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Iran's Pharmaceutical Sectoral Innovation System

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Abstract

By reviewing economic performance, two main phenomena could be identified: The first phenomenon is prior to the third wave of the Industrial Revolution in which limited resources are the predominant input; in other words, physical and natural resources are much more credited than human resources. The second phenomenon resonates with the third wave of industrial revolution to the present time, suggesting the pivotal role of humans in production and accumulation of wealth, in which limited resources are no longer considered as predominant input. The present research seeks to understand the behavioral logic of the players of Iran's pharmaceutical sector so as to infer the innovative treatment of the firms in this sector. The concept of innovative system is indebted to the efforts economists and other scientists have made by analyzing economic development based upon technological development. Meanwhile, sectoral innovation system (SIS) is a tool for analyzing a technological sector in the context of evolutionary economics with an emphasis on institutional capabilities. The structure of such an approach is composed of some components through which performance analysis of certain technological sector could be made possible. In research, we use expert panel with 12 experts from Universities, Companies, Governmental institutes. The current study wishes to explain structural model of institutional elements in this technological sector. Subsequently, in light of such an explanation, structural elements of this sector would be analyzed through identification of legal and regulatory framework, innovative culture, innovative infrastructure, financial resources, information resources, technology transfer mechanisms, commercialization support and marketing.

Keywords: Evolutionary Economics, Institutional Approach, Technological Development, Sectoral Innovation System (SIS), Iranian Pharmaceutical Sector (IPS).

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Introduction

By reviewing economic performance, two main phenomena could be identified: The first phenomenon is prior to the third wave of the Industrial Revolution in which limited resources are the predominant input; in other words, physical and natural resources are much more credited than human resources. The second phenomenon resonates with the third wave of industrial revolution to the present time, suggesting the pivotal role of humans in production and accumulation of wealth, in which limited resources are no longer considered as predominant input, rather, the abundance of wisdom and knowledge is more privileged. In other words, the second phenomenon has occurred in response to the remarkable scientific and technical achievements and also due to the emergence of history acceleration phenomenon.

Nowadays, when it comes to economic performance, market mechanisms including temporal and spatial dimensions of knowledge, role of government and the degree of governmental power intervention, social and cultural factors, procedures, routines, functions of creativity and innovation, management of tacit knowledge, learning, R&D, imitation and diffusion, and factors as such are drawn into attention. Perhaps the analysis of such factors are more properly represented by using institutional approach, as Nelson (2002) pointed out the important issue that analysis of Adam Smith is concerned with the division of workforce in the market; nonetheless, it is better to focus on the role of institutional co-evolution of physical technologies and work organization, which is referred to as Theory of Evolutionary Economic.

In this research, it has been attempted that first by reviewing the evolutionary economics, innovation systems' approaches and SIS would be surveyed and then, this system would be analyzed in the IPS. Undoubtedly, in order to enter the realm of a scientific examination of any social phenomenon, it is necessary to have a mindset by help of which, a theory of fundamental concepts is formulated. Economics is a social phenomenon in essence. In this context, policy making as a social process is of no exception. Therefore, first it is necessary to make required arrangements for establishing a proper intellectual organization (Malerba, 2002; 2004). Then, in order to establish a necessary theoretical formulation, the main peculiarities of the evolutionary economics must be examined initially. In this regard, two main elements of market and government have been discussed, and also Innovation System as the foundation of evolutionary economics has been a controversial subject. The very final phase of theoretical formulation in the present study has been pointed up based on the SIS.

Theoretical Formulation

Evolutionary Economics

Although nowadays neoclassical economics- which is based on the maximization of firm profits and static balance- still continues to be the dominant economical view, evolutionary economics which is maneuvering on the weaknesses of the current economic theories has been able to achieve a highly notable position in the literature of industrial policy making by designing novel theories, and consequently, providing appropriate responses for the unanswered questions as to the industrial development field in developing countries, excessive efforts of its mind-alike scientists and adding more field evidence and studies. By publishing the book "An Evolutionary Theory of Economic Change" in 1982, Nelson and Winter shed more light on introducing the theory of evolutionary economics. Through introducing various theoretical dimensions of evolutionary economics to the world of neoclassic, this book later on entailed numerous developments in the economic and scientific literature. Evolutionary thinking

of economics, as with schools of evolutionism in sociology, has its roots in theories of Darwin and Theory of Evolution in biology and its basis is evolution, uncertainty, and natural selection. This line of thought, unlike neoclassical wisdom which is less concerned with outside of firms, government, and national systems and deems market structure and firms as the basis of prevailing economic balance, tries to represent the simultaneous role of firms, markets, institutions and governments in their theories. In other words, the followers of this thought, despite the acceptance of market structure, regard it based on the experiences, especially those of successful industrial and scientific policies in East Asia and put great emphasis on the importance and role of state policy in the industrial and technical development of the industries (Teubal et al., 1991; Lall & Teubal, 2001).

