CIRCULAR AGRI-FOOD SYSTEMS: A GOVERNANCE PERSPECTIVE FOR THE ANALYSIS OF SUSTAINABLE AGRI-FOOD VALUE CHAINS

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Abstract

Different organizational arrangements have supported the adoption of sustainable-oriented innovations (SOIs) in the agri-food industry. However, despite the promises of SOIs, diffusion has been slow. We claim that the gap between the creation and diffusion of SOIs is due to the neglect of the governance dimension of sustainable agri-food value chains. This study contributes to bridging this gap by providing a theoretical framework that disentangles the governance elements of circular agri-food systems. After discussing the organizational logic of linear systems, we outline five propositions that shed light on different governance aspects related to the establishment and stability of circular agri-food systems: (i) complementarities, (ii) interdependencies, (iii) the role of a leading organization, (iv) the role of a bridging organization, and (v) the influence of technology. We argue that circularization should only occur if the potential benefits of the adoption of SOIs are higher than the overall production costs and the costs of designing an organizational architecture compared with other feasible agri-food systems configurations, whether linear or circular. Governance costs might explain why the diffusion of SOIs is often slower than predicted by scholars, entrepreneurs, and policymakers.

Keywords: agri-food systems, agribusiness, circular economy, governance mechanisms, transaction cost.

1. INTRODUCTION

This study examines the organizational factors that constrain and enable the design of circular agri-food systems. As the deadline for achieving the Sustainable Development Goals approaches, the analysis of the drivers of and constraints to the establishment of circular business models has attracted growing interest from scholars, entrepreneurs, and policymakers. Within this broad context, different contributions have highlighted that the development and adoption of sustainable-oriented innovations (SOIs) at the *firm level* differ from transformative changes at the *systemic level* (see del Río et al., 2010; Adams et al., 2016). The available evidence shows that the "circularization" of firms ensues from exogenous factors such as regulation (Fischer and Pascucci, 2017; Cainelli et al., 2020) and the characteristics of markets and consumers (Hazen et al., 2017; Nainggolan et al., 2019) as well as endogenous factors such as innovation management capabilities (Ayuso et al., 2011), human resources policies, and contracts with external consultants (Lee, 2009; Petruzzelli et al., 2011). The strengthening of sustainable-oriented networks, value chains, and clusters, on the contrary, demands the emergence of disruptive organizational practices at the systemic level such as collaborative financing schemes and learning routines among a diverse pool of stakeholders (Taylor, 2005; González-Moreno et al., 2019; Testa et al., 2019).

Particularly in agri-food systems, different organizational architectures have enabled farms and firms to adopt SOIs that tackle fundamental sustainable development challenges such as food waste, energy recovery, resource efficiency, carbon emissions, land degradation, and the reuse of materials (Mirabella et al., 2014; Simboli et al., 2015; Fernández-Mena et al., 2016; Pagotto and Halog, 2016; de Jesus et al., 2019; Kendall and Spang, 2019). Innovative governance arrangements potentially underpinning the circularization of agri-food systems include the adoption of reverse logistics and take-back systems, design of contracts that facilitate the deployment of new technologies, development of incentives and collaboration schemes aimed at enhancing circular flows across the supply chain, new service-oriented revenue engines such as pay-per-result and pay-per-use, and new long-term financing mechanisms with longer payback periods (Roos and Agarwal, 2015; Pieroni et al., 2019). Urbinati et al. (2017) arrange these innovative governance arrangements within the circular economy into a taxonomy encompassing (i) *downstream circular* models (i.e., adaptations in value capture and delivery), (ii) *upstream circular* models (i.e., adaptations in value creation), and (iii) *fully circular* models (i.e., the combination of upstream and downstream models). Taken as a whole, this emerging literature highlights the importance of governance considerations for the creation and resilience of circular agri-food systems.

Despite these advances, the "governance dimension" is still considered to be one of the most acute knowledge gaps in the circular economy, hampering its development (Korhonen et al., 2018a; Hobson, 2020). While much prior work on the application of the principles of the circular economy in agri-food systems uses case studies to shed light on the promises related to the adoption of sustainable processes in food, fiber, and energy production, less attention has been paid to the pitfalls that hinder the wider diffusion of these processes. In other words, while existing studies describe the different organizational arrangements that support the adoption of SOIs and green business models at the systemic level, it is less clear (i) how governance costs constrain the effective organization of circular agri-food systems and (ii) how firms, farms, and bridging organizations contribute to mitigating the impact of governance costs in the establishment of more sustainable practices in the agri-food sector. In this study, we follow Williamson (1991b) by characterizing governance costs as the costs of negotiating, supervising, and enforcing contractual relations (see also Klein et al., 1978).

The purpose of this study is to outline the governance foundations and mechanisms of *circular agri-food systems*, namely, sustainable value chains that integrate the principles of the circular economy into agri-food analysis. We apply the key principles in the literature on economic organization to develop five propositions that allow us to compare and evaluate the governance properties of agri-food systems. Our theoretical deductive effort stands on an extensive narrative literature review that covers (i) articles that discuss the organizational features of agri-food systems and (ii) contributions that scrutinize the governance properties of circular systems. Our starting point is the characterization of the governance foundations of a linear agri-food system according to the perspective of Williamson (1985). We then extend this characterization by adding boundary conditions, efficiency conditions, and shifting conditions that explain the circularization of linear agri-food systems. After each proposition, we present brief examples that illustrate and suggest potential uses of our theoretical ideas, setting the stage for further empirical research.

This study is important because it bridges the theoretical literature on economic organization and the growing literature describing circular governance arrangements, helping close knowledge gaps that hinder a comparative organizational assessment of agri-food systems. As we argue in more detail, the circularization of an agri-food system is contingent on the establishment of a set of return or lateral transactions that connect the diverse stages of the system in novel ways, unlocking new value creation, value proposition, and value capture opportunities (see also Aminoff et al., 2017; Planing, 2018). We explore the logic of the organization of these transactions as well as the role of technology in promoting the circularity of agri-food systems, building on the basic argument that the design and assessment of a circular agri-food system must consider both production costs and governance costs. More specifically, circularization should only occur if the potential benefits of the adoption of an SOI are higher than the overall production costs and costs of designing an organizational architecture compared with other feasible agri-food systems, which may be linear systems.

