of 5% after 2012. Regarding the ethanol mix it is targeted a 5% for 2014.

4. Methodology

This section describes the methodology applied to test in what extend the comparative advantages in the LAC economies explain their biofuel policies. With this aim there are described the empirical measures for comparative advantage considered for this study. Other biofuel policy drivers identified in previous studies are considered. Then, there is included the model specification; in this regard two equations are specified to differentiate between ethanol and biodiesel policies. The analysis considers Argentina, Brazil, Colombia, and Mexico for the period 1991 to 2011. The equations are estimated applying OLS by a panel data method considering fixed effects.

4.1. Empirical Measures for Comparative Advantage

This section describes the empirical approach for the comparative advantage measures applied to agricultural commodities. In this sense, there is described the comparative advantage index proposed by Vollrath (1991). Then there is explained the approach to this concept used by Doku and Di Falco (2012) based on Jumbe et al. (2009).

4.1.1. Revealed Comparative Advantage Index

The first approach to the comparative advantage concept is based on the RCAI proposed by Vollrath (1991). Sugarcane and soybean are the largest feedstock for ethanol and biodiesel production, respectively in the LAC countries (Duffey and Stange 2011; Pistonesi et al. 2012; Sorda et al. 2010). Sugarcane cannot be transported for long distances due to its high perishable characteristics, thus there is no international commerce for this crop. Sugarcane producer needs to make the decision between producing ethanol or sugar once the crop is harvested. In this regard, sugar raw centrifugal is used as a proxy for sugarcane to evaluate the RCAI for the ethanol equation. Moreover, the RCAI for soybean is computed to evaluate the comparative advantage for the biodiesel equation.

The equation to calculate the RCAI for commodity *a* in country *i* is given by:

$$RCA_a^i = RXA_a^i - RMA_a^i \quad (1)$$

Where,

$$RXA_a^i = (X_a^i / X_a^i) \;/\; (X_a^r / X_n^r) \; (2)$$

$$RMA_a^i = (M_a^i / M_a^i) \;/\; (M_a^r / M_n^r) \; (3)$$

Equations (2) and (3) are the revealed comparative advantages for exports and imports, respectively for commodity *a* in country *i*.

Where,

X = Exports

M = Imports

w = World

i = Analyzed country

r = Rest of the world

t= Total of agricultural commodities

a = analyzed commodity

n = Rest of the commodities

Equation (2) is obtained as follows:

$$X_n^w = X_t^w - X_c^w (4)$$

$$X_n^i = X_t^i - X_c^i (5)$$

$$X_a^r = X_a^w - X_a^i (6)$$

$$X_t^r = X_t^w - X_t^i (7)$$

$$X_n^r = X_t^r - X_a^r (8)$$

$$RXA_a^i = (X_a^i / X_n^i) \;/\; (X_a^r / X_n^r) \; (2)$$

Equation (3) is obtained following the same process explained in equations (4)-(8) but considering imports instead exports.

4.1.2. Comparative Advantage Alternative Measure

Doku and Di Falco (2012), based on Jumbe et al. (2009), mentioned that the arable land in hectares per person could be used as proxy for biofuel crops comparative advantages. They justify this variable from the relevance of land requirement of biofuel production. More specifically the authors mention that "in order to engage in biofuel production, agricultural land is required, as is an appropriate climate, to grow certain crops (Doku and Di Falco 2012, 102)" thus "to measure natural endowment that proxies for comparative advantage we…use land [in hectares per person] (Idem, 105)".

4.2. Model Specification

This paper proposes two equations to differentiate between the possible drivers of ethanol and biodiesel policies. The analysis considers Argentina, Brazil, Colombia and Mexico over the period: 1991-2011. The variables considered in the model correspond to those proposed by Doku and Di Falco (2012) and other authors (Pistonesi et al. 2008; Sorda et al. 2010; UNCTAD 2013). Two sets of equation are estimated considering the comparative advantage approach from Vollrath (1991) and Doku and Di Falco (2012). Both sets of equations are estimated by OLS using a panel data method with fixed effects.