Since 1934, theory of evolutionary economic started by studies of Schumpeter's primary theorizations and in the last two decades, such an economic attitude has been highly taken into consideration. However, one cannot name a single unit to introduce evolutionary economics for in this context there have been quite different perceptions and insights. It appears that among all current approaches to evolutionary economics, there could be seen common characteristics:

In an economic world, everything is subject to change and an essential part of such changes is qualitative (not quantitative) such as technological changes. Evolutionary economics in general believes in the complexity of economic system. Such a complexity makes the interaction of the factors present in the system seem to be having nonlinear and even in chaotic form. Evolutionary economic maintains that owing to innovations, complexities, and also uncertainties of the real world, people often fail to have a grasp of what is happening and what will probably happen in the future. In the other words, most human decisions, instead of being originated from a comprehensive rational analysis, emerge from simple primitive rules of thumb. These concepts in evolutionary economics are identified as "Bounded Rationality" (Nelson & Winter, 1982).

Innovation Systems and SIS

The view of the fifth wave of the concept of innovation is directed toward the systematic relationships, integrated internal and external interactions and also networking (Rothwell, 1992). Regarding this approach, the present study longs for explaining the concept of innovation systems in order to achieve a proper understanding of the concept. Basically, the system is regarded as a set of interrelated components moving in line with a specific purpose. The approach of systematic innovation and its importance has contributed to the fundamental changes in economic analysis and policy making studies. A system consists of constituents of which the most important of all are players. Charles Edquist (2008) defines innovation system to be composed of players, systematic relationships and attributes which together make up a coherent whole. There exist numerous definitions for players of innovation system but in general, the main players of an innovation system include individuals, firms, financial institutions, educational institutions and research institutions, policy makers, administrators, supervisors, etc. By relationships, it is meant the link among players in such a way that characteristics and behavior of each player of the system influence on the characteristics and behavior of the entire system. Moreover, by features we mean the characteristics of players and relationships between them defining the specifications of the innovative system.

One important feature of innovation systems is the concept of system border, i.e. innovation system is separated from the external environment of the system, and system borders also should be identified. To this end, in the literature of innovation systems, these borders are defined in three levels: National Innovation System (NIS) (Freeman, 1982),

(Lundvall, 1992), (Nelson, 1993), (Patel & Pavitt, 1994), and (Metcalfe, 1995), Regional Innovation System (RIS) (OECD, 2009) and (Cook & Morgan, 1998) and SIS (Malerba, 2002).

The concept of innovation system has been based upon the understanding of the relationship between players involved in innovation to improve the performance of innovation and technical developments. Therefore, innovation system is a complex set of relations between the players in production, distribution, and beneficiaries of different kinds of knowledge. Hence, the innovative performance of a country highly depends on the relationship between players as components of a collective system of knowledge production and technology application. Table 1 is derived from OECD report (2005) (Cook & Morgan, 1998) and (Breschi & Malerba, 1997) which represents the conceptual definition of innovation systems in the review of literature.

Table 1: Selected Definitions of Innovation Systems

NIS	"… A network of institutions in public and private sectors whose activities and interactions lead to originality, modification and development of new technologies" (Freeman, 1982).
	"Elements and associations involved in the production, diffusion and utilization of new, economic and useful knowledge interacting with each other within the borders of a certain country" (Lundvall, 1992)
	"A set of institutions whose interactions determine the innovative performance of national firms" (Nelson, 1993)
	"National institutions and the structure of stimulators and their merits that determine the rate and orientation of learning technologies in a country" (Patel & Pavitt, 1994)
	"A series of specific institutions which participate in the development and diffusion of new technologies -alone or collectively- and provide a framework through which government implements its policies to influence on the innovative processes" (Metcalfe, 1995)
RIS	"A system in which organizations and other companies involve in an interactive learning process through an institutional communities and this community embodies inclusive characteristics" (Cook and Morgan, 1998).
SIS	"A system of new and existing products intended to be applied in a particular field and also players existing in the market and non-market interaction of creation, production and selling of its products" (Breschi & Malerba, 1997).

The main players of innovation systems are institutions. Institutions determine social status and function of individuals and groups, so that they create a branch of formal and informal rules for shaping the behavior. Formal institutions are organizations, rules, regulations and informal ones are procedures, routines, and rules of the games (Nelson, 2002). Formal institutions include: government organizations, universities and schools, research centers, mediator organizations and commercial companies and enterprises, rules and regulations and legislative and executive resolutions; informal institutions are a set of rules for the games that determine inter-organizational relations including financial flows, skill and knowledge or market and non-market transactions.

To understand the features of each innovation system, Galli and Tubal (1997) emphasize on different kinds of linkage between players and sub-systems. They believe that the features of each innovation system depend on market transactions, non-market transactions, financing flows, skills and knowledge. From Metcalfe's point of view, the above mentioned

features are meant to create innovation and the development of product technology of a group of interactional organizations responsible for producing, connecting and saving all the elements of required specialized knowledge in the procedure of innovation. Since each system consists of components and interactions of components, the failure of an innovation system occurs in two aspects: first, wherever knowledge accessibility is required, and due to lack of relation or due to inefficiency, the relation between organizations would not be made possible. Second, when there has been no appropriate organization for creating that very knowledge or for facilitating access to that knowledge (Nelson, 1993; Freeman, 1982; Edquist, 2008). Therefore, the focus of analysis on enterprise and isolated units in economy (enterprise, customers) shifts toward collective infrastructures of innovation and technology development. This approach points out the whole system in which knowledge is produced and distributed, rather than the individual components of the system. This issue leads to innovation from non-linear perspective. As the nature of innovation phenomenon is mutual, interdependent, and retrospective learning, the relationship between components should be examined meticulously. An immediate outcome of an interdependence logic and non-linear perspective is that demand should be construed as an important determiner factor in innovation. In this view, even governmental provision and supply of technology can be considered as a policy tool (Mowery, 1983; Edquist, 1997).