2. BACKGROUND

Before we discuss the conditions for the emergence of a circular agri-food system, we outline the governance foundations of a linear agri-food system. The idea that the analysis of the governance of transactions in the agri-food sector should adopt a systemic perspective precedes the concerns about the environmental sustainability of food, fiber, and energy production. Since the end of the Second World War, several researchers have drawn inspiration from the successive waves of transformation in the agri-food sector to analyze the nature of the interconnections among the multiple activities from farm to fork (see Reardon and Timmer, 2012). An early example is found in the book *A Concept of Agribusiness* published by Davis and Goldberg in 1957, which expands the scope of analysis to the sum of all operations in an agri-food system including production, storage, processing, distribution, and retailing. Other contributions with a systemic perspective include the works of authors such as Michael Morris, Raphael Kaplinsky, and John Humphrey on global value chains, the French *filière* approach (see Raikes et al., 2000 for a review), and the governance perspective (Zylbersztajn, 1996; Masten, 2000; Ménard and Klein, 2004). In this section, we discuss the theoretical foundations of the governance perspective for linear agri-food system analysis.

Starting from the work of Williamson, the governance perspective examines the logic behind the adoption of governance mechanisms to support the relationships among the multiple stages within an agri-food system. The domain of the governance perspective reflects the scope of Williamson's (1991a) "discriminating alignment hypothesis," which sheds light on the diverse organizational arrangements that can be established to govern a transaction between technologically separable stages of production. An example helps illustrate the arguments presented in the following paragraphs. Suppose that a family farmer sells agricultural goods to a food processing firm. Each side in this relationship owns a given bundle of resources (e.g., land, machinery, and the food processing facility) and specializes in one activity. The governance perspective helps us explain the drivers of the choice of a governance mechanism to support the transaction between the family farmer and food processing firm. According to the discriminating alignment hypothesis, transactions with similar attributes should be governed by arrangements with the same characteristics. Convergence toward the adoption of similar organizational solutions for transactions with the same attributes ensues from a search for efficiency, or the minimization of governance costs, meaning the costs of negotiating, supervising, and enforcing contracts (Klein et al., 1978; Williamson, 1991b).

To operationalize the discriminating alignment hypothesis, three transactional attributes are potential independent variables: asset specificity, frequency, and uncertainty. In turn, three dimensions are used to describe the characteristics of the adopted governance mechanism: (i) the nature of the incentives that shape the behavior of the exchange partners, (ii) nature of the authority for dispute settlement, and (iii) contract law regime that supports the transaction (Tadelis and Williamson, 2012). The interplay between these dimensions gives rise to three generic types of governance mechanisms: market governance, which is supported by standardized contracts, hybrid forms, which rely on more complex contractual arrangements and often have specific dispute settlement systems (Ménard, 2004), and hierarchies (Williamson, 1991a). In this sense, Williamson's framework is embedded in the idea that firms are hierarchies. Figure 1 summarizes the main elements behind the discriminating alignment hypothesis.

< INSERT FIGURE 1 >

The governance perspective extends the basic logic of the discriminating alignment hypothesis to analyze the configuration of agri-food systems (see Figure 2). Let us return to our example, which is represented by transaction T_2 in Figure 2. Investments in specific assets may be a necessary condition for the provision of a good or service to a business partner. Suppose that the food processing firm decides to pay a higher price for fresh agricultural goods that are not produced in the surrounding area. In response to these price incentives, the family farmer decides to buy land close to the firm and negotiates a supply contract with the company. Suppose also that the food processing plant is the only viable buyer in transaction T_2. For example, other potential buyers may be too far away from the land bought by the family farm and thus transportation costs would be prohibitive. In this scenario, the managers of the food processing plant may realize that if they renege on the previous agreement, the family farmer will have no alternative but to throw the harvest away. Perhaps this conclusion will motivate managers to renegotiate the contract ex post, offering a substantially lower price than the price originally agreed. In doing so, the managers will act opportunistically (Williamson, 1991a). From the point of view of the family farmer, the threat of the ex-post appropriation of some—or even all—of the quasi-rents from this investment in a specific asset may be sufficiently high to convince that buying the land is not worth the risk (Klein et al., 1978).

< INSERT FIGURE 2 >

This does not mean that investments in specific assets are never made. According to Williamson (1991a), the solution is the adoption of a governance mechanism that protects both sides from opportunistic behavior. As the discriminating alignment hypothesis highlights, this protection derives from characteristics such as the contract law regime and dispute settlement system used to solve controversies. In the example discussed above, vertical integration (i.e., the food processing firm internalizing the production of fresh food and using a hierarchy to govern it) might be the only available alternative. After all, the processing plant would retain a considerable amount of bargaining power given the lack of other buyers for the farmer's output. However, vertical integration should not be the most obvious answer to coordination challenges. Economic agents choose the governance mechanism that minimizes governance costs. Hence, a relatively costly solution such as vertical integration is seen as a last resort adopted only when other alternatives are not as effective at incentivizing the materialization of investments in specific assets.

From a governance perspective, agri-food systems can be analyzed at multiple levels. The first level refers to the fundamental research question from Oliver Williamson's work: *what are the boundaries of the firms within an agri-food system?* Researchers dealing with this level of analysis investigate the drivers of vertical integration. Empirical conclusions should help scholars understand why an agri-business firm was established and identify the transactions organized within its legal boundaries (Zylbersztajn, 1996; Allen and Lueck, 2002). A second level of analysis relates to the patterns of coordination at the supply chain level. Since several independent organizations, each with their legal and organizational boundaries, compose an agri-food system, *what governance mechanisms support the exchanges among independent farmers and firms?* Two alternatives are (i) spot-market arrangements, which are typically employed in transactions carried out in perfectly competitive markets, and (ii) hybrid forms, which suggest a higher level of coordination among independent organizations, but not as strict as in the case of a hierarchy (see Ménard, 2004; Ménard and Valceschini, 2005). Whenever the level of coordination is sufficiently high among the independent participants in the agri-food system, the adoption of a broader scope of research is possible. Indeed, a firm within a strictly coordinated agri-food system can play a role similar to that played by the entrepreneur who establishes a firm (Zylbersztajn and Farina, 1999).

