

## Economic Aspects of Segregation between GM and Non-GM Crops in Italy

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This article assesses the food supply chain for non-GM soybean meal, with particular regard to the upstream stages between overseas producers, international trading companies, and their supply to Italian feed producers. Using transaction-cost economics as a methodological framework and the information collected from a set of interviews with industry representatives, we describe the organizational arrangements that agents adopt to minimize transaction costs. Consistently with theory, we examine the impact of uncertainty on the coordination arrangements. We focus on two dimensions of uncertainty—product-quality uncertainty and environmental uncertainty. We argue that the actual organizational arrangements between transactors are consistent with the theory that, whereas product-quality uncertainty and some degree of asset specificity would lead to vertically integrated forms of governance, environmental uncertainty operates in the opposite direction.

**Key words:** GMOs, segregation, non-GM labeling, soybean, transaction costs.

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### Introduction: The Market for Non-GM Products

The worldwide area dedicated to GM crops has been steadily increasing over the last 20 years and, to date, more than 150 million hectares are devoted to these varieties (Tillie, Vigani, Dillen, & Rodríguez Cerezo, 2012). In countries where these technologies are available, the rate of adoption is generally high. According to the US Department of Agriculture (USDA, Foreign Agricultural Service [FAS], 2012a, 2012b), the United States, with 69.5 million hectares of GM crops planted in 2012, is the largest producer in the world. Brazil ranks second, with nearly 36.6 million hectares of GM maize, soybean, and cotton in the 2012/2013 marketing year. The adoption rate of GM soybean reached 85% in 2011/2012 (21 million hectares), whereas the share of GM cotton was about 32% (490,000 hectares) and that of GM maize was 67% (almost 10 million hectares). By July 2012, Brazil had 34 genetically engineered crops approved—19 maize varieties, 9 cotton, and 5 soybeans. Argentina, with 23.6 million hectares in 2011/2012, provides almost 15% of the total world production and is the third largest producer (USDA FAS, 2012c, 2012d).

Although these data provide a clear picture of the adoption of GM crops around the world, assessing the size of non-GM production is more difficult. This value is not simply the difference between the total production and the GM one, as a non-GM crop is defined according to specific labels requiring thresholds for GM admixture and certifications of compliance. Production data of

identity-preserved (IP) non-GM crops are even more difficult to derive; non-GM IP crops require stricter controls along the supply chain, third party certification, and a stronger commitment of all the parties involved. Therefore, most estimates rely on trade data, although they mostly provide upper limits rather than ranges (Tillie et al., 2012).

The demand for non-GM crops has three main destination markets (EU, South Korea, and Japan) and remained stable over the last ten years. According to the European feed industry association (FEFAC), almost 15% of the EU compound feed production is certified as non-GM. Poultry is the sector with the strongest demand for non-GM feed, as a significant part of poultry meat is sold under some sort of quality labels (i.e., organic) requiring non-GM feeding. Moreover, soybean meal—for its characteristics—is hardly replaceable in poultry, piglet, and calf feeding, while cattle and mature animals can find more substitutes (Bertheau & Davison, 2011).

The EU is almost self-sufficient for maize; only 10% of the internal consumption relies on imports (nearly 6.2 million of metric tons [MMt]), 75% of which are non-GM and originate mainly from Ukraine and Brazil (USDA FAS, 2012b). Instead, the EU is a net importer of soybeans and soybean meal, with non-GM varieties imported mainly from Brazil. Although the rate of adoption of GM maize and soybean crops in Brazil has been steadily increasing over the last few years, this country is still the largest world exporter of non-GM soybean

and maize products addressed mainly to EU-27, Japan, and South Korea. India and China are also large producers of non-GM soybean, but they do not contribute to trade; China does not export soybeans, mainly because of the large internal demand for protein feedstuff, while safety issues hinder India from exporting soybean meal (Tillie et al., 2012).