Regarding what has been mentioned concerning the innovation system concept, there could be felt a sense of requirement for having a sectoral point of view toward it owing to its unique features of market and non-market transactions, knowledge flow, skill, and technology in specific fields. Hence, explaining the concepts related to its specific areas of technology and knowledge makes the theoretical principles important. In the following, theoretical principles, the concept of SIS and its dimensions will be reviewed.

SIS

Studying the researches and past experiences in the field of science policy, technology and innovation shows that various industries within the borders of a country are involved with different institutions and structures. To this end, determining a specific area in industry or technology could contribute to deepening of the analysis and identifying the body, just the way the SIS have been created (Malerba, 2002; 2004; Edquist, 1997). SIS approach emphasizes that various departments work under various technological regimes, in which the type of knowledge and its owners in any regime are, to a large extent, unique, and over time, the evolution of such regimes runs the analysis of their nature; therefore, each section is required to be analyzed separately. This approach focuses on agents and non-commercial transactions and these aware and legal interactions are of paramount importance. The theory of sectioning the innovation systems has been centered on a few serious considerations (Malerba, 2002):

1. In this theory, processes are transition-oriented and boundaries of dynamic sector.
2. This theory is based on the performance of agents and their interactions.
3. This theory considers supply along with demand and market simultaneously.
4. This theory pays special attention to interactions with non-market transactions in the market.

The basic elements of SIS (Viotti & Costa, 2001), (Teubal et al., 1991), (Edquist and Johnson, 1997), (Nelson and Winter, 1982), (Malerba, 2002), (Grandstand, Patel and Pavitt 1997) are:

1. Knowledge, learning processes and technologies
2. The players and networks
3. Institutions

Analyzing SIS leads to consideration of existing structures in that sector, in a way that not only is it based on the Industrial Division but also it focuses on the basis of the relationship between perpetrators, technologies and knowledge of that section. Therefore, understanding the function of each component in the system can shed more light on its analytical approach. Table 2 Introduces the function of the sectoral innovation constituents.

Table 2. Introduction of the function of components of the SIS

Constructive Elements of the SIS	Function of Components
Knowledge, learning processes and technology	Knowledge is the main stimulant of technology, which is diffused among firms but the extent from which the firm benefits lies in its capability to absorb it. This capability could be achieved over time and by accumulating the knowledge and various ways of learning, the very thing that make the main differences between the various technological sectors. Each section of the SIS is known by its knowledge base, the technology and by its especial inputs. Most sections of technology are associated with a variety of technologies. The linkage between types of technologies, plays a critical role in defining the boundaries of knowledge in each section. The basis of technology formation for a firm is as follows: ways to create knowledge and to access it, operational and diffusional mechanism and also considering the internal and external economies. For this purpose, the absorption of knowledge and learning processes determine the upper limit of R&D in firms. On the other hand, the market and its needs determine the required degree of knowledge on the part of the firms for innovation. Hence, receiving continuous and constant feedback from the gained, diffused and required knowledge in market-oriented technologies is quite a key. On the other hand, the knowledge environment in which firms are operating to develop the innovation, has been referred to as "technology regime". Therefore, there is a close bond between the aspects of knowledge in a technological section and its learning.
Agents and networks	The most important and fundamental agents in the SIS are the effective firms. These firms include all manufacturing, distribution, supplying, trading, research, support companies, etc. The way such agents are synthesized with different characteristics, different kinds of knowledge and different merits on one hand and education and research system as well as sovereignty on the other hand, coin the concept of the network. Hence, in any SIS, heterogeneous agents are working up with different objectives and functions in a network structure; Therefore networks are taken as approach for analyzing a wide range of official and unofficial engagements of agents in specific technological sections. The most important point is that the networks have been created not because of the similarity of agents but precisely because of their very differences. Their most important functions is providing an access to supplement of knowledge, integrating their different capabilities and specializing them.
Institutions	Within each SIS, there is a series of norms, procedures, common habits, laws, regulations, standards and so forth, which are shaping the agents' perceptions, behavior, and interactions. Some institutions are public and are applicable for all or most of the technological sections and some other are defined only for a particular section. The pattern of sectoral specialization in each country to a large extent is due to the institutional features. Oftentimes, there could be seen a sense of nonconformity among national and sectoral institutions, therefore one must not assume that there is always a unilateral relationship from national to the sectoral; sometimes the situation is reversed.

Iran's Pharmaceutical Sector (IPS)

