International Journal of Academic Research in Business and Social Sciences
June 2012, Vol. 2, No. 6
ISSN: 2222-6990

# Identifying Local Determinants of Research Commercialization Strategies In Iranian Biotechnology Sector

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**Abstract**

Biotechnology industry has a special place among novel industries. The majority of biotech companies are start-ups or small companies that have been working for several years yet are not profitable. Evidences showed that firms and researchers have problems in turning academic findings to commercial revenue and there is problem in commercialization process and choosing method of the exploitation academic opportunities or choosing proper commercialization strategy in this industry. In this study, firstly, the local determinants of commercialization strategy in 41 Iranian young biotechnology companies were identified through interview and then a questionnaire was prepared integrating these determinants and the rest of them exist in literature and was distributed among a larger sample in order to obtain the integrity. Finally, after analyzing the questionnaires, the local determinants of commercialization strategies for Iranian researcher in biotechnology sector were identified.

**Keywords:** determinants, research, commercialization strategy, biotechnology, Iran.

## Introduction

What today it makes a country developed or back ward is use of technology in different aspects of development; particularly development in technology. Development in the current conditions of the world would not be possible without achieving the advanced technology. Increase in investment in technology entrepreneurship and establishment of start-up firms develop knowledge and technology with significant potential commercial applications and consequently cause development of countries. The youth, start-up innovators of these firms have little experience in the markets and they have at most two or three technologies at the stage of potential market introduction. For these firms, a key management challenge is how to translate promising technologies into a stream of economic returns and to obtain a competitive advantage. In other words, the main problem is not so much invention but commercialization (Gans and Stern, 2003). Shaker Zahra (2002) quotes from Cooper (2000) that the successful

commercialization of the technology is a necessary factor for survival in today's competitive world.

Since technology is considered as a vital strategic source and the new technology and researches do not add any value to the company unless they become commercialized , therefore decision about commercialization and acquisition of technology is considered as a strategic selection regarding different special resources required by the company for achieving sustainable competitive advantage (Barney, 1991; Hamel, 1991; Lanctot and Swan, 2000; Zhao et al., 2005), hence the importance of determinants is more obvious.

Since biotechnology as a converging technology (Roco & Bainbridge, 2002) is considered to be of strategic technology in the developed countries and it is naturally an innovative and young industry (Gans and Stern, 2003) and since the fact that the institutional, situational, and historical aspects of entrepreneurship in this industry are peculiar (Dixon, 2009), it is an attractive environment for studying commercialization strategy. The evidences show that, despite production of new and important products and revolutionary techniques, the financial performance of biotech sector has not appropriate conditions (Standard & Poor's, 2010; Ernst & Young, 2011). Most of biotech firms are young and small size companies but despite the fact that they have a plenty of activities in this regard but they could not considerably profit up to now. Their major focus is on process of translating ideas to the income i.e. commercialization (Gans and Stern, 2003; Dixon, 2009) and the necessary step in this process is an important and strategic selection about manner of delivering these products to the consumers and in other words manner of using the produced knowledge and technology which is called selection of commercialization strategy (Gans and Stern, 2003; Kascha and Dowling, 2008; Dixon, 2009; Haeussler, 2010). Although this phrase is meaningful for the entrepreneurs who have activity in the field of biotech and have experienced in this regard, but direct translation of this phrase to the academic frames is difficult and while many strategy theories capture some important elements of commercialization strategy, none capture the full range of meaning understood by practitioners(Dixon, 2009) and no comprehensive classification has been presented yet (apart from the research approach used for extraction of factors and regarding the special conditions of the study country) and this is the main goal of this research.

The objective of this study is to identify the determinants of commercialization of researches and technology in biotech field in Iran reviewing the existing literature in commercialization field and recognizing the determinants of these strategies through qualitative- quantitative mixed method (Bryman and Bell, 2007; Hesse-Biber, 2010). In summary, this study aims to identify factors that have effect on the decision of Iranian biotech companies in selection of the commercialization strategies of researches.

