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Dynamics of Innovation and Governance of Economic Growth

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Abstract

Innovation ability plays an important role in economic growth not only in under- developed countries, but also in developed countries, especially when markets are in recession. In this paper, we analyzed changes in major developments in the context of innovation capacity and the causality relation between innovation and its sources through an empirical study based on the automotive subcontractor network, which has experienced a number of architectural innovations. We showed that most of innovation sources (information sharing, organizational size, investment in R&D, and knowledge volume) are the accelerators or "effects" rather than the stimulators or "causes" of innovation.

Keywords: Organizational innovation, Network, learning, Dynamics of innovation, Innovation governance, Innovation accelerators, Innovation Stimulators

1- Conceptual framework

1-1- Terminology of Innovation

1-1-1- Importance of innovation for firm's survival

In order to gain the economic profit as the preliminary incentive to stimulate the production system and continuous growth in the presence of scare resources, firm is faced with an increasingly competition. Innovation as one of the sources of firm's competitive advantage makes the firm capable to introduce

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and supply new products or services to market, and to improve productive capacity. Decreasing the period of designing a new automobile model, from 10 years in 1980's to less than 3 years in 2000, indicates that the innovation growth rate is accelerating. So, as leverage and a source of competitive advantage, innovation must become an integral part of organization's strategy. Literatures on competition have been introduced five sources of competitive advantage namely, price, reputation, quality, commercial services, and innovation[1]. Among these sources, innovation has a significant contribution because of its control over four other sources. More innovations introduce lower prices, better quality, more commercial services, and higher reputation. Hayek argued that, "*competition is a virtuous mechanism of selection of resources through the price or the invisible hand mechanism in an open classical economy*". In such a simple model, market signal conducts the enterprises to find required information in a minimum price. In contrast to Hayek definition and more advanced regarding to Walrasian equilibrium neoclassical model, the Schumpeterian school of thought consider it as a continuous process of learning. Through the firm's production system, innovation generates not only the new products but also finds the new ways and techniques to save the materials and time in the national and even international levels.

1-1-2- Definition of Innovation

There are a great number of literatures allocated to conceptualization of "innovation"[2]. The classical approaches consider the innovation in a micro product-based framework. Hence, it concentrated to the industrial and economic aspects to promote the production process. For this reason, these academics were tried to develop the knowledge about component design concepts and the way in which they are implemented in a particular product during a long epoch. But, in a saturated market and existence of a great number of differentiated products, economic survival could not be obtained by mere incremental innovations because of the violent competition between established firms. In contrast, a dynamic approach requires architectural knowledge about the ways in which the

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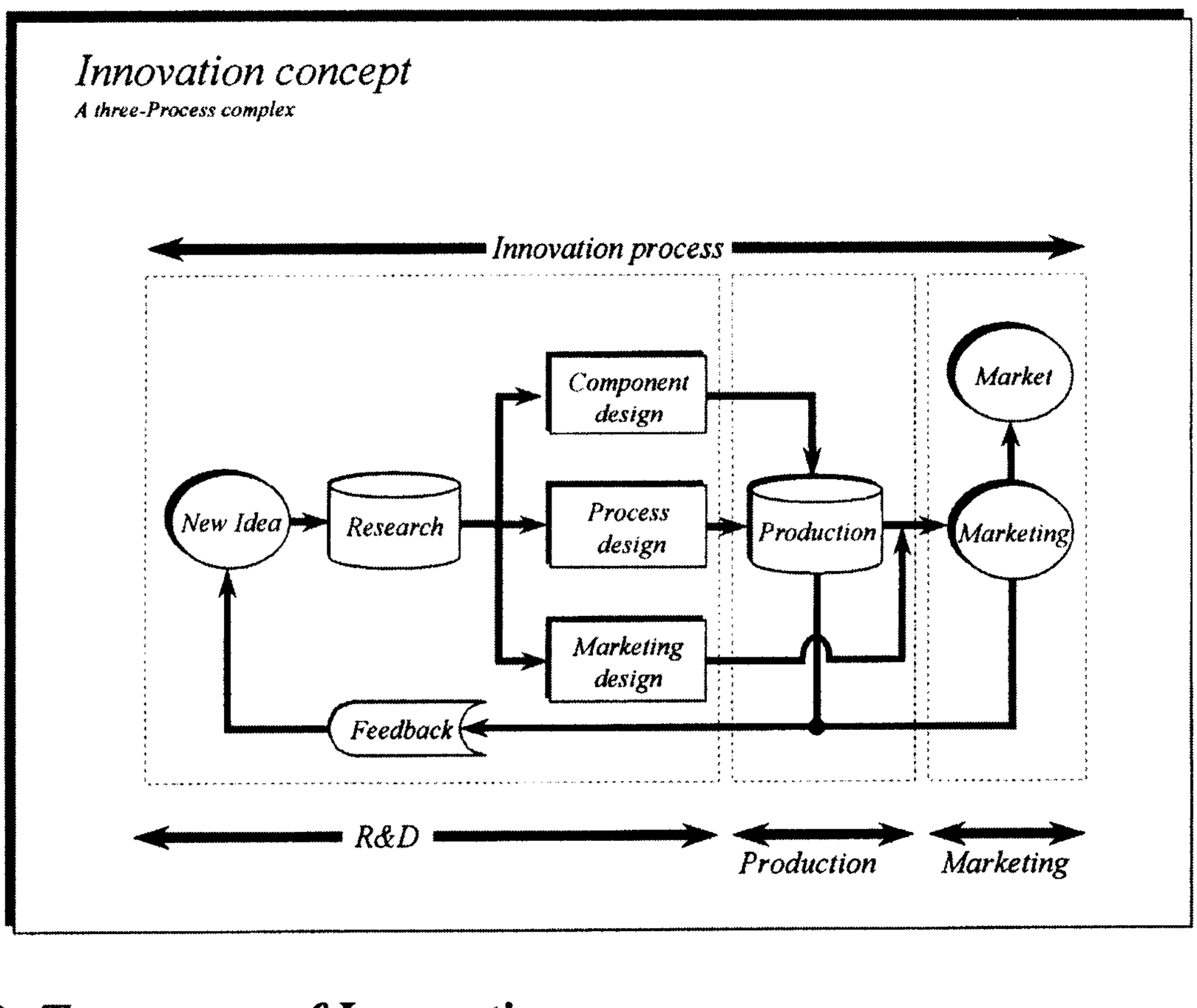
1 - Kashani (2003b).
2- e.g. OCDE (94) and Kashani (2003).

