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Designing a dynamic model for evaluating the research and development projects cost focused on technical indicators and market share in knowledge based companies

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Abstract

In this research, according to the previous studies and the extraction of factors affecting the economic valuation of research costs and the identification of cause and effect circles, a dynamic model has been developed. Subsequently, using the DEMATEL technique, the relationships between them and the effective coefficients were determined and included in the model. Hence, in order to test the accuracy of the model and determine the behavior of the state variables and the rate of information gathering from the eight knowledge based companies in the science and technology parks of Alborz, Pardis and Tehran University in the period of 24 months, by assessing the 24-month behavior of research in the framework of the model as well as sensitivity analysis, the validity of the designed dynamic model was evaluated.

Keywords: Dynamic Model, Economic Valuation of Costs, Research and Development Projects, Knowledge Based Companies

Projetando um modelo dinâmico para avaliar os projetos de pesquisa e desenvolvimento, custos focados em indicadores técnicos e participação de mercado em empresas baseadas em conhecimento.

Resumo

Nesta pesquisa, de acordo com os estudos anteriores e a extração de fatores que afetam a valoração econômica dos custos de pesquisa e a identificação de círculos de causa e efeito, um modelo dinâmico foi desenvolvido. Posteriormente, utilizando a técnica DEMATEL, as relações entre eles e os coeficientes efetivos foram determinados e incluídos no modelo. Assim, a fim de testar a precisão do modelo e determinar o comportamento das variáveis de estado e a taxa de coleta de informações das oito empresas baseadas em conhecimento nos parques de ciência e tecnologia de Alborz, Pardis e Universidade de Teerã no período de 24 meses , avaliando o comportamento de 24 meses da pesquisa na estrutura do modelo, bem como a análise de sensibilidade, avaliou-se a validade do modelo dinâmico projetado.

Palavras-chave: Modelo Dinâmico, Valoração Econômica de Custos, Projetos de Pesquisa e Desenvolvimento, Empresas Baseadas no Conhecimento

Diseño de un modelo dinámico para evaluar los costos de los proyectos de investigación y desarrollo centrados en indicadores técnicos y participación de mercado en empresas basadas en el conocimiento

Resumen

En esta investigación, de acuerdo con los estudios anteriores y la extracción de factores que afectan la valoración económica de los costos de investigación y la identificación de los círculos de causa y efecto, se ha desarrollado un modelo dinámico. Posteriormente, utilizando la técnica DEMATEL, las relaciones entre ellos y los coeficientes efectivos se determinaron e incluyeron en el modelo. Por lo tanto, para probar la precisión del modelo y determinar el comportamiento de las variables estatales y la tasa de recopilación de información de las ocho empresas basadas en el conocimiento en los parques científicos y tecnológicos de Alborz, Pardis y la Universidad de Teherán en el período de 24 meses Al evaluar el comportamiento de 24 meses de la investigación en el marco del modelo y el análisis de sensibilidad, se evaluó la validez del modelo dinámico diseñado.

Palabras clave: modelo dinámico, valoración económica de costos, proyectos de investigación y desarrollo, empresas basadas en el conocimiento.

1. Introduction

One of the most influential and essential factors that have contributed to the development of knowledge and technology has been the activities and processes of research and development, therefore, the research and development process is one of the key factors in accelerating the growth of knowledge and technology. In the meantime, there are several costs involved in the process of research and development, which are not necessarily financial and cash-based. Moreover, due to the nature of the research process, which has plenty of fluctuations to reach the final result, exact calculation of the costs spent on R & D projects has become very complex and ambiguous. Several scholars such as, Siouzaki Ki, et al., Wang Ji, Engels H et al., 2017) argue that the cost of research and development projects is not a valid criterion for the economic valuation of such projects due to the ideas, innovative methods and solutions in conducting research and development projects, as well as the lack of a suitable criterion for the valuation of such intangible assets in the process of carrying out R & D projects. On the other hand, since the research process takes time, especially in the field of basic sciences and fundamental research, and the nature of the outcome oriented research process and the importance of its applications in practice to solve problems or to improve the current conditions have led to the process of economic valuation of research and development projects, rather than the outcome of the research process, which depends on its impact on the implementation process and its applications on the implementation of the knowledge and technology.

2. Literature Review and Research Background

In various opinions, the accumulation of knowledge is mentioned as the main engine of technological advancement. Different countries are developed, so that developing countries are forced to invest in research and development activities to maintain competitiveness in the global economic environment. R & D is the key to technology growth. Nowadays, most new technologies are being developed by organizations with institutions that have extensive research and development activities (Resutek Robert J, 2015). In fact, one of the important results of research in each economic sector is the significant increase in the productivity of factors. R & D boosts productivity by increasing innovation as well as the potentiality for emulation. Technological imitation plays a crucial role for countries that are far from technologically advanced countries. Obviously, the efficiency of technological imitation decreases when it approaches the technology frontier of advanced countries (Shannon P, elt, 2010). Research on the accumulation of knowledge attracts the attention of foreign economic research and development by other companies. Therefore, the benefits of foreign investment in research and development in developed countries overflows into other developing economies. In fact, this is one of the major reasons for the miraculous growth in Southeast Asian countries over the past three decades. Participating in the competition for R & D activities for its winner creates a monopoly profits in short and long term, which enhances the scope and power of large companies in the market (Laurel Franzen, elt, 2009). Nowadays, research and its activities take place beyond the boundaries of countries and become international activities. The internationalization of R & D activities has become a knowledge and investment activity in high technology industries such as ICT, pharmaceuticals and biotechnology, but also in mid-tech industries, such as mechanical engineering, automotive and chemical industries. Moreover, with the increase in the number of large companies in the countries, more international companies are being set up, which will give companies a simultaneous challenge in managing more efficient R & D and maintaining competition. Meanwhile, technological change is happening quickly, which forces companies to introduce new products to the market. Therefore, companies need to be in close contact with the consumer, the target market and the supplier in order to respond quickly to market needs. Ultimately, this leads to the growth of international research and development. The advanced technology in the developed countries, on the one hand, and the huge cost of research and development on the other hand, has led to a wider spread of technology and production gap between developed countries and other countries. Therefore, technology-rich countries can hardly reduce this gap by spending huge amounts of money, as most new innovations are actually the result of expanding existing knowledge or simply improving it (Lee, C.K, elt, 2007).

