

**ADVANCES IN SUPPLY CHAIN ANALYSIS IN AGRI-FOOD SYSTEMS**  
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This book reflects the research programs carried at the Wageningen University and The University of São Paulo in cooperation with organization scientists from other important knowledge centers. Our research objectives are the same. To focus on the relevant questions and challenges that are faced by the global food-fiber-energy chains and networks.

The University of Wageningen and The University of São Paulo organize traditional conferences on Chain and Networks in The Netherlands and in Brazil. This book reflects the research initiatives of both Universities and introduces the relevant topics that are part of the contemporaneous debate in food-fiber and energy chains and networks. The book is organized in six parts, reflecting recent topics that are part of our research programs. The first part discusses trust and culture, and presents two papers focused on the role of trust to explain the observed cooperation arrangements in food production and marketing systems. The contributions are authored by Danny Claro, Peter Zuurbier and Decio Zylbersztajn. Part 2 discusses collaboration and vertical coordination in food chains and in research and contains contributions from Jos Bijman and Peter Zuurbier. Part 3 introduces the topic of food quality and safety, very relevant in modern global food systems with contributions from Wijnard van Plaggenhoef, Jack Trienekens, Onno Omta, M. Meuwissen, Miranda Mouritz, Maria de Graaf, Ruud Huirne, Eduardo Spers and Decio Zylbersztajn. The topics of sustainability and governance are presented in part 4 with contributions from Pinheiro Machado, Harry Bremmers, Samuel Gioordano, Mike Cook and Molly Burrell. Part 5 is dedicated to new approaches in chain theory and method based on contributions of Paul van Beek and Marcos Fava Neves, and finally part 6 presents papers on innovation and entrepreneurship with contributions from Frances Fortuin, Onno Omta, Sylvia Macchione Saes, Fabio Mizumoto, Gert Jan Hofstede and Jan Omvlee.



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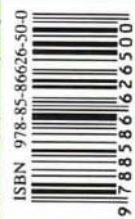
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# ADVANCES IN SUPPLY CHAIN ANALYSIS IN AGRI-FOOD SYSTEMS

University of São Paulo and University of Wageningen:  
18 years of academic cooperation

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# Public and Private Mechanisms in Food Safety

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The guarantee of good quality food is a growing focus of governments, companies and the standardization, certification and trade agents. Their efforts are addressed to influence the consumer's perception over the many attributes of a food product, with special attention to the nutrition and safety aspects. The warranty of quality suggests voluntary standards by companies and more regulation by the government. The public and private mechanisms have been analyzed separately in marketing and regulation literature. The analysis of the interactions among these mechanisms provides conflicting and extreme visions like the private food quality and safety mechanism being substituted by the public and other where the performance of the state is unnecessary due to the consumer's trust in the reputation of a brand or organization. A third vision happens when the regulation is complemented with the use of private strategies and vice versa. The objective of this chapter is to propose a model generated from the framework of game theory and hedonic demand analysis of attributes to evaluate these interactions.

## 1. Introduction

Food safety attributes are not always easy to observe. In many cases public regulations are necessary to monitor the quality of food in the market. Private mechanisms are also relevant, and they are expressed in the form of reputation of brands. Both public and private mechanisms to guarantee quality attributes are not independent. The question of whether they are complements or substitutes is relevant for firms to decide strategies and governments to define public policies.

Public and private mechanisms are usually analyzed separately in the literature of food safety and quality. Conflicting views appear as reputation

mechanisms are substituted by regulatory measures or else, when regulation is complemented by reputation. According to Cohen (1998, p. 47), two research areas are relevant in dealing with adaptations of firms to legal changes. First, external incentives such as the incorporation of social norms, social pressures, and reputation mechanisms. Second, internal incentives that the organization possesses to adapt to legal changes. This chapter focuses on the first area, analyzing how consumers perceive the external incentives to the adoption of a public mechanism such as norms and State monitoring as well as the incentives to adopt a private mechanism such as quality brand advertising. The aim is to characterize the interaction of public and private mechanisms in terms of complementarity and substitution.

