THE EVOLUTION OF ENVIRONMENTAL GOVERNANCE MECHANISMS: AN INSTITUTIONAL FRAMEWORK APPLIED TO BIOFUELS[1]

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1. Introduction

Environmental protection requires the coordination of several actors whose actions affect environmental outcomes. How well this coordination is performed depends on the environmental governance, defined as a "set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes" (LEMOS and AGRAWAL, 2006, p. 298). This set may rely on government regulation and public enforcement by a regulatory agency or by more complex arrangements that involve private parties in different degrees.

The recent evolution of environmental governance is an interesting case of institutional change driven by the interplay between public and private mechanisms of control, incentives and regulation (CASHORE, 2002; PAAVOLA, 2007). In the last 20-30 years, there has been a trend of the transfer of regulatory functions from public to private actors, towards a more decentralized mechanisms such as private certification systems (TROSTER and HIET, 2018).

Compelled by the recent demand for environmental protection and the internationalisation of supply chains, the mechanisms of private governance have been used in natural resource management and have also acquired importance in most economic activities related to environmental goods (OLIVEIRA et. al, 2017). Environmental certification and labeling have expanded in various economic sectors, especially those related directly to natural resources, such as agriculture (CASHORE, 2002; DE MAN and GERMAN, 2017).

To explore these transformations and their impact on markets, this article proposes an analytical tool to predict how private certification systems evolve, and how this evolution is shaped by the interplay with public regulation and industry features. Some recent articles have also tried to explain evolution and success of private certification systems,

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mainly based on features of the certification schemes and public regulation (DE MAN and GERMAN, 2017; TRÖSTER and HIETE, 2018). Our contribution is to highlight additional variables, such as industry structure and network externalities that were not taken into account in previous studies.

This article relies on three complementary research strategies. First, we borrow from the forestry sector experience, commonly referred to as a prime example in the development of private environmental governance (CASHORE, 2002), the basic insights that, together with the theoretical lens of Institutional Economics and Industrial Organization, provide the grounds for developing the analytical framework. Second, to validate the proposed framework and its applicability to biofuels, we conducted interviews with representatives from environmental and consumer organizations, biofuel producers, government, and researchers[4]. Third, to apply the framework to the evolution of environmental governance in biofuels, we conducted document analysis of biofuel policies and private certification standards.

Based on the literature of institutional change (GREIF 2006; NORTH, 2005) and on the forestry case (CASHORE et al., 2004), we identify three pre-existing variables that drive the trajectory of environmental governance: public regulations, industry competition and organisations, and legitimation mechanisms. Departing from these pre-existing variables, it is possible to predict the evolution of private certification systems, and how this evolution is shaped by the interplay between public regulation and industry features.

This article is divided into four sections. Section 2 presents some key theoretical concepts that provide the foundations for the analytical framework for understanding and predicting the evolution of private environmental governance. The primary focus is the emergence and competition among private certification systems, increasingly important in international transactions in production chains. In Section 3, we apply the same framework to predict the evolution of private certification in the biofuels market, which is still far from consolidated. Final remarks follow with a summary of results and policy implications.

2. The evolution of private environmental governance: analytical framework

In this section, we develop a tool to analyse the emergence and the evolution of private environmental governance. For that, we combine both deductive (by the use of economic theory to derive conclusions) and inductive methods (by the reference to previous cases to guide the selection of relevant variables). The forestry industry, as the first successful case of private environmental governance, provides some insights that helps the development of the analytical framework in an abstract level. The relationship among variables is mediated by a deductive reasoning given by the literature of institutional dynamics and, in particular, of competition among standards, based in contributions of Institutional Economics and Economic Sociology.

4. This research used non-structured interviews with several players on the biofuels industry. We also conducted semi-structured interviews with researchers and industry representatives in order to have a more comprehensive view of environmental governance mechanisms under development on this sector.

For sake of clarity, this section first presents the key theoretical concepts to understand the dynamics of institutions and how they are applied to private environmental governance. Whenever appropriate, this section also refers to the insights that came from the forestry experience. The analytical framework is then presented at an abstract level, indicating the observable variables and how they interact to predict the outcome of the private environmental governance. Finally, the forestry case is presented as a concrete case to illustrate how to apply of the analytical framework.

2.1 Key theoretical concepts

This section presents three theoretical concepts, from the Institutional Economics and the Economic Sociology, that are necessary to understand how private certification systems are selected by firms.