Therefore, after extraction of the determinants of commercialization strategy existing in the literature and identification of the other factors affecting in this process for suppliers and experts in the country, through a qualitative research, the integrity of the final identified factors, using a questionnaire presented to a larger sample, was measured (Hesse-Biber, 2010), and finally the classification of the determinants of each commercialization strategy of

*International Journal of Academic Research in Business and Social Sciences*
*June 2012, Vol. 2, No. 6*
*ISSN: 2222-6990*

researches in biotechnology industry (especially considered for the Iranian experts) has been presented.

**Literature Review**

In this part; firstly the commercialization strategy is defined and different types of strategies used in biotech are introduced. Then, the existing literature on determinants of commercialization strategies is reviewed.

**Commercialization Strategy**

Commercialization Strategy refers to a series of operation alternatives that a company is faced with them for transferring a product or technology to the market (Servo, 1998; Gans and Stern, 2003, Kascha & Dowling; 2008). In this study, the researcher, following Kascha and Dowling, has selected the following classification (of commercialization strategy type) as a basis for her researches:

1) Merger and integration
2) Bilateral cooperation
3) Unilateral cooperation

Sales or unilateral cooperation means full transfer of intellectual property rights. Bilateral cooperation is considered as integration interface and market exchanges. Kascha and Dowling show that bilateral cooperation can include types of joint ventures (Servo, 1998; Shan, 1990), exploitation permit or outsourcing agreement (Ford and Ryan, 1981; Teece, 1986; Servo, 1998), and minority equity alliances.

In the integration strategy, two companies integrate with each other, or a company buys another company. The purpose of integrating the companies is to form a company (Sytch & Bubenzer, 2008; Pearce and Robinson, 2005; Mehta, 2008; Ceccagnoli and Hicks, 2009). However, this question is raised that which factors acts as determinants of this commercialization strategies.

**The Determinants Of Commercialization Strategy**

For the first time, Teece (1986) was referred to the subject of the factors affecting the commercialization strategy in his article entitled " Profiting from technological innovation: Implication for integration, collaboration, licensing and public policy ". He introduced the complementary assets such as product development, production and marketing and the systems protecting intellectual properties as the factors affecting the commercialization strategy and stated "the companies select from three strategies: its required complementary assets, cooperation with other companies, or sale of its technology property". Other researchers, like Greis (1995) and Shan (1990) stated that the competitive and complementary assets are the effective factors in this selection. Gans and Stern (2003) referred to

*International Journal of Academic Research in Business and Social Sciences*
*June 2012, Vol. 2, No. 6*
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complementary assets and the role of environment in commercialization. They stated that due to differences in commercialization environment that the start –up innovators are faced with them in each sector, the innovation changes the market leadership in some industries and reinforces the excellence in the other industries. The commercialization environment – the micro economic and strategic conditions in front of a company which change an idea to a product-determines the most efficient commercialization strategies i.e. process of delivering the innovation to the market environment. The fundamental element of commercialization strategy of a company is to select the competition or cooperation with the new established companies and the differences existing in the commercialization environment in front of the start-up innovators create different competitive dynamics in the advanced technology sector(Gans and Stern,2003; Dixon, 2009). Then Kascha & Dowling (2008) in their article entitled "Biotech commercialization strategies" have experimentally identified the determinants of commercialization strategies in biotech industry in United States of America reviewing 101 products of new biotechnology companies. After performing some studies (Gans and Stern, 2003; Greis et al., 1995; Katila and Mang, 2003; Pisano and Wheelwright, 1995) for approving the commercialization, they have stated that: (1) strong protection of the technology or what they call strong appropriability regime often leads to cooperative commercialization strategy. Furthermore, (2) complementary assets (R & D and marketing) as direct capabilities, (3) indirect capabilities (access to the network of distribution channels, interacting with customers and partners), (4) financial resources (type and amount of financial resources and bargaining power), (5) competition (number of competitors, and speed of competition in product markets), (6) asset specificity (the types of complementary assets), (7) uncertainty (uncertainty of technology and uncertainty of market)and 8)synergy (fundamental competencies and product dependence on key activities of company) are also the determinants of commercialization strategy, but in the continuation of study, there was no evidence confirming the factors of synergy, uncertainty, asset specificity and indirect capabilities in the study community.