Overall, the EU produces limited amounts of soybean and needs to import more than 30 MMt yearly of soybean and soybean meal to feed animals. Although Italy is the largest EU producer of soybeans (350,000 tons/year), the country is still a large net importer with imports that constitute more than 90% of the total available soybean meal. Italian imports of soybean meal were up to 2.15 MMt in 2010, 7.5% of which non-GM (hard IP).<sup>1</sup> Considering that the domestic production is 100% non-GM, total non-GM availability can be approximated at 13.8% of the total available soybean meal on the domestic market.<sup>2</sup> Imports of non-GM soybeans in grains are generally zero; only in years of scarce domestic harvests imports may turn positive and significant. Italy imports non-GM soybean meal mostly from Brazil. Concerning maize, Italy is much more self-sufficient with imports that weigh less than 20% of the total available maize on the domestic market. Roughly 95% of the imported maize (1.9 MMt in 2010) comes from other European countries where GM varieties are not allowed, with the largest share from Germany and France. Only 5% of imported maize is from Ukraine and Latin America, and it is not clear whether this product is non-GM.

The Italian market for non-GM feed is relatively small, and both manufacturers and their customers are specialized enterprises in a specific supply chain, with livestock breeders being at most small-medium enterprises. That is, the competitive advantage for producers does not necessarily depend on the exploitation of economies of scale, but rather on the slim and flexible structure and the capacity to respond promptly in terms of

volumes sold, delivery schedules, and just-in-time production to temporary supply shortages<sup>3</sup> (Boccaletti, Leoni, Varacca, & Soregaroli, 2012). Moreover, unit costs are minimized at full capacity, a condition harder to achieve in large, non-GM specialized facilities.

## Survey

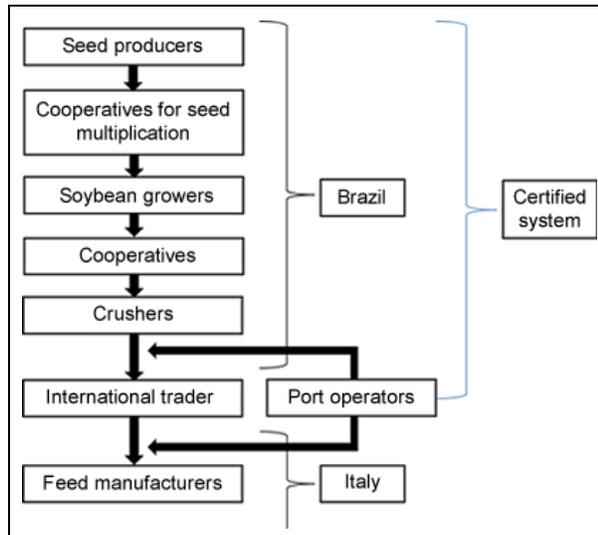
We investigated the structure of the Italian supply chain for maize and soybean through a number of vis-à-vis interviews with representatives from relevant enterprises. Each interview lasted two to three hours; case by case, questions were organized in a framework developed on the basis of a comprehensive review of the available literature regarding the structure, the organization, and the governance of the supply chain (for GM and non-GM crops; Boccaletti et al., 2012). This framework consisted of two structured questionnaires addressed to investigate the upstream and the downstream part of the supply chain, respectively. Downstream respondents were from the feed, retail, soybean-crushing, and livestock-breeding industries; those involved in upstream operations were primarily from large international trading companies and port operators.

The questionnaire for the upstream operations has been more difficult to build and validate. Following the lack of information regarding how international trading companies organize their transactions and manage product and information flows, we faced a certain degree of uncertainty in drafting the framework. For example, we were not able to pre-test it, and therefore we made progressive adjustments as the interviews proceeded. The questionnaire is structured into four sections. The first section identifies how the product and information flows are shaped, with emphasis on contractual arrangements and liabilities; the two following sections investigate the operations and responsibilities at the port level; whereas the final section refers to the physical transportation of the product from the origin to the destination country.