The guarantee of food quality is a growing focus of governments, companies and standardization agents. Efforts are addressed to control the attributes of a food product, with a peculiar care of the nutrition and safety characteristics. Guaranteeing quality is gaining notoriety as food consumption is being better appraised for the rulers, consumers and companies. This better evaluation suggests more voluntary quality assurances for companies and more regulation for the government (Caswell, 1998, p. 409).

To understand how these private and public mechanisms interact in terms of complementarity or substitution is important (Lazzarini, 2002, p. 2). If a substitution exists, a private company could invest on branding when the public monitoring is not present to ensure consumers high safety perception. Instead, if a complementarity exists, a private company needs some kind of public monitoring.

Trust is commonly seen as a substitute for complex contracts in interorganization transactions, whereas in an alternative perspective, formal contracts are seen as a complement (Poppo and Zenger, 2002, p. 707). Different levels of incentives exist, tacit or imposed, to the adoption of a quality guarantee system, through economic units, norms and regulators. These incentives help in understanding the adoption of private strategies and public policies.

Pressure for more regulation appears as a consequence of low trust in institutions and limited rationality by consumers when they overestimated, underestimated and did not understand certain risks and benefits in food consumption. This justifies why this article focuses on consumers to evaluate the private and public mechanisms. Which combination, intensity or situation of public and private mechanisms should be used to provide incentives

to consumers' high safety perception? The main goal of this chapter is to propose the discussion about the complementary and substitution relationship among the public and private mechanisms regarded in food safety.

The chapter is structured into four sections including this introduction. Initially, the food safety issue is characterized, and the adoption of public and private mechanisms in Brazil is discussed. In section three, a theoretical model is proposed based on the consumer's perception, hedonic model and game theory. Finally, the conclusions are presented in section four.

## 2. The Enforcement of Food Safety

Food safety is the consumer's warranty to acquire food with quality and health attributes (Spers, 1993) Institution changes like new industrialization processes, new consumer demands, industrialization and urbanization, increase in competitiveness, development of scientific research, decrease in income expenses on food and globalization demands increasing the consumer, government and private organizations' interest for safety and quality

The food segment has been focused on by a growing and successive crisis of credibility, fear and insecurity due to accusations of contaminations and adulterations. Another factor that contributes to this distrust is the little understanding about developments obtained by process and genetic engineering. Although there are benefits, some consumers and nongovernmental organizations believe that these technologies can be dangerous if more intensively explored. The communication between the producing system and the final consumer becomes more dynamics and complex. Demand for food information grows as the consumer's knowledge and involvement increase with regard to constant changes in their attributes, process, and conservation. New attributes such as the genetic modified organism (GMO) could cause misunderstanding, distrust and overestimating their effects.

Distrust regarding State enforcement of health and consumption of healthy foods have worsened with the crisis of mad cow disease. Industries and distributors try to increase their trust by a non-commercialization of GMOs. Companies are accused of not appropriately informing the consumer about scientific improvements and risks, creating negative perception and antipathy.

Meat is a source of protein and important vitamins and minerals. However, if produced and marketed in an incorrect way by private companies, it can cause alimentary intoxication and, consequently, loss of value and reputation to the final consumer. In the case of Brazilian beef, the healthy profile is emphasized as a "green" cattle (that grows in the fields), different from those intensive processes that led to the mad cow disease, which opens discussions about the State's effectiveness in guaranteeing consumer's safety (Enriquez-Cabot and Goldberg, 1996).

Understanding how consumer perception behaves over government enforcement policies and private branding strategies could help in an appropriate introduction of effective communication over food safety aspects.