The governance perspective has inspired theoretical and empirical developments in a broad range of fields in agri-food management research. Topics of interest include the organization of cooperatives (e.g., Cook, 1995; Ménard, 2007), the role of contracts in the distribution of surplus in business relationships within agri-food systems (e.g., Grandori, 2015; di Marcantonio et al., 2020), innovation in linear agri-food systems (e.g., Karantininis et al., 2010; Materia et al., 2017), and the role of institutions and organizations in rural development (e.g., Cook and Chaddad, 2000; Swinnen and Maertens, 2007). The governance perspective has also helped identify new research puzzles such as the existence of concurrent sourcing strategies (Ménard, 2013), establishment of non-hierarchical firms in agri-food systems (Grandori, 2017), and organizational diversity within sets of similar transactions or arrangements (Miranda and Chaddad, 2014; Miranda and Grandori, 2019). For our purposes, however, it suffices to start with the basic characterization of a linear agri-food system, as summarized in Figure 2. We now build on these ideas to characterize a circular agri-food system.

3. CIRCULAR AGRI-FOOD SYSTEMS

A linear system becomes a circular system when its members start to consider the relationship between the use and disposal of resources (Andersen, 2007; Ghisellini et al., 2016; Lieder and Rashid, 2016; Kircherr et al., 2017). A circular system requires diverting end-of-life products from discarded waste and replacing primary input resources with secondary materials that result from the reprocessing of end-of-life products in forward supply chains (Geyer and Jackson, 2004; Genovese et al., 2017a). The establishment of a circular system is closely related to the idea of "circular economy". As Geissdoerfer et al. (2017) contend, the circular economy is a regenerative system in which the use and waste of resources, emission of gases, and leakage of energy are minimized through the deceleration, closing, and narrowing of material and energy loops (see also Geissdoerfer et al., 2018). Murray et al. (2007) add a human dimension to the definition of circular economy, emphasizing that transformations in production systems must consider both the resilience of ecosystems and human well-being.

The idea of circular economy contrasts with the assumptions behind mainstream agri-food system analysis. Focusing on the description of the organization of linear agri-food supply chains, previous applications of the governance perspective have implicitly used a "take-make-use-dispose" structure (Stahel, 2016). Scholars assume that the organizations within the system have an unconstrained ability to use and transform natural resources. Consequently, the emphasis on a linear perspective has hindered the identification of opportunities for value creation and appropriation that ensue from the circularization of processes. Indeed, the value associated with a product or service in a linear business model is lost after consumption (Rosa et al., 2019; Centobelli et al., 2020). The use of a perspective based on the principles of the circular economy, on the contrary, may inspire organizations to design an organizational architecture that preserves the environmental and social value in addition to the economic value incorporated into the product or service in the system over its lifecycle.

Integrating the principles of the circular economy into agri-food system analysis implies the consideration of *return transactions* (Linder and Williander, 2017), which create novel connections among the stages of the system. Figure 3 illustrates a simplified representation of the complex organizational relationships in a circular agri-food system. First, each original transaction in a linear agri-food system (T_1, T_2, T_3, T_4) has a potential mirrored transaction (T_1', T_2', T_3', T_4') that moves in the opposite direction, thus creating loops. Second, the economic activities in each stage of a linear agri-food system lead to the accumulation of secondary products or materials that may be used in another linear system, connected through a lateral transaction (T_1'', T_2'', T_3'').

Not all the transactions in Figure 3 must exist for the system to be circular. Likewise, the same logic can be used either to describe existing transactions or to identify unexplored loops. Only the detailed description of an agri-food system can provide information on the set of actual and potential mirrored or lateral transactions. Empirical analysis may also shed light on thresholds that preclude the incorporation of transactions to the system or help explain the drivers of diminishing returns in the establishment of new mirrored or lateral transactions. As a rule, reuse and recycling can become difficult or expensive at some point because of missed business opportunities and physical laws (Andersen, 2007).

< INSERT FIGURE 3 >

At first sight, the existence of loop transactions does not invalidate Williamson's (1991) discriminating alignment hypothesis. Any of the dyadic relationships in Figure 3 can be examined so that the characteristics of the transaction (i.e., level of asset specificity, frequency, and uncertainty) are associated with the adoption of a specific governance mechanism. There is no reason to assume, a priori, that a governance mechanism that sustains sequential interdependence in the supply chain (e.g., by enabling individuals to carry out transaction T_2) will also support a mirrored transaction such as T_2' or even consider the existence of that transaction (see Linder and Williander, 2017). Perhaps more importantly, an organization may not adopt a circular production process precisely because the combined governance costs of carrying out transactions T_2 and T_2' (or T_2 and T_2'') are high. Analysts who ignore the effects of governance costs on the design of an agri-food system cannot explain why certain agri-food supply chains remain linear despite the existence of SOIs that would allow the circularization of the system. In other words, economizing considerations (Williamson, 1991b) matter for the design of circular agri-food systems. For that reason, we now discuss the boundary conditions and incentive conditions that help explain why a lag between technological promises and implementation pitfalls may exist.

3.1. Boundary conditions

Empirical evidence highlights that the potential complementarities between a transaction and a set of return or lateral transactions matter for the performance of a circular system (Lüdeke-Freund et al., 2018; Corona et al., 2019). Two transactions are complementary if the value created by carrying out them at the same time is higher than the value created by carrying out each transaction in different periods (see Milgrom and Roberts, 1990). Yet, value creation does not necessarily imply value appropriation. Designing organizational arrangements that protect the value created in the transaction is a necessary condition for value appropriation (Klein et al., 1978). In this sense, the design of a circular system poses a series of technological trade-offs directly influenced by governance considerations.