The first concept – legitimation and society preferences – is related to the demand side for certification systems, which represents the choice of consumers and, more generally, of the society. The ability to coordinate actions among economic actors requires the general acknowledgment and acceptance of its validity (SUCHMAN, 1995). This is a particularly complex task in international transactions, since there is no central authority to enforce the norms prescribed by environmental certifications, and those norms are likely to conflict with national sovereignty (HURD, 1999). In cases like this, legitimation of environmental governance by social actors is essential for its general adoption.

In the absence of international agreements, a common feature in environmental issues, private governance mechanisms may coordinate actions between demanders and suppliers of a given good, to ensure that production will meet required sustainability standards. This private governance mechanism interacts with public regulation from both national and local level, in a complex arrangement known as multilevel governance (CENT et al., 2014). This type of mechanism has been studied in the forestry sector under different nomenclatures. Cashore (2002), for instance, explores how "Non-State Market-Driven (NSMD) Governance Systems" relies on pragmatic legitimacy, related to the value that society and final consumers assess to sustainability attributes of products.

The second key concept – transaction costs – is related to the supply side of the certified product. Certification systems prescribe two types of actions for producers to comply with the required standards, which may imply higher costs. The first comprises all activities to produce a good that meets the sustainability criteria embedded in the certification system, which often requires changes in product quality and more costly production process. This is the incremental production cost for supplying an environment-friendly product, whose production is welfare enhancing if, and only if, consumers value more this product than the costs of producing it (PINTO et al., 2014).

Nevertheless, incremental production costs are only part of the costs to comply with the required standards. The supply of a certified product also involves the costs to negotiate, monitor and enforce the certification system, which is generally referred to as transaction costs (COASE, 1960; WILLIAMSON, 1996). The costs related to collecting and verifying information about product attributes are particularly important for certifica-

tion systems since certification is required for goods whose information is not available by means of direct and costless inspection. This is the case of environmental goods, whose sustainability attributes cannot be assessed through inspections or even consumption (i.e. credence goods). In such cases, it is necessary to monitor the production process or to rely on variables that inform about how the good was produced and its impact on the environment.

The costs of collecting and verifying information, a component of transaction costs, is referred by the New Institutional Economics literature as measurement costs (BARZEL, 1982). In an estimation of these costs for the Clean Development Mechanism (CDM), established in the Kyoto Protocol, Michaelowa and Jotzo (2005) show that they account for a significant share of the costs of CDM projects, precluding investment, especially for small-scale projects. As these costs affect the decisions of suppliers to adopt a certification scheme, they play an important role on the evolution of certification systems.

A third key-concept – network externalities – is relevant to determine the outcome of the competition among certification systems. The value of a certification label increases with the number of suppliers and consumers that adopt this system, a phenomenon known as network externalities (ECONOMIDES, 1996). Therefore, when a producer chooses a certification system, the willingness to adopt it, in the case of other producers, or to accept it, in the case of consumers, increases. Other things equal, they will prefer a well-known certification system that can be used with multiple producers and consumers.

Network externalities bring about important dynamic properties to the competition among certification systems. New standards need to achieve a minimum number of participants, known as critical mass, to be sufficiently attractive to producers and consumers. Consequently, those certification systems that are not able to incorporate in their early life this critical mass of producers and consumers are not likely to prevail. On the other hand, network externalities imply a self-reinforcing mechanism, by which the established standards will tend to attract more participants, and every new participant will add more value to the certification system (EVANS and SCHMALENSEE, 2016). Accordingly, competition among certification systems tends to converge to just one winner or, if they are not perfect substitutes, to a few complementary systems.

2.2 How to assess the evolution of environmental governance mechanisms

Departing from these theoretical concepts, we propose an analytical tool to assess the emergence and evolution of certification systems.

First, legitimation is a necessary condition for the adoption and acknowledgment, by society and consumers, of the sustainability attributes and the environmental governance mechanism that enforces those attributes. This is also clear in the experience of private environmental certification in the forestry industry, in which non-governmental organizations, such as the WWF, played a crucial role as a source of social legitimacy (CASHORE et al., 2004; DE MAN and GERMAN, 2017; OVERDEVEST and RICKENBACH, 2006; PATTBERG, 2005). One could note that non-governmental agencies may not represent the views of all stakeholders and, as such, they will not be able to provide absolute

social legitimacy. Indeed, Suchman (1995) defines legitimacy for a group of observers, not necessarily all possible stakeholders. For the framework developed herein, this group of observers needs to be large enough to represent the simple majority of stakeholders.