Kascha and Dowling (2008), with putting together the three theories, have tested the obtained factors and finally four factors i.e. direct capabilities, synergy, financial resources and appropriability regimes were approved.

**Methodology**

Qualitative-quantitative mixed method (Bryman & Bell, 2007; Hesse-Biber, 2010) are used in this study. Accordingly, after extracting the determinants of the existing strategy from the literature as well as identification of the local factors through semi-structured interview in the qualitative stage, using a questionnaire in the quantitative stage, the final identified factors are measured for final approval and integrity until finally the determinants of each commercialization strategy of researches in the biotech industry field (especially for the Iranian experts) were identified. In this study, the relevant community in both qualitative and quantitative stages is the start-up biotech companies with maximum 10 years of experience. Based on the list received from Iranian Biotechnology Association, 41 active companies in the different fields of biotechnology in Tehran Province, including 41 managing director and 39 idea

owners, researcher and manager of research and development Dept. were identified that the statistical population in this study was totally 80 persons.

Semi-structured interviews were used for gathering data in qualitative method. After the interview with 35 persons, data was saturated and the qualitative data analysis was started. Manual coding method was used for analyzing the interviews and extraction of factors. Therefore, as it is stated by Bryman and Bell (2007); firstly the interview converted into the text and then using the constant comparative analysis, and in accordance with Strauss and Corbin method (1990), the texts were analyzed to identify the factors. Manner of extracting the concepts from the recorded voice and final coding are presented in Tables 1 and 2, respectively.

**Table 1 first phase of interview coding (for financial concepts as a sample)**

| Interviewee code | Verbal Statement | Extracted Concept | Concept Code |
|---|---|---|---|
| $I_{16}$ | The financial resources which could be provided through loan have been increased by growing the company and cooperating with a well known company. | Increase in financial resources with taking action for cooperation | 1000 |
| $I_1$ | The main reason that we decided to work with ... was the conditions set by the Ministry of Health and we required for production and we had not the required capital to build facilities considered by them and knew that …. Company has the required space and facilities. | Need for the required capital for providing the facilities | 1001 |
| $I_{14}$ | The problem is that in this scale funding is required for industrialization and according to our estimate, several billions are required and it is unlikely that we could lonely get higher levels. | Need for high budget for industrial production | 1002 |
| $I_{11}$ | Due to lack of sufficient initial capital, we did not have bargaining power and were not able to conclude a contract with large pharmaceutical companies because we had to transfer a large portion of our salary and we wanted to produce our product independently and also continue our researches. | Financial power | 1003 |

Twenty and fifteen persons out of the total number of interviewees are managing directors (57%) and managers of research and development (43%), respectively.

The new Identified factors include: Cooperation culture, existence of suitable infrastructure, supportive and complementary services such as specialized counseling centers in biotechnology industry and nature and life of industry, that are not included in the groups of factors extracted from literature and therefore they are considered as local factors. Finally, all the identified local factors and the factors extracted from the literature were classified again regarding definition of each factor and its features and based on the experts' viewpoints, in order to facilitate the process of studies and commencement of quantitative study.

**Table 2 Classification of coding result (for financial dimension as a sample)**

| Item | Concepts | Dimensions | Interviewee Code | Frequency |
|---|---|---|---|---|
| 1 | Need to provide the capital required for providing facilities (1001), (1000),(1002) | Financial resources | $I_{16}$, $I_1$, $I_{11}$, $I_{14}$, $I_{21}$, $I_{25}$, $I_{29}$, $I_{27}$ | 8 |
| 2 | The financial power (1003), | | | |

Thus the factors of specificity of assets and financial resources due to focus on the resources required for the commercialization are placed in the group of "factors of the resources"; factors of direct capabilities, indirect capabilities and synergy due to focus on specific capabilities and competencies that lead to competitive advantage are in the group of" factors related to the capabilities and competencies"; competitive and uncertainties factors are classified in the group of "factors of environment" since they are affected by external conditions ; All factors related to the appropriability regimes and legal factors are in the group of" factors related to property rights", and ultimately the factors of cooperation culture , suitable infrastructure, supportive and complementary services such as specialized counseling centers in the field of biotechnology, and nature and life of the industry are classified in the group of "local factors of country".

