Innovation System in Agribusiness: New Institutional Economics, Sustainable Equilibria, and Chaos Theory (Part 1)

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Abstract: The aim of this paper is to propose a model to analyze and manage the scientific-technological innovation systems in public organizations dedicated to R&D in agribusiness, like Embrapa, under the terms of the theoretical system supplied by the New Institutional Economics. The purpose is to identify parameters that increase the efficiency and efficacy of strategic and operational management decisions of Embrapa in pursuit of sustainable competitiveness for Brazilian agribusiness compatible with R&D demands, the welfare of society and national development goals. Conceptual bases are from Coase-Williamson-Penrose contributions, considering "bounded determinism", derived from common assumptions of uncertainties of human behavior and those of external environments, affecting key-variables related to transactions and to the growth rate of the firm. The boundaries of an innovative firm tend to be flexible and unstable, reaching cyclical but "sustainable fitter" *equilibria*, strategically designed to "search for profits" over time, but made up of "remediable efficiency" which are farsighted and organized as a discrete, comparative, economizing governance solution at a given moment and place. The "dynamic capability approach" would mainly give operational content to this model. A hypothesis is raised that, independently of the hierarchy of the system under analysis, this logical "process" of *equilibria* repeats itself, but "products" are simultaneously related to temporal and spatial environments A quantitative system simulation based on chaos theory is suggested to subsidize managerial decision-making and/or to empirically test relationships of key-variables of the model when applied to Embrapa's "innovation system/subsystems".

Key words: R&D production and transaction, systems analysis, agribusiness

1.Introduction

In economic literature, numerous articles aim at attacking the dominant theories, seeking to identify inconsistencies that could cause a reduction in their importance and explanatory empirical power. In response, counter-arguments can be presented which end up increasing antagonisms or incorporating criticisms. New proposals can fit into the general theory opening up other contradictions. Debates are renewed, giving space to the emergence of alternative theoretical and methodological approaches leading the cycle to rebegin. Competition intensifies and a similar critical process is unleashed in the attempt to replace the predominant models. However, these cyclical *equilibria* theories are located at different levels than before: they evolve. Besides experience gained and accumulated in this process, the discussion environments also change: Radically, when the qualitative nature of the problems is altered, so that the available conceptual *apparatus* is unable to solve them; or, incrementally, when the theory is perfected to answer similar problems in other specific situations.

In most debates, economic analysis models have been taken more as competitors than as complements, even when the cyclical circumstances may indicate a need on the contrary for the qualitative/quantitative advance of the theory. Certain dilemmas are superficial, distinguishing only in their appearance because essentially they are nothing more than different sides of the same coin. Though they assume varied terminological dressings, they tend to repeat with surprising regularity. They almost always focus on the same types of issues (micro vs. macro-analysis, reductionism vs. holism, deduction vs. induction, individual vs. society) or discuss the order of causal precedence among relevant variables. However, economic systems have continued to follow their course, under varied contours without acknowledging the inflexibility and partiality of the models designed to explain them.

Similar situations have been observed in the unending debates on the "theory of the firm". Several concepts are adopted by different groups of economists implicitly seeking to force on the others the "definitive" theory because it is the only possible representation of causal relations that explains the origins, evolution and functions of the firm and supports the normative interventions in any circumstance. Taking this position, it is accepted implicitly that reality should adjust to theory, or, exceptions are nothing more than irrelevant details, in the face of the theory's wide explanatory power. It is evident that having a prior model of analysis is essential, but it is not possible to exempt it from contestetion No matter how complete it may seem, there will always be gaps and questions. However, this does not mean that one must be subject to accept a "theory of the firm", either as: a mosaic of isolated, disconnected and even conflicting approaches (such as perfect competition); or as a compacted whole where one approach predominates by its level of abstraction (such as pure monopoly). The first alternative would mean adopting a "subjectivity" of conceptual relativism and, the second, accepting the existence of an "objectivity" on criteria of "divine" generality.

If, alternatively, it is assumed that knowledge has logical (as a "process") and extra-logical (as a "product") components, it is possible to conclude that it could represent a "synthesis of reality", that is both specific and general. It is specific in the sense that the different partial views are "related"(not relative) to the context from which they emerge. They are not valid in themselves and do not intend to establish absolute criteria true or false. They were logically processed, but their validity is limited to the context in which they belong. It is general in that it accepts that these partial views are

only understood when composing an integrated whole that allows for the manifestation of synergic effects without necessarily causing damage to the specific content of its components (D´Apice, 1965).

In this sense, dichotomies between theories can be taken as apparent when confronted. Paradoxically, they only gain explanatory relevance when "related", because they belong to subsystems within the same system being studied - the theory of the firm. The "process" of knowledge intends to be methodologically logical, whereas their "products" cannot cease to have an extra-logical environment content, in addition to being subject to the personal biases of the observer himself. Therefore, questions about the theory should not be discarded *a priori*, because there is always the possibility of contributing to the analysis, either by reducing gaps or broadening applications. The important analytical task is to evaluate whether these questions improve or not the identification of validity limits of the inferences obtained, as well as the logic of the hierarchical relations and the degree of intensity maintained among the key-variables in the system/subsystem under analysis. This provides conditions to evolve and advance in the understanding of the phenomena under analysis. In the dichotomies, the similarities and connections of the system/subsystems can be identified.

The truly crucial problem that needs to be solved is to discover which contextual conditions - when and where – favor the inflection of the systemic relations of the relevant variables within a static-dynamic perspective. At a given time and space, certain variables of a model are identified as keeping specific relations of dependence and intensity. In the next moment and different place, the variable previously taken as endogenous becomes exogenous. As a result, conflicts between explanatory models would remain only in the appearance of the "stamps" attributed to the functions exercised by the variables of the system/subsystems. If contexts (or, broader systems) are taken from a comparative static dimension, the theory tends to emphasize the local conditions. If they are taken from a dynamic dimension, the emphasis is given to the temporal conditions of growth/retraction. But the locational and temporal contexts themselves also interact, affecting the changes in the direction of the signal and in the intensity of the relations among variables of the system/subsystems.