components are integrated and linked together into a coherent whole production system.

In this paper we define innovation as a three-process complex including R&D, production, and commercialization. As it showed through the following figure, in the first stage of innovation, a concreted idea implicated to a series of R&D activities. The result of this stage is product design, process design, or marketing design. During the second stage, the results of product and process design introduce into production system in order to generate the commercial products. Finally by the third stage, these products are supplied to consumer markets through the commercialization process designed by the R&D stage. Any feedback from the side of consumer market could be a new motif to modify the current product or to regenerate a new product.



1-1-3- Taxonomy of Innovation

Terminologically, innovation is classified in four types: incremental, modular, architectural, and radical[1]. "Product innovation" corresponds to the

1- Henderson and Clark (1990), Stuart (1999).

introduction of a new or improved product into the market. "Incremental innovation" can often take the form of smaller enhancements around major radical innovations. It can take the form of design improvement, learning by doing and learning by using. Often underestimated in contrast to radical innovation, incremental innovation is crucial for firms' productivity growth. Incremental innovation introduces relatively minor changes to the existing product, reinforces the capabilities of the established organizations, and often reinforces the dominance of established enterprises. "Architectural innovations" are discontinuous events, which are the result of a deliberate research and development activity. Architectural innovation is based on a different set of engineering and scientific principles and often opens up new markets and applications. Radical innovation often creates great difficulties for established firms and can be the basis for the successful entry of new firms.

Impact of innovation specificity		
Innovations	**Market**	**Production system**
Incremental	- Emerge innovative firms - Higher competition - More advantages for consumers	- Unchanged network structure - Improve slightly resources
Modular	- Deteriorate current resources - Introduce new resources in market - More advantages for consumers	- Change slightly network structure - Improve current resources
Architectural	- Threat the current resources - Introduce new resources - Increase uncertainty for consumers	- Change deeply network structure - Change one part of resources
Radical	-Threat current resources -Improve considerably uncertainty for consumers	-Endanger entire of network (resources and relations between the partners).

Source : Kashani (2003), Luthardt (2002)

1-2-Theoretical backgrounds

1-2-1- Dynamics of innovation through networking

In a simple traditional perspective, bounded knowledge about the use of resources is distributed asymmetrically among the actors. The actors differ in their knowledge about the possible use of resources. Consequently, innovations may have different effects on the competence and assets of single actors. In reality, emergence of innovation through network complementary is often the result of dynamic relations between partners rather than the transfer of technology.

Traditional Schumpeterian industrial economics suggests that market is not often in equilibrium and firms should take constant and effective innovations in dynamic market place. So, motivation to make the profit is the central element to determine the firm's innovative behavior. A new theory called "resource-based", argue that differential firm behavior and performance is fundamentally attributed to the firm's heterogeneous resource endowments rather than industry structures[1]. The resources are rare, valuable, and imperfectly substitutable. Under this situation, firm's innovation could be interpreted as a result of exploiting certain resources. But in reality, a firm is not often a mere independent actor, but situated in different types as well as network system. In order to explain the advantage or disadvantage of an individual firm often linked to the advantage or disadvantage of the network production system, a new approach called "network system" have been introduced, especially in domain of supply production systems. Network system plays a critical role in activation of innovation process. As Schumpeter pointed out, firms need to innovate in order to handle the changing market conditions. Through the entrepreneurial activities, firms take on continuous innovation to obtain persistent profitability by taking advantage of the opportunities. To explain this notion a set of theories with different vision levels are introduced. Regarding the network production system on the inter-organizational level, analysts began to pay growing attention to the inter-firm cooperative relationships. The logic behind this tendency lies in the firm's connections in the network production system.