Consider once again transaction T_2. Suppose that the transaction can be associated with two productive processes. The first, P_1, is based on linear reasoning and, as such, precludes the materialization of T_2'. The second, P_2, unlocks new value creation opportunities through the application of the principles of the circular economy (i.e., by creating the possibility of carrying out both T_2 and its "mirrored" transaction T_2'). However, the nature of transaction T_2 may change depending on the choice of the productive process, meaning that its characteristics are different in a linear context $P_1 = (T_2, 0)$ and a circular context $P_2 = (T_2, T_2')$. Which of the two productive processes will an organization adopt? The answer depends on a comparison of the overall governance costs associated with each option. The profits derived from the adoption of P_2 may be lower than the profits from the adoption of P_1 if both production and governance costs are considered. For example, the materialization of T_2 and T_2' might demand investments in specific assets that require the design of complex governance mechanisms, offsetting the potential gains from the circularization of the system. We thus argue:

Proposition 1: In a circular agri-food system, organizational decisions ensue from an integrated analysis of the governance costs and benefits of a set of complementary transactions. The "circularization" of the system depends on the establishment of a governance structure that prevents the dissipation or capture of value from specific investments.

Take the example of the recycled water program established by the government of the Californian city of Santa Rosa in the United States in the 1970s and since expanded (USDA, 2008). The creation of the program demanded public investment in specific assets such as the construction of a water reuse facility, an extensive pipeline distribution system, and several storage reservoirs, which irrigate around 6,000 acres of land. Moreover, early users of the system received a payment incentive from the city. In this sense, the materialization of the program depended on political decisions that, in practice, led the city of Santa Rosa to bear most of the governance costs of the initiative. These costs included not only specific investments, but also the design and monitoring of contracts and compliance with Californian and federal environmental rules. Around 75% of the land covered by the project is owned by farmers who have water supply contracts with the city. The remaining 25% is city-owned land rented to small farmers, an arrangement that facilitates planning according to the supply of recycled water (USDA, 2008).

An interesting aspect of the example of Santa Rosa is the coexistence of diverse arrangements within the same project. In 1997, the city of Santa Rosa reached an agreement with E & J Gallo Winery, one of the leading wine producers in the United States, for the use of recycled water in a 300-acre premium wine grape vineyard. Although the agreement is celebrated as an example of fruitful public–private cooperation for the adoption of circular economy processes (USDA, 2008), an analysis from the governance perspective may reveal the low replicability of the arrangement. Besides the value creation prospects associated with harvesting quality wine grapes, three factors contributed to the success of the agreement (see City of Santa Rosa, 1998). First, the E & J Gallo Winery decided to pay the full costs of the construction of the reservoir before the agreement with the city of Santa Rosa. In case reuse water was not available, the company would fill the reservoir with potable water and therefore the asset specificity issues associated with its construction were not dramatic. Second, low investment in pipelines was needed to connect the reservoir of the winery to the city's reuse water system. Finally, reuse water demand from E & J Gallo was limited. Consequently, government officials did not have to worry about the effects of an agreement with a large organization on the distribution of reuse water to other members of the projects, an issue that could have jeopardized the trusting relationships built with many small farmers in the region. In summary, the comparative governance costs for the establishment and monitoring of the agreement were relatively low because the feasibility of the arrangement was contingent on the complementary investments made by the winery, which were not highly specific.

Transition into the circular economy also implies the acknowledgment that different types of interdependencies matter for the establishment and stability of a circular agri-food system. The governance perspective focuses on explaining how organizational choices influence the process of value creation and value protection in cases of sequential interdependence (Zylbersztajn, 1996; Masten, 2000). As Thompson (1967) points out, however, different types of interdependencies exist: pooled, sequential, and reciprocal (see also Van der Ven et al., 1976). Moreover, diverse types of interdependencies may be found in the same supply chain or network (Lazzarini et al., 1997). This means that the governance of a set of complementary transactions is affected by the nature of the interdependencies among the organizations in the circular agri-food system. Grandori and Furnari (2008) note that multiple configurations of organizational elements may be employed to support innovation and protect the value derived from cooperation. In this sense, the governance costs associated with organizing a set of interdependent transactions depend directly on the configuration of the governance mechanisms chosen by the members of the system. This reasoning leads to our second proposition:

Proposition 2: The comparative governance costs in a circular agri-food system derive, ceteris paribus, from the nature of the interdependence among the members of the system. In a typical circular agri-food system, different types of interdependencies coexist in the system.

Again, an example may help illustrate our arguments. Suppose that a stage in an agri-food system is characterized by a pattern of collaboration embedded in reciprocal interdependencies, so that participants jointly develop new capabilities or a new product (Dyer and Nobeoka, 2000). For example, a group of small coffee producers may decide to engage in a collective effort to adopt organic farming and Fairtrade principles within the organizational boundaries of a cooperative (see Taylor, 2005; Raynolds, 2012). As Gulati and Singh (1998) point out, reciprocal interdependence tends to be supported by mutual adjustment among the parties. In other words, reputation and the emergence of relational contracts contribute to the reduction of governance costs, which lowers the likelihood of opportunistic behavior. At the same time, suppose that these small producers are linked to the subsequent stages of the food system through a pattern of sequential interdependence. For example, a coffee roaster firm may decide to negotiate a contract with the group of small farmers to acquire all the organic coffee harvested. An immediate consequence of such an agreement is that the maintenance of the cooperation among the small producers over time will be more likely, ceteris paribus, if the coffee roaster adopts a strategy that reinforces the need for cooperation in the production stage. Therefore, the existence of one type of interdependence ends up reinforcing the other, which influences the governance costs and possibility of circularity in the agri-food system.

3.2. Incentive conditions

The discussion so far has focused on factors that may hinder the establishment of circular agri-food systems. Both the existence of complementarities between transactions and the consolidation of complex patterns of interdependencies among organizations suggest that the governance costs in circular agri-food systems are higher than those in linear systems. Truth be told, circular systems are also characterized by novel value creation opportunities that may compensate for these additional governance costs. Besides this discussion, however, one should not lose sight of the fact that incentive (i.e., distributive) issues matter as much as efficiency issues when analyzing the feasibility of a complex governance structure. More specifically, two questions may help researchers identify the potential constraints to the emergence of sustainable practices in an agri-food system: *who pays the costs of the establishment and stability of a circular system and who benefits from the existence of such a system?* Misalignments between these two dimensions often explain why linear systems predominate despite the existence of available technologies that could circularize the system.