### 3. A Model for Transaction between a Consumer and a Food Company

The proposed model is based on the consumer's perception regarding public and private mechanisms' attributes, which occurs in different intensities between consumer and company. A hedonic model measures the preference of different attributes of public and private mechanisms, and game theory evaluates these mechanisms' decisions, which allows the achievement of a Pareto situation.

In Lancaster (1971), goods are not directed objects of their preference but have associated a group of relevant attributes. The utility function is a set of attributes ( $A_j = (o_h)$ ) or characteristics obtained through several products.

Analyzing the process of meat purchase, Barcellos and Callegaro (2002) interviewed 400 consumers in a Brazilian city, and, through factor analysis, they reduced the variables in information quality indicators. Keeping constant the information about the animal and the product and choosing a specific type of meat, the consumer preference structure could be defined by the monitoring attributes (or public mechanism) and brand (private mechanism). We use these results as an assumption to the proposed model.

In the hedonic model, the product  $i$  is defined as a combination of attributes  $A_j = (o_h + a_{i+1} + \dots + a_{i+n})$ , which is produced in a technological structure of production  $T$ . When the quality attributes are not perfectly

observed by the consumer in purchasing, as is the case of most food safety attributes, an organization  $O$ , in a certain market  $j$ , could offer the same product  $i$  with a different combination of attributes that varies from  $A_j'$  with low quality to  $A_j$  with high quality. As it follows along the chain value, the product  $i$  suffers transformations at a cost  $Z_i$  that will be offered to the final consumer who perceives a benefit or a value  $V_i$  in the product  $i$  (Besanko, et al, 2000, p. 395).

Preference of a product  $i$  will be a function of  $V_i$ ; the value or medium benefit perceived by the consumer in relation to the product  $i$ ;  $p_i$  is the market price paid and received by the product  $i$ , and  $Z_i$  is the medium cost of production of the product  $i$ . In a transaction among a consumer  $C$  and an organization  $O$ , which accomplishes the offering of a product  $i$ , the total value is divided between the consumer and the organization. In this case,  $(V_i - p_i)$  is the medium value received by the consumer  $C$ , and  $(p_i - Z_i)$  is the medium profit received by the organization  $O$ .

Assuming the existence of different technological combinations of production  $T$ , that are different combinations of attributes  $A_j$ , the product  $i$  will provide different benefits to the consumer  $C$ , which vary from a value  $V_i$  to  $v_i$  (assuming  $V_i > v_i$ ). For instance, the consumer perceives, in the acquisition of a certain meat that contains attributes that guarantee a higher level of safety and quality, also a higher value than other meat that does not possess these attributes nor has a lower level of the same attributes.

If organization  $O$  offers a value  $V_i$ , it is reasonable to suppose that their technological structure of production  $T$  has a higher cost, because it incorporates additional procedures to food safety guarantee. Considering different quality patterns, the structure of production cost could vary from  $Z_i$  to  $z_i$  (assuming  $Z_i > z_i$ ).

Even if there are variations in perceptions over the attributes of benefits among different segments of consumers, we suppose that part of the population is willing to pay for a better quality pattern and consumer  $C$  does not buy the product in case he or she notices a low quality  $(V_i - p_i) < 0$ .

According to Baird et al. (2000, p.6), a strategic problem begins when two people interact and both have to decide what to do without knowing what the other is accomplishing. The adoption of a norm related to food safety is accomplished by how rigorous the State is in enforcing and punishing organizations and how technically and economically difficult the norm to be



adopted is. Both have to decide the enforcement they will exercise without knowing the other strategy. This behavior will also depend on the legal environment. We may suppose that the organization will adopt the higher quality norm in case the punishment imposed by the State is higher.

Laffont and Tirole (1993, p. 211) argue that a monopolist who does not suffer any type of regulation will have two incentives to adopt high standards of quality and safety. When the quality is observed by consumers before the consumption, when it has a reduction of sales and when the income of the monopolist's price exceeds the marginal cost. When the quality is observed by consumers only after their consumption, the monopolist has the incentive to provide a high-quality pattern, unless the consumer repeats the purchase. In this case, the private mechanism appears as reputation and branding. The public and private mechanisms are alternatives and could interact between themselves in terms of complementarity or substitution.