1- Barney (1991).

A network can be defined as "a set of nodes such as persons and organizations linked by a set of relationships". This vision views the firm as one node actor in a network in which the economic and social institutions are in fact embedded. It underlined that the sources of innovation are commonly found in the network inter-actions rather than inside firms[1]. In this perspective, innovation as one of the firm's most important strategic actions under presence of a saturated market could be seen as a highly structured activity embedded in the networks. For all the four types of potential innovation: modular, incremental, radical, and architectural, it needs substantial incorporation or sharing of rare resources not only within the firms but also between them. Then we may expect a considerable value creation among trading partners when they combine resources in a unique interactive complementary system. Network system creates inter-organizational routines for innovation knowledge and organization learning sharing.

In addition, innovation is engaged to the personal motivation, technical or knowledge competency and finally, to the commercial uncertainty embedded in production system. This process in not often integrated in a unique enterprise, but rather in a wide spread of different firms implicated in a sector of economy. Hence, a considerable temporal adaptation, cooperation, vertical interaction and communication flows[2] between these firms becomes logically necessary when innovation is crucial. Consequently, network-based system could provide a broader scope and thus better conditions for innovation improvement in comparison with the firm scope alternative. Networking plays an important role in the innovation process. In network system, the firm is connected to a set of players and could well be a source of information and shared technology by other firms. Networking is not a mere aggregation of individual players and bilateral contracts, but also a system of innovators[3] relied on interactive relationships according to the specificity[4] or importance of assets. This bilateral relationship creates an extent of dependency between partner firms. Beside of asset specificity, some other factors affect this dependency, namely, relative size

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1- Powell et al. (1996).
2- Von Hippel (1988).
3- Freeman (1991).
4- Kashani (2003 a).

of partner firms, uncertainty or risk sharing, proximity, number of partners and frequency of transactions[1]. Transaction cost theory indicates increasing opportunism due to increasing degree of asset specificity. A strong dependency promotes the risk of hold-up. When the partners makes the investment highly specific under a strong dependency, once the investment is sunk, a partner is vulnerable to opportunistic hold-up by the outsourcing firm, which could demand that the partner deliver the good at marginal cost. Therefore, more the partners are dependent, more the network system is similar to vertical integration and less the innovation activities are motivated.

On the other hand, a close and frequent interaction through vertical integration is capable potentially to eliminate the hold-up problem and to project effectiveness because of the transaction costs reduction. In contrast, weak dependency promotes the innovation diffusion, mobility opportunity and collective organization. The degree of dependency determines the advantages or disadvantages of network efficiency depending on the asset specificity. According to transaction cost theory, asset specificity refers to the extent to which resources not easily redeployable are used in inter-organizational transactions. It seems that in the presence of an asset highly specific (e.g. aerospace industry), a closed and integrated networking is more relevant regarding innovation activities. Contrary, in the case of a standardized specific asset (e.g. computer) a weak dependency between partners is more innovative.

1-2-2- Dynamics of innovation through institutional approach

Regarding the neoclassical assumptions, all enterprises have equal access to the same information (knowledge symmetry), technologies and markets (power symmetry). Through this "perfect competition" paradigm, it is just the technological structure of production system and market conditions that enable an enterprise to differentiate itself from other enterprises. But in reality a) all of them have not the same access because of market imperfection, information and technology as the production sources have to be obtained from different ways either by investing or by educating; b) economic size and asset specificity cause power asymmetry between competitors. These "imperfect" conditions provoke

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1- Kashani (2003 b).

different levels of quality, product cost and competitive power. In a static economic system, there are not enough propensities to competition or innovation. In a stable infrastructure the need to obtain a higher level of profit motivates the competitors to generate an innovate product.

1-2-2-1- Transaction cost theory framework

Transaction cost theory presented a new approach to analyze the innovation process in an incomplete economic system. The basic argument of transaction cost theory is based on achieving the optimal allocation of resources in the economy regarding the elimination of transaction costs and the size of enterprise through vertical cooperation, merge, acquisition, and horizontal concentration. Transactions costs occur because of the constraints reflect cognitive capabilities or "bounded rationality", human behavior or "opportunism" and technological conditions underlined "asset specificity" that are assumed to be prohibitively costly to change. In business world, products and services are produced by transforming a set of inputs in a complex called "enterprise". This is done through a manufacturing process in different combinations and proportions depending on the technologies, which have been adopted. A different perspective focuses on how enterprises ensure the supply of inputs on the one hand and reach the final consumer on the other hand: rather than production functions, enterprises are regarded here as "governance structures"[1]. Transaction cost theory concentrates on the relative efficiency of different exchange processes. If the internalization (local content) of one or more production process might generate technological economies, from the organizational viewpoint, it could lead also to transactional economies by eliminating the excessive transactions (related to purchase the same products in market). Intermediate governance between market transaction and intern production is the subcontractor governance. The decision to enter durable contractual relationships and the alternative vertical integration governance share the same motivation: the choice among these governance modes is then a matter of degree. According to the transaction cost theory, enterprises evaluate the relative costs of alternative governance structures (spot market transactions, short-term contracts, long-term contracts, vertical integration) for handling transactions.