Social legitimation defines the set of certification systems that will be available for suppliers to choose, i.e acceptable certification systems. It is likely that in the early stage of an environmental good, several certification systems will be available for suppliers, all of them meeting the requirement of legitimation. This is the first driver that guides the institutional path of private certification systems.

As certifications are established and are legitimized by society, competition among them takes place. Here lies the role of public regulation and how they affect the costs to comply with the certification systems. As firms can choose among several certification systems and their choice is typically driven by profits, the costs faced by producers play a central role in determining which one will be selected by firms. If demand conditions are the same for all certification systems, firms tend to choose the lowest cost alternative, i.e. the one that minimizes the costs of collecting and verifying information. If the certification requirements are closer to public regulation requirements, the costs to comply with the certification scheme will be lower, inducing more firms to adopt it (DE MAN and GERMAN, 2017). In short, whereas legitimation affects the demand side of certification systems, public regulation affects the costs of to comply with each of them (i.e. the supply side).

For this reason, public regulation will play an important role in the dynamics of private certification systems (CASHORE et. al, 2007). If public regulation is enforced, firms will operate above the minimum standards established by public policy. Therefore, private certification systems that emulate public regulation requirements imply lower compliance costs, and, consequently, will likely be adopted. Consequently, a convergence between public regulation and private certification systems is expected, brought about by the choice of firms for the minimum cost alternative. Public regulation, therefore, is the second driver to assess the institutional path of the private certification system.

Industry organization also affects measurement costs and, hence, will influence firms' decisions. If the production chain is more vertically integrated (different tiers on the production chain are under the same organization), measurement costs will be lower, making it easier for firms to adopt a particular certification system. Moreover, certifications are indivisible and non-depletable, which make them subject to economies of scale. As a consequence, larger firms will more likely adopt a private certification system (SHUT et al., 2010).

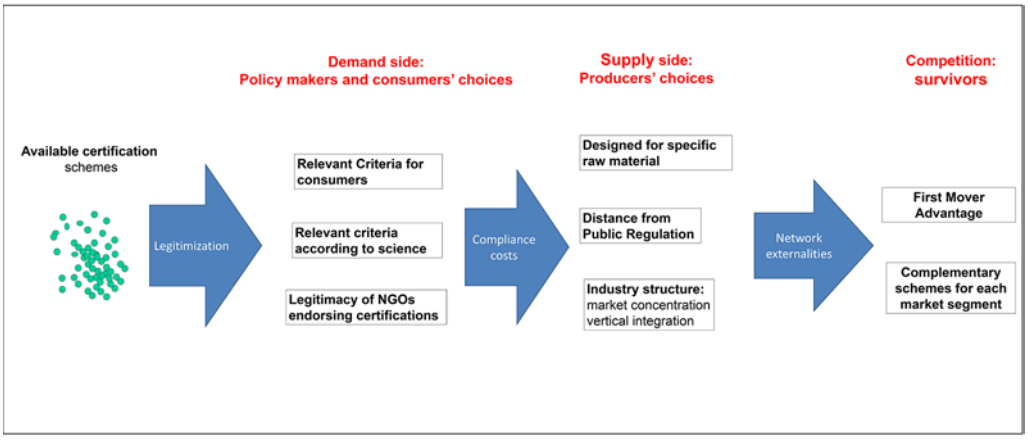
Also, the more fragmented the production chain, formed by small-holders and small processors, the greater the challenge to apply certification procedures (FROGER et al., 2010). In many biodiesel chains, for instance, the raw material is produced in small properties by family farming. Shut et al. (2010) analyzing forest and agricultural certification in Mozambique presented evidence that certification costs in this chain configuration (small-holders not integrated to industry and processing) is considerably higher than the one measured in more integrated chains. Due to the lack of formal education and limited economic resources, small-holders face bigger challenges to comply with the monitoring

procedures, such as filling in the questionnaires. In most cases, the industry or exporting company involved in this process had to take care of these tasks to their suppliers, raising the certification costs. For all these reasons, industry competition and organization is the third driver that orients the institutional path of private certification systems.

Finally, the network externalities play a crucial role in the competition among certification systems. In the early stages of an environmental good, there may be several candidates for certification systems. This competition in the first years is quite complex and unpredictable since certification systems are still struggling to build their governance mechanism and to legitimize their actions for demanders and society in general (ARTHUR, 1994). After some certification systems reach a certain level of acknowledgment (i.e. a 'critical mass'), the dynamics of competition becomes more predictable and quite dependent on firms' choices. The certification system that meets the legitimation requirement and presents the lowest compliance cost will be more likely to be adopted by firms. Due to network externalities, the benefit of adopting a certification system increases the greater the number of adopters. Therefore, as more suppliers and consumers adopt a given certification system, other suppliers and consumers will also tend to adopt it. If certification systems are close substitutes, at the end of the day, a single one prevails.