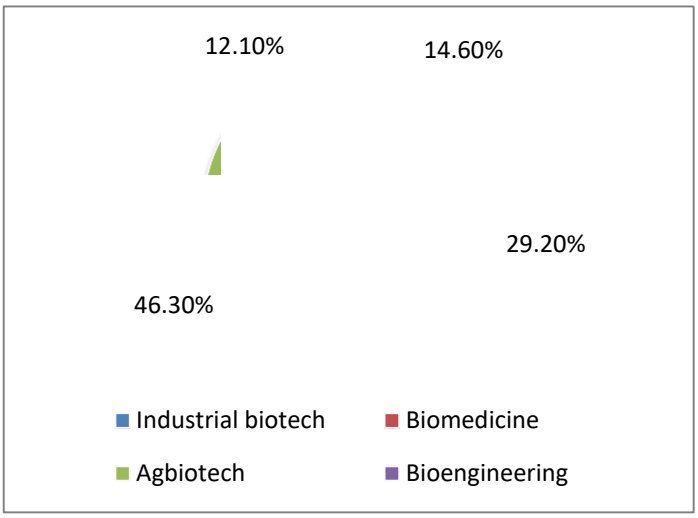


**Diagram 1** Distribution percentage of biotechnology companies in Tehran province

After completion of qualitative stage, all the factors extracted from existing literature and the identified local factors were also studied in the quantitative stage in order to review the amount of influence of each group of the factors on the selection of each one of three strategies used in this part. Accordingly, a questionnaire was designed and distributed among the relevant members. In the quantitative stage, Cochran's formula is used for estimating sample size and classified probability sampling is used for selecting members of sample. Therefore, in view of the statistical population which was 80 persons and using Cochran's formula, with an error factor of 0/05, and considering the value of p = 0/5 the sample size is considered 66 persons in order to obtain a large enough sample size. Regarding the information obtained from Iranian Biotechnology Association , the active companies in this area can be divided into four general categories: Industrial Biotechnology, Pharmaceutical Biotechnology, Biotechnology in Agriculture and Biotech Engineering that six companies in the field of the industry biotechnology (14/6%), nineteen companies in the field of agbiotech (46/3%), five companies in the field of bioengineering(12/1%) and twelve companies in the field of biomedicine (29/2%) are active (Diagram 1). So in this stage, eleven, nineteen, twenty nine and eight questionnaires were distributed among industrial biotech, pharmaceutical biotech, agricultural biotech and biotech engineering companies, respectively. Finally, frothy five filled questionnaires were received.

The experts' viewpoints are used to ensure the validity of the used tools (content validity) and Cronbach's Alpha was used to measure the reliability of the questionnaires. Based on the results, the questionnaire's alpha coefficient was 0/9. One sample T test and analysis of variance (ANOVA) are used for analyzing the questionnaires. Out of total number of sample, there were twenty two managing directors (48/9%), nine researches (20%), five consultants and member of Scientific Board (11/1%) and nine managers of R & D Dept. (20/0%). At this stage, the respondents were asked about the effect of individual factors on selection of each one of three commercialization strategies and the final results of each group were analyzed.

**Results**

The results of research showed that commissioning strategy (merge and integration) with 80% utilization rate is the most widely used strategy and after that cooperation strategy (bilateral cooperation) with 15/5% and sales strategies (unilateral involvement) with 4/4% utilization rate are in the next ranks, respectively(Diagram 2). One sample T-test was used for reviewing role of each one of seven identified factors in selection of each strategy.

The results of these tests showed that factors related to resources, industry have effect on the selection of unilateral cooperation strategy (Table 3), The factors of capabilities and competencies have effect on the merger and integration strategy (Table 4) and the factors related to resources, environment, property rights, and the factors related to the government have effect on the selection of the bilateral cooperation strategy (Table 5) by Iranian biotechnology companies. One-way analysis of variance was used to investigate the viewpoints of the sample members from an occupational and educational viewpoint. The results revealed that from an occupational viewpoint except the factors related to the industry, among viewpoints of the individuals participating in the research there is no significant difference in the other determinants of strategies.