1- Williamson (1996).

Transaction costs could be defined as the costs of acquiring, handling, processing, collecting and applying the information about the products, the relevant prices, and the supplier's reputation and so on. On the other hand, contractual agreements are costly because of the costs of negotiation, writing the terms of the arrangements, monitoring the performance of the partners and enforcing the contracts. In this context, the enterprise emerges as a tool of economizing of transaction costs in the presence of uncertainty where contractual arrangements are too expensive. O.E. Williamson advanced this framework since 1971 accompanied introducing two key concepts: "bounded rationality" and "opportunism". Bounded rationality underlines that individuals have limited cognitive competencies and generally the contracts turn out to be in some way incomplete and the latter is defined as self-interest seeking. Where it is possible to choose among many enterprises, the competition becomes crucial and then opportunism is not an important problem. The provoked collective engagement through subcontractor production system creates simultaneously some kind of independence and rents. The enterprise, which is not owner the specific asset, may extract these quasi-rents. According to Williamson, transaction costs are relevant when relationships are frequent, uncertain and if specific assets are involved. It is argued that, the uncertainty is important only when associated with specific assets. With regard to frequency, the transaction may be one-time, occasional or recurrent; a frequent transaction in the presence of specific assets is more likely to be internalized, since expected damages from opportunistic behavior are higher.

The main contribution of transaction-cost theory is the introduction of relevant cognitive and behavioral assumptions into the firm's theory. Focusing on investment strategy, organizational structures and bounded rationality, the transaction-cost paradigm can contribute to a theory of innovation. In this regard, considering the behavioral condition of opportunism and the cognitive condition of bounded rationality, individuals who want to minimize transaction costs should choose the markets rather than hierarchies. Markets permit to make a contract in order to eliminate opportunism by switching to other parties and to operate within the constraint of bounded rationality by engaging in adaptive decision making.

1-2-2-1-1- Uncertainty

Focusing on the uncertainty, as far as there is uncertainty, complete contracts cannot be foreseen and the enterprise investment on the specific assets is disadvantaged when future contingencies impose to re-negotiate the contract terms and the hold-up problem is more likely to be arising. Analytic context on transaction cost recognized two kinds of uncertainty: environmental uncertainty related to future contingencies and behavioral uncertainty including "adverse selection". Since 1970's, we may categorize a rich literature not only on the transaction cost theory (the articles, book and empirical studies are increased from 200 cases in 1994 to 600 cases in 2000)[1], but also on the uncertainty in economic decision. One of the most cited literatures called "adverse selection". It arises in a market where buyers cannot accurately gauge and evaluate the quality of the product that they are buying; it is likely that the marketplace will contain generally poor quality products[2]. Uncertainty refers generally to the lack of available information about the state of the subject for determining if a classical statement is actually true or false. Uncertainty in economic is an important variable especially in view point of transactions cost models of governance. When there is no uncertainty, the partners will be able to rely on relatively simple market contracts to manage their transactions. As uncertainty increases, it may be necessary to adopt more complicated forms of governance, including intermediate forms such as strategic alliances and joint ventures. In hierarchical forms of governance, motivations of opportunism in a transaction can be come down over time and appropriate remedies can be developed. Under a higher level of uncertainty in transactions, it may be necessary to adopt hierarchical forms of governance. In general, high levels of ex-ante uncertainty about opportunism in a transaction can leads to high levels of ex-post opportunism[3]. Increased level of ex-post opportunism, in turn leads to the adoption of progressively more hierarchical forms of governance. Through vertical integration, the enterprise could be able to protect itself from the threat of opportunism that attends this highly uncertain set of transactions. Vertically

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1- Boerner and Macher (2001).
2- Akerlof (1970).
3- Williamson (1996) & (1985).

integration in manufacturing organization effectively eliminates these opportunistic threats.

1-2-2-1-2- Asset specificity

Asset specificity as the engagement arises by investment and it is a controversial matter to decision making. An asset is "specific" if it makes a significant contribution to the production of a good and it has much lower value in alternative uses. The contracting party who commits assets is vulnerable to hold-up. The other party can treat opportunistically by reneging and offering lower prices that only cover incremental costs.