The ethanol policy equation is specified as follows:

$$ET_{it} = \beta_0 + \beta_1 RCASC_{it} + \beta_2 Y_{it} + \beta_3 PSC_{it} + \beta_4 AGP + \beta_5 RAD + \beta_6 EM + \varepsilon_{it} \quad (9)$$

ET is a dummy variable which indicates if the country has an ethanol-gasoline mix requirement or if the policy in place considers a specific target[1]. RCAI represents the comparative advantage for sugar raw centrifugal (RCASC). It should be stressed that sugar raw centrifugal was used as a proxy for sugarcane. Sugarcane producer needs to make the decision whether produce ethanol or sugar right after the crop is harvested. This variable is expected to be negative. If a decrease in the comparative advantage of sugar is presented the country should specialize in ethanol and promote ethanol policy.

Sorda et al. (2010) stress the relevance of external incentives to achieve the biofuel targets, in this sense, GDP in current dollars (Y) represents "the financial feasibility for countries to undertake and support biofuel policies" (Doku and Di Falco 2012, 105); the expected sign

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[1] This binary dependent variable measures ethanol requirement policy or whether an ethanol-gasoline target is pursued. It doesn't measure whether the countries are adhering to them in practice.

for this variable is positive. PSC is the sugarcane price in current USD; the expected sign for this variable is positive. Rural development promotion might be one of the ethanol policy drivers in the LAC. In this sense, a higher feedstock price would increase the farmers' profits, contribute to rural development and thus it can be seen as an incentive to promote ethanol policies.

AGP is the economically active population in agriculture which is expected to be positive. UNCTAD (2013) mentions that technology is a relevant biofuel policy driver in the developing countries. In this sense, technology is approached by research and development (RAD) expenditure as a percentage of GDP; this variable is expected to be positive. Furthermore, reduction of oil imports dependency is another possible factor for LAC economies biofuel policies (Pistonesi et al. 2008; Doku and Di Falco 2012; Sorda et al. 2010). In this regard, EM represents the net energy imports as a percentage of energy use[2]. This variable is expected to be negative. All the variables are evaluated for the country *i* at the time *t*.

Equation (9') is the second equation estimated for ethanol policy. In this equation the comparative advantages are measure by the arable land in hectares per person as proposed by Doku and Di Falco (2012) who at the same time based on Jumbe et al. (2009). All the other variables are the same as in equation (9).

$$ET_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 Y_{it} + \beta_3 PSC_{it} + \beta_4 AGP + \beta_5 RAD + \beta_6 EM_{it} + \varepsilon_{it} \quad (9')$$

An additional equation is specified for biodiesel policy as shown in Equation (10). BD is a dummy variable which indicates whether the country *i* has a biodiesel mandatory requirement or its biofuel policy considers a specific biodiesel production target at the time *t*. Soybean is the major feedstock used to produce biodiesel in the LAC countries. In this regard, this equation considers the RCAI for soybean to measure the comparative advantages. By contrast

[2] Net energy imports are estimated as energy use less production, both measured in oil equivalents. A negative value indicates that the country is a net exporter. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport (Data Bank World Bank 2013).

with the ethanol policy equation where sugar raw centrifugal was used as a proxy for sugarcane and thus the interpretation needed to be adapted, soybean represent the principal biodiesel feedstock. For this reason this variable is expected to be positive.

The price of soybean (PS) is also considered in the biodiesel equation for similar reasons than in the ethanol equation the sign for this variable is expected to be positive. The rest of the variables are the same as proposed for the ethanol policy equation.

$$BD_{it} = \propto_0 + \propto_1 RCASB_{it} + \propto_2 Y_{it} + \propto_3 PSB_{it} + \propto_4 AGP_{it} + \propto_5 RAD + \propto_6 EM_{it} + \mu_{it} \quad (10)$$

Similarly than for the ethanol policy case, a second equation for biodiesel is estimated considering the alternative empirical measure for comparative advantages (arable land in hectares per person). In this sense, Equation (10') has the following specification:

$$BD_{it} = \propto_0 + \propto_1 L_{it} + \propto_2 Y_{it} + \propto_3 PSB_{it} + \propto_4 AGP_{it} + \propto_5 RAD + \propto_6 EM_{it} + \mu_{it} \quad (10')$$

All the other variables are the same as in equation (10).