Figure 1 represents this framework in three steps. Firstly, certifications need to obtain legitimacy in order to be considered by demanders as a tool to transmit relevant information. To achieve this legitimacy, the schemes need to develop relevant criteria and verification process, which should be supported by marketing and scientific researches. The actors supporting each certification initiative also play an important role on this process, transferring their legitimacy as environmental specialists to the schemes.

Figure 1. Certification schemes selection: main steps



Source: elaborated by the authors

The next step relates to the producers' decision, which takes into account the compliance costs to obtain the certification. Here the second and third drives – public regulation and industry structure – interact to explain firms' choices. Compliance costs

vary according to both direct costs (the verification process) and indirect costs (adaptions in the production process in order to achieve the criteria). The indirect costs depend on the production techniques already used by producers, which is directly related to the requirements in place according to public regulation. Therefore, the distance between local regulation and the certification requirements affects indirect costs, and therefore, the incentives for producers to adopt the certification. Another important factor determining the adoption by producers is related to the industry structure. The degree of vertical integration reduces measurement costs; firms' size reduces the average certification costs; and the existence of producers' association, such as cooperatives, facilitates the information about the market advantages of a certification, as well as the diffusion of the necessary technologies for the producers.

Finally, in the last step, certifications compete for producers and consumers. In this process, the network externalities give an additional advantage to the schemes that have more adopters. Therefore, established schemes benefit from a first-mover advantage in comparison with new certification systems, since they have already a network of adopters whereas the entrants have still to attract the first users. This advantage will be larger if the certification develops criteria specific to a market segment, granting producers a larger market under reduced costs for adoption.

2.3 An illustration: private certification systems in the forestry sector

As mentioned in the introduction to this section, the well-established experience of certification systems in the forestry sector offered insights to support the choice of variables for the development of the analytical framework just presented in a more abstract and general level. In this section, we use the forestry case as a concrete illustration of the analytical framework with the aim to explain how the abstract concepts may be translated to a concrete case. In section 3 the framework will be applied to understand and predict the evolution of private certification systems for biofuels, an experience that is still in its earlier stages.

The increasing deforestation observed throughout the XX century pushed the demand for environmental protection. From the 1980s on, United Nations along with national governments and NGOs have tried to design an international mechanism to complement national laws in place. Notwithstanding the demand for an international regulation, countries failed to coordinate themselves towards a consensual regulatory proposal (CHAYTOR, 2001)

Considering these limitations, in 1993, the Forest Stewardship Council (FSC), a private organization focusing on environmental governance, was founded with an attempt by the environmental movement to occupy a regulatory vacuum in the absence of a multilateral international agreement to preserve forests. The internal governance of the FSC operates through a specific system formed by a Board. All decisions are deliberated by members of three chambers (social, environmental and economic) in meetings, workshops, and public consultations. The three chambers are also divided between the representatives of developed nations and the developing nations. This form

of governance, in which these groups interact towards gaining a consensus, is considered one of the main virtues of this system for resulting in a more balanced, democratic and legitimate decision-making process. Therefore, the FSC was able to survive the first step of the evolution of private governance, gaining legitimacy on the environmental arena.

As for the second step, considering producers decision to adopt the certification, the FSC faced stronger resistance. Firms questioned the elevated requirements of some criteria. This situation led to problematic interaction between business and the other chambers, which pushed more stringent standards. This discontent is an important factor for explaining the creation of at least 23 other certification systems competing with the FSC (PATTBERG, 2005).

In 1999, some of the stakeholders in the forest production chain developed the Programme for the Endorsement of Forest Certification Schemes (PEFC). Unlike the FSC, the PEFC focused on adapting existing national standards, a process named "accreditation" (VOIVODIC, 2010). Thus, while the FSC was formed mainly by NGOs and other bodies representing civil society, the PEFC has a greater representation by industries and governments (which control large forest areas). This origin resulted in more flexible standards for forestry industries and a lower cost of compliance (GULBRANDSEN, 2005). The differences between these two schemes are also related to operational procedures. PEFC certification does not require annual inspections in loco by accredited certification bodies, following a 5 years' revision process (PATTBERG, 2005). Therefore, the costs of certification are lower, especially in large forest areas, which are usually owned by governments.