The solution to this problem can emerge if one accepts that the complexity in the interactions of variables and uncertainties of the contexts do not reside in the phenomena being studied, but derive from the human incapacity to understand them, such as the "bounded rationality" of Simon (*apud* Fransman,1994). However, using the very boundaries of rationality, one could compose a "synthesis of reality" , an interconnected set of partial views, the objective of which is to offer both a general and specific model. When assumed to have a so-called "bounded determinism" in space and time, it is possible to achieve cyclical, unstable but sustainable *equilibria* in the long run. Thus, the idea is to construct a systemic model that seeks a generality of the logical "process" of knowledge, specificity in its resulting "products", and a disciplinary partnership in solutions of identified or anticipated problems (Paez,1995). The synthesizing cooperation in partial theoretic views of reality permits a gain of specificity in the understanding of phenomena without necessarily losing generality in inferences obtained nor rejecting theoretic bases of the past.

2. Objective and Justification

The main objective of this article is to propose a model of analysis and management of a scientific-technological "innovation system" within organizations working with public resources and devoted exclusively to R&D (Research and Development) for agribusiness, such as Embrapa's coordination of the National System of Agricultural Research (SNPA), through advances in economic theory, based on the "New Institutional Economics" (NIE). Making use of the NIE as a theoretical system as proposed by Williamson (1985) and according to Joskow(1995) composed of the TCE (Transaction Cost Economics, e.g. Coase,1937; Williamson,1993), IO (Modern Industrial Organization, e.g. Tirole,1988), and IE (Institutional Environment Changes, e.g. Coase,1959; Davis and North,1971; North,1991), it would then be possible to establish an interactive and dynamic logic in the joint model of "innovation system" and of "firm system"

Using systems analysis, in addition to satisfying the need to construct a mentioned "synthesis of reality", would be in accordance with the initiatives of Embrapa since its beginning in 1973, when it sought to introduce the analysis of systems applied to its research activities (Gastal,1976,1980; Blumenschein,1978) and more recently in Castro et al (1994) and Portugal,(1998). In the General Theory of Systems, the interaction between the components is precisely the keyword in its definitions, reductionism-holism are complements, and the interdisciplinary approach is adopted.

In the initial conception of the model, the intention was to establish a parallel analysis between the "innovation system" within an R&D "firm system" for agribusiness and the so-called "Agro-Industrial System" (SAG), according to the theoretical approach of NIE, adopted by PENSA/FEA-USP (Zylbersztajn,1996; Farina et al,1997). The idea was to extrapolate this PENSA approach in order to maintain it coherent with the systemic focus of management of R&D Embrapa, developed from the end of 1989 (Goedert et al, eds.1994), which reemphasized the insertion of research in broader environments - that of agribusiness – rather than focusing exclusively on "within the farm gates". Among the activities, a methodology was developed by Embrapa (Castro et al,1994) and projects were conducted by interdisciplinary teams of researchers from Embrapa/SNPA for the characterization of R&D demands from the agribusiness clientele, under systemic and prospective views, and of segmented R&D markets (Castro et al, eds.1998). In its preparatory methodological phase, a seminar was presented by the PENSA coordination and the concepts discussed resulted in the consideration given to the transactions and the organizational and institutional environments by these projects.

Because R&D activities are of long maturation, the model to be constructed, in addition to taking into account the micro and macro

analytical levels, needs to reconcile the comparative discrete dimension of the transactions with the dynamic dimension of the growth of the firm. The objective would be to identify relevant parameters of decision-making for the improvement of economic efficiency and efficacy in the strategic/operational planning and management of Embrapa. The goal is to seek sustainable competitiveness of Brazilian agribusiness, compatible with the evolution of the R&D demands of society, the welfare of its individuals, and of national development.

At the turn of century, one could take the oil embargo, imposed in the 1970s on the developed world, followed by the loss of competitiveness by the USA, as warning signs of imbalances of forces, pressuring the emergence of changes, especially in scientific-technological (S&T) paradigms, such as information/computers/communication and biotechnology, for example. These transformations not only favored the emergence of various dynamic structures of the economic systems but also maintained significant relationships with the planning and management of the "innovation system", both at private and public firms. Though indissoluble, the economic and S&T environments can be separated only for analytical comparison, considering the specific case of Embrapa. In economic environments, the source of competitiveness is no longer explained exclusively by comparative advantages, derived from the differentiated endowment of the resource base, as assumed by conventional economic theory. It also depends on the advantages created by the degree of coordination of the agents during the phases of input transformation, production of outputs and consumer access to products. In the S&T environments, the functions of innovation as generating sources of comparative and competitive advantages have been broadened qualitatively and quantitatively. Similarly, the entire exercise of these complex and uncertain functions demands internal organizational structures to sustain them. It depends not only on the endowment of technical and managerial competence, but also on the capacity to speed up the transformation of S&T within a coordinated *continuum*, keeping close connection with the "final consumer" - the clientele of R&D, including clients, stakeholders as well as their R&D partners (Embrapa, 1998).

Thus, the ability of R&D to be competitive in "innovation systems" in S&T environments, as well as being a source of competitiveness in "firm systems" in economic environments of agribusiness, is paradoxically linked to the capacity to cooperate. From this perspective, the competitiveness of Embrapa, and even its very survival, depends on the interaction achieved by:(a) an intensification of the channels of communication with R&D clients and beneficiaries of the agribusiness economic environment;(b) a strengthening of the interactions with its partners in the S&T environment (organizations of the SNPA, other correlated and financing entities, national/international and public/private). The "innovation system" (R&D in agribusiness), located in a "firm system" (Embrapa/SNPA), related to other "firm systems" (or SAG) and situated in macro-environments (Brazil in a global economy on the brink of the 21st century) is no longer exclusively oriented by the supply model (science-technology push), or by the demand model (demand pull) but rather is configured by the strategic, simultaneous, and systemic interaction of both, in the so-called "R&D market" (Goedert et al.,1995).

3. Theoretic Foundations and Conceptual Bases

Within the NIE framework, the foundations and concepts of the theoretical model to be constructed originate from the contributions made by Coase (1937) and Williamson(1975;1985;1996) in the analysis of transaction costs, and by Penrose(1959) in the analysis of the growth of the firm. Included as complements were the respective later developments of interest to the objectives of this work, especially the "dynamic capabilities approach" (Teece, Pisano and Shuen,1997), complemented by the Spiller and Zelner's (1997) R&D supply-demand dynamic model.