4.3. Data

All variables for the possible biofuel policy drivers were retrieved over the period 1991-2011. The data was obtained from data bases of international agencies (Data Bank Indicators. World Bank 2014; FAOStats. FAO 2013) and from previous studies for developing countries, in particular for LAC biofuel contexts (Duffey and Stange 2011; Doku and Di Falco 2012; Sorda et al. 2010; UNCTAD 2013). The countries considered for this analysis are: Argentina, Brazil, Colombia, and Mexico. Table 1 describes the variable used in the estimations, their measure units, and their source.

Table 1. Variable description and its source.

Ethanol and Biodiesel Biofuel Policy Equations			
Variable	Description	Unit	Source
ET/BD	Biofuels policy: ethanol's requirement/biodiesel's requirement.	Yes=1	Duffey and Stange (2011); Doku and Di Falco (2012); Sorda et al. (2010); UNCTAD (2013).
RCA	Reveled Comparative Advantage Index for sugar raw centrifugal and for soybean.	Index	Calculations by the authors based on data from FAO (2013).
Y	Per capita GDP.	USD Current Prices	Data Bank Indicators. World Bank (2014)
L	Arable land	Hectares per person	Data Bank Indicators. World Bank (2014)
PSC/PSB	Price for Sugar, Raw Centrifugal/Price for soybean	USD Current Prices	FAOStats. FAO (2013)
AGP	Economically active population in agriculture.	Number	FAOStats. FAO (2013)
RAD	Research and Development expenditure.	% of GDP	Data Bank Indicators. World Bank (2014)
OM	Fuel imports	% of the total imported goods	Data Bank Indicators. World Bank (2014)

It should be mentioned that the series for Research and Development expenditure (RAD) presented some missing values. The reason of this data limitation is because the database started reporting this variable in 1996 for the LAC countries. A shorter period of time was intended to be considered for the analysis (2000-2011) to have a balanced panel but any variable resulted statistically significant. Doku and Di Falco (2012) faced to a similar situation when calculating their model but mentioned that: "though we lack a full, consistent data set, we believe that our research in this subject is crucial, and could have imperative policy implications" (2012, 105).

Additionally, since ET and BD only measure the ethanol and biodiesel mandatory blends requirements or biofuel mix targets all the countries were given a start year as mentioned in their policies, regardless as to whether they accomplish the targets or adhere to their requirement in practice.

5. Results

This section explains the results for the equations specified in the methodology. A total of four equations were estimated by OLS applying a panel method with fixed effect using the software GRETL. The first set of equations consists in the regression for ethanol and biodiesel policies using the RCA from Vollrath (1991) as the comparative advantage. Furthermore, the second set includes the estimations for these policies considering the alternative measure for comparative advantage as suggested by Doku and Di Falco (2012) and Jumbe et al. (2009). The objective of this section is to explain in what extend the comparative advantages of the biofuel feedstock explain the biofuel policies in the LAC countries.

Table 2 includes the estimates for the first set of equations. The first equation of this set consists in the ethanol policy equation (ET). It can be observed that the comparative advantage for sugar raw centrifugal presented a negative sign which is the expected sign according to Ricardian theory. If a decrease in the comparative advantage of sugar is presented the country should specialize in ethanol and promote ethanol policy. Similarly, the effect of GDP on ethanol resulted positive as expected.

Price of sugar cane (PSC), agricultural economically active population (AGP) and research and development (RAD) variables have positive signs. The first two variables supports the idea that ethanol policies in developing countries is promoted to encourage rural development. A higher sugarcane prices implies larger farmers' profits, which contributes to rural development and thus a potential ethanol driver. Additionally, the positive sign for research and development confirms UNCTAD's (2013) statement who stresses technology as relevant biofuel policy driver in the developing countries. Finally, energy imports presents (EM) the expected sign. From this estimates it can be observed that even if the comparative advantage is significant with the ethanol policy variable, other factors such as technology and energy imports contribute more to ethanol's policy promotion.

The second estimates of this set correspond to the biodiesel policy equation (BD). In this regard, it can be observed that the comparative advantage has the expected sign. The comparative advantage in soybean represents a positive factor to promote biodiesel policy.