PEFC has also lower costs relates to the interaction between these standards and the existing regulatory mechanisms. Because PEFC relies on existing standards, the costs of measuring information are lower than those that are incurred by the FSC, which, in most cases, go beyond the requirements made by law.

As a result, although the FSC is usually mentioned by the governance literature as the most important mechanism of forestry certification, the PEFC has almost double the area of certified forest (223 million hectares to 113 million hectares, respectively in the year 2005). In short, producers' choices – the second stage of the framework presented above – placed the PEFC in a more privileged position in the competition among certification systems for the forestry sector. In the final step, still ongoing, network externalities tend to direct companies and consumers towards the dominant certification system, which is the PEFC. FSC remains as an important scheme for its particularities, which makes both certification systems imperfect substitutes. However, it is not expected that the FSC will prevail as the dominant certification system.

These two certification schemes illustrate two ideal types that differ in terms of stringency and legitimation, following distinct institutional paths. The experience of the forestry sector illustrates how the difference in the level of stringency and legitimation, interacted with the drivers presented in Section 2, determines the trajectory of those certification systems.

Next section applies this analytical tool to the incipient ethanol international market, in order to predict the institutional path of environmental governance in this industry.

3. The analytical tool in action: Predicting the institutional path of environmental governance on biofuels sector

The emerging biofuels market is a suitable case for an assessment of the evolution of private environmental governance. In a parallel to the forestry sector, biofuels have sustainability attributes that are demanded internationally as one of the mechanisms to mitigate carbon emissions and greenhouse gases. In addition, although there is a demand for an international regulation of carbon emissions, for several reasons, coordination among countries for a unified regulation is unlikely. Therefore, there is a leeway for the development of private environmental governance with the aim to coordinate actions throughout the production chain in different countries.

Indeed, by 2012 there were more than 40 certification systems available for producers to certify their biofuels (UNICA, 2012). The presence of dozens of certifications systems, which one requiring different environmental standards, means that there is not yet a single standard that is universally accepted. The question we address here is: what is the expected path of private environmental governance for biofuels? Or, in a slightly different way, which biofuels certification systems will prevail in the near future? Aiming to answer these questions we apply the framework presented in Section 2.

The first step is to verify if the conditions of the biofuels case are consistent with the application of the analytical framework, which was developed based on insights from the forestry sector. The aim in building an abstract analytical framework was to have a general model that may be applied to different sectors, provided that their differences can be represented in the variables present in the framework. Still, it is important to check if the applicability to the biofuel case is indeed within the scope of the proposed framework.

Similarly, to the forestry industry, biofuels are also based on agricultural products and their demand is fundamentally motivated by environmental concerns. Moreover, biofuels and forest governance are deeply affected by public regulation, presenting a similar interplay between public and private governance mechanisms. These similarities have been addressed by the literature, which also claims that many criteria and monitoring tools that were previously developed for forestry case were later applied to biofuels (DE MAN and GERMAN, 2017; NIKOLOYUK et al., 2010). For those reasons, the biofuel case is an appropriate setting for the application of the proposed framework.

The biofuels environmental governance emerged from an institutional setting with pre-existent regulation and private governance mechanism borrowed from other sectors. According to the Cramer Commission (CRAMER et al., 2006), a survey conducted by a group of experts at the request of the Dutch government, most of the possible harm that could come directly from the production of biofuels was already being monitored using available tools in the agricultural and forestry certifications. Issues such as land degradation, pollution, the depletion of aquifer reserves, air pollution, deforestation, the loss of biodiversity, greenhouse gas emissions in agricultural production and degrading working conditions in the plantations were listed among the direct effects that, according to Cramer Commission, already had appropriate tools for monitoring. Thus, the report of this Commission suggested that national governments accept pre-existing certifications

in agriculture and forestry to certify the sustainability of biofuels entering their territories.

This strategy was adopted by Germany in 2007 and by the UK in 2008, establishing the so-called meta-standards. Under this system, biofuel producers could submit certifications, such as the FSC, to prove that their products have not caused deforestation. Likewise, other agricultural certificates could be used to establish the criteria for the sustainability of biomass cultivation.

One of the first greenhouse gas emissions certification systems was the International Sustainability Carbon Certification (ISCC). The project began in 2006 and received in 2010 the worldwide first official state recognition by the German authorities. Later, in 2011, it was among the first certification schemes to be accepted by the European Commission, under the EU Renewable Energy Directive. Given its acknowledgment by Germany and the EU, the ISCC benefited from a first-mover advantage to attract users. By 2015, it certified 205 biodiesel plants and 75 ethanol plants, most of them in Europe. That was the effect of the network externalities enjoyed by the ISCC with European producers and consumers.