This subject is far from trivial, as it involves a long-standing discussion. As stated by Andersen (2007), the rational profit-maximizing managers of a firm must have already assessed the costs and benefits of circular strategies such as recycling and reuse. Hence, adoption will be carried out only if it is desirable from a private point of view, which will be at a level lower than that from the social point of view. This could help explain why circular agri-food systems are less prevalent than scholars enumerating the potential benefits of circularization suggest. However, we can advance two counterarguments. First, Coase (1960) shows that a private solution can lead to an optimal social level of waste reduction if property rights are well defined and the parties involved can negotiate freely with each other. The second point concerns the assumption that firms are run by fully rational managers. The governance perspective is based on a different assumption, namely, that people have bounded rationality. The presence of bounded rationality implies that individuals and firms cannot draw complete contracts (i.e., contracts that anticipate all future contingencies) (Williamson, 1991a). Opportunism is thus possible, demanding the establishment of costly governance structures that protect the investments made to sustain an economic relationship. This is where the emphasis of the governance perspective on reducing governance costs and the search for feasible, and not necessarily perfect, solutions is born (Coase, 1960). In the design of organizational solutions, aligning incentives among individuals and firms with potentially divergent interests is the fundamental goal (see Holmström, 2016).

The costs of aligning incentives in a circular agri-food system can be reduced in at least two ways. The first possibility is the emergence of a *leading organization*, which plays the role of organizing a subset of the circular agri-food system. Zylbersztajn and Farina (1999) describe the existence of strictly coordinated agri-food systems in which a leading organization coordinates the flows of resources. The authority of the leading organization derives from a central position in the nexus of contracts that ties together the parties. Authority in an agri-food system does not necessarily ensue from the establishment of hierarchical relationships. For instance, such authority is often characterized by the delegation of decision rights to a third party, which coordinates the flow of resources and provides dispute settlement tools that mitigate the probability of opportunistic behavior along the system (Ménard, 1996; Arruñada, 2002). The given organization accepts the full governance costs of organizing a circular agri-food supply chain if its share of the benefits is sufficiently high, or, in the case of a collective organization, if the costs imposed on its members are not prohibitively high. We thus advance:

Proposition 3: The search for the minimization of governance costs in a circular agri-food system fosters the emergence of a leading organization that coordinates the system. This leading organization accepts a disproportionate share of the governance costs of the system if the benefits from value creation and appropriation are sufficiently high.

Take the example of the Brazilian Association of Organic Livestock (ABPO). ABPO members are cattle breeders in the Pantanal, a region characterized by a fragile and biodiverse ecosystem and poor infrastructure. In the early 2000s, ABPO coordinated the supply of organic beef to an international slaughterhouse, playing the role of the leading organization. Although individual contracts were signed between ABPO members and the slaughterhouse, it was up to ABPO to collectively negotiate the terms of the contract. The contractual terms included the duration of the contract, price to be paid, and criteria for classifying the slaughtered animal. The contract also determined mutual exclusivity and the obligation to supply a fixed number of animals per month in addition to meeting all the rules established by the slaughterhouse industry for raising organic cattle. In 2013, however, the contract was not renewed, and cattle breeders were faced with the possibility of having to sell their animals on the spot market, losing the investment made to adopt sustainable practices. Once again, ABPO played a leadership role and managed to establish a new agreement with another company, ensuring that the value of investments was not lost (Caleman et al., 2017).

The second possibility of aligning incentives in a circular agri-food system is the emergence of a *bridging organization* that connects the members of different networks (Brown, 1991; McDermott et al., 2009). Several studies highlight the relevance of networks for the generation and exchange of knowledge, which is a necessary condition for the emergence of sustainable practices (Kowalski and Jenkins, 2015). As the recurrent publication of case studies suggests, however, the adoption of sustainable practices is far from generalized. Reflecting the fact that networks are heterogeneous (see Granovetter, 1973; Burt, 1992; Uzzi, 1996), we expect farms and firms to have different levels of access to knowledge resources and possibilities to identify business opportunities. Likewise, the absorptive capabilities of the organizations in the system may vary considerably (Cohen and Levinthal, 1990), affecting the ability to learn from others and ultimately marginalizing firms from more dynamic knowledge flows (Giuliani, 2007). In this sense, bridging organizations may contribute to reducing governance costs in circular agri-food systems in two ways. At the system level, they can build trust and provide dispute settlement procedures that reduce uncertainty (Hahn et al., 2006; Stewart and Tyler, 2017). At the firm level, they can support lagging organizations, enabling the acquisition of knowledge and adoption of sustainable practices.

Proposition 4: The existence or absence of bridging organizations helps determine the governance costs in a circular agri-food system. Ceteris paribus, the establishment of a bridging organization reduces the governance costs of a set of complementary transactions, incentivizing the circularization of an agri-food system.

3.3. Shift parameter

Technology is an inseparable element of a circular agri-food system. Technological innovation in the circular economy entails the use and application of new digital technology paradigms both to manage increasingly large amounts of data and to continuously improve the processes involved in the upgrade, repair, reuse, refurbishment, remanufacturing, repurposing, recycling, and recovering of products and materials (Jabbour et al., 2017; Blomsma et al., 2019). Digital technologies, particularly with the emergence of Industry 4.0, are also one of the strongest drivers of circular economy innovation in most sectors (Pagoropoulos et al., 2017). Furthermore, the adoption of emerging digital technologies such as the Internet of things, big data analytics, cyber-physical systems, and simulation paradigms allows companies to implement innovative ways of monitoring the exploitation of natural resources and biological cycles, alongside the integration and monitoring of agri-food product lifecycle stages in circular systems (Gupta et al., 2019; Rosa et al., 2019). These technologies can be applied to create enhanced social and environmental value in processes and methods regarding, for example, seed quality, harvesting and post-harvest production methods, processing techniques, food safety standards, and traceability (Sharma et al., 2019).