Penrose and Coase were interested in opening the "black box" of the marginalist theory of the firm, aiming only to complement it in relation to the gaps left in intermediate situations of imperfect competition and identification of sources of growth of the firm in the real world. To address this problem, they put themselves in opposite positions, demonstrating their different facets. Penrose works from the inside of the firm towards the outside environment to understand its dynamism, but ends up emphasizing the relations of industry, market structure, and internal organization of the firm (Pitelis and Wahl,1998). Coase takes the opposite direction to understand the origin of the firm in terms of marginal *equilibrium* of transaction costs between those of the market vs. those internal to the firm. However, both end up identifying the relevance of the management factor, reflected in the human behavior present in the transactions or in the conduct of the firms, that affects the economic efficiency objective: "minimization of transaction costs" among agents and "search for profit" of firms, respectively.

Distinguishing themselves from the previous attempts of economists, both changed the perceptions of reality, offering a compatible treatment to the mainstream of economic theory. Coase's contributions could be classified as "incremental advance" (as in item 1) insofar as he added new elements to the marginalist analysis, providing a quantitative change to the evolutionary cycle of the theory of the firm, when the pressures for its revision were increased in the 1970s. Comparatively, the contributions of Penrose represented a major leap forward ("radical advance" as in item 1) in that she made possible the establishment of relations between static and dynamic dimensions on new bases. Sustainable *equilibria* are obtained in the "search for profit", equivalent to the growth rate of the firm over time, which counters the logic of a short-term optimizing *equilibrium* expanded for a long term, as in the marginalism-case.

In the crisis of the 1970s, the task of revising the theory of the firm went back in time in order to evolve. From Coase, and under the leadership of Williamson, the TCE was established as a new discipline and the strategy to relate the theoretic advances of economics around the NIE, began to be outlined. This linkage is centered on the effects of human conduct (in the transaction and in the firm) with emphasis on interdisciplinary relations within the

economics and with law, business administration, and other correlated social sciences (Williamson,1985; Coombs, Saviotti and Walsh,1992; Callon,1992). Thus, with TCE, a new critical *momentum* was provided, gathering questionings of economists dissatisfied with marginalism, as mapped by Machlup(1967) in addition to the institutionalist followers of Veblen and Commons, as mapped by Rutherford(1996). In common, the firm is no longer taken as a mere automatic mechanism for transforming inputs into outputs: the "black box" of the firm was effectively opened. It takes on its own identity, complete with body, name, and surname and has the strategic capacity to interfere in the results of the competitive game and in the market structure to reap profits, but is also influenced by these results. The gradation of this specificity varies, according to the theoretic approach adopted, and confrontations between theories of the firm arise once again mapped by Fransman (1994), allowing similar dilemmas as in the marginalism-case to be renewed. In short: a new *equilibrium* of theories was established. The firm is now taken as a "system" which produces, transacts and interacts with others of the hierarchy of the systems (or, external environments), maintaining various levels of intensity of relations in its key variables.

Adjusting to this new dynamism of the theory of the firm, the treatment given to innovation demanded a compatible approach (as mapped by Tushman and Nelson,1990). In this task, economics also returned to the past in order to evolve, reviving the postulates of Schumpeter(1942) and recuperating Penrose(1959), such as the evolutionary theory of economic change (Nelson and Winter,1982). R&D also designed itself as a "system" with its own life giving "soul" to the "firm system". However, with the increase of this identity, the human component becomes even more evident in the generation of S&T knowledge. The creativity or the intangible human ability to innovate grows and not only the capacity to organize the economic relations of production and transaction, or to alter the rules of the competitive game - the institutions. Thus, at the turn of the century, the "innovation system" is one of the most important weapons of the "firm system" leadership in the markets, both at domestic and global levels. However, in isolation, no organization is capable of capturing increasing but uncertain returns, offered by the new S&T paradigms and availing itself of competencies to absorb the magnitude of present complexities.

Within this panorama, it is also evident that the theories of the firm and of innovation, when considered in isolation, are not sufficient to grasp the complexity involved in the analysis, as was empirically tested by Poppo and Zenger(1997). In a specific situation, the decision to use market governances, to integrate, or to cooperate, will depend on the criterion used for transaction cost minimization, and also on a long run perspective - the capacity of the firm to produce and grow, focused on the chosen strategic direction and internal core competencies, conditioned by and conditioning its external environments. If economizing is the best strategy (Williamson,1991), it is clear that there is no point in economizing without knowing where to go. It is necessary to have both in order to incrementally construct a dynamic competitiveness of the "firm-innovation systems" as a whole in the long run. In this context, the "dynamic capabilities approach" (Teece, Pisano and Shuen, 1997) stands out by combining the firm's dynamic dimensions of Schumpeter(1942), Penrose(1959) and of Nelson and Winter (1982) with the transaction's comparative discrete dimensions (TCE), expanded for specific cases of the "innovation system", relating to and/or inserting into "firm systems". Moreover, the contributions of Spiller and Zelner (1997) would be added so as to build a dynamic model of analysis of R&D supply and demand, considering inter-firm collaboration among innovative firms and those owning downstream complementary assets.. In this proposed model, cyclical *equilibria* are suggested for bundled products, based on the combination of Chandler's theoretical postulates (Chandler,1962) with TCE's's and illustration provided by the telecommunications service sector.

The innovation can be understood as the "search, discovery, development, improvement, and adoption of new products, processes, and new organizational structures and procedures" (Jorde and Teece,1989;1992). Innovation is considered by the authors to be a highly interactive and interdependent process, characterized as an activity of high risk, uncertainties, and irreversibly cumulative. It has its origins in specialized (tacit) knowledge and/or of public domain (codified), which can be located in the environments internal/external to the firm, working with public/private resources, and be accompanied by a powerful public good component and the existence of free riders. By comparison with the "firm system", the "innovation system" in a R&D "firm system", like Embrapa, would be hierarchically represented by: (a) having its own technical function of production, given by the"technological paradigm"concept (Dosi,1988); (b) being oriented as a function of economic profits, symbolized by the "technological trajectory/regime" (Nelson and Winter(1977); (c) being related to other paradigms, composing clusters (Freeman and Perez,1988), such as a strictly coordinated set of "firm systems", emerging in economic environments; (d) being inserted into S&T macro-environments, or the "technical-economic meta-paradigm" (Freeman and Perez ,1988).