The second questionnaire was revised after pre-testing with market experts from associations of producers, therefore they held deep knowledge of the feed industry and its major trends. It is structured into six sections. The first section refers to the vertical and horizontal structures of the supply chain and also asks about some preliminary details on market concentration and vertical

1. *In general, hard IP requires strict thresholds and segregation practices as well as tests performed by accredited laboratories all along feed/food supply chains. Definitions distinguish between hard and soft IP. Some sources refer to hard-IP product management systems as arrangements implying accurate traceability; others define the difference between hard and soft IP in terms of certification and auditing procedures (Co-Extra, 2007).*
2. *Even if reliable data are not available, experts estimate that between 15% and 30% of EU soybean imports consist of non-GM IP soybeans or meal (Tillie et al., 2012).*

3. *Requests for small and possibly unscheduled quantities are not uncommon in this context.*



**Figure 1.** The supply chain for soybean meal supplied to Italy.

Source: Personal interviews (2012)

integration. The second section considers the market for primary processed maize and soybean as well as the market for compound feed, listing questions on trade data and domestic production volumes. Sections three and four focus on the governance aspects of the upstream supply chain, including terms of trade among actors and pricing mechanisms. The last two sections are dedicated to the marketing and management of non-GM segregated products and to the role of certifiers.

In this article, we decided to focus primarily on the upstream portion of the supply chain (Figure 1). Based upon the information obtained from representatives of international trading companies, our aim was to assess the transactions between major overseas producers of non-GM soybean meal, international trading companies, and domestic producers of non-GM feed. The product management and information flows from the field to the export terminal together with the following unloading and storage phases in dedicated facilities at the destination port are the key steps for segregation between GM and non-GM commodities (Co-Extra, 2009; Pelaez, Aquino, Hofmann, & Melo, 2010). Therefore, we focused on two main transactions—the first between Brazilian selling companies (which aggregate non-GM soybeans and produce non-GM soybean meal) and the main international trading companies; the second between international trading companies and Italian feedstuff producers.

## Methodology

Building upon Williamson (1979, 1981, 1987, 1991), Riordan and Williamson (1985), Ménard (2004, 2010), and Ménard and Valceschini (2005), we rearranged the information from the interviews using a transaction cost economics (TCE) approach. The objective is to describe the nature of vertical relationships through the analysis of the determinants of economic organizational structures, namely asset specificity and different types of uncertainty. The core of the theory refers to whether a transaction is performed more efficiently within a hierarchical structure (i.e., within a firm) or by unrelated agents (i.e., market governance); the scope of the analysis relies on the transfer of goods and services. How this transfer occurs is the main outcome of interest. TCE also asserts that agents carrying out transactions are rationally bounded, risk neutral, and in some cases they behave opportunistically in presence of asymmetric information.

Although the neoclassical perspective of transactions considers market governance as more efficient than vertical integration because of the role played by competition and the reduced burden of bureaucracy, transaction characteristics and the behavioral problems of economic agents may lead to market failures. The specificity of the assets involved (transaction-specific assets), the frequency of the transaction, and the level of uncertainty (which is mainly related to the bounded rationality and opportunistic behavior of the agents involved) represent the three main dimensions which may cause markets to fail. Markets fail because transaction costs arise, making transactions through a simple market governance inefficient; these costs refer to search for ex-ante information, ex-ante and ex-post monitoring costs. Market failures suggest that, for some degree of asset specificity, uncertainty, and frequency of the transaction, hierarchical structures could perform better than markets. Williamson defines three main economic organizations under which transactions can be established—market, hybrid forms, and hierarchy. Hybrid forms are organizations between the market governance and hierarchical structures; according to the core of TCE, all hybrids share some common characteristics. In particular, Ménard (2004) emphasizes the following three characteristics.

- *Resource pooling.* Whatever the hybrid form is, the agents involved converge in organizing their activities through inter-firm cooperation and coordination so that investment decisions relevant to the

exchange are made jointly. The choice of the partner becomes a central issue.

- *Contracting.* Coordination relies mostly on contracts, which differ by nature.
- *Competition.* Parties within a hybrid form often compete against each other and also tend to compete with other arrangements. Formal mechanisms to discipline partners, solve conflicts, and avoid free-riding become crucial.