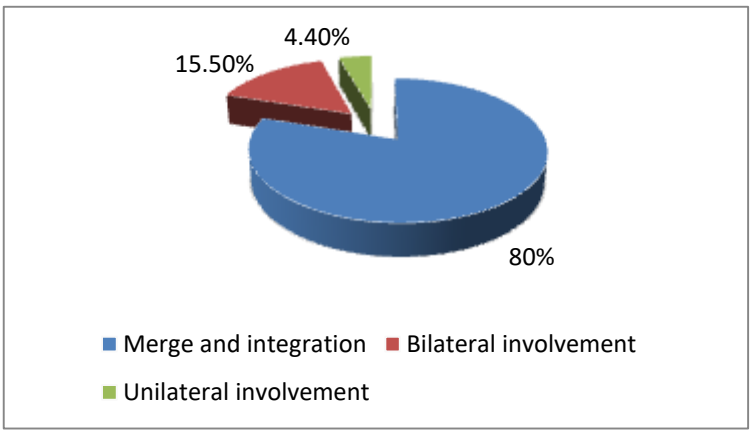


**Diagram 2** The application of commercialization strategies (percent) in the study sample

It means that there is no significant difference among the viewpoints of the four occupational groups (MD, researcher, managers of R&D Dept. and scientific board members) concerning the effect of the relevant factor on the selection of strategy (except the factors related to the industry). And from an educational viewpoint, there is no significant difference in the determinants of strategies.

*International Journal of Academic Research in Business and Social Sciences*
*June 2012, Vol. 2, No. 6*
*ISSN: 2222-6990*

**Table 3 One sample T-test for reviewing role of identified factors in the selection of unilateral cooperation strategy**

| Statistic / Unilateral Cooperation | Average | Average Test Score | T | DF | Significance Level | Average Difference | 95%Confidence Level | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Low | High |
| Factors related to property rights | 2.4963 | 2.5 | -.039 | 44 | .969 | -.00370 | -.1954 | |
| Factors related to environment | 2.6074 | 2.5 | .935 | 44 | .355 | .10741 | -.1242 | |
| Factors related to resources | 2.843 | 2.5 | 2.82 | 44 | .007 | .34630 | .0995 | |
| Factors related to capabilities | 2.4815 | 2.5 | -.136 | 44 | .892 | -.01852 | -.2921 | |
| Factors related to government | 2.3056 | 2.5 | -1.13 | 44 | .262 | -.19444 | -.5392 | |
| Factors related to industry | 2.76 | 2.5 | 3.03 | 44 | .004 | .26889 | .0900 | |

**Table 4 One sample T test for reviewing the role of the identified factors in selection of merger and integration strategy**

| Statistic / Unilateral Cooperation | Average | Average Test Score | T | DF | Significance Level | Average Difference | 95%Confidence Level | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Low | High |
| Factors related to property rights | 2.5852 | 2.5 | 1.073 | 44 | .289 | .08519 | -.0748 | |
| Factors related to environment | 2.4259 | 2.5 | -.637 | 44 | .527 | -.07407 | -.3083 | |

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*ISSN: 2222-6990*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Factors related to resources | 2.3463 | 2.5 | -.846 | 44 | .402 | -.15370 | -.5199 |
| Factors related to capabilities | 2.0543 | 2.5 | -2.82 | 44 | .007 | -.44568 | -.7632 |
| Factors related to government | 2.3611 | 2.5 | -.711 | 44 | .481 | -.13889 | -.5325 |
| Factors related to industry | -.299 | 2.5 | -.299 | 44 | .766 | -.03778 | -.2923 |