1-2-2-2- Innovation specificity

Radical innovation requires new modes of learning and new skills. Since radical innovation changes the core design concepts of the product and a problem occurs related to adapting the old product version with this new one. In the case of standard specified products such as computer software, the adaptability or compatibility process is likely simple. But in the case of multi-component products such as computer hardware, this process leads to a failure market supply for the established firms, because, they have to remove the market for previous versions. Once an organization has succeeded in reorganizing itself, the building of new architectural knowledge takes a significant successive time and resources. On the other hand, new entrants to the industry must also build the architectural knowledge necessary to exploit an architectural innovation, but since they have no existing assets, they are faced to an uncertain and difficult situation beside of monopolistic power of established firms. These complications discourage the new entrants because of risk increment. Thus, the industry would experience a stagnated period that decreases the innovation motivation. In this case, the old established firms would be the kings of the locked markets.

1-2-2-3- Innovation and organizational size

It is recognized that small enterprises have proved to be more innovative than large enterprises. Innovation as a linear and sequential process proceeding through specific steps including R&D, production and commercialization, has been developed by a systemic approach under effects of a set of variables. This process is considered as a complex system embracing interactive elements. In order to gain the comparative advantages, the enterprises realize innovation; and

environment in which they operate is affected the innovation. One of the new models to study systemic innovation is the innovative "network" model in which where the enterprises exchange inputs and outputs with each other as the suppliers and buyers. Through this paradigm, inter-organization transactional relationships, proximity and network learning process characterize the innovation content. Through networking relationship, proximity and collective learning, information and technology transfer became more rapid and depends on network performance; the transaction costs will be relatively lower. In addition, through a network production system, the firms realize a common basis on trustworthy and cooperation could enhance the "core-specialization" or competency in a few stages of the production in order to facilitate the innovation process and to decrease the production costs regarding the economies of scale.

1-2-2-4- Impact of trust on innovation

In the case of innovation, trust between the firm partners facilitates and enhances the co-specialized assets vertical cooperation. In order to involve and enter to a new economic idea or concept as the first stage of innovation process, the partners have to put themselves at risk. With growing trust, there is an increasing willingness to risk adoption. Building trust is particularly important for complementary parties to reach the potential network benefits of scale and scope. Trust extent is likely to be constrained due to partners' cultural gap and lack of interaction experience. In organizational relationships the trust could be extended beyond personal level. In the presence of asymmetry in contract relationship, the dominant partner may be tempted to use power to ensure control over small party and discourage the potential of organizational innovation. Thus the "synergistic creativity" of specialized suppliers realizes through a trusty environment characterized by mutual interdependency and equity. Such relationships may promote the innovative abilities if asymmetric partners are able to build organizational trust.

2- Empirical study

2-1- Model presentation

According to hypothesis of our model integrated through the following figure based on transaction cost theory and its development due to "network theory", we distributed the questionnaires to French subcontractors among

which they allocated a major part of their capacity to automobile parts during 1996-2001. Our questionnaire contains five modules (with 53 questions) including: 1) company presentation, 2)relationships between manufacturers and subcontractors, 3)contract presentation, 4)project handling and 5)commercial strategy. The model we are intended to analysis could be representing by:

$$\text{Innovation} = f(\alpha_1 + \beta_1 X_1 - \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 - \beta_7 X_7 + \beta_8 X_8)$$

$$\text{Knowledge} = f(\alpha_2 + \beta_9 \text{ Innovation} - \beta_{10} X_2)$$

$$\text{Investment in R\&D} = f(\alpha_3 + \beta_{11} \text{ Innovation} + \beta_{12} X_1 - \beta_{13} X_2)$$

$$\text{Uncertainty} = f(\alpha_4 + \beta_{14} \text{ Innovation})$$

$$\text{Organizational size} = f(\alpha_5 + \beta_{15} \text{ Innovation})$$

$$\text{Information sharing} = f(\alpha_6 + \beta_{16} \text{ Innovation} + \beta_{17} X_1 + \beta_{18} X_4 - \beta_{19} X_5)$$

$$\text{Trust} = f(\alpha_7 + \beta_{20} X_6 - \beta_{21} X_5 - \beta_{22} X_1)$$

Where,

X_1 : asset specificity

X_2 : uncertainty with respect to the "adverse selection"