Ménard (2004, 2010) revisited the diversity of hybrid organizations proposed by Williamson, providing the idea that the decision to adopt one form of hybrid organization over another is linked to the logic of transaction costs (Révion & Chappuis, 2005). Hybrid forms based on trust (which operates as a weak form of governance) are those which are closest to the market governance; on the other hand, formal governance includes hybrid forms sharing more characteristics with hierarchies than with market governance. Relationships characterized by trust fit with a low degree of asset specificity, while formal governance structures are associated with higher investments in transaction-specific assets. Between these two forms of hybrid organizations we may find relational networks and leadership; the former, differently from trust, presents formal rules defining the relationship, and the latter is a hybrid form coordinated by a leader with a key position along the supply chain.

Concerning the three dimensions that drive transaction costs, the classical TCE view (Williamson, 1991) emphasizes the predominant role of asset specificity in determining the properties of the economic organizations for transactions. Asset specificity refers to the degree to which the assets employed within a specific transaction can be redeployed to other uses without sacrificing productive value. According to the theory, as asset specificity increases, redeployability gets lower and interdependency between parts increases, fuelling opportunistic behavior under market governance. In his review on the diversity of hybrid forms, Ménard (2004) supports the hypothesis that the most important property affecting the form of alignment between parties is the degree of specificity of the assets involved.

A second important dimension is uncertainty: this transaction cost determinant arises either when the relevant contingencies surrounding a transaction are to a large or small extent unpredictable to be formalized into an ex-ante contract, or when performances cannot easily be predicted and verified ex-post. The issue of uncertainty on quality is central to the supply chain for non-

GM goods. Uncertainty in transactions where the quality of the goods involved is relevant originates from a problem of information asymmetry between agents; the lack of information affects primarily the buyer, unable to identify ‘plums’ from ‘lemons.’ According to Akerlof (1970), with information asymmetry, the weak side of a transaction (the buyer) faces a “moral hazard” problem and faces a higher risk of finding a bad partner. Additionally, information asymmetry protects bad partners if they cannot be easily separated from the good ones (Révion & Chappuis, 2005). Some authors recognize several types of uncertainty—environmental uncertainty, behavioral uncertainty, technological uncertainty (i.e., uncertainty related to product’s quality), and volume uncertainty (Walker & Weber, 1984). Williamson (1991) also states that the role played by uncertainty on the degree of vertical integration or coordination depends on the degree of specificity of the assets. That is, increased uncertainty in the presence of a non-trivial degree of asset specificity suggests that continuity between the transacting parties becomes important, and adaptive capabilities are necessary, thus rendering market governance less preferable than other organized structures (i.e., firms or hybrids). Nonetheless, hybrid forms—in presence of transaction-specific assets—are perceived as less valuable as the degree of uncertainty increases. In fact, a hybrid form is bilateral in nature, but mutual consent is hard to achieve with very high levels of uncertainty. However, there are several studies addressing the role of uncertainty without accounting for its interaction with asset specificity, or at least they do not focus on the combined effect of uncertainty and asset specificity. These studies try to explain whether uncertainty may cause either hierarchical or market-oriented organizations independently from the specificity of the assets involved (David & Han, 2004; Geyskens, Steenkamp, & Kumar, 2006; Joshi & Stump, 1999; Lee, Yeung, & Edwin Cheng, 2009; Wei, Wong, & Lai, 2012).

In the case of segregated supply chains for non-GM goods, we expect uncertainty to play a key role in shaping the organizational forms by virtue of the higher transaction costs generated by both market conditions (price changes, total transaction volumes, characteristics of the demand) and agents’ behavior (suppliers’ unpredictability, regulatory uncertainty; David & Han, 2004). Consistently with TCE (Ménard, 2010), prior research (Jap, 1999; Klein, Frazier, & Roth, 1990) supported the effectiveness of hybrid forms of governance in the presence of a non-trivial (but not very high) level of uncertainty; in fact, uncertainty makes both market

governance and hierarchies less effective, and the adoption of hybrid organizational structures may contribute to mitigating the problems of evaluation and monitoring caused by uncertain environments (Joshi & Stump, 1999; Lee et al., 2009). This is particularly true when it comes to uncertainty stemming from market turbulence and unpredictable demand and supply conditions (Joshi & Stump, 1999; Lee et al., 2009; Wei et al., 2012). Considering the uncertainty of quality under pure market conditions, the buyer bears the risk of acquiring a sub-optimal product whenever a minimum quality standard is required. Whereas different forms of signalling could help the buyer in a preliminary selection of the suppliers, the goodwill between transactors must be guaranteed with a specific organizational structure able to avoid opportunism and cheating (Réviron, 2000). In this case, a non-trivial level of uncertainty calls for tighter control of the buyer over the supplier.