More recently, other certifications have been developed specifically for biofuels. Two of them deserves special attention: Better Sugar Initiative (BSI-BONSUCRO), which covers biofuels made from sugar cane, and the Roundtable on Sustainable Biofuels (RSB), which cover biofuels produced from different raw materials. The development of these schemes follows a similar path when compared to FSC and PEFC, making the analytical framework built on these case experiences useful to understand the likely path of biofuels certification in the coming years.

RSB was released in 2006 under the coordination of the Energy Center da École Polytechnique Fédérale de Lausanne (EPFL). Many environmental groups and NGOs already working in the forestry sector (e.g. Friends of Earth and WWF) are also participating on the RBS. Like FSC, this certification scheme has an internal governance system made of representative cameras, which report to the coordination committee. These cameras represent different stakeholders that participate in the biofuels chain (raw-material producers, traders, industry, blenders, local populations affected by biofuels productions, NGOs, etc.). The powerful representation of NGO and another representative of environmental groups contributed to raising the requirements established by the RBS, including water and soil protection, GEE emissions, labour rights, local economic development, food security, land rights, among others.

BONSUCRO project began in 2008 as a response from private companies involved in the sugarcane-based industry, which produces sugar, ethanol, and bioelectricity. Among these members can be mentioned oil companies (BP, Shell), beverage companies (Coca-Cola), automobile (Toyota), trading companies (Cargill, Bunge), sugarcane producers' associations (UNICA-Brazil) and NGOs (Friends of Earth, WWF). Under the coordination of WWF, BONSUCRO offered a more simplified (and less stringent) set of criteria to assure biofuels sustainability, and it is specific to sugarcane products.

The trajectory of each certification scheme can be analysed through the lens of the analytical framework presented in Section 2. When considering the impact of local legislation on the development of RBS and BONSUCRO, it is clear how each of them

interacts with the requirements set by public regulation in a different way. Whereas BONSUCRO has most of its criteria already covered by local legislation (in many cases, the certification requirement looks to enforce the rule of law), RSB has established new standards and usually higher requirements than the ones in placed by local legislation. Consequently, the cost of adaption (both production and management expertise) to fulfill RSB requirements is higher than the ones necessary to achieve BONSUCRO's, what makes the latter the likely choice of sugarcane ethanol producers. As a matter of fact, most mills certified by BONSUCRO did not need to change their production practices to achieve the standards (SNEYD, 2014).

As for legitimation mechanism, both certification systems included well-known environmental non-governmental organizations, such as WWF and Friends of Earth, in their environment governance. Moreover, the level of stringency required for legitimation is sensitive to social preferences, what is related to the value of the certified information for consumers and voters. Societies more concerned with environmental issues resulted in more stringent sustainability requirements for bioenergy, as it is the case of the European Union (DI LUCIA, 2010).

Once the sustainability standards are decided in the political arena, policymakers can choose between different levels of sustainability by establishing criteria and monitoring mechanisms. For instance, countries can use their federal agencies to verify these criteria or outsource this task by the accreditation of voluntary certification schemes. While U.S. adopted the first strategy, developing criteria monitored by the Environmental Protection Agency (EPA), European Union chose to create a meta-standard for private certification schemes (ENDRES, 2010).

In June 2011, the European Commission approved several certifications that fulfill all the criteria that are required for the sustainability of biofuels, according to the Renewable Energy Directive (EU, 2009). RSB, BONSUCRO, and ISCC were among the seven approved certification systems, granting the same access to the European market. Consequently, the first stage of the evolution of private environmental governance in biofuels was accomplished by a share of the more than 40 certification systems available.

Considering the network externalities, ISCC had a clear first-mover advantage for European producers and consumers, benefiting from its established critical mass in the European market. BONSUCRO, on the other hand, has several features that put it in a privileged position in the second stage, the firms' choice of certification systems. As it is based in the accreditation of local regulation, and industry features facilitate the coordination throughout the production chain, BONSUCRO implies lower measurement costs.

In addition, a certification system may result in quite different measurement costs in accordance with its specialization: if they are crop-specific or based in meta-standards applicable to any crop. In a general, crop-specific certification systems are less complex and less costly. In the specific case of sugarcane ethanol, a crop-specific certification system is even more advantageous. Since sugarcane production for biofuel is produced mainly in large farms, certification tends to be less costly. Furthermore, the higher level of vertical integration between sugarcane mills (many of the mills cultivate their own sugarcane) enhance the control on the chain of custody necessary to certify the biofuel.