X_3 : Information sharing

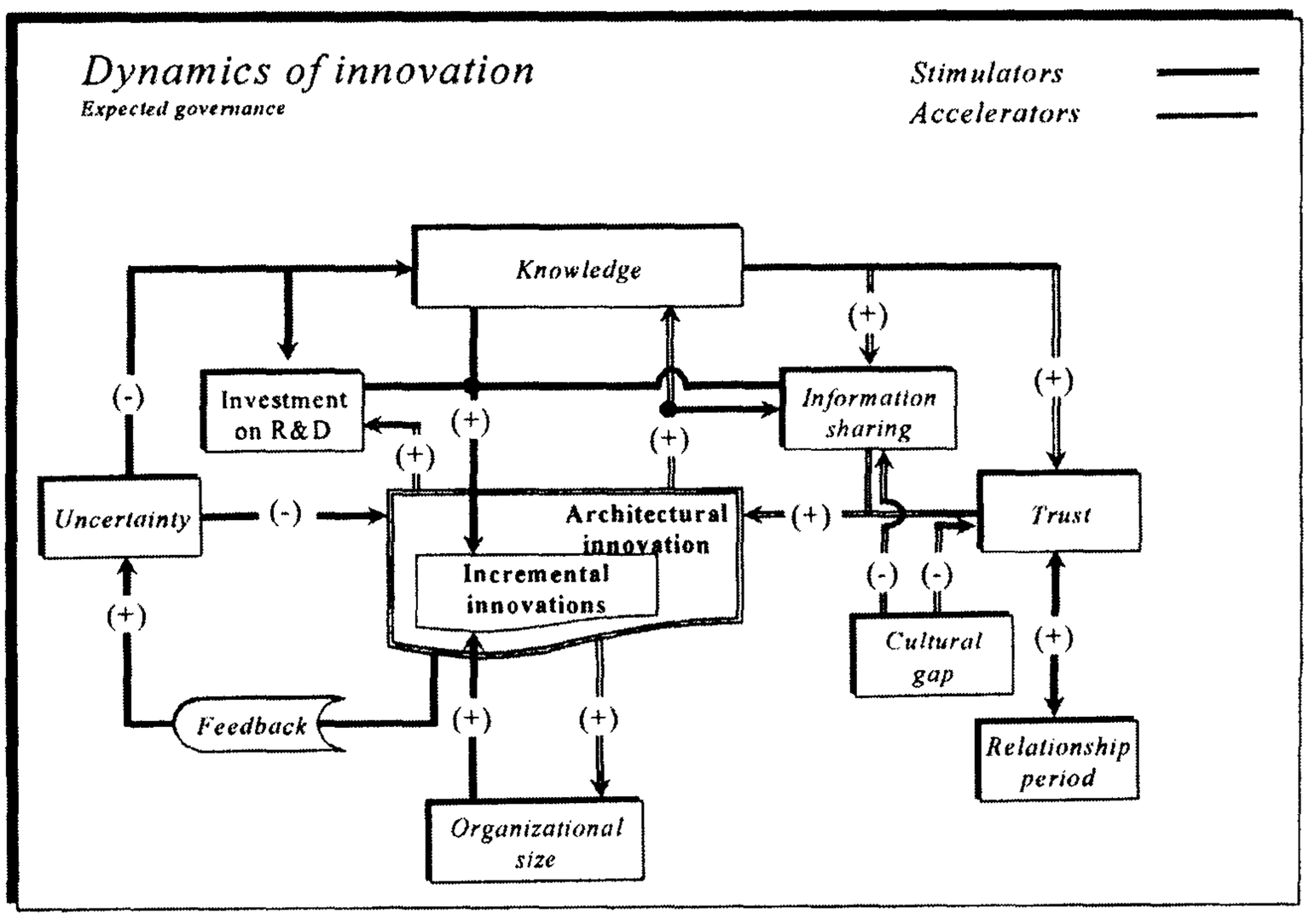
X_4 : trust of manufacturers on subcontractors

X_5 : cultural gap

X_6 : relationship period

X_7 : organizational size

X_8 : investment in R&D



Dependent variable : innovation

The dependent variable (INNO) as a representative of innovation capacity is a rank variable from 1 to 6 based on Likert scale and is measured by asking the questions about firm's innovative abilities.

Independent variable 1 : asset specificity

The "knowledge" embedded in assets as one of the most important elements in the technology configuration (human capitals, instruments, process and knowledge) is manifested in the form of documents, plans, maps, statistical data and information. Indeed, it reflects the capacity of producers to design and development of the complex and complicated products. So, this specificity is a source of competition advantage, as well as a lever, in viewpoint of authority. With regard to the impact of "knowledge" over vertical cooperation or contract decision, many economists have observed a dual role. In one hand, manufacturer need to cooperation with subcontractors to minimize the cost of production through organizational learning, sharing information and data transferring in subcontractor network required promoting innovative abilities. But on the other hand, these processes need certain distribution channels. These later provoke successively transaction costs. Let we consider N as the number of partners in the subcontractor network, then by hierarchical governance such as classical organizations, we need N-1 communication channels. Whereas, by a network governance, we need N(N-1)/2 channels[1]. These channels make multiple the needs of transactions between partners[2] and decrease the motivation to cooperate between partners. So, we expect that, an asset with a high degree of "knowledge", specificity has a negative impact on the vertical cooperation in automobile subcontractor. In order to measure the asset specificity in present model, we have introduced an index for asset specificity based on a ranked value. So, the first independent variable (KNOW) representative of "knowledge" is a result of a score from 1 to 6 according to its characteristics and is measured in the model by this asset index multiplied by the coefficient of R&D[3].

1- Alstyne (1997).
2- Malone and Crowston (1992).
3- The percentage of employees in R&D activities.