Transactions characterized by a very high level of uncertainty are less likely to be organized in hybrid forms since mutual consent is generally not feasible (Lee et al., 2009). In fact, as uncertainty gets larger, hybrid organizations have to deal with some coordination issues: this translates into a higher effort for accommodating adaptation (in order to keep flexibility), control (in order to maintain the process unaffected), and incentives (to prevent opportunistic behavior). In this case, either unilateral forms of governance (Wei et al., 2012) or market-oriented structures may solve the problem. However, some authors (Joshi & Stump, 1999) assert that, given that the organizational structures are dynamic, this sharp distinction is rather deceptive.

In this article, we mainly focus on the role played by the different types of uncertainty in shaping the organizational structure of the transaction between Brazilian suppliers, international trading companies, and Italian feedstuff producers.

### Supply Chains for Non-GM Soybean Meal

To reduce quality-related uncertainty, Brazilian producers of non-GM soybean meal, the international trading company, and feed manufacturers developed an organizational structure that relies on highly formalized contracts and provides for a traceability and certification system covering all the steps along the supply chain, from Brazilian growers to Italian port operators. The upstream part of the chain is built and validated by large international certification bodies in partnership with Brazilian crushers, and it represents a necessary feature

for the product to match the standards set by Italian feed manufacturers.

In one of our case studies, the Brazilian crusher established contracts with individual farmers and wholesalers implementing the segregation of non-GM soybeans. The certifier approves the soybean meal as non-GM by certifying each stage of the supply chain, including production and multiplication of seeds, grain production, industrial processing, and delivery for export.

At the seed production and multiplication stage, the crusher inspects and approves the entire process through a set of activities that ranges from the production of seeds by specialized cooperatives to the distribution of the seeds to soybean growers. The company is also in charge of monitoring the distribution of the seeds from the cooperatives to multipliers, seed planting, seed harvest, and storage in dedicated silos (Pelaez et al., 2010).

Grain production is also inspected and approved by the Brazilian crusher; at this stage the task is not limited to monitoring and includes testing procedures for the absence of GM events. Transportation of the harvested soybeans is a sensitive step of the production system and implies systematic strip testing on chronologically numerated batches. All the information is recorded and maintained for system certification.

Industrial processing involves sample collection as soybeans are unloaded into the processing plant. Twice a week, composite samples are PCR-tested at an accredited laboratory (Pelaez et al., 2010).

The crushing company's monitoring activity intensifies in the last stage, because the risk of admixture of non-GM products with other loads at the port terminal is very high. Certified procedures for export include: sampling when trucks are loaded; machinery and personnel cleaning before truck unloading or ship loading operations; daily physiochemical test on composite samples;<sup>4</sup> the issue of one Transaction Certificate of Compliance for each shipload; once the product is loaded on the ship, one further sample is taken for PCR analysis to certified laboratories and results are disclosed while the vessel is still on its way to Europe. The Brazilian crushing company forwards the certification papers to the trader, who requires such documents (in addition to any other formal document the company might require) when the payment is completed (Pelaez et al., 2010).

4. *Composite samples are homogenized and then strip tested. If tests turn out positive, samples are individually tested for batch identification.*

On its part, the international trading company must deploy a system that guarantees compliance with the GM threshold required by Italian customers for the non-GM product. The trader is responsible for the ship's hold cleaning and inspection before the soybean meal is loaded and tested. Cooperation and coordination between the parts involved in these activities is crucial for achieving a low level of presence of GM events into the cargoes.