GDP seen as the capacity of a country to protect their biodiesel market showed the expected sign (positive). The price of soybean and technology had both a positive sign. Additionally, the energy imports variable resulted to be negative. Similar results were obtained to those for the ethanol equation in terms of comparative advantages; even comparative advantages in soybean drives the biodiesel policy, other variables explain more the biodiesel policy promotion.

Table 2. Set of Estimates for ET and BD Considering RCA for Comparative Advantage Measure

Dependent Variable: ET						
Constant	RCASC	Y	PSC	AGP	RAD	EM
-3.911*	-0.0458**	7.27E-13*	0.0075688	4.26E-04	1.857***	-0.006***
(2.2229)	(0.0210)	(3.75E-13)	(0.005)	(0.0003)	(0.6235)	(0.0018)
R-squared	0.778					

Dependent Variable: BD						
Constant	RCASB	Y	PSB	AGP	RAD	EM
-3.903**	0.0213**	6.51E-13**	0.0009*	0.0003	2.327***	-0.006***
(1.5744)	(0.0093)	(3.1018E-13)	(0.0005)	(0.0002)	(0.6210)	0.001
R-squared	0.744					

Table 3 includes the set of estimates for ethanol policy equation and biodiesel policy equation considering the arable land in hectare per person as the comparative advantage measure. For the first equation corresponding to ethanol policy, comparative advantage approach by hectare per persons, as suggested by Doku and Di Falco (2012), has a positive sign. With this measure, comparative advantage results to be more significant as an ethanol policy driver than using the RCA. Considering the ethanol policy's drivers the comparative advantages result as significant as the other variables. The sign of all the other variables results as expected.

In terms of the biodiesel policy, the comparative advantage using the alternative measure seems to be less significant explaining the biodiesel policy than when using RCA. Its positive sign is still the expected. Similarly than in Table 2, other factors, such as research and development and energy imports, are more significant explaining the biodiesel policy than the comparative advantages.

Table 3. Set of Estimates for ET and BD Considering Land for Comparative Advantage Measure

Dependent Variable: ET						
Constant	L	Y	PSC	AGP	RAD	EM
-7.977***	4.2094***	8.06E-13**	0.0187***	0.0008***	0.4857	-0.008***
(1.8067)	(1.156)	(3.41E-13)	(0.0054)	(0.0002)	(0.6520)	(0.0017)
R-squared	0.813102					

Dependent Variable: BD						
Constant	L	Y	PSB	AGP	RAD	EM
-4.0385**	1.7822*	6.83E-13**	0.0008	0.0002	1.5382**	-0.007***
(1.6170)	(1.0606)	(3.16E-13)	(0.0005)	(0.0002)	(0.6868)	(0.0019)
R-squared	0.732491					

6. Concluding Remarks

The objective of this article was to evaluate in what extend the comparative advantages of the biofuel feedstock explain the biofuel policies in the largest LAC countries. In this sense, there were mentioned the biofuel policies in LAC, and special emphasis was given to Argentina, Brazil, Colombia, and Mexico. Furthermore, considering these economies there was specified an empirical model over the period 1991-2011. An ethanol policy equation and a biodiesel equation were specified evaluating two different comparative advantage measures.

The ethanol policy estimation considering the comparative advantage approached by the RCAI proposed by Vollrath (1991) it was observed that even if the comparative advantage is significant with the ethanol policy variable, other factors such as technology and energy imports contribute more to ethanol’s policy promotion. Similar results are observed for the biodiesel equation specified with this measure for comparative advantages.

When there is considered the measure proposed by Doku and Di Falco (2012) for comparative advantage, it can be observed that for the ethanol policy equation comparative advantage gains relevance becoming as significant as the price of sugarcane, agricultural population and energy imports. By contrast in the biodiesel policy equation energy imports resulted to be more significant than the rest of the variables. In this case, even if comparative advantages were a driver other variables explained more the biodiesel policies. It should be mentioned that using this alternative measure, the comparative advantage factor presents a larger effect in both, the ethanol and biodiesel equation, than using the RCA approach. Even if the comparative advantage represent an important driver in the biofuel policy of the LAC4 countries, other factors are more significant explaining the ethanol and biodiesel policies.

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