Independent variable 2 : uncertainty

The ex-ante uncertainty attached to asymmetry of information between partners to evaluate the proposed product quality by the manufacturers shows itself when there is not a sufficient knowledge between the partners. In order to measure the uncertainty with respect of "adverse selection", we asked questions about the number of quality certifications in each subcontractor especially ISO 9001 and compared it to the rate of success in tenders by manufacturers. Less he has the certificate and more he is succeeded in parts tenders, then higher is the "adverse selection" (the ex-ante risk to select a non-qualified partner). The second independent variable (UNCER) as a representative of uncertainty with respect of "adverse selection" is a rank variable from 1 to 10 based on Likert scale and is measured by asking the questions about firm's tender success rate comparing the number of quality certificates.

Independent variable 3 : information sharing

The mechanism of sharing the data and information is one of key stimulators of innovation especially when the production system is extended in network level. The independent variable three (INFO) as a representative of information sharing is a rank variable from 1 to 16 based on Likert scale and is measured by asking the questions about firm's participation in product design.

Independent variable 4 : trust

The variable (TRUST) is a rank variable from 1 to 3 based on Likert scale and is measured by asking the questions about propensity of manufacturers to adopt of theirs subcontractors in order to develop a new product or process and to reinforce this cooperation during relationship period.

Independent variable 5 : cultural gap

Essentially we expect that the "cultural gap" between manufacturers and subcontractors affect negatively the vertical cooperation and then the innovative capacity. The variable (CGAP) as the representative of "cultural gap" is a rank variable from 1 to 3 based on Likert scale and is measured by asking the questions about the subcontractor's feeling about theirs customers especially with respect to the foreign ones.

Independent variable 6 : relation period

The variable (PERIOD) as an indicator of relationship duration is a nominal variable and measured directly by asking the question about the average period of theirs contracts with manufacturers.

Independent variable 7 : organizational size

The variable (SIZE) as an ordinal variable represents the relatively size of subcontractors. It is calculated based on a Likert scale from 1 to 10. We expect that the smaller the firm is, the more it is innovative.

Independent variable 8 : Investment in R&D

The variable (R&D) is indicator of investment on assets allocated to research and development processes. This is a nominal variable calculates as the percentage of R&D expenditures in subcontractor's turnover.

2-2- Research method

The data collected to analyze these 9 variables are related to 20 subcontractors in French automotive industry and matched with the data provided in a Ph.D. thesis by the author in 2003. As we mentioned earlier, most of variables in this model are ordinal. This is why we applied some ordinal-based non-parametric correlation coefficients such as Spearman, Gamma and Kendall to calculate the association between the variables through a cross correlation table. Beside that, in order to determine the causality relation between some variables, we have introduced a Somer's d coefficient.

2-3- Descriptive results

As it sowed through the following cross correlation table, Spearman's rho coefficient represents a significant positive association between innovation abilities and "knowledge", "information sharing", "organizational size", "R&D investment". In other words, among the eight variables, these four ones especially the knowledge volume have a significant role to enhance the innovation ability.

Cross correlations (Spearman's rho)									
Variables	INNO	KNOW	UNCER	INFO	CGAP	PERIOD	TRUST	SIZE	R&D
INNO	1								
KNOW	**0,747(**)**	1							
UNCER	-0,214	-0,151	1						
INFO	**0,471(*)**	**0,379(*)**	-0,331	1					
CGAP	0,111	0,166	0,266	-0,046	1				
PERIOD	0,072	0,140	-0,252	**0,581(**)**	**0,395(*)**	1			
TRUST	0,302	0,072	**-0,470(*)**	**0,584(**)**	-0,010	0,294	1		
SIZE	**0,423(*)**	**0,435(*)**	**-0,699(**)**	**0,389(*)**	-0,277	0,233	0,321	1	
R&D	**0,447(*)**	0,330	-0,236	**0,983(**)**	-0,009	**0,571(**)**	**0,512(*)**	0,310	1

* Correlation is significant at the 0.05 level (1-tailed) ** Correlation is significant at the 0.01 level (1-tailed)

Listwise

2-4- A Causality test

In order to determine the real independent variables, we carry out a causality test based on Somer's d coefficient. The results represent a complication around the distinction between dependent and independent variables. This complication arises when the definition of causality relation varies across contexts. The term of independent variable usually refers to the "cause" and dependent variable usually refers to the "effect". Considering the association between innovation and information sharing, we presupposed that information sharing is one of the innovation improvement causes and hence the independent variable. So, innovation is the effect and hence the dependent variable. But, the empirical results in the automotive subcontractor network represent an inverse causality association. As you see through the following tables, examination of different sources of innovations including, 1)knowledge, 2) information sharing, 3) organizational size, 4) investment in R&D,