Product management at the destination port is another critical step, and the implementation of best management practices helps to avoid commingling and adventitious presence. Therefore, it is important for international dealers to rely—on the one hand—on process-certified terminals and—on the other hand—to coordinate the activities of any actor involved in port operations, namely grain terminals, shipping agents, port supervisors, and final customers. In particular, grain terminals are bound to employ dedicated cells, properly cleaned before non-GM soybean meal is being loaded; besides, terminals are also required to unload products using dedicated vacuums and blades. Lastly, the terminal's operators (and any other port operators involved in handling these products) shall be trained in order to minimize commingling. Port elevating can be operated by the terminal itself or multinational trading companies can lease it to other structures; what is important is that GM and non-GM batches are stored in dedicated facilities with shipping documents kept separately in order to avoid product misplacement. When the product approaches Italy, the trading company makes arrangements to unload the non-GM holds in certified facilities. The trading company is liable if the product does not match the requirements, down to the loading on feed manufacturers' trucks. All the upstream documents are forwarded to the final customer and the imported product receives no further certifications.

In the Italian case, in the main destination port of Ravenna, the international trading company, together with port terminal managers, shipping agents, port supervisors, and final customers agreed on a common protocol for the management of non-GM shipments from inbound vessels to truck delivery. Final customers consider this protocol a valuable asset. Additional PCR tests are carried out when the meal is warehoused at the destination port; these cross tests are carried out on behalf of final customers and before the product leaves the port heading to final destinations (storage or processing facilities). Final customers are responsible for transportation from the port to the processing facilities and to any further stage.

## Factors of Uncertainty: Hypothesis and Results

### Quality

We consider non-GM IP products as goods with higher quality than conventional ones. It is not our purpose to discuss whether the actual quality of non-GM IP soybean meal is effectively higher than its GM alternative; however, since the former requires higher investments in product quality management (i.e., coexistence measures at field level, segregation practices for harvesting, transportation, crushing, etc.), these extra costs must be matched by a price premium, which indicates the perception of a differentiated product. The uncertainty related to product quality refers to the risk of commingling the non-GM IP soybean meal with the GM meal, which would cause a downgrade of the product, with negative economic consequences for the entire supply chain.

Consistently with the theory concerning information asymmetry and product quality, we identify the following cases.

- *Upstream risk of commingling.* International trading companies face a risk of incurring more than 0.9%<sup>5</sup> of EU-approved GM events or even more than a lower threshold (0.5% is the threshold level required by the international trader when purchasing non-GM soybean meal from Brazilian producers) or unapproved GM events. If tests for unapproved GM events are positive and the product was intended for the European market, the ship can still change its destination while surfing the ocean.<sup>6</sup> The international trading company has to find a quick alternative, i.e., a non-European destination, in order to avoid a long and costly stop at the dock, possibly creating stock shortages downstream. On the other hand, if the product had already reached the port of destination, other measures shall be adopted and the economic impact changes accordingly.<sup>7</sup> Since the amount of non-GM product is limited and specifi-

5. *This value represents the legal threshold below which the product does not have to be labelled as GM (Reg. 1829/03).*

6. *Samples are taken for PCR-tested before vessels leave the departure port. Test results are generally available when the vessel is on its way to Europe.*

7. *Cases of vessels carrying maize batches positively tested for EU-unapproved events in the port of Rotterdam were described by Backus et al. (2008).*

cally addressed to specialized feed manufacturers (which need to work at full capacity) and livestock breeders (mainly small-medium enterprises), any upstream stock shortage may cause serious problems, both from a legal and economic point of view. The downgraded product is usually sold at lower prices. The price may decrease further if a backup destination is not promptly available and the product needs to be sold as soon as possible. If the GM events in the batch are approved in the EU, then the product presenting values above threshold is still marketable at lower prices. Unfortunately, the regular price wouldn't cover the additional costs for the segregated non-GM supply chain.

- *Downstream risk of commingling.* The international trading company is still liable in cases of non-compliance at destination. Even if the international trader purchased the product with a presence of GM events less than 0.9%, the threshold required by end-users is usually 0.5% (they want to keep safe from the legal threshold and the risk of GM labelling of feed). Consequently, the international trading company applies the lower limit of 0.5% to the Brazilian producers. If the content of GM events in the soybean meal batch in the destination port is above the legal threshold, the trader is bound to market the product as GM to other potential customers. If the product has already been unloaded, the trader also has the costs of stowing and maintaining the product. Feed manufacturers bear the risk of commingling after this point: if at the feed processing plant the legal limit is not respected and the manufacturer discovers it, the batch can be sold on the conventional market at lower prices. If the feed manufacturer is integrated downstream with the meat processor, the economic loss refers to a temporary shortage of feed; this might force the company to buy non-GM feed directly from the market at higher prices. If the feed manufacturer is not integrated, non-compliance might create losses of reputation and damage relationship with customers. Uncertainty related to product quality may cause relevant monetary and non-monetary losses borne by non-compliant agents, but with negative effects on the entire supply chain.

With reference to our methodological framework, we expect a non-trivial level of uncertainty to be controlled through hybrid organizational structures. However, as quality uncertainty changes from a non-trivial

degree to a higher one, the buyer has a strong incentive to adopt stricter organizational forms.

### **Environmental Factors**

Aside from the uncertainty of quality, we recognize other types of uncertainty linked to environmental factors, i.e., to unanticipated changes in the circumstances surrounding the buying firm, with firms unable to write and enforce contracts which account for all future contingencies (Lee et al., 2009). We call this environmental uncertainty (David & Han, 2004; Walker & Weber, 1984).

*Supply-side Uncertainty.* As we already stated in the first section, the availability of non-GM soybeans has been steadily decreasing over the last decade, with the main international producer (Brazil) increasing the area cultivated with GM soybean varieties up to 80% of the total soybean area. The availability of non-GM soybean meal for international trading companies and domestic feed manufacturers is primarily related to the opportunity cost of producing GM soybean products by Brazilian farmers and processors. Several factors affect the choice, ranging from the management of the supply chain to the surge of the conventional product's price resulting from an increasing demand for GM soybean, especially from China and India, and a steady supply. The availability of non-GM product also generates an opportunity cost issue for the international trading company. In fact, according to traders, the shrinking volumes will probably reduce the already low logistics efficiency along the supply chain of non-GM goods. This, together with the uncertainty at the demand level and the increasing demand for conventional products from developing countries, may support the decision to market GM soybean only. Domestic non-GM feed manufacturers are bound to their own (or retailer-driven) technical specifications and, more generally, to specific non-GM supply chains (Passuello, Soregaroli, & Boccaletti, 2013). Being part of a non-GM supply chain may reduce the incentive for feed producers to switch to GM feed. However, the choice also depends on the availability of substitutes for the non-GM IP Brazilian soybean meal. This issue is, to date, highly debated at the European level (Tillie et al., 2012).

*Demand-side Uncertainty.* The existing data regarding the awareness of European consumers towards both biotech crops and food derived from GM varieties are largely inconsistent across member states (Tillie et al.,

2012). This variability affects the incentive of downstream actors to abandon non-GM labelling, since the monetary and organizational costs to maintain segregation might turn out unsustainable in the long run.<sup>8</sup> In this uncertain scenario, the decision to abandon non-GM products could prevail and the market could shrink to a niche of producers.

**Price Uncertainty.** Price uncertainty results from demand-side and supply-side uncertainty. As regard to the upstream portion of the supply chain for non-GM soybean meal, the contract between the international trading company and the Brazilian supplier of non-GM soybean meal envisages a premium price for the non-GM standard; however, without a reference market for such premium, it is the result of a negotiation process based on several factors, including the international price for soybean, the availability of non-GM soybean at the world level, the costs of the segregation techniques, and the characteristics of the demand. The outcome of the negotiation is uncertain, although an estimate of the final premium is still possible. Clearly, price premiums have been increasing over the last few years in response to a shrinking global supply for non-GM soybean; aside from the pure market effect of this contraction, one should also account for the reduction in logistics efficiency determined by lower volumes. Although the supply side provides some insightful information regarding the trend of this premium price, the demand-side effects are less clear, in particular the willingness to pay for non-GM food. Moreover, estimates of the demand price elasticity for non-GM food are also missing and probably highly unstable. Hand-in-hand with the attitude of European customers towards genetically modified organisms, food producers—and more often retailers—play a central role on the pricing mechanisms. Considering the actual price gap between non-GM and GM soybean meal, it is unlikely that this differential is fully transmitted to consumers, as the willingness to pay would not be sufficient. Therefore, the price differential must be borne by some actors along the supply chain. These can include the producer of branded products or the retailer with its private-label brand (in this case the labelling strategy could be considered as an investment in brand equity) and other upstream actors willing to accept lower margins to cope with downstream require-

ments achieving long-term advantages from being part of a specialized supply chain.

Consistent with our methodological approach, we predict the appearance of hybrid forms of governance in the presence of a non-trivial level of environmental uncertainty. Nonetheless, as uncertainty increases to a high level, according to the theory, hierarchical and hybrid governance forms are less suitable to the uncertain market conditions, and a more market-oriented governance form is preferable.

## Organizational and Managerial Implications

The core of TCE identifies the most appropriate hybrid governance forms depending on both asset specificity and uncertainty. This work mainly takes into consideration uncertainty. As expected, the structure of the exchange between the upstream and downstream agents results from the combined effect of both environmental and quality-related uncertainty. A high degree of environmental uncertainty drives to a market-oriented governance form. In fact, both the upstream and downstream agents adopt a flexible framework based upon yearly contracts with a price premium for the non-GM standard, re-negotiated on an annual basis. These contractual forms are expected to better manage upstream shortages. On the other hand, the uncertainty related to product quality is counterbalanced through a set of downstream-driven technical requirements enforced with process certification schemes. The buyer's monitoring of the supplier's performance is achieved through formalized contracts and process certification. Contracts between the international trading company and Brazilian producers are renewed annually and transactors have been using them for many years, building upon trust and enduring personal relationships. In accordance with the literature on trust (Ding, Vee-man, & Adamowicz, 2012; Kwon & Suh, 2004; Wei et al., 2012) and the transaction's long-term orientation (Joshi & Stump, 1999), we observe that the long-lasting trust-based relationships between local crushers and international trading company may serve as a flexible vertical coordination mechanism to reduce uncertainty and transaction costs (Johnston, McCutcheon, Stuart, & Kerwood, 2004). The main benefits of the relationship include

- a stabilization of the price premium that the international trading company recognizes to Brazilian producers for non-GM soybean (this is of particular

8. *It is the case of UK retailers, who decided to abandon the requirement that producers use only non-GM feed for poultry (Davies, 2013; Dutta, 2013).*

relevance, as there is no reference market for this premium);

- a secure market channel for Brazilian producers, i.e., a lower incentive to switch to GM crops; and
- a stable and reliable supply of non-GM crops to the international trader.

The frequency of transactions between the international trading company and Brazilian crushers seems to play a key role in building trust.

The exchange between the international trading company and feedstuff manufacturers is mainly managed through spot contracts. However, if we take into consideration the relationship between the trader and the main Italian customer, we cannot classify this transaction as pure market governance, where the identity of the transacting parties is irrelevant and no mutual dependency exists. What we notice is that the two parties maintain their autonomy but are bilaterally dependent in a nontrivial way: their identity matters and each of them cannot be replaced without cost. The degree of uncertainty heavily affects the structure of the transaction: the volatility of demand and supply conditions may reduce the buyer's capacity to control the supplier. However, at this point of the supply chain, other economic determinants play a crucial role in shaping the transaction's governance form. The relatively small volumes of non-GM soybean meal necessary to satisfy the Italian demand resulted in a single international trader supplying the entire market. In this context, the buyer can control the supplier only through bilateral consent on the product's technical specifications and information/product management. This is usually done by large feed processors, such those integrated in the poultry sector, while relatively smaller feed manufacturers are more price and quality takers.

Additionally, the feed manufacturer aims at establishing a trust-based and long-term oriented relationship with the international trader in order to curb the transaction costs arising from uncertainty. These are not necessarily specific to non-GM supply: as we observe from interviews, large Italian feed manufacturers have been doing business with one particular international trading company, mainly because of the reputation of the upstream suppliers and the trust relationship between the two companies' staff.<sup>9</sup>

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9. *The importance of this trust relationship may be emphasized by some cases of product non-compliances, where the international trader claimed responsibility for it and paid the price gap between the GM and the non-GM final product.*

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## Authors' Notes

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