Then, what is the role of technology in a governance approach for the analysis of circular agri-food systems? To understand this question, it is fundamental to realize that when choosing a governance mechanism to support a transaction, farmers and managers also make a technological choice in connection with the level of the investment. That is, technology, asset specificity, and the level of contractual safeguards (i.e., the governance mechanism) are defined at the same time (Williamson, 1975). However, technology in a broad sense is considered to be "constant" when choosing the governance mode. For instance, technology is absent from Figure 1, which describes the relationship between the technologically separable stages of production (Williamson, 1991a). Hence, technology takes on the function of a shift parameter. Changes in technology and the subsequent diffusion of knowledge in the market affect the comparative production and governance costs of different types of transactions (see Langlois, 1992), inducing the materialization of new relationships in an agri-food system, whether linear or circular.

Specifically, technology becomes a relevant component in circular agri-food systems because it is through technological change that new transactions can be envisioned, generating or enhancing the potential for circularity. The governance perspective sheds light on the organizational architecture that should connect these technologically separable stages of the system, calling attention to the implications of the arrangements designed to support a set of transactions. Take, for example, a food production process whose input materials ultimately become by-products, which are nutritionally rich and therefore potentially applicable to reintegration into other value chains. With the proper use of technology, processing facilities could develop, for example, a specific by-product flour to be used as a functional ingredient in other types of food products. Nevertheless, all the technological potential that enables the reintroduction of by-products into other value chains is not sufficient to guarantee the adoption of the innovation. Let us imagine that the processing segment holds a considerable amount of bargaining power, controlling the design of contracts and ex-post distribution of the value derived from cooperative relationships. Under these circumstances, farmers and other suppliers may not be incentivized to build higher technological capabilities, as the benefits may be captured in other stages of the agri-food system (e.g., Rossi et al., 2020). The actual adoption of the technology may depend on the emergence of leading firms that accept the costs of exploring this economic opportunity. Accordingly,

Proposition 5: Technology may unlock unexplored opportunities or enable new opportunities for value creation toward circularity. The materialization of these opportunities, however, may *require additional transactions with technology suppliers and new transactions with other stages of the agri-food system or with other systems. These transactions only occur if the governance structure allows for a minimum degree of alignment and incentive among those involved.*

We now present two examples that illustrate the idea that the existence of an SOI does not imply its widespread use precisely because the establishment of an organizational architecture is a necessary condition for the circularization of an agri-food system. First, anaerobic digestion (AD) is a technology-enabled innovation in circular agri-food systems that acts as a shift parameter (Loizia et al., 2019). AD technology breaks down biodegradable material, usually coming from waste, into fuels in the absence of oxygen (Slorach et al., 2019). This process can be applied to food waste and generate electricity, heat, fuel, and soil enrichment products. The technology has been steadily growing as a response to tackle food waste across the value chain. It also influences the development of circular economy policies and, more importantly, the emergence of new public–private organizational arrangements in the food sector (de Sadeleer et al., 2020; Slorach et al., 2020). However, the emergence of AD has not guaranteed the adoption and diffusion of the technology per se. Public organizations have played the crucial role of bridging heterogeneous stakeholders by designing innovative policies, legislation, and incentive programs to incentivize the use of AD technology in specific areas, cities, and regions within a country (e.g., eco-parks, industrial symbioses, and industrial ecology arrangements). Again, the potential benefits of AD have materialized in places in which an organization has actively helped reduce the governance costs of circularization or, in many cases, raised the opportunity costs of the non-adoption of this SOI.

Innovative packaging solutions provide another example, as their adoption has also been widely influenced by both technological developments and organizational arrangements. In particular, transformative technologies (TT) have been regarded as enablers of packing solutions to chilled food sectors via (i) digital technologies, altering how the interactions between physical and digital assets take place, (ii) engineering technologies, based on advanced materials and recycling technologies, and (iii) hybrid technologies, allowing for the trace and return of food products and digital printing (Lacy and Rutqvist, 2016). These three types of TT might significantly change not only the amount of packaging used but also the relationships among recyclers, packaging manufacturers, consumers, retailers, food processors, and raw material suppliers. After all, TT demand the development of new contracts, different product development strategies, and the integration of new suppliers and customer segments (Clark et al., 2019). The adoption of TT must be embedded in data sharing mechanisms, aligned incentives, and, ultimately, joint product development processes across the value chain. Within such a context, once again, the governance costs emerging from integrated practices and interdependencies must be adequately factored, as they can offset all the net benefits of the implementation of innovative packaging enabled by TT in the agri-food sector.

4. IMPLICATIONS AND NEXT STEPS

In a discussion in 1964, the British economist Ronald Coase argued that analysts should always use real-world examples to compare the costs and benefits of two or more policy options (Williams and Coase, 1964). Indeed, using examples that only exist in textbooks as a benchmark for decision making can be of little help if the goal is to understand the consequences of our choices in complex social systems. Coase specifically refers to the insistence with which social scientists use characterizations of the world that include the unrealistic assumption of "zero governance costs." Yet, it seems that many researchers and policymakers have implicitly assumed the existence of a world in which governance costs play no role to evaluate the design and implementation of policies aligned with the principle of the circular economy. The result may be a sense of disappointment. As several analysts have pointed out, the potential displayed by the various levels of technological innovation for the circular economy in agri-food remains unrealized, reflecting multiple constraints in the adoption of circular economy practices and technologies (Sehnem, 2019; Ghisetti and Montresor, 2020).