5)uncertainty, 6) trust, 7)cultural gap and 8)relationship duration shows that four first of these sources are the accelerators or "effects" rather than stimulators or "causes" of innovation. We can explain this phenomenon through the cumulative interaction of innovation dynamic. For example, innovation initiates the improvements in the volume of science. On the other hand, the cumulative synergy of science promotes the innovation and technical changes. Regarding the information sharing, subcontractors do not share theirs information to promote the innovation abilities, but rather to take advantage the innovative capacity of theirs partners. In return, the later will be motivate to enhance theirs capacity because of demand improvement for innovative products. It is why we called these sources as the "innovation accelerators". In the same manner, these enterprises invest in R&D in order to take advantage of established innovation capacities rather than triggers the new innovations. Organizational size is one accelerator that provides the necessary infrastructures (especially physical assets) to facilitate the innovative capacity. But, why the firms are so passive regarding the exploitation of innovative capacities? We can describe that by distinguishing between architectural and incremental innovation. Indeed, architectural innovations disturb the production process in short term because of excessive needs ad uncertainty for new investment in moulds, machine tools, instruments, plants etc. to reorganize the overall production system. In addition, it involves the firms to new consumer exigencies and double uncertainty in long term. It is the reason why in a saturated locked market, firms prefer to maintain the actual situation by taking advantage only the incremental innovations in order to motivate the consumer's taste in short term. Market surveys on innovative products show that manufacture's profit decreased more and more, whereas the consumer's relative advantage increased continuously since two past decades.

INNO ⇔ KNOW			
Correlation		Value	Approx. Sig.
Ordinal by Ordinal	Kendall Tau-b	0,604	0,000
	Gamma	0,623	0,000
	Somer's d		
	INNO (dependant)	0,589	0,000
	KNOW (dependant)	0,619	0,000
INNO ⇔ INFO			
Ordinal by Ordinal	Kendall Tau-b	0,384	0,007
	Gamma	0,418	0,007
	Somer's d		
	INNO (dependant)	0,357	0,007
	INFO (dependant)	0,413	0,007
INNO ⇔ SIZE			
Ordinal by Ordinal	Kendall Tau-b	0,354	0,037
	Gamma	0,408	0,037
	Somer's d		
	INNO (dependant)	0,345	0,037
	SIZE (dependant)	0,363	0,037
INNO ⇔ R&D			
Ordinal by Ordinal	Kendall Tau-b	0,352	0,011
	Gamma	0,396	0,011
	Somer's d		
	INNO (dependant)	0,335	0,011
	R&D (dependant)	0,369	0,011

(a) : Based on normal approximation : SPSS version 11.5

Conclusion and Implications

A. Policy implication

Examining different innovation sources in a closer view, we have presented that most of innovation sources (information sharing, organizational size, investment in R&D, and knowledge volume) are the accelerators or "effects" rather than the stimulators or "causes" of innovation. Thus, in order to accelerate innovative efforts, one would upgrade level of information sharing, increase investment in R&D, and accumulate knowledge volume. An important conclusion from this investigation is that the ratio of expected innovation is systematically less favorable for smaller firms than for larger ones. The fact that innovative capacity is relatively low for smaller firms can at least partially be explained by the presence of a fixed and sunk entry cost, which yields a higher threshold to R&D for smaller firms, especially in automotive industries.

Innovation is complex, and only partly measurable. It changes the productive capabilities and functionality of knowledge stock. As we mentioned, innovation means Idea creation, Production, and commercialization. Looking at resource use and flows reduces the qualitative dimension to a measurable analogue.

The attempt to develop the concept of "Innovation" also has important implications in the field of Industrial Economic. Innovation as a crucial subject is a key tool for policy-makers in order to govern the industry and to enhance the firm's competitive capacity. Especially in the field of Industrial Economics, academics are trying to determine the optimal size of enterprise regarding the uncertainty around the exchange between manufacturers and subcontractors. They are willing to understand the dynamics of innovation and to know what are the stimulators and accelerators of innovation. Assuming "bounded rationality" in organizations, enterprises could enhance theirs capabilities through network production system approach.

From a network point of view, cooperation within and between firms through different ways is the roots of capabilities addressing the so-called "Knowledge sharing" or "transfer of technology" between countries, universities, and industries.

Regarding firm's size, smaller firms that do participate in automotive industry, spend less on equipments, R&D, and tools per unit of firm size. According to the underlying model the implication is that larger firms are more design efficient. So, larger firms are more innovative than small firms in the sense that they are more likely to engage in innovative activity. Large firms may very well have an advantage in specific kinds of innovations and they produce knowledge spillovers.

The implications of this paper are important for developing countries for three reasons. First because policies that are being pursued in these countries are based on the idea that technology is an immeasurable complex paradox. But, as it was presented above, we could extract different elements of innovation and consider them either in a separate environment or within an integrated system. Secondly, the presented model is useful to understanding the dynamic system of innovation for industrial development. Thirdly, as pointed out by a number of academics, the evolutionary literature on innovation tend to give little attention to aspects related to the paradoxale role of innovation within an interactive industrial environment. This model could improve analytical framework of innovation issues.

B. Implication for Iran:

According to the mentioned implications, the policy for promoting Iran's automotive industry should focus on:

- Supporting firms with larger size in order to utilizing their economics of scale and scope.
- Extending and simplifying the support of R&D oriented firms.
- Strengthening of information sharing relations between universities and firms
- Institutional changes especially in regards to technology transfer
- Enhancing knowledge volume through promoting of codified and tacit knowledge.

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