Like other economic models, game theory simplifies a certain social situation, and it has been used in the field of organizations, law (Katz, 1990) and consumer behavior (Gunnthordsdottir, 2002). The application of this theory will accomplish the understanding of how economic units behave due to a varied combination of public and private mechanisms.

Three elements are necessary to a game: (1) the players, in the case of private organizations and the consumers; (2) the available strategy, to buy or not, to offer higher or lower quality and accomplishing the public mechanism or not or adopting a private mechanism; and (3) the compensation that each player receives for a possible strategy, differences between value perceived and price for the consumer and between price and cost for the company. The premises to formulate the game are described next.

In case an organization offers a product of high quality, it will receive  $\pi_i - Z_i$ , and the consumer C will perceive a value  $V_i - \pi_i$  when purchasing the product. In another situation, where the organization offers a product of low quality, the consumer will receive a value  $v_i - \pi_i$  and the organization  $\pi_i - z_i$ . Although the company offers high or low quality, if the consumer C does not buy the product, both will receive zero. Evaluating the payoffs between the consumer and the organization (C,O), the Nash Equilibrium occurs in a situation in which the Pareto is lower if the game has been played in a single time (Figure 1). As the quality and safety are not noticed by the

consumer, the game can be seen in a simultaneous way; in other words, the consumer does not see the movement of the organization.

Figure 1: Payoff between Organization "O" and Consumer "C"

		Organization O	
		Offer high quality	Offer low quality
Consumer C	Buy	$V_i - P_i, P_i - Z_i$	$v_i - P_i, P_i - z_i$
	Not buy	0, 0	0, 0

Where:

$p_i$  = price of the product  $i$ ;

$V_i$  = Consumers' value received from a product  $i$  with high-quality attributes;

$v_i$  = Consumers' value received from a product  $i$  with low-quality attributes;

$Z_i$  = Organizations' cost of producing high-quality product  $i$ ;

$z_i$  = Organizations' cost of producing low-quality product  $i$ .

Considering  $V > v$  and  $Z > z$

To increase welfare, it would be desirable that the balance of the game happens in the strategy of "buying" and offering a "high quality." For this, we suppose the presence of government or a regulator  $R$ , with a public mechanism of monitoring that could detect, with a probability  $s$ , and not to detect with a probability  $(1-s)$ , the offers of a low-quality product.

### 3.1 Introduction of the Public Mechanism

The government is present in the economy to enforce property rights and the execution of the contracts (Klein and Leffer, 1981, p. 615). It has the function of guaranteeing, through the public mechanisms of inspection and punishment, the execution of the necessary activities that reach a safety level demanded by the society. When establishing regulations and norms, two types of costs happen, one enforcing and another monitoring. Therefore, to minimize their costs, they should decide which governance structure would be more efficient, in other words, at a smaller transaction cost.

The presence of public mechanisms related to enforcing food safety (Turner, 2000, p. 43) is growing. Some examples are (1) rules or labeling

the minimum and maximum limits of vitamins, minerals and additives, (2) limits of pesticides, residues and pollutants, (3) structures of monitoring and regulation agencies and lawsuits, (4) information about new complex technologies, (5) non-tariff barriers and (6) practices of controlling food production processes and conservation, identifying the origin and the history of a product, like traceability, which is used in meat. To export bovine meat, the producer needs to have the Brazilian System of Bovine Identification and Certification (SISBOV) and the Federal Inspection System (SIF) for food products of animal origin.

Norms and regulation instruments in a market are introduced due to the presence of asymmetry in information between buyers and sellers. In the case of food consumption, there are difficulties in verifying many of the intrinsic safety attributes; for instance, organic production and the presence of residues forbidden or above the tolerated limit. Besides, there cannot be consensus among consumers, government and private companies about which should be the best level of food safety enforced.