This theoretical study calls attention to a fundamental constraint, namely, the fact that circular agri-food systems are often characterized by considerably high governance costs compared with other feasible configurations. In other words, the prevalence of linear agri-food systems as opposed to the wider adoption of downstream, upstream, or fully circular models is highly influenced by a systematic lack of understanding of the effects of governance costs on the incentives to adopt circular technologies (see Korhonen et al., 2018a; Hobson, 2020). Even when SOIs are readily available, economizing considerations play a crucial role. The search for SOI-related pathways to achieving circular agri-food systems contrasts with the necessary adoption of an organizational architecture that protects specific investments and supports the exploitation of new business opportunities. Since the technological uncertainty stemming from circular innovation creates higher risks that incentivize the development of more complex and costly organizational arrangements (Poppo and Zenger, 2002; Jurgilevich et al., 2016), the case for SOIs in agri-food systems must clearly show the benefits that offset the governance costs from the exchange of resources and establishment of circular flows in the supply network.

4.1. Theory

The circular economy has mostly been examined in engineering and technical terms, which favors sectors built around highly technical artifacts (Korhonen et al., 2018b), such as electric and electronic equipment, machinery, automobile, information technology, and packaged goods. Even so, the literature is disproportionately geared toward the descriptive, celebratory documentation of circular systems, with fewer systematic discussions on governance implications (Hobson, 2020). That is, although we have considerably improved our understanding of the promises of the circular economy, these advances have left several theoretical and empirical blind spots. This study contributes to the discussion on agri-food systems and theory of the circular economy by proposing a framework for governance analysis grounded on the organizational challenges of designing circular agri-food supply chains. Formal governance mechanisms have the potential to improve overall sustainability performance, ensure legitimacy, and exert control in the technological transition toward the circular economy (Geels, 2010; Markard et al., 2012; de Gooyert et al., 2016).

This does not mean that the governance perspective provides a "one-size-fits-all" approach that suffices to shed light on the potential constraints to the adoption and diffusion of SOIs. For instance, Williamson's (1991a) discriminating alignment hypothesis is embedded in the implicit assumption that people are equally able to design all governance mechanisms. Since everybody can both "make" and "buy," choosing one or the other option mostly depends on the potential consequences of opportunistic behavior by exchange partners. This assumption is far from realistic, however. After all, both "making" and "buying" demand the ownership of suitable resources and knowledge (Demsetz, 1988; Jacobides and Winter, 2005). Once farms and firms start to be conceived as heterogeneous bundles of capabilities and resources, the logical implication is that "making" or "buying" may be unfeasible (see Miranda and Chaddad, 2014). In this sense, the design of circular agri-food systems must consider the set of feasible organizational arrangements as well their efficiency and distributive consequences. Adding the effects of heterogeneity into our framework is a fundamental next research step.

4.2. Practice and policymaking

Overall, our framework may inspire the development of analytical tools that support farms and firms to better understand governance changes and challenges. Practical applications include the use and adaptation of our framework to scan and systematize the governance elements of agri-food systems. Users of our framework may identify relevant transactions and organizations to be involved in the design of a circular system as well as specify the governance mechanisms that should be used. Moreover, our framework helps managers examine how different circular configurations of agri-food systems may look after technological and organizational changes and compare their organizational features. In this sense, it might guide internal data collection protocols to inform and validate the adoption of SOIs. It could also inspire strategic actions to reduce the governance costs of circularization, such as building a leadership position in the agri-food system and establishing bridging capabilities and organizations.

Our framework contributes to the design and comparison of policies as well. At the core of circular economy-oriented policymaking is the question of how to foster a sustainable transition toward a circular economy. As multiple countries, regions, and industrial sectors struggle to identify the costs and benefits of circular transition, little has been said about how governance issues have hindered this transition. In this sense, our framework highlights pressing issues that policymakers should keep in mind when designing new sustainable policies or analyzing the pitfalls of current practices. For example, by explicitly incorporating the governance perspective into the formulation of circularity-oriented policies in the agri-food sector, policymakers could compare the governance costs and benefits of different organizational arrangements as well as the implications of the existence of bridging or leading organizations in circular agri-food systems. Moreover, policymakers could assess how their actions (e.g., the creation of institutional rules and incentives) might influence the governance costs of different agri-food system configurations.

4.3. Directions for empirical validation

Our study is conceptual and does not aim to test our propositions. Testing the empirical validity of our propositions is thus a natural further step. For *Proposition 1*, an overarching case study setup could properly depict the structure of organizational decisions in specific investment settings to assess whether organizations favor structures that capture and protect value (see Ünal et al., 2019a, 2019b for two examples of empirical operationalization). Small-N case studies could also help scholars identify the coexistence of heterogeneous organizational architectures and their influence on the adoption of SOIs and value creation and distribution patterns (see Poteete et al., 2010). As for *Proposition 2*, comparative governance costs could be adequately assessed using modeling and simulation methods such as system dynamics that highlight the structure of the interdependences (i.e., feedback loops) among the actors in the agri-food system and their behavior over time. The coexistence of different types of interdependencies can be not only mapped out, but also explained, simulated, and projected (e.g., Kumar and Nigmatullin, 2011). The test of *Propositions 3 and 4* could start from supply chain value mapping and modeling approaches to chart the potential leading and coordinating roles of the farms and firms in the system along with the existence of bridging organizations and collaboration mechanisms (e.g., Suárez-Barraza et al., 2016). Finally, *Proposition 5* may inspire comparisons between two static equilibria (i.e., the configuration of agri-food systems before and after the creation of an SOI) as well as studies that scrutinize the dynamic, reciprocal influence of the adoption and diffusion of SOIs on the design of organizational arrangements in the agri-food sector. For example, Ghadim and Pannell (1999) and Pigford et al. (2018) discuss factors that may influence the diffusion of innovations in agriculture.

5. CONCLUSION

We can only deliver all the Sustainable Development Goals if we have a clearer picture of the many constraints that affect the transition toward the adoption and diffusion of SOIs and replicability of successful circular models across industries and societies. Helping close this knowledge gap, we provide a theoretical framework that dissects the governance elements of circular agri-food systems. Building on the basic organizational features of linear agri-food systems, we outline five propositions that shed light on different organizational aspects related to the establishment and stability of circular systems. We claim that (i) successful circular economy initiatives typically have different interdependent relationships among heterogeneous stakeholders that enable the establishment of a set of complementary transactions (*Propositions 1 and 2*); (ii) SOIs for the circular economy are likely to be further incentivized when contract-based negotiations between farms and firms in the agri-food system are disproportionately borne by a leading organization or a bridging organization creates specific routines for the exchange of information and knowledge *(Propositions 3 and 4)*; and (iii) although technology can shift the equilibrium of an agri-food system, unlocking or increasing value creation through circularity, the governance costs of circular systems must be compared with other feasible arrangements, which may be linear *(Proposition 5)*.