Finally, the sugarcane-based industry presents a consolidated trade union organization (UNICA-Brazil), which plays an important role in coordinating producers and supporting the technological changes necessary to fulfill the requirements for certification. All these features make BONSUCRO more likely to attract producers.

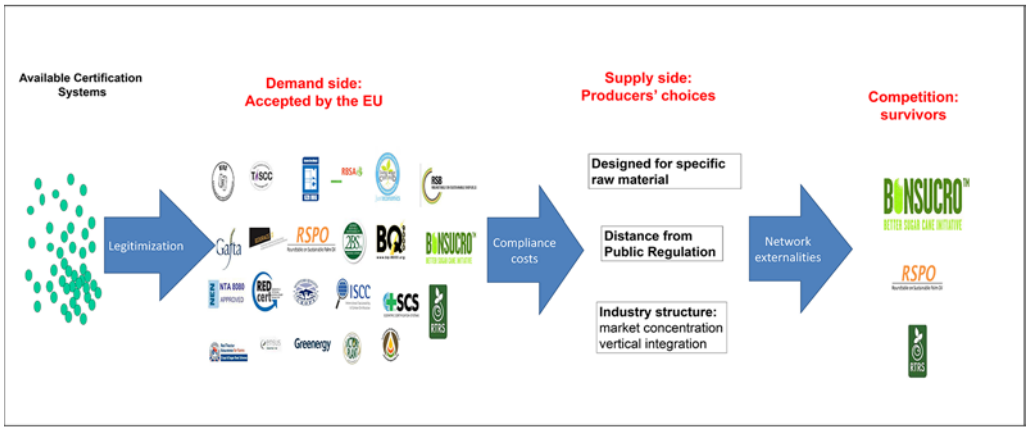
Therefore, BONSUCRO presents higher chance to expand in the biofuel chain based on sugarcane. Indeed, by 2015 BONSUCRO had already certified 46 ethanol plants, in Australia, Brazil, and Honduras. Moreover, all certified ethanol plants in Brazil, all based on sugarcane, held a BONSUCRO certificate. In this second stage of the evolution of private environmental governance, BONSUCRO dominates the choice of producers of sugar-cane ethanol, and ISCC prevails in Eurocentric transactions. RSB, in contrast, although recognized as one of the most reliable certification systems, struggles to compete with the other certification systems.

Considering the proposed analytical framework, it is expected that BONSUCRO certification system will consolidate itself as the main private environmental governance in the ethanol market. Given the relevance of sugarcane ethanol for sustainable biofuels in international markets, it is expected that BONSUCRO will be the dominant certification system, even though it applies only to a singular raw material (sugarcane) and biofuel (ethanol). ISCC, on the other hand, as a first mover and widely accepted in Europe, will hold an important position as a dominant scheme for biodiesel and other forms of greenhouse gas capture.

As for RSB, two reasons make it less likely to emerge as the dominant certification system. First, the RSB has to deal with a more complex and costly task, as it has to collect and verify information in a more diverse set of production chains. Second, the RSB requires more stringent environmental standards and that are not so close to public regulation as is BONSUCRO increase measurement costs. As a result, firms will tend to adopt BONSUCRO since it gives access to the same markets. Since the EU, the market that requires more stringent standards granted the same access to both certifications, BONSUCRO label is more attractive to producers, since it implies lower costs.

The above discussion contrast RSB and BONSUCRO, two relevant competing certification systems, for which we predict quite different prospects. Figure 2 summarizes the above discussion, as well as represents several other certification systems. The proposed framework predicts how they are likely to compete and, as a consequence, the evolution of private environmental governance for biofuels.

Figure 2. The evolution of environmental governance in biofuel



Source: elaborated by the authors

4. Conclusion and policy implication

The changes observed in environmental governance over the course of the past decades reveal the complexity of the new environmental problems that have emerged in the wake of the internationalisation of the chains of production and consumption. The emergence of certification systems is a response to the failure of traditional regulatory mechanisms to address complex problems, urging effective policies to mitigate climate change (IPCC, 2007).

The evolution of new governance mechanisms can be explained by the interplay between public regulation, the organisational and competitive structures of industries and the legitimation mechanisms prevailing in the environmental arena. More stringent certification systems, even if they enjoy the preference of environmentalists, will fail to compete with a simpler and less costly certification system, provided that the latter also meet minimum standards, so as to be legitimized by the demanders of environment protection. That is the case of the competition between RSB, preferred by environmentalists, and BONSUCRO. For being simpler and less expensive, BONSUCRO holds the dominant position among sugarcane producers.