In order to analyze the "firm system" and the "innovation system" as an integrated set and considering the important role played by the transactions in R&D organizations, it would be necessary that assumptions of the dynamic dimension be compatible with those of the comparative discrete dimension of TCE within the systemic reference of the NIE. Both in Penrose and Coase-Williamson, determinism exists among key-variables, but is "bounded" by human behavior or the conduct of the firms, in addition to uncertainties of the external environments. In Penrose, this "bounded determinism" is located in the temporal dimension, assuming: (a) sustainable *equilibria* in "searching for profits" where internal allocative production/management *criteria* combine with the projection of the "mental image" of the firm over its external environment with strategic conducts being adopted to profit from "productive opportunities"; (b) "services" as true inputs of firm production function rather than "resource-bases"; (c) specificity of the firm as given by "objective knowledge" and "experience", influencing capacities to manage, recreate, learn and work as a team. In Coase-Williamson, "bounded determinism" is located in the spatial dimension, assuming: (a) bounded rationality and

opportunistic behavior of agents that with the frequency and external uncertainties of transactions, translate into capacity for a "farsighted view" of problems during the execution of incomplete contracts, by nature; (b) use of this "farsighted view" to adapt the transaction-cost economizing modes of governance sequentially; (c) understanding internal organization of the firm as a governance solution in continual betterment to furnish "the farsighted means by which order is accomplished, thereby to mitigate potential conflict and realize mutual gains"(Williamson, 1998).

These same points in Penrose and Coase-Williamson are explicitly evident in the degree of R&D asset specificity (Farina, Azevedo and Saes,1997) involved in the relations of production and exchange. That is, the differential asset specificity contained in firms and in transactions. As a result, the more specific the assets are, the greater the possibilities of opportunistic behaviors by parties in transactions, covered in external uncertainties (as in TCE), like specific opportunistic strategic conducts of firms taking advantage of "productive opportunities" of the external environment (as in Penrose). In TCE, factors that allow for "opportunism" are asset specificity, interacting with frequency and external uncertainty of transactions, conditioned to institutional environments. Penrose, seeing the problem from an opposite angle, proposes that firm specificity ("experience plus objective knowledge") allows new "productive opportunities" to be seen, which instead of restricting, broadens the possibilities of interfering in the future for human capacity to foresee new "services" for "resources, or firm growth leading to new opportunities and additional expansion. (Penrose's "virtuous cycle" paradox, in which specialization induces diversification and vice-versa, creating opportunities for further growth, as focused by Pitelis and Wahl (1998)

Penrose assumes that "objective knowledge" can be transacted freely in the market, whereas "experience" has a value exclusive to the firm with no alternative uses outside it. However, it is precisely because firm assets become specific that they can complement the asset specificity of other firms. New "services" are seen by the inter-firms, opening up alternative possibilities to be combined, via transactions, without each firm necessarily losing its identity (its "soul") but rather continuing to expand (as a network). The firm can "grow" even further through collaboration because, in addition to sharing profits, it is not tied to internal routines and its stocked "resource" bases. According to time required and "resources" available to place "services" foreseen by parties, transactions external to the firms can be conducted to reduce this interval and reach the most economical organizational arrangements possible, related to external environments, including those of legal appropriation of R&D results (Teece, 1986). Then, the link between Penrose and TCE can be established. For the "objective knowledge" of Penrose (as a generic asset in TCE), the economizing exchanges are made via market governances. For the "tacit experience" of Penrose (as an asset with several grades of specificity in TCE) economizing governance are hybrid solutions (or, cooperating at different degrees of commitment and integration) or via vertical integration under unified management control when high asset specificity is present These solutions depend on key variables identified by TCE, and also on firms' internal factors (managerial and technical both in terms of scale and scope economies) and those linked to market structure, farsighted strategic view with signs from the environment. Thus, no more than three dynamic-factors highlighted by the "dynamic capabilities approach" – the firms' "process-position-path" (Teece, Pisano and Shuen, 1997).The interactions of these factors condition and are conditioned by the environments in their joint spatial and temporal dimensions. Inasmuch as the firm's assets are specified by the "objective knowledge/experience", acquired throughout the processes of production and exchange, the governances adjust to the market solutions and vice-versa (or Williamson's "fundamental transformation" of transactions). New unstable dynamic *equilibria* are achieved in a dynamic fashion (intra- and inter-firms), making the firm's boundaries flexible. What gives the firm sustainability over time is its strategic capacity to discern (or, foresee) what is essential to generate its continuity in the alternative scenarios viewed in their contexts, producing and transacting to search for profits and survive. The integrity of the firm is incrementally guaranteed in terms of comparative "remediable efficiency" of TCE for each situation/moment given (firm instant growth rate) to maintain dynamic performance in the long run (its growth rate over time of Penrose). Thus, the link between the productive/ allocative dynamic efficiency of an innovative "firm system" and the compared efficiency of the costs of R&D transactions can be established, even in public R&D organizations that do not have economic profit as their exclusive objective. [1]

If the assumptions of the effects of human behavior associated with contextual uncertainties were adopted, "sustainable fitter" *equilibria* could be reached by the firms, strategically outlined in the long run, but made up of comparative discrete efficiencies, which can be attained at a given moment and place ("the fitter" of TCE), differentiating itself from "the fittest" *equilibrium* of marginalism. However, a special difference exists, for example, between a sustainable yield catch function of a "stock of fish" and that of producing from a "stock of human knowledge". Though the latter is also, in democratic societies, a renewable, common ownership and an open-access resource, its intensive exploration, in addition to not lowering, actually increases this "stock" even further (or, "R&D increasing returns case"). In comparison, the "stock of fish" is only a "resource", using the definition given by Penrose. It is subject to natural laws (birth/mortality rates) and uncontrollable environmental conditions. However, only human inventiveness has the power of deciding and intervening (or, creating "services" for this "resource"): to free the stock of fish from extinction, capturing it at sustainable bio-economic yields; or to reduce it; or to destroy it; or even to limit the pressures of demand by means of aquaculture with the technical support offered by R&D.

[1] Indeed, if Embrapa was a private corporation, and according to Jensen and Meckling(1976); Fama and Jensen(1983), it would not cease being an "agent" acting in the name of the objectives defined selectively by the "principal" – its financial stakeholders - be they for "equity" (in the case of its R&D clientele) be they for "debt" (in the case of society, in general, and the taxpayer, in particular). The selective hybrid solutions of "financing" would be contemplated by the term "dequity", given by Williamson (1988).