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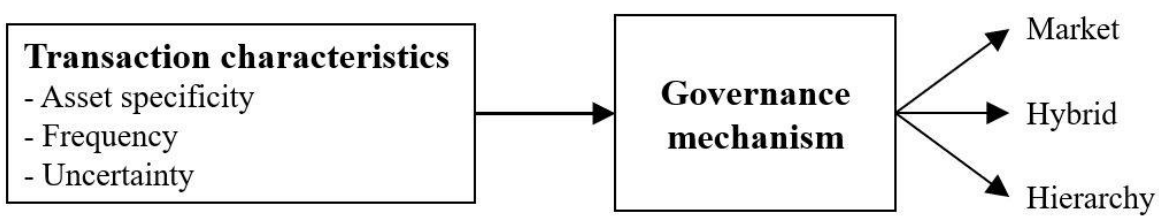

Figure 1: Discriminating alignment hypothesis

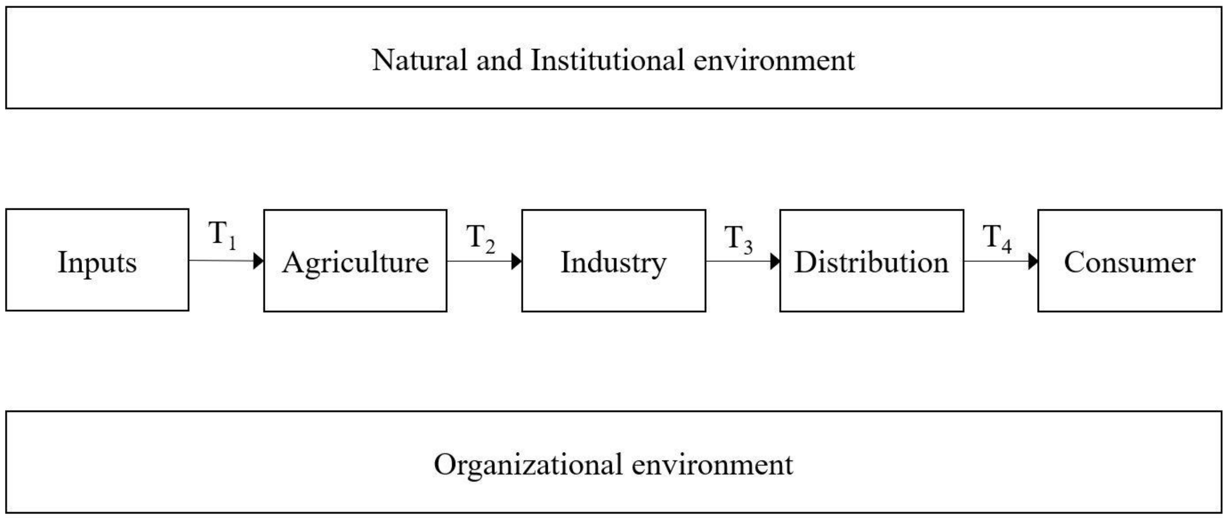

Figure 2: Linear agri-food system

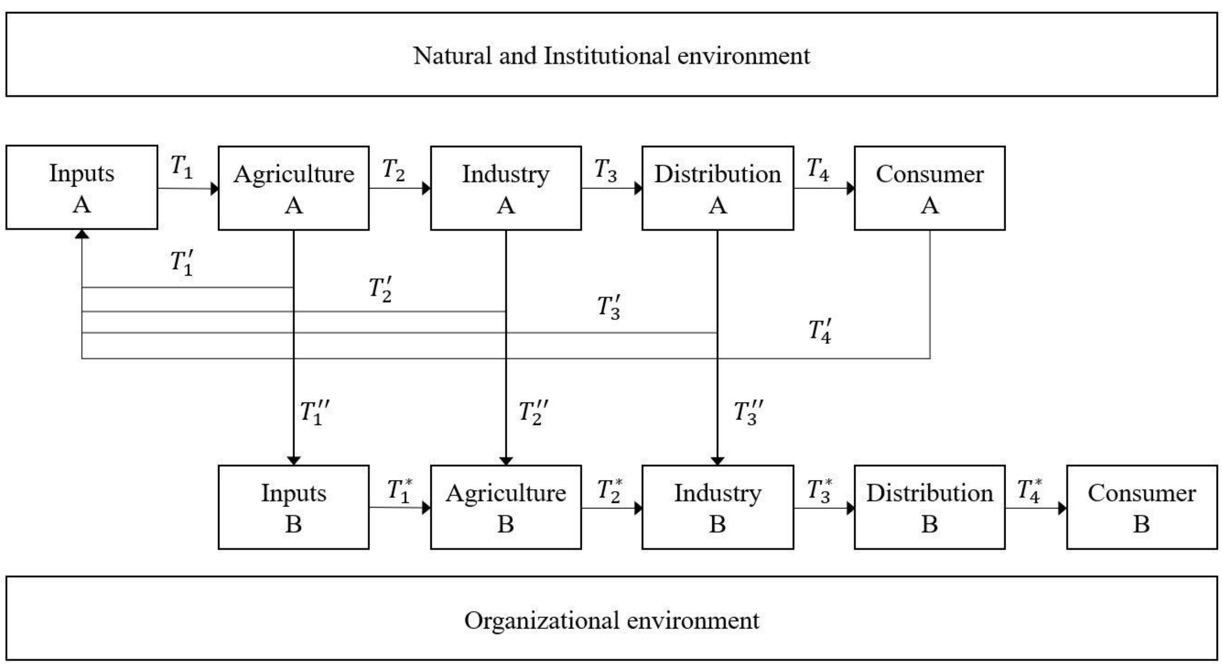

Figure 3: Circular agri-food system