The competition among certification systems also leads to the convergence of environmental standards of private certifications to the ones established by public regulation. Certification systems that base their requirements on the pre-existing regulation tend to be more attractive to producers and, consequently, tend to be adopted. Therefore, when regulatory environmental requirements are more stringent, private certification systems will also be more restrictive.

As an important normative implication, the efficacy of environmental governance depends on compliance costs for producers and, consequently, hinges on prevailing public regulations. Because regulation is under the control of policymakers, it should be designed accounting for not only its direct effects on sustainability but also its implications on

the development of private certification schemes. Since public regulation establishes a minimum standard for local producers, it reduces the costs of adopting a more stringent private certification and, therefore, affect the trajectory of the environmental governance.

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Original Article

THE EVOLUTION OF ENVIRONMENTAL GOVERNANCE MECHANISMS: AN INSTITUTIONAL FRAMEWORK APPLIED TO BIOFUELS

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THE EVOLUTION OF ENVIRONMENTAL GOVERNANCE MECHANISMS: AN INSTITUTIONAL FRAMEWORK APPLIED TO BIOFUELs

Abstract: This article proposes an analytical tool to assess the evolution of environmental governance mechanisms. The institutional path of certification systems is driven by three pre-existing variables that interact to determine the evolution of environmental governance: public regulations, industry competition and organisation, and legitimation mechanisms. Competition among certification systems results in the convergence of public and private environmental regulations, which tend to move towards the median demand for sustainability standards. This framework is later applied to the still incipient sector of biofuels, seeking to predict the certification schemes that have better chances to prevail. As an important normative implication, the efficacy of environmental governance depends on compliance costs for producers and, consequently, hinges on prevailing public regulations. These regulations must be designed not only by accounting for their direct effects but also by considering their indirect effects on the development of private certification systems.

Keywords*:* environmental governance; certification; biofuels; regulation.

A EVOLUÇÃO DE MECANISMOS DE GOVERNANÇA AMBIENTAL: UMA FERRAMENTA ANALÍTICA INSTITUCIONAL APLICADO AO SETOR DE BIOCOMBUSTÍVEIS

***Resumo*:** Esse artigo apresente uma ferramenta analítica para avaliar a evolução de mecanismos de governança ambiental. A trajetória institucional dos mecanismos de certificação é influenciada por três variáveis pré-existentes: regulação pública, organização e competição setorial e mecanismos de legitimação. A competição entre sistemas de certificação resulta na convergência entre critérios públicos e privados, levando a um nível intermediário de exigência desses mecanismos. Essa estrutura analítica foi aplicada

na análise da governança do setor de biocombustíveis, buscando prever quais sistemas de certificação teriam mais chance de prevalecer. Como importante implicação de política, esta pesquisa revela que a eficiência dos mecanismos de governança depende dos custos que serão incorridos por produtores de forma a atingir os critérios exigidos pelas certificações, afetada pelo nível de regulação público pré-estabelecido. As regulações públicas devem ser desenhadas considerando tanto seus efeitos diretos sobre produtores, como também os efeitos sobre os critérios estabelecidos nas certificações privadas.

***Palavras Chave*:** governança ambiental; certificação; biocombustíveis; regulação.

EL DESARROLLO DE LOS MECANISMOS DE GOBERNANZA AMBIENTAL: UNA ESTRUCTURA ANALÍTICA INSTITUCIONAL APLICADA A LO SECTOR DE BIOCOMBUSTIBLES

***Resumen*:** Este artículo presenta un instrumento analítico para evaluar el desarrollo de los mecanismos de gobernanza ambiental. La trayectoria institucional de los mecanismos de certificación está influenciada por tres variables preexistentes: regulación pública, organización y competencia sectorial y mecanismos de legitimación. La competencia entre sistemas de certificación resulta en una convergencia entre criterios públicos y privados, llevando a un nivel medio de exigencia de esos mecanismos. Esta estructura analítica fue aplicada en el análisis de la gobernanza del sector de biocombustibles, buscando predecir qué sistemas de certificación tendrían más posibilidades de prevalecer. Como una importante implicación de política, esta investigación revela que la eficiencia de los mecanismos de gobernanza depende de los costos que serán incurridos por los productores para alcanzar los criterios exigidos por las certificaciones. Regulaciones públicas deben ser diseñadas considerando tanto sus efectos directos sobre productores, así como los efectos sobre los criterios establecidos en las certificaciones privadas.

***Palabras clave*:** gobernanza ambiental; certificación; biocombustibles; regulación.