**Table 5 One sample T test for reviewing the role of the identified factors in selection of bilateral cooperation strategy**

| Statistic / Unilateral Cooperation | Average | Average Test Score | T | DF | Significance Level | Average Difference | 95%Confidence Level | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Low | High |
| Factors related to property rights | 2.7630 | 2.5 | 3.137 | 44 | .003 | .26296 | .0940 | |
| Factors related to environment | 2.7914 | 2.5 | 3.357 | 44 | .002 | .29136 | .1164 | |
| Factors related to resources | 3.074 | 2.5 | 5.701 | 44 | .005 | .57037 | .3687 | |
| Factors related to capabilities | 2.6049 | 2.5 | 1.292 | 44 | .203 | .10494 | -.0588 | |
| Factors related to government | 2.666 | 2.5 | 1.542 | 44 | .130 | .16667 | -.0511 | |
| Factors related to industry | 2.2111 | 2.5 | -2.17 | 44 | .035 | -.28889 | -.5563 | |

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**Discussion**

In parallel with other studies conducted into determinants of commercialization strategy (Gans and Stern, 2003; Kascha & Dowling; 2008; Ceccagnoli and Hicks, 2009; Haeussler, 2010; Lin et al., 2010), in this study we have also identified the determinants of commercialization strategy. The main difference between this study and other studies is that with using interviews we have identified local determinants of specific commercialization strategies especially for Iranian experts apart from just testing existing literature.

The results of qualitative stage of this study as well as interviews with experts and activists in biotechnological field in Iran showed that, the existing atmosphere dominated the commercialization of biotechnological researches strongly suffers the weak intellectual property protection laws and this factor more than the other factors prevents developing this industry and similar developed industries. Most researchers and suppliers formed the statistical community of this study believed that this factor, is the mother of the other obstacles in the path of development and competitiveness of the country and it is also considered as the most important deterrent and anti motivational obstacle in the path of scientific growth of the researchers and this problem can be only removed by the legislators and the relevant organizations as well as policy making in the macro sections of country. The results of interviews also revealed that the factors related to the need to supporting and complementary services, provision of infrastructure, and the factors related to unfamiliarity with team work and inability to do it, unreliability and non-acceptance of cooperation are identified as local determinants of commercialization strategy. Therefore, the main task of policy makers is to meet the requirements of the researchers and suppliers in order to create a cooperation culture and a space for encouraging them in innovation, to produce knowledge and to make required scientific and industrial cooperation between the activists in this field. In this study, the positive or negative effects of each one of the main groups and the sub-factors of each group on selection of each one of the strategies have not been investigated and the exact orientation of the factors towards a specific strategy was not identified .It is proposed to review the positive and negative effect of each factor on each strategy and to determine the correlation amount of each factor with each strategy; in addition, the effect of the whole factors can be compared with each other. It means that it is proposed that the identified determinants of each strategy be reviewed next to each other in the selection process and the correlation of factors be compared to each other so that the effect of the factors on each other can be determined.

**Conclusion**

One of the important aspects in the commercialization success is to select an appropriate strategy and selection of this strategy is one of the main duties of the managers and owners that here they are called intellectual property owners and managers in the pharmaceutical and biotechnology companies**.** Qualitative-quantitative mixed method or exploratory mixed method are used in this study, in order to conduct this research and to understand this phenomenon better and to cover the defect which is caused due to use of a quantitative method or

qualitative method alone. For this reason, firstly after reviewing the existing literature about the commercialization strategy, the determinants were identified and then by conducting the qualitative research and interview with 35 active members of 80 persons statistical community mentioned in the list of 41 biotech companies in Tehran introduced by the Iranian Biotechnology Association, the local determinants were identified according to the viewpoints of the local researchers and experts. After analyzing the data of qualitative research with coding method, two identified new determinants group and the determinants which are obtained from literature review were finally tested in the quantitative research using questionnaires in order to identify, confirm and extend the results of qualitative research. Finally, the main determinants of researches commercialization strategy, for local biotechnology companies, were identified and for coverage of similarities and integration of the categories of factors which were made regarding the economic theories of the origin of each factor, a new classification which the basis is the specific features of each factor is presented. Finally, the final identified factors with a new classification in the form of 7 groups of factors with specific subcategories and with determination of the effect of the specific factors group on the selection of each one of three commercialization strategies existing in the field of biotechnology was presented in the form of a model.

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