In terms already systematized under the NIE, the "dynamic capabilities approach" would give operational content to the "innovation system" proposed model, with a single but major difference. Nelson and Winter's(1982) theory of the evolutionary firm and its micro- and macro-analytic developments (Dosi, ed. 1988) would have no more of a descriptive character than an explanatory one, though they also adopt the existence of non-stable *equilibria.* The assumptions of the evolutionists do not escape a mechanic determinism, ruled by "natural laws", borrowed from Darwin (also pointed out by Coombs, Saviotti and Walsh,1992). They did not detail the role played by human behavior, and according to Fransman(1994), the uncertainty component did not merit adequate theoretic treatment in the decision-making of the evolutionary firms. Darwin's laws would serve as a reference when evolution followed its natural course, such as the catches at the end of the last century not affecting significantly the fishery biomass. Now, with biotechnology, means have been created for humanity to intervene in natural selection itself, thus increasing the ethical and moral responsibility of the scientist for the destiny given to his discoveries by society. On the other hand, laws may even be followed by human beings, but not always. Ultimately, one could argue that, if "routine-search-selection" of the evolutionary firm were the only answer to the problems of bounded rationality, then the greater the accumulated number of answers over time is, the greater the bounds imposed on its rationality are, and consequently the lower the possibility of survival in mutant environments. In time, this firm would be "involutionary", in the sense that, with so many rules mechanically established, it would no longer "see" the changes of the environment, nor would it adjust to them. Schumpeter's "creative destruction" would become true. Williamson's "farsighted view" of contractual problems would not be possible nor would Penrose's "mental image" of the firms be projected to their environment. In the competitive game, the survival of the fittest in knowing the rules of the game is an *ex post* explanation. The fittest of today are not always capable of maintaining evolution in motion, just as the competitive game does not have its result defined beforehand, otherwise there would be no interest in playing. In the beginning, only the rules are known. The unusual situation of the less apt winning can occur (as in Vietnam), when components of uncertainties in the environment and human behavior are taken into account to change the very rules established and even affect natural cyclical patterns of evolution.

On this particular, Allen(1988) demonstrated empirically that when deviations of human behavior are inserted in the optimizing models, the results can lead, on the one hand, to the unexpected amplification of fluctuations, and on the other hand, tend to approach the cyclical variations actually observed. An example was evidenced, using a model of dynamic spatial equilibrium in the exploration of fishing zones when two types of fishermen's conduct were introduced: "stochastic" (giving little importance to rationality and available information to select the fishing areas) as opposed to "cartesian" conduct. Translating Allen's(1988) viewpoint in terms of the NIE. For evolution to occur, information must circulate between both types of fishermen (via R&D transaction, formal or informal) and the changes in S&T must not be commanded by those that represent the mean-standard, because this is the phase of stability (Penrose specialization, or Allen cartesian behavior) and not of changes (Penrose diversification, or Allen stochastic behavior). One could conclude that both conducts (or roles) are essential to the survival of the system. They must be maintained in their specificities (as in TCE, where economizing governance solutions are selective) and not outweighed by equalization of the probabilistic mean of the deviations from the parameters (as in marginalism, a single optimizing solution in any circumstance, obtained by the agent rational behavior assumption).

Considering the emphasized link between TCE and Penrose, it would even be possible to suppose that the behavioral deviations of individuals and those located in complex and uncertain environments are present in all organized systems, not only in the transactions of individual parties, but also in those situated at successively higher hierarchical levels. Regardless of the scale of the system, they would be repeated – individuals/ firms/nations and so on – and the most economical organizational arrangements possible will be selected (means, or governance modes) to reduce these deviations, aiming to survive as long as possible (ends, or meeting the evolution goals of the system). Generalizing: the "systems" under consideration (the firm and the innovation) are in accentuated transformation, in addition to being a "process" and a "product" at the same time. As a "process", systems would follow the logical procedures that are repeated regardless of scale. As a "product", systems would have extra-logical components related to particular contexts, both in spatial and temporal dimensions and combinations of both. Systems are oriented by goals (common to the whole system and specific to their subsystems) that join parties and divide tasks. In a dynamic dimension, systems are unstable and cyclical but tend to search for sustainable *equilibria* in the long run, having a "bounded determinism" in a given space/time (internal to each subsystem and joined to the system). The causal relationship of relevant variables could invert itself, intra- or inter-systems/subsystems, affecting the external contexts and being affected by them. Thus, "process" and "product" are indissolubly linked to the system/subsystems. Only for purposes of analysis can they be dissociated. In practical terms, the point can be exemplified with the intangibility of the human capacity to manifest itself in narrow and mutual relation to external environments: being a grammar teacher does not make someone a great writer, just as no one becomes a great scientist by living isolated from the world.

Finally, it becomes necessary to further emphasize that conflicts among economists, created by the assumption of behavioral opportunism of the agents of the TCE, emerge from confusing "individuals" with "actors" that have *status a*nd play several roles in the different systems they participate in. The concern is not precisely with "stochastic" (or, opportunistic behavior of the agents in the TCE), but the *status*-role attributed to this actor for the functioning of the "firm system" and/or "innovation system" in a particular situation. In other systems, this actor can assume diverse roles, just as a "stochastic" fisherman can be a "cartesian" in the *status*-role of the father. It would be the same situation raised by Penrose when emphasizing that "services" are not necessarily linked to "resources" in the firm's production function, just as an

individual/firm/nation has several roles designated by the story line evolution of the various "plays" (or, systems) they participate in, inserted in specific "scenarios" (broader systems or external environments). In Parsons' concrete system of actions, the social, the personality, and the cultural systems are included which, by interacting, allow reciprocal transformations to occur, with human actors having *status* and playing roles (1952,*apud* Ianni and Cardoso, eds.1961). Compared with the NIE framework, the opportunism/bounded rationality of TCE would be characteristic of the personality system of Parsons. The institutional/ organizational/competitive environments, focused on IE and TCE within the NIE, would be almost equivalent to Parsons' cultural system. Similarly, the strategic conduct (human component of firm and of transactions) is the variable within the NIE linking TCE, IE, and IO that would correspond in Parsons to the action/interaction of social, cultural, and personality systems.