2.1. Theories and Literature on Causal Relationships

The cause and effect relationships of the dynamic model of economic valuation of research and development costs are based on previous theories and studies, which are presented in the following table.

Table 1
The Results of Previous Research on Causal Relationships Valuation of R & D Costs

Number	The Researcher	Year	Variables	Causal Relationships
1	Biancardi, M., elt	2018	The degree of innovation growth, the success rate of R & D projects, the growth rate of technological capability	The growth rate of innovation on the success rate of research projects has a positive impact on the growth of technological capability.
2	Sharma, S. K., elt	2018	The amount of sales of products and services, the amount of promotion of competitive ability and the amount of capital spent	The amount of spent capital on the enhancement of competitive ability has a positive impact and the amount of competitive ability on the sales of products and services.
3	Suzuki, K., elt	2018	Risk, capital spent, success rate of research project, the use of specialized teams	The amount of capital spent increases risk, and, on the other hand, contributes to the success rate of research projects, however, the use of specialized teams reduces risk and increasing the success of research projects.
4	Wang, J	2018	The amount of capital spent, the growth rate of innovation, the amount of hardware and software utilization, technological capability and research costs	The amount of capital spent positively affects the growth of technological capability and increases costs, as well as the use of hardware and software and specialized teams which have a positive impact on costs.
5	Martín-Barrera, G,elt	2018	Use of specialized team, product development, innovation growth rate, technological growth rate	The use of specialized teams has a positive impact on product development, innovation growth, technological development and brand equity growth.
6	Engsner, H, elt	2018	Profitability, product and service sales, the extent to which the competitiveness is enhanced, and the growth rate of productivity	The amount of sales of products and services on profitability and the rate of productivity growth have a positive impact on improving the competitive ability and sales of products and services. It also reduces system costs.
7	suresi A	2018	The success rate of research projects, brand value, productivity growth, product development and the growth of the quality system	The success rate of research projects has a positive impact on brand value, productivity growth, product development and the growth of the quality system.
8	Yu, H	2018	Innovation growth, product development, brand value and sales of products and services	The growth rate of innovation has a positive impact on product development, which has a positive impact on the growth of brand value and sales of goods and services.
9	Khoshnevis, P, elt	2018	The success rate of research projects in terms of improving competitive ability and technological capability	The success rate of research projects has a positive impact on the extent of enhancing competitive ability and the growth of technological capability.

10	Jun, S. P., elt	2018	The growth of the quality system, the promotion of competitive ability, the growth of productivity and profitability	The growth rate of the qualitative system has a positive impact on the extent of enhancement of competitive ability and the growth rate of productivity and hence lead to lower costs and increase system profits.
11	Jinfa, L, elt	2018	Brand growth, technological capacity, profitability, cost, productivity growth, competitive capacity enhancement	The economic value of R & D activities is an outcome of the growth of brand value, profitability, the promotion of the growth of competitive and technological potentials, and the increase in productivity.

Calculating the Research Variables

1. The Growth Rate of Innovation

This variable is calculated according to the process approach and application of innovation in the system of products and services, therefore, in the process of innovation, review process has inputs and outputs and achievements. Inputs include the set of applied costs (personnel costs, the cost of information equipment, etc.) in the research and development labs, whose outputs include patents, technical knowledge, publications, innovative approaches and innovative solutions, which leads to optimal planning, more efficient engineering of the service and product structure, or the strengthening of marketing infrastructure, ultimately, these activities are organized in the form of achievements such as reducing the cost of improving products and services and increasing the competitive and productive capacity of the organization. This is the same as the adaptation of the Global Indicator of Innovation (GII) model, which includes input components and output components, which are based on the gains obtained from the process of innovation and the rate of innovation growth. According to the model (Asymglio Di et al., 2018), the proportion of the coefficient of reducing the cost of improving products and services on the coefficient of output of the innovation process is calculated as follows.

$$\text{Innovation Growth Rate} = \frac{\text{Ratio of reducing the cost of improving products and services}}{\text{Innovation output process coefficient}}$$

2. Risk

The effect of risk on the various goals of R & D projects in terms of cost indicators can only reflect the financial effects of not achieving these goals at a specific time, while some of the effects of risk may not impose costly effects on the company at that time, however, in the long term it may have significant effects on participation (Ridnick et al., 2015). Therefore, in the process of calculating risk, it is necessary to measure the dimensions, such as the effect of risk on customer satisfaction, the quality of products and services, performance, time and costs in terms of the development of risk factors that affect research and development projects. In this research, in the course of 24 months, the five-dimensional Risk-Impact Assessment (RIS) questionnaire has been filled out in R & D projects based on the model (Gerszak, 2014) to calculate the risk, and