Table 3: Structure of IPS

Elements	Description
Firms, market and industry structure	The total pharmaceutical market value in the world is nearly 1044 B$ USD from which Iran's share is 9.3 B$ USD, i.e., 0.37 %. In this part, there are 160 FPC, 80 API, 50 wholesale distribution companies, 160 drug importer merchandising companies, and approximately 12000 pharmacies. IPS market structure includes TIPICO's Holdings 18%, Koubl 11%, Shafa 7%, Barekat 6%, Tehran Chime 6%, Behestan 5%, Shafayab 3%, Actover 3%, CinnaGen 3%,, Kosar Amin 2%,, and 35% of market share is allocated to the rest of the companies. IPS market combination is generic-based, generic drugs 57%; Over- the- Counter (OTC) drugs 12% and brand drugs 31%. (During the recent decades, from 2005 to 2015, the national market share has been decreased to imported drugs, from 72% to 66%; in other words, the share of imports has been increased from 28% to 34%. IPS dates back to more than 70% that its market value has reported more than 3 B$ USD in 2015. This value has been approximately 2 B$ USD in 2005, meaning that it has been nearly 174% of market value increase during the recent decade. This industry has created over 26000 jobs. According to the latest statistics reported (2015), there have been 2900 drugs in various forms in the registries list of Iran's FDA, so far consisting of 97% of national production in terms of numeric, but as to Rial, 66% of it is produced by national companies; in other words, 3% of numeric volume of national consumed drugs has allocated 34% of Rial value of the market to itself.
Research and Education System	In this section, there are approximately 20000 pharmacists, 36 Scientific Communities, 23 Pharmacy Colleges, 1130 hospitals, Medical Plants Institutions, Virtual Institution of Medical Biotechnology, Pasteur Institute, Scientific and Industrial Researches Organization, Blood Transfusion Organization, and Red Crescent Society.
Governance	The main administrator and supervisor of the country's pharmaceutical governance is Iran's FDA operating under the Ministry of Health. The main and chief policies of the IPS are based on supervision and drug control, based on the society's need, quality and its rational use; encouraging internal production and developing the capability of pharmaceutical organizational processes regarding the prices; efforts concerning reducing drug imports and relying on national capacity; reducing costs imposed on consumers (people); guidance toward maximum use of insurance facilities; increasing pharmaceutical quality and security as well as supplying the drugs required in the society; promotion of generic drugs production; promotion of domestication of generic active pharmaceutical ingredient.

Resource: derived from reports of Iran's FDA

Explanation of the SIS in IPS

Organizing learning and innovation is possible via institutions, associations and professional organizations, offices, hierarchies and networks. Whether or not, due to the specific circumstances of the country, and based on the intended activities and technologies, markets are deemed to be one of the most effective and efficient mechanisms in the very field. Undoubtedly, the effectiveness of special mechanisms may change over time. In general, market stimulant policies have three main concepts: Priority, stimulants and institutions.

Priority: Setting national and social priorities and extensive outlook for industrial and technological development of the country are

market incentives and also these are all on the part of the government. The government should make a decision regarding the specific economic and non-economic national objectives in which the market do not have the ability to reach them. As an example, the government could make a decision in relation to deepening and strengthening the industry, localizing technological activity or developing large manufacturing groups to internalize the different markets. Even entrusting everything to free markets is also a purposive selection.

Stimulants: Another market driver is to activate signals for economic agents in the industrial and technological activities when it is malfunctioning. Among the implementation phase of projects, we may mention supporting companies, which for whatever reasons do not enter the area of demand in terms of technology, or that they are unable to coordinate their technological activities or due to the problems in the operation and ownership of the benefits of investment in R&D, they invested less than what is required.

Institutions: Creating a non-market mechanisms, institutions and organizations are among the policy mechanisms for supporting two previous categories in stimulating the market. Institutions involve two main issues: the first issue includes creating an appropriate policy mechanism, creating an administrative procedures, institutions and investment and capabilities required for implementation of the policy; prioritizing and formulating strategy. Then, there is a policy enforcement, including creating new institutions and organizations in the public and private sectors, for supporting the brokers, and also cooperating and communicating with them.

As noted earlier, given the market stimulant policies, identifying priorities, determining stimulants and precise definition of institutions is of utmost importance. Therefore, if we take the main function of learning (which is innovation) into great consideration, we shall determine the innovation in pharmaceutical industry, which is this research part in question. Accordingly, we could determine three positions, such as the time of the emergence, stabilization time and maturity as to approaches including: focus on innovation, competition in innovation, risk in innovation, innovative production systems, the dominant innovation capabilities, industry structure of innovation and geographical features of innovation. As it can be seen in the following charts, innovation in products and manufacturing processes of drugs has been presented by several approaches and in the three conditions of time of the emergence, stabilization time and maturity

Chart 1

Innovative Approach

The possibility of innovation in pharmaceutical product is high. Although there is a high risk, it could respond to market's demand, and complexity of the market for this product is very high.

Focus | The possibility of innovation in manufacturing processes for pharmaceutical products is high. And these become the key factors by better understanding of the market's needs and the inadequacy of diverse production systems

and domination of specific design towards production methods.

That resonates with the gradual improvement of production processes, in order to achieve higher performance and lower costs in the very industry. Lack of innovation is fundamental, but there is the possibility of using new technologies to enhance product life cycle and its procession.

|			Time of Innovation
Emergence	Maturity	Consolidation	

Chart 2

Innovative Approach

According to the three main characteristics of quality, price and degree, firms in this industry are competing to meet customers' demand. Competing in the industry and at this stage is the ability to introduce new products and it occurs among small innovative business firms.

Competition

Competition at this stage is based on high performance and the ability to prepare the needs of the market, and also it occurs in terms of price of the product.

The competitive challenge at this stage and in this industry is mainly based on quality, due to asymmetry of the information in; competitions are carried out according to the performance of firms in relating the effective experts to the market place. Due to price, research, and quality, stability of this level is extremely important.

			Time of Innovation
Emergence	Maturity	Consolidation	
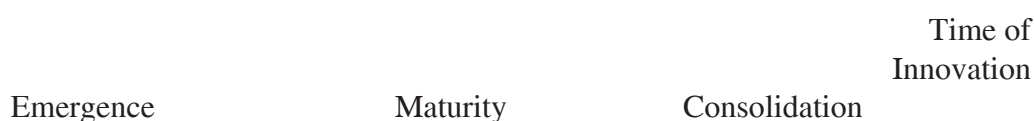
Chart 3
Innovative Approach

Risks associated with product innovation have been limited but there is an investment risk in production processes. Production would be highly at stake and many of the products would face market failure. Careful and constant monitoring of the internal and external variables is required.

Risks   At this level, risk of production processes and investment in research and the market has been discussed in the pharmaceutical industry.

Product performance and the process have been known and determined to have no high risk, but only from the rivals' view they have a low structure cost.

Time of Innovation

Emergence   Maturity   Consolidation

Chart 4
Innovative Approach

Due to great changes in the production of pharmaceutical products and the speed of market change, dynamic production systems-which are used in the flexible structures- are required.

Product Innovation   Since the template plan has been prevalent and product-quality-based competition is of high importance in this industry, flexible quality production on a large scale is essential for the firms to benefit from economical cost.

At this point, the mechanized production process becomes standard and the equipment almost becomes single-purposed in producing the standard products or standard process on a larger scale.

Time of Innovation

Emergence   Maturity   Consolidation

Chart 5

Innovative Approach

Especially, research capabilities could be developmental and have a potency to convert a firm into a center responsible for linking the relevant companies with finance and knowledge. The learning process in this stage and in this industry is the key.

Core Capabilities

The firms in question (in this industry) are not capable of quick entrance and mass-production. Large firms having power in this industry are given much credit, because they are experts in producing, managing and marketing. Such capabilities may be better defined by using technological capabilities.

Organizing the production at optimal scale and the empowerment of human resources and marketing forces are important at this stage.

Time of Innovation

Emergence   Maturity   Consolidation

Chart 6

Innovative Approach

There are numerous large and small and medium firms, many of which are involved in distributive activities. There are a few large research firms playing a better role in the 1economic scene of this industry.

Structure of Industry

Many newly established small firms of the industry, at this point, have been removed and omitted from the competition cycle, and some others are involved in big and powerful companies. Perhaps the main reason is the technology foundation in the industry's activity requiring powerful analysis and institutional forces.

At this stage, few large companies are established in the industry and the bulk of the market is on their hands. These firms become exclusive in innovation and producing products and capabilities and learning among them are constantly on the spin.

Time of Innovation

Emergence   Maturity   Consolidation

Chart 7

Innovative Approach

At this level, Pharmaceutical industry is based on the fundamental innovation of products. But as to Iran, the issue of incremental innovations refers back to the imitation of patterns from the world's top companies.

Performance

Gradually (at this stage), the resulting innovations faces the new competitors in the market in which the industry should be planning for new product development.

At this stage, pharmaceutical products have possessed a place in the market and producing companies and competitor strive to offer a new sample and better quality to prove the point that by similar price and sometimes slightly increasing the price, they could offer similar products.

Time of Innovation

Emergence   Maturity   Consolidation

Chart 8

Innovative Approach

Formation of companies operating in this industry at this stage are centered on multi-cities or multi-regions, this is despite the geographical distribution of key research centers associated with this industry.

Features of Geographical

Overcoming the special design products and consequently outreaching the well-known manufacturing processes, the geographic concentration of production are gradually formed in smaller places.

With the standardization of products and processes, direct competition is highlighted regarding the need to transfer them into the areas, which have somehow lower structural cost. The possibility of transmission to less-developed regions has been felt as well.

Time of Innovation

Emergence   Maturity   Consolidation

The issue of policy making over developing technology in this research is based on the section and at inter-firm level; thus, in the analysis of technologies of surface treatment, it is necessary to create the basic foundations for developing the innovation system. Hence, the basic foundations for establishing the innovation system are as followed:

Creating basic foundations of the SIS in IPS

A. Identifying the foundations of knowledge and learning processes formed in the pharmaceutical industry:

Knowledge at firm level is diverse and do not spread easily. So much effort and cost is needed to absorb and apply knowledge by firms with different capabilities. This feature can be placed in the context of organizational capabilities, cultural, technological, etc. It is important to note that the science and technology by any degree of complexity, and in any organization with any level of capability, have such a potency to absorb the knowledge but the level varies.

The science in the SIS of IPS is reviewed in different domains.

Special science and technologies are resonated with pharmaceutical industry services:

Knowledge bases have several sources; one of them is science and technology linked with the pharmaceutical industry. The most important of these sciences in Iran which can be mentioned are sciences of physics, chemistry, bio-physics, bio-chemistry, pharmaceuticals, bio-technology, nanotechnology, microbiology, etc. The most important technologies associated with the IPS are the technologies related to equipment, materials and compilation and combination of technologies with raw material of medicine.

Overflow of general technologies, which do not have a direct relationship with the pharmaceutical industry:

Overflow of technology means a kind of science that has found its way through this industry from other industries and the one that leads to new innovations in this area. To draw the attention of policy makers in the field of Pharmaceutical Science and Technology, we may attribute the main players in the field of technology overflows mentioned in academic research as an intermediary institution, the development of the electronics industry, telecommunications and computer and so forth.

Functional nature of pharmaceutical demand in the various markets of Iran:

Drug users in Iran change their demands regarding functionality, which is itself a sort of scientific feedback to create and exploit. Seasonal change, outbreaks of certain diseases and geography-dependent illnesses must all be highly taken into consideration.

Other features of learning and knowledge in the Pharmaceutical Industry:

Accessibility:

The more accessible the knowledge in this industry or in other words, the more targeted and systematic collaborative research between academia and industry, the higher it will have distinct mechanisms and on the other hand decentralizes industry structure, takes ownership limits. Therefore, the possibility of overflow and imitation is higher, in which the diffusion of knowledge will be extended and the learning rate will be increased. IPS is decentralized, meaning that many players are involved in this industry. Quick and easy access to knowledge would increase the innovation for a decentralized industry and also enhances the rate of innovation.

Opportunities:

Another feature of learning and knowledge in this industry is a plethora of opportunities

existing at the heart of activities such as joint academic researches, R&D activities among firms, creating related tools for suppliers and consumers and as well as technology transfer agreements which could set the stage for creating and implementing the technology through knowledge lied in the organization.

Accumulation of knowledge:
Accumulation of knowledge is the main essence of knowledge on which the learning was based. This is directly associated with the capacity of firms in this industry, regarding each firm's market share and the way of learning it (which is different). Schumpeter also acknowledges that mutual moving from a market to the next resonates with a creative destruction and creative accumulation.

Characteristics of creative destruction:
Easy entrance, fast replacing paths, capabilities of limited possession and limited accumulation on firms;

Characteristics of creative accumulation:
Difficult entrance, relative stability in the structure of the industry, high acquisition and high accumulation in firm;
Identifying the basic technologies in IPS; Outputs and inputs. In order to understand the nature of demand and the relationships in network of the SIS in IPS, first, certain questions must be answered to determine the nature of demand and relations of the players in the technological network cooperation.

What kind of technologies are so-called "base of technology" in this industry?
Are technologies in this industry defined in accordance with market potentials or technology push?
In what ways are the innovations of firms defined, and how is firm's communication out of the organization?
What kind of business inputs are there?

Are the system's inputs synchronized with market needs or they are provided based on the capacity of firms?

Identifying the type of interactions within the firm, and among firms and the mechanisms of such interactions in the Iran's pharmaceutical Industry:

Central firms:
The firms in IPS are the one that are either pharmaceutical products or aim to produce raw materials of the final product. Or that they are involved in sale and distribution of the products. If these firms in this category assign a significant share of the market to themselves, then they are called central firms. In the SIS, researching institutions are also considered as a part of central firms.

Relation with non-firm organizations, universities, research institutes, financial institutions, government agencies and local organizations:

Discussion within the firm:
If we consider the firms as one of the factors involved in shaping the innovation to understand the relationships and mechanisms of interactions in this industry, we must first study the firm from the inside. What are the factors influencing the innovation of firms in this industry and which firms have more innovations? How? To study within the firm, noting the following elements would be quite important:

Size of the firm:
What happens in this industry within the firm is the very thing to be paid special attention to and that is as follows: Patents, new products, volume of turnover, number of customers and the variety of products.

Technological intensity effort:
This element has been checked by several factors: strategy and culture manifests of

the firm, the number and size of contracts, licenses, technical knowledge and any joint projects which could be determined, R&D, and the volume of funds. These all could display the differences between firms. The amount of training and development of specialists are of the most important factors.

Discussion within the firms:

This issue should be analyzed from the important perspective of the providers, consumers, competition and cooperation among firms. In this regard, subsequent questions should be answered: Is communication in this industry based on market and the price of products? Or is it based on the quality and technology used? What level of information does the consumer in the market deal with? Which controlling mechanisms are provided? Are there a large volume of the firms acting as a leader in technology path or they are merely imitating each other?

Institutions

In this industry: Laws, efforts, customs, routines, habits, stimulates, incentives, behaviors etc. are shaped over time accelerating innovative activities. The effect of this volume of investments and relations, communication channels with the market and consumers could identify the capitalist and the worker over time. In this industry to what degree evaluating each factor in innovative interactions is possible?

Table 4: Constituent elements of main institutions in policy-making of the SIS in IPS

Structural Elements	Regulatory Framework	Innovative Culture
Industry composition Competition Export orientation Cost structure Access to markets Natural resources Foreign ownership Networks Company size Industrial clusters	Tax regime Regulatory environment IPR	Human resources Military Education Schools Universities Parks Incubators of technology R&D programs
Financial Credit	**Innovation Infrastructure**	**Leading Innovation**
Government's financial plans Private sector Venture Capital Stock market Foreign Investment	Higher education institutions Governmental Innovation Institutions Private Innovative Organizations S&T Park Foreign Trade Networks	Macroeconomic Policies Risk of Capital Fund Industry Research Centers Mechanisms for Coordination
Commercialization	**Information Diffusion**	**Diffusion Mechanisms**
Market Management Government Agencies Incubators Corporation Output	Industrial Association Universities Industrial networks Websites Database patents	Government programs R&D Organization R&D Network

In general, with an accurate definition of the SIS in IPS, its structural factors including players, networks and institutions could be identified and then relevant internal and external functions can be formulated. By evaluating such functions, stimulants and disincentives are grouped and they are involved in this sector's policy making. Finally the impact of adopted policies by distinct mechanisms can be measured and modified. Figure 1 shows the structural linkage to the SIS in IPS.
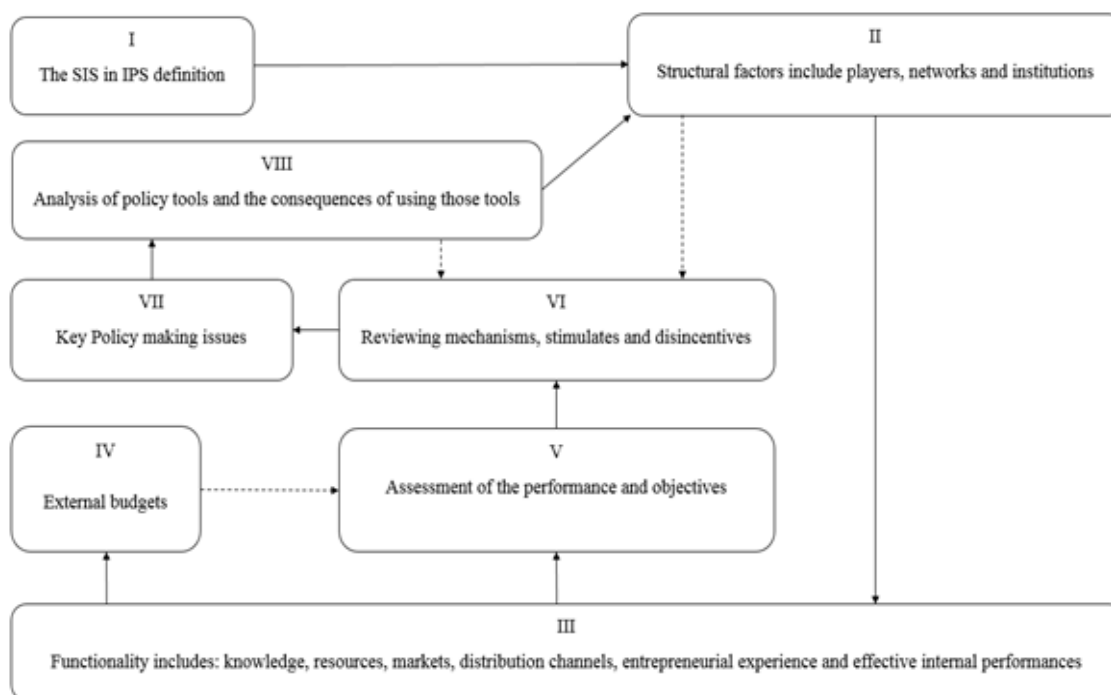
Figure 1: Structure of the SIS in IPS

Source: (OECD, 1999).

Step 1: Defining the SIS in IPS

This case study is related to Pharmaceutical Holdings of drug supply: This Pharmaceutical Holdings is one of the largest active pharmaceutics in Iran, with 120 subsidiary companies operating in production and distribution of pharmaceutical products handling nearly 70 % of the total pharmaceutical market.

Step 2: Structural factors: These factors include agents, networks and institutions.

Agents: agents in the SIS in IPS include: value of chain firms, universities, research institutions, multi-sectoral organs of government, trade unions, trade associations, hospitals, specialists and sub-specialists in certain hospitals and large pharmacies.

Networks: The networks on the SIS in IPS could be divided into two categories: formal and informal networks. Some of these networks have been created to solve special issues, including: Standardization networks, networks of participation in public and private sector. Also, some of these networks have been informally active such as: linkage of supplier and consumers, and linkage of university and industry.

Institutions: The defined institutions in the SIS in IPS includes: laws, regulations, procedures and culture in this area. If the technologies are supposed to spread fast and utilized by activists, therefore institutions are required to attain compatibility and cope with the latest

features of technology.

Step 3: Functions:
Knowledge development and its diffusion: a kind of knowledge that should be determined, In other words, it should be determined that knowledge used in this industry is multi-faceted: scientific, technological, manufacturing, marketing and the like. The source of knowledge should also be recognized as whether this source belongs to universities or R&D centers. Moreover, whether learning belongs to new applications or is it based on the production or technology transfer or imports? Measuring the knowledge is also of high importance: The number of scientific articles, the number, size, and orientation of the R&D projects, patents, developments made in technology and contracts on the one hand and on the other hand, the learning process must be constantly monitored and their changes due to production growth should be recorded to see whether it is effective for reducing of the cost or not.

Distribution channels: in the IPS the element of distribution is critically notable. Groups of firms and institutions are involved in it. In identifying the activists, power of performance within the limitations of factors participating in this regard, are effective.

Experimented entrepreneurs: In order to overcome the basic problems of innovation and conquering the existed uncertainty, experience in parallel to knowledge is also crucial. When knowledge and experience-based learning appear in form of an innovation, the entrepreneurs are encouraged to experiment more.

Market: initially there is no specific market for SIS in IPS, but gradually by identifying the market's potential, growth rate, size of the market and consumers' purchasing processes, very good markets have been created and cared. In this direction, embryonic markets exist out there focusing on learning, in the next stage, the transition period markets take place by increasing the entrance into relative scales and by entering the new players, and the

mass markets eventually are founded by the complete formation of SIS.

Internal budget: In this industry taking the advantage of the economic cost is shaped up by three areas:

1. Forming a reservoir of skilled labors which will reduce costs for companies.
2. The gradual formation of specialization and emergence of specialized suppliers of possible intermediate goods and related services.
3. Deepening the flow of information and overflowing of knowledge for the main agents.

External budget: This budget includes the effects of business coming from outside in which government has no direct role. This cost includes the positive cost (facing the industry in the competitive environment) and negative cost (immense problems in cities in which industry is located).
Finally:

1. Forming a reservoir of skilled labors;
2. Emergence of specialized suppliers of possible intermediate goods and related services;
3. Increasing the flow of information and overflowing of knowledge and the development of knowledge and its dissemination are carried out.

If we provide the conditions for development and shape the information flow for these processes, then we have contributed to economic efficiency.

Step 4: Evaluating the performance or operation of the SIS in IPS
We must first evaluate how each of these functions act desirable and then evaluate them together to see the utility and efficiency of each. According to policy making experts, for evaluation, using two techniques as the life cycle of industry and comparative systems of

the intended SIS in industry with other SIS of industry are possible.

The SIS based on its position in the life cycle of industry: Study based on the aspect of time, study based on the aspect of technology and market uncertainty, study on the basis of diffusion of knowledge and technology, and level of economic activity , reviews based on density of activities in this chain, and also study on whether the demand is formed or not and the key and main consumers as well were able to formulate the nature of their demand, (the more we reach the stabilization point, the more specialized firms would become).

The SIS of IPS based on the comparative estimation with other industries: reviewing based on the SIS in IPS with the SIS of other countries, or checking based on the SIS in IPS with the SIS of other industries in Iran.

Step 5: Identifying the mechanisms of stimulators and disincentives

In order to better understand the mechanism of stimulators and disincentives, in linkage to the functions of the SIS in IPS, the following linkage process has been extracted.

Step 6: Determining the key policy issues

These issues should be based upon the functions, structural elements and mechanisms of stimulation and disincentives.

Step 7: Analysis of policy tools and checking its consequences:

In policy making, attempts are toward approaching and approximating the goals. Political learning in which the policy makers should take advantage of, is required not only at the level of firm, but also at the macro level. Analysis of policy tools should be determined first on the economic development of the country's macro approach, and later it should measure and evaluate the means, goals, and other institutions with related techniques in the SIS.

Discussion, conclusion and suggestions

It is also worth noting the infrastructures: The current state of IPRs among the components of formal institutions is undesirable, probably it is because in the field of protection of IP, the outside rules of related organizations are not concerned and applied within organizations and the vacuum of such laws in the related organizations have been fully felt. The current state of the functioning of policy making, governance and organizing the innovation and R&D compared to other functions are undesirable, perhaps that is because now the responsible ones for development of technological innovation are not clear. Several institutions are operating in this field, which is partly entailing duplication and confusion in policy making, and also in R&D cases.

Generally, the problems caused by lack of funding can be vividly observed. But unfortunately the lack of coordination in the system creates the greatest problem in the field of finance and also other fields. Low intakes or the amount allocated to researches are also one of the major problems in this industry which even in cases such as the inappropriate projects, assigning great amount of budgets have been reported. This is rooted in the lack of coordination among infrastructure.

By strengthening the informal cooperation among the types of collaborative knowledge, we can mention some cases like strengthening the core of innovation consisting of individuals aware of the needs of industry's customers, along with some industry researchers, careful selection of staff and the inclusion of criteria such as having a sense of taking risks, spirit of cooperation and teamwork, strengthening the spirit of criticism of top managers and so forth. To improve such managing areas, the most important proposal is the creation of systematic thought in the minds of the administrators. Lack of systemic approach to the development of sectoral innovation on one hand causes the formation of linear perspective in developing

the innovation, which mainly focuses on individual or collective ideas, and then developing the products and providing them for customers. But the systematic face of innovation is not solely based on individual or aggregated creative ideas without interaction with the external environment and interactions with knowledge; it is the outcome of various learnings an organization earns by knowledge-able interactions.

In an elite field, it seems that IPS faces fewer challenges in areas of recruiting elites than developing and maintaining elites. According to the inflexible structures and lack of reward systems, after a period of time most of the elites with low payments and promotions, lose their motivation to continue the job or even they resign. Therefore, improving the systems related to maintenance and developing elites in this area are the main topics in SIS. Using research and innovative companies from other sections in the form of outsourcing or research collaborations with these companies is one of the mechanisms of strengthening the SIS, and at the same time letting elites from other parts to take action. Of course, this approach now has being expanding but we should have mechanisms to attract the knowledge gained from such agreements as much as possible. Respondents to the open ended question-naire in twenty-five cases demanded with such phrases as: to use academic experts as observers in research projects, and phasing out of exclusiveness shell, they desired a cooperative improvement among university and the industry.

According to the literature of organiza-tions' evolutionary economics, sometimes they merely follow a dominant design of products and the usual processes which have encouraged them to continue the past routine and eventually causes system lock. For this reason, organizations keep on with creative destruction and systematic procedures and their usual working practices, by following the teachings of Peter Drucker and Schumpeter.

Another structural problem is the lack of systematic view causing the formation of parallel activities and sometimes is contradic-tory in various fields. As an example, although in a systematic view, communication and external relations with other departments and also in the international arena are the requirements of innovation development, the employed procedures now give a cooperation chance to the pharmaceutical industry and make the situation very tough for them. Therefore, it is suggested that these procedures be adjusted appropriately.

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