4. Theoretical Model: A Synthesis

The model proposed to be applied to the analysis of an "innovation system", located into a "firm system" (both working exclusively for R&D, or those combining R&D and business units), would be, at the same time, general and particular, because it would be put in the terms that follow. Given certain environmental conditions (time, place, time vs. place) and assuming the human behavioral assumptions (bounded rationality and opportunism), the selection of the economic organizational arrangements should be compatible and specific to the type of problem in question that keeps the system and its subsystems from interacting efficiently and from effectively achieving their final objectives in the long run. Ultimately:
(a) if assets involved are generic, routine, codified, with a high frequency of occurrence in the system and/or short term without uncertainties, the instruments of the market will tend to give a transaction cost minimizing solution (prices/costs, impersonal classic contracts, financing by loans in the market, consultative councils);
(b) if assets involved are specific, non-routine, strategic, tacit, with a low frequency of occurrence in the system and/or with an elevated component of uncertainties, the discretionary hierarchical instruments will tend to give the transaction cost minimizing solution (personalized discretionary power, vertical integration, financing by issuing shares, deliberative councils).
(c) In cases of assets of intermediate specificity, the combination of instruments - hierarchical power and automatic of the market - will tend to give selective hybrid solutions, following, by successive decomposition, the same logic proposed by TCE (neoclassical and bi- and multi-lateral contracts, financing combination, "dequity").

The dynamic evolution of these "innovation and firm systems" is guaranteed by attaining efficiently, incrementally, and effectively their growth objectives in "searching for profits" (measured in monetary terms or otherwise), via sustainable *equilibria*, given by the benefits/costs ratio of the relationships of production and exchange, intra- or inter-agents, reciprocally related to the environments external to the systems. The numerator corresponds to the infinite possibilities of the human capacity for multiplying the benefits by the creation, invention, reconfiguration, reutilization of "services" through the "resources" available or to be incorporated. The denominator corresponds to the infinite human capacity to select, to coordinate, and to monitor the organizational arrangements economizing production and transaction costs. As a result, costs cease being absolutely high or low: they are comparatively high or low with reference to the benefits intended, current or anticipated (farsighted). The boundaries of the "firm system" become flexible and connected to the limits of the "innovation system". Its instant growth rates would be given on comparative discrete bases in a given moment and place – increase of benefits versus cost reductions – but would be strategically directed at the search for growth/survival in the long run. Thus, Penrose's "virtuous circle" is maintained as are the sequential adjustments of Williamson's incomplete contracts operating within the "fundamental transformation" of governance transactions *ex post*. In other words: "stochastics" (source of movement) cyclically discovering innovations/governances so that "cartesians" (source of stability) can explore and exhaust them; the information circulating among them, via transactions (formal or informal); and all of them evolving in the long run to fulfill their specific roles in the system/subsystems under analysis.

Putting the proposed model in these terms, means that both in the "innovation system" and in the "firm system", there are no single solutions but rather selective ones: it is not economical to treat "cartesian" problems with "stochastic" solutions and vice-versa, if the objective is to evolve and create the future. If this logic exists, it could be also supposed that the types of roles played by the "stochastics" and the "cartesians" in the evolution of the systems coexist and are repeated in the successively infinite hierarchical level. If this is the case, then one would conclude that the systemic framework given by NIE, interconnecting disciplines of economics and the other social sciences, would represent the mentioned "synthesis of reality", because it would embrace these partial theoretic views in the study of complex and uncertain systems. By extension, the previously insolvable theoretical and methodological conflicts would be only apparent among disciplinary components of the NIE, such as holism/reductionism, individual/society, deduction/induction, efficiency/efficacy, competition/cooperation, and, mainly, micro- and macro-analytical levels. This is because the logic of the "process" would be repeated on an ever broader scale with differentiated "products" at diverse complexity levels, though reciprocally related. So, gains in the explanatory power of the system are achieved with increases in the depth of analysis of its disciplinary components, allowing the elevation of quality and refinement of the logical, hierarchical, and successive interactions to be maintained among the relevant variables of the systems. Furthermore, if these dilemmas are only apparent, as sides of the same coin, then one can conclude that to compete it is necessary to cooperate; to generalize it is necessary to specify; to specialize it is necessary to diversify; and, to intervene it is necessary to know, understand, foresee, act, and relearn incrementally with experience, and vice-versa, depending on the specific contextual situation given. Proceeding from there, the next problem would be limited to identify contexts that favor inflection and change on intensity of the

systemic relations, aiming to interfere in these conditions in order to intervene in the cyclical patterns of movement expected, whether strategically retarding them or speeding them up, depending on the point of view of the parties involved in the competitive game.

5. Applied Model Proposal: Conclusion and Recommendation

This theoretical model applied to analysis and management of the "innovation system" and "firm system", framed in respective contexts, is represented by a longitudinal cross-section of time and place, as if it were a "photo" component of a "movie", or the co-evolution of these two systems/subsystems (Figure 1). The model would apply to Embrapa/SNPA, taking alternatively: (a) the "innovation system" coupled with an exclusive R&D "firm system" - Embrapa - interacting with its R&D partners in S&T environments (or, R&D supply side); (b) the "innovation system" in a "firm system"- Embrapa - currently interacting with the R&D clientele located in agribusiness "firm system" (or, the SAG using the terminology of PENSA) in economic environments (R&D demand side). The SAG make up specifically called by Embrapa the "productive chain/natural system/knowledge chains" to match the types of clienteles which emerged from the 37 decentralized R&D units, respectively, classified as: R&D products centers; R&D ec-regional/forestry centers; and R&D basic theme centers. In Figure 1, dynamic links between "firm system" and "innovation system" and respective organizational arrangements would be located in the "R&D market" which as defined of Embrapa, represents the meeting *locus* between the supply and demand of R&D (Goedert, Castro and Paez, 1995). Embrapa's decentralized centers, offering R&D interact among themselves and other R&D partners to fill the demand of their R&D clientele of agribusiness and consequently the necessities of their final beneficiary – society. In terms of TCE within NIE, this "R&D market" for agribusiness corresponds to the broad environment of relations among diverse specificity grades of R&D assets and it tends to assume the most varied ("infinite") modes of governances from market solutions to hybrids and/or those vertically integrated.