The literature justifies the need for a governmental intervention (Mercurio and Medema, 1997; Viscusi, 1985; Buzby, 1998; and Posner, 1998) from demand type, imperfect competition, public property rights, externalities, incomplete market and imperfect information. If there is a market failure, it is necessary to identify appropriate governmental mechanisms (Stiglitz, 2000, p. 249) and food safety, depending on the case, that may be related to one or more of those failures.

Henson and Traill (1993) argue that for a perfect market operation, in the case of products that involve risks, may have a divergence between private and public or social food safety levels: (1) perception of the consumer's risk may differ from specialists; (2) imperfections in offering information about food safety; (3) failure of price system, reflecting the total costs and benefits, and (4) unfair distribution of costs and benefits associated with changes in safety levels.

Law (2001) argues that government intervention in the US food sector was an answer to a higher transaction cost imposed by the need of information and changes in regulation that passed through the federal level.

The lack of property rights regarding food safety consumption shows the need for the State performance (Demsetz, 1967). Safety could be demanded and offered in different property levels. If there is a market failure, different

private and public desires regarding the level of quality and safety allow opportunistic behavior. An organization could restrict knowledge or information about their product quality to difficult consumer perceptions.

Food safety is a service offered by an organization that chooses the level of offering and different patterns of quality attributes. The regulator defines these patterns in services that are difficult to be specified through rules, and, when health attributes are evolved, it could generate controversies. It becomes more difficult with the introduction of new services and constant innovations related to production and conservation. The regulator needs to define the minimum quality pattern that could be accomplished and enforced by periodic inspections and fines (Kahn, 1998, p. 22). The market failure regarding asymmetrical information is evidenced by several authors (Law, 2001; Akerlof, 1970; Katz, 1998 and Stigler, 1961). The presence of incomplete contracts and asymmetrical information also allows opportunistic behavior, and so the government's intervention and enforcing is needed.

Public choice studies the political process (Buchanan, 2000, p. 153). Not always the law can be formulated with one or some consumers' or companies' desires, because their interests would not be necessarily equal to that of most. The regulatory agencies could work exclusively to a particularly group of interests (Buchanan, 2000, p. 331). Therefore, it is important that, even when formulating public mechanisms of regulation, the existence of lobby and corruption could affect their accomplishment and efficiency in generating welfare. An organization can be detected by a regulatory agency as offering low quality but not punished due to the existence of corruption. Organizations could lobby for a superior quality standard regulation, because they have better condition or higher competitive advantage to accomplish producing these pattern products (Law, 2001, p. 9).

Organization O, which wants to offer high quality, could have problems due to the impossibility of guaranteeing a hundred percent safety. The adoption of practices for a higher level of safety could allow them to avoid punishment, since the probability of  $s$  would be null and  $(1-s)$  equal to 1. Being  $s$  is also considered quality of inspection; if organization O, is discovered by regulator R, as offering a low quality, it will receive a fine  $m$  (Figure 2).

If  $z_i + s f_i$  ( $Z_i$  (or  $s f_i$  ( $Z_i - z_i$ ), the Nash result balance will be higher for consumer C in purchasing the product and for organization O that of-

fers high quality, then, a desired situation occurs. However, if  $s_i < Z_i - z_i$ , the consumer and the company will need another mechanism to reach the result of superior Pareto-like reputation.

Figure 2. Payoff with introduction of regulator "R"

		Organization O	
		Offer high quality	Offer low quality
Consumer C	Buy	$V_i - p_i, p_i - Z_i$	$v_i - p_i, p_i - z_i - s_i m_i$
	Not buy	0, 0	0, 0

Where:

$s_i$  = probability of discovering lower quality of product  $i$  or enforcement efficiency;

$m_i$  = fine paid for low quality by organization O;

$F = s_i m_i$

$s_i m_i \geq Z_i - z_i$  or  $F \geq Z$

### 3.2 Introducing the Private Mechanism

Safety could be managed, quality becomes important, costs exist, and their profitability affects food companies. Some damages and costs caused by contaminations are related to the quantity of product loss, legal actions, compensations to consumers, corporate and brand image, consumer's trust, crisis administration and the impact on other companies that produce similar products.

The food sector is worrying and investing in the quality management of their products. Besides the harmful aspects mentioned, some benefits motivate investments in product attributes, consumer's and supplier's credibility, brand protection and in the desire for obtaining competitive advantage.

There are internal motivations to adopt a private mechanism to control quality, which is difficult to measure and could vary from company to company. These incentives are the improvement in production efficiency, management and quality controls, consumer service, facility of a new partner introduction in the chain, identification and solution of problems, market share and consumers' maintenance. Some private companies have property

rights over goods and attributes regulated by law that identify certain quality patterns accepted and perceived by the market as brand and seals.

Increasing market complexity and competition could represent the decline in loyal consumers. Some consumer segments that have fewer brands loyal demand more investments in communication. In meat, the perception among different quality attributes is difficult, and, therefore, they have no reasons to be loyal to a certain brand. Brands are tools to conquer meat consumers' trust, which could tranquilize them while all other problems are solved by a brand owner (Spers and Zylbersztajn, 1997).

Private companies need a brand that could generate enough sense of trust to obtain consumers' loyalty from valued attributes as safety. According to Arnold (1992), the aim of an organization is to create value to consumers' minds by product or service. This means products and messages like brand private mechanisms that induce purchase in the future.

Considering now that organization O and Consumer C interact repeatedly and the future payoffs are adjusted with a discount factor that could have several interpretations, it can be considered as an indicator of degree of interaction or purchase frequency in the future. The problem of moral hazard can appear as consumer ignores quality choice. The infinite repetition of that interaction strategy is necessary to guarantee the desired market efficiency (high-quality product) and could support the perfect (therefore, sequential) strategy balance. The supply of high quality will be part of the perfect balance of the repeated subgame (Abreu, 1988 and Burguet, 1996) if, i.e.,

$$\frac{p - Z}{(1 - \delta)} \geq p - z - sf + 0$$

That is equal a:

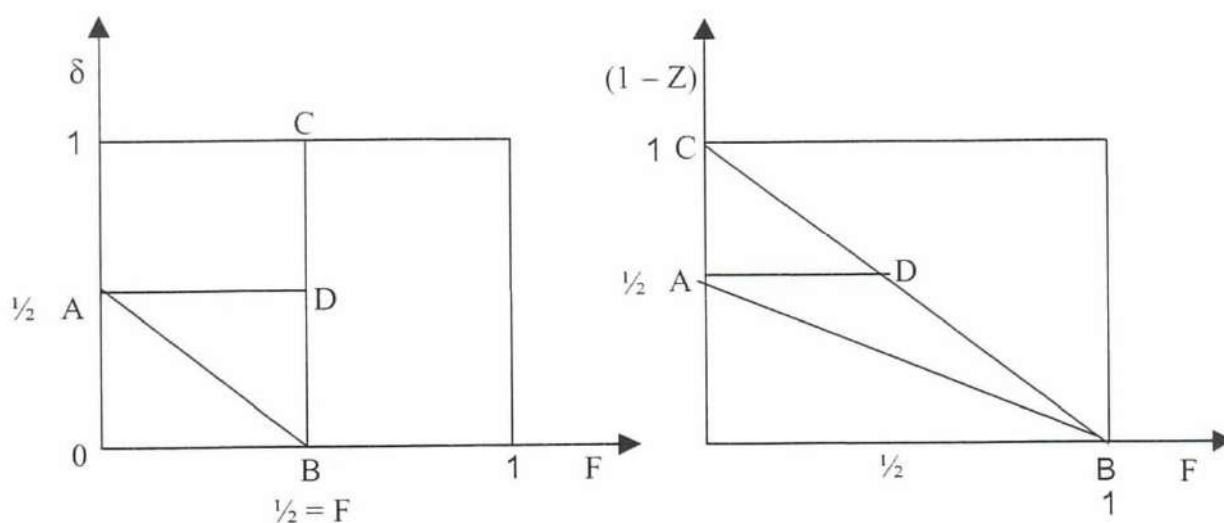
$$\delta \geq \frac{(Z - z - sf)}{(p - z - sf)} \quad (1)$$

Simplifying the analysis, normalizing  $p = 1$ ;  $Z < 1$  and  $(1 - Z)$  the margin sale, denoting  $F = sf$  as the expected level of punishment, assuming  $z = 0$ , equation (1) would be

$$\delta \geq \frac{(Z - F)}{(1 - F)} \quad (2)$$

Based on Figure 3 AB (assuming  $Z = \frac{1}{2}$ ), CB ( $F > Z$ ) and AD ( $\delta > F$ ), we can solve the game and verify the combinations that culminate in a balance where consumer C buys and organization O offers high quality. If  $sf = F \delta Z$ , the regulation guarantees by itself the supply of high quality.

Figure 3: Balance for  $Z = \frac{1}{2}$ , in agreement with different levels of  $F$  and  $\delta$



As  $\delta$  increases, or the value of the future earnings is larger than  $\frac{1}{2}$ , the reputation or private mechanism alone guarantees the high quality, since public mechanism is smaller than  $\frac{1}{2}$ . Public mechanism substitutes the private guaranteeing the desired balance, whenever it goes larger than  $\frac{1}{2}$ , and in case it is smaller, since  $\delta$  is equal to  $\frac{1}{2}$ , the complementarity between public and private mechanisms will happen. If  $F$  or  $\delta$  go simultaneously smaller than  $\frac{1}{2}$ , the purchase will not be executed, since equation (2) does not match. In all cases, the not buying is also a perfect balance of the subgame, because it is part of the Nash equilibrium of repetitive game. Therefore, the repetition is not enough to attempt high quality.

In case of incentives for the adoption of public mechanisms by an organization, a more complex and possible way to work with the problem is to input the role of brand. In Klein's and Leffer's approach (1981), the brand is used to avoid competitors' entrance, once it imposes unrecoverable costs in certain markets. Otherwise, there would not be a prize ( $p-Z$ ) to be arbitrated.

The brand can signal quality in a situation where consumers could form expectations over a product (or attributes) through a communication strategy (Tirole, 2002. p. 107-108). If the firm sells a product with more advertising, a larger price is necessary to guarantee its quality (Klein and Leffler, p. 632). According to Horstmann and MacDonald (1994, p. 578), neither introductory price nor advertising serves as signs of product quality.

We assumed that brand or quality stamp is a private mechanism that can facilitate perceptions of high product quality when generating reputation and future purchases. Brand loyalty concept is assumed here as being a proxy to measure the discount factor  $\delta$ . According to Chaudhuri and Holbrook (2001), brand loyalty can be measured to identify trust and affection.

Concluding, some hypotheses could be proposed if regarding public and private mechanisms in the different levels of consumer perception of product quality.

#### 4. Concluding Remarks

Food safety involves several agents: government, organizations and consumers. The relationship among those agents is dynamic and must be analyzed together.

The increase in safety perception by consumers reflects government action of increasing enforcement; and organizations could apply more efficient mechanisms of product differentiation. On the other hand, the government could increase consumer's sensibility and concern regarding safety aspects through educational programs.

Studies with this proposed model could capture regional differences. In some regions, depending the level of consumer perception of safety, the use of a public or private mechanisms could be substitute or complementary. Applications in other problems that involve both private and public strategies such as environmental and social subjects could be useful.

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