The conduct of the agents is symbolized in Figure 1, by the "scientific-technological strategies" and entrepreneurial "agribusiness strategies", respectively. Both have as a common base the "imponderability" of human behavior in the relationships of production and exchange, associated with the uncertainties of the external environment, manifested at successively higher hierarchical levels. The conducts represent strategic decision-making, capable of changing, creating and constructing a path to the alternative possible futures, foreseen by the interaction between their external and internal environments in co-evolution. These decisions, by joint and/or simultaneous effects, return to their components and change the configurations of the system/ subsystems, assuming a dynamic of their own. These reciprocal effects, leading to unstable and cyclical but sustainable *equilibria*, are symbolized by two-way arrows. From there, it is possible to use this constructed theoretical model:(a) to subsidize the decision-making in terms of "innovation system" management, located in a R&D "firm system", interacting with other agribusiness "firm system"; (b) to simulate and empirically test hypotheses, refering to the key-variables with the theoretic framework supplied by NIE

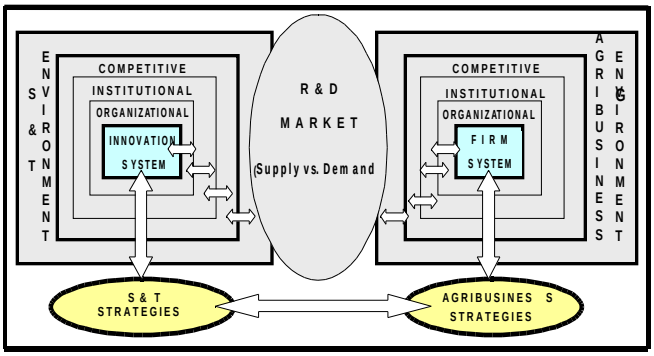

Figure 1 – Representation of the Theoretical Model for Agribusiness Innovation Systems in R&D Public Organizations

However, one question still remains. Due to the level of complexity in the analysis – dynamic models, non-stable *equilibria*, involving uncertainties of human behavior and environments: - what would be the quantitative instrument that would allow one to test, to simulate and to confront empirically the systemic relationships among the key-variables and to foresee them? Levy(1994) helps find an answer when he applies the instruments of the chaos theory to subsidize managerial decisions in the case of a firm in the computer production chain, dependent on suppliers and parts from abroad. According to this author, the chaos theory, as an extension of the systems theory, is also able to demonstrate how a simple set of causal relations generates a repetitive "fractal" pattern causing unpredictable results: there is order in disorder. Levy(1994) considered that the application of the chaos theory in social sciences is possible, as long as differences in the "laws" that rule the physical and social sciences are assumed, along with the existence of several chaotic systems interacting (prices/crops affected by climatic and economic conditions). He further highlighted that, if chaotic systems have fractal patterns repeating at any interval (such as the cyclical and repetitive fluctuations found in the capital market by minute/hour/day/month/year), they can permit short/medium term predictions, similar to weather forecasts. On this point, he stressed that the technique of alternative scenarios helps the configuration of chaotic models by reducing the amplitude of possible futures in their modeling. Then, one can conclude that alternative scenario techniques do nothing more than clarify what external conditions can possibly occur, favoring the emergence of certain events (like having atmospheric conditions to refine the weather forecast, as pioneered by Lorenz (1996), when used chaos theory in the study of complex, nonlinear dynamic systems).

Various theoretical and empirical papers, related to chaos theory applied to social sciences worth mentioning are Kelsey (1988), Baumol and Benhabib (1989), Carthwright (1991), and Van Staveren (1999). Based on Levy (1994), the compatibility of the generic model outlined in this paper and chaos theory is obvious, permitting the supposition of its utility, aiming to subsidize quantitative analyses of correlation of relevant variables and/or decision-making in case of unstable systems with multiple acting

variables, including effects on human behavior and uncertainties of the external environment. If this is the case, then it could be assumed in the theoretical model proposed that fractal patterns of chaos theory are contained in TCE, combining with the dynamic factors identified by Penrose, their later developments and relations to other social sciences, within a theoretic system are referenced in the NIE – "synthesis of reality". This model is at the same time particular (as an environmental "product") and general (as a logical "process"of knowledge). As a consequence, NIE could be understood as a theoretical system that is moving "modest[ly], sluggish[ly], molecular[ly], but definite[ly]" (Williamson's words) towards the analytical refinement of the study of interacting social and economic systems.

In particular, this model would be applied to the analysis and management of activities of production and transaction of R&D developed by Embrapa/SNPA – "Embrapa's innovation system" (SIE) - aiming at the competitiveness of agribusiness and the welfare of Brazilian society in domestic and global markets for the 21st century.

6. References

Allen,P.M. Evolution, innovation and economics. In: Dosi. Giovanni., ed. *Technical change and economic theory*. London: Pinter Publish, 95-119, 1988.

Baumol, W.J. and Benhabib J. Chaos: significance, mechanism, and economic applications. *Journal of Economic Perspectives*, 3(1) 77-105. 1989.

Blumenschein, A. *Princípios da pesquisa no sistema Embrapa.* Brasília: Embrapa, [s.n.],1978. 47p.

Callon, M. The dynamics of techno-economic networks. In: Rod Coombs; Paolo Saviotti, Vivien Walsh., eds. *Technological change and company strategies.* London: Academic Press, 72-102, 1992.

Carthwright, T.J. Planning and chaos theory. *Journal of the American Planning Association*, 57(1):44-56, 1991.

Castro, A.M.G., Cobbe, R., Quirino, T.R., Luchiari Jr. A. and Martins, M.A.G. Aplicação do enfoque sistêmico na gestão de C&T. In: Wenceslau Goedert, Maria Lúcia D´A. Paez, Castro, A.M.G. eds. *Gestão de C&T*: pesquisa agropecuária. Brasília: Embrapa-SPI, 77-104, 1994.

Castro, A.M.G.; Paez, D´.A., Cobbe, R.V.; Gomes, D. and Gomes, C.G. Demanda: análise prospectiva do mercado e da clientela de P&D em agropecuária. In: Wenceslau . Goedert, Paez, M.L.D´A. and A.M.G. Castro eds. *Gestão de C&T:* pesquisa agropecuária. 165-202, 1994.

Castro, A.M.G.; Lima, S.M.V., Goedert W. J.; Freitas Filho, A. and Vasconcelos, J.R. eds. *Cadeias produtivas e sistemas naturais:* prospecção tecnológica. Brasília: Embrapa-SPI, 1998. 564p.

Chandler, A. D. Jr *Strategy and structure*: chapters in the history of industrial enterprise. Cambridge, Massachusetts: MIT Press, 1962.

Coase, R.H.. The nature of the firm. *Economica*, 4 (nov):386-405, 1937.

Coase, R.H. The lighthouse in economics (1974). In: Ronald, H. Coase ed. *The firm, the market and the law*. Chicago: The University of Chicago Press, Chapter 7. 1990.

Coombs, R., Saviotti, P. and Walsh, V. Technology and the firm: the convergence of economic and sociological approaches? In: Rod Coombs, Paolo Saviotti and Vivien Walsh, ed.s *Technological change and company strategies.* London: Academic Press, 1-25, 1992.

D'Apice, M.L.B. *A problemática de planejamento e sua relação com a realidade brasileira.* São Paulo: Pontifícia Universidade Católica de São Paulo, [s.n.]1965. 33p.

Dosi, G. Sources, procedures, and microeconomics effects of innovation. *Journal of Economic Literature,* XXVI (Sept.):1120-1171, 1988.

Embrapa. Secretaria de Administração Estratégica (Brasília, DF). *III Plano Diretor da Embrapa:* realinhamento estratégico; 1999-2003. Brasília: Embrapa-SPI, 1998. 40p.

Fama, F.E., and Jensen, M.C. Separation of ownership and control. *Journal of Law and Economics*. 26(jun): 301-326, 1983.

Farina, E.M.M.Q.; Azevedo, P.F. and Saes, M.S.N. *Competitividade:* mercado, estado e organizações. São Paulo: Singular, 1997. 285p.

Fransman, M. Information, knowledge, vision and theories of the firm. I*ndustrial and Corporate Change*, 3(3.):713-757, 1994.

Freeman, C. and Perez, C. Structural crises of adjustment: business cycles and investment behavior. In: Giovani Dosi, ed. *Technical change and economic theory*. London: Pinter Publisher, 38-66,1988.

Gastal, E. *Teoria de sistemas e a pesquisa agropecuária*. Brasília: Embrapa, [s.n.], 1976. 22p.

Gastal, E. *Enfoque de sistemas na programação da pesquisa agropecuária.* Rio de Janeiro: IICA, 1980. 207p. (Desenvolvimento Institucional, 8).

Goedert, W., Paez, M.L.D´A. and Castro, A.M.G., eds. *Gestão em C&T*: pesquisa agropecuária. Brasília: Embrapa-SPI, 1994. 392p.

Goedert, W., Castro, A.M.G. and Paez, M.L.D´A. Sistema Embrapa de planejamento. *Revista de Administração,* 30(4): 19-33, 1995.

Henderson R.M. and Clark, K..B. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*. 35(1) p. 9-30, March 1990,

Ianni, O. and Cardoso, F.H. eds. *Homem e sociedade*. São Paulo: Companhia Editora Nacional, 1961. 332p.

Jensen, M.C.and Meckling, W. Theory of the firm: managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3, 305-360, 1976.

Jorde, T.M. and Teece, D.J. Innovation, cooperation and antitrust. *High Technology Law Journal*, 4(1): 1-112, 1989.

Jorde, T.M. and Teece,D.J. eds. *Antitrust, innovation, and competitiveness.* New York: Oxford University Press, 1992. 244p.

Joskow, P.The new institutional economics: alternative approaches. *Journal of Institutional & Theoretical Economics*, 151(1): 248-259, 1995.

Kelsey, D. The economics of chaos or the chaos of economics. *Oxford Economic Papers:* Quantitative economic history, Oxford University Press, 3-31,1988.

Levy, D. Chaos theory and strategy: theory, application, and managerial implications. *Strategic Management Journal*, 15(167-178),1994.

Lorenz. E. *A essência do caos.* Brasília: Editora Universidade de Brasília, 1996. 278p.

Machlup, F. Theories of the firm: marginalist, behavioral, managerial. *American Economic Review*, LVII(march):1-33, 1967.

McKelvey, M.. Coevolution in commercial genetic engineering. *Industrial and Corporate Change*, 6(3): 503-532, 1997.

Nelson, R. and Winter, S. In search of a useful theory of innovation. *Research Policy*, 6(1): 36-77. 1977.

Nelson R., and Winter, S. *An evolutionary theory of economic change.* Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 1982. 437p.

Paez, M.L.D´A. *Sistemas estaduais*: projetos de planejamento estratégico e de prospecção de demandas, uma proposta de operacionalização. Brasília: Embrapa-SSE [s.n.] 1995, 13p.

Penrose, E.T. *The theory of the growth of the firm* (1959). Oxford: University Press/Basil Blackwell Publisher, (2nd edition). 1980, 271p.

Pitelis, C.N. and Wahl M.W. Edith Penrose: pioneer of stakeholder theory. *Long Range Planning*, 31(2): 252-261, 1998.

Poppo L. and Zenger, T. Testing alternative theories of the firm: transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management Journal*, 1997 (forthcoming)

Portugal, A. D. A importância estratégica da prospecção tecnológica para o SNPA. In: Castro, A.M.G.; Lima S.V.; Goedert W.; Freitas Filho, A.; Vasconcelos, J.R.P., eds. *Cadeias produtivas e sistemas naturais:* prospecção tecnológica. Brasília: Embrapa-SPI, 1998, Cap. 1.

Rutherford, M. *Institutions in economics.* (1994). New York: Cambridge University Press, 1996. 225p.

Schumpeter, J.A. *Capitalism, socialism and democracy.* New York: Harper & Row, 1942.

Spiller, P.T., and Zelner, B.A. Product complementarities, capabilities and governance: a dynamic transaction cost perspective. *Industrial and Corporate Change*, 6(3):561-594, 1997.

Stephan, P. The economics of science. *Journal of Economic Literature,* 34(Sept):1199-1235, 1996.

Teece, D.J. Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy*. 15:285-305, 1986.

Teece, D.J., Pisano, G. and Shuen, A. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7):509-533, 1997.

Tushman, M.L. and Nelson, R.R. Introduction: technology, organization and innovation. *Administrative Science Quarterly*, 35(1):1-8, 1990.

Van Staveren, I. Chaos theory and institutional economics: metaphor or model". *Journal of Economic Issues.* XXXIII(1):141-167, 1999.

Williamson, O. *Markets and hierarchies*: analysis and antitrust implications. New York: The Free Press, 1975. 285p.

Williamson, O. *The economic institutions of capitalism*: firms, markets, relational contracting. New York: Free Press, 1985. 449p.

Williamson, O. Corporate finance and corporate governance. The Journal of Finance. XLIII(3): 567-589, 1988.

Williamson, O. Strategizing, economizing and economic organization. *Strategic Management Journal*, 12:75-94, 1991.

Williamson, O. *The mechanism of governance.* New York: Oxford University Press, 1996. 429p.

Williamson O. Human actors and economic organization. In: *Second Annual Conference of The International Society for New Institutional Economics.* Sept. 17-19, 1998. Paris: [s.n.], 1998. 35p.

Zylbersztajn, D. Governance structures and agribusiness coordination: a transaction cost economics based approach. R*esearch in Domestic and International Agribusiness* Management, 12, 245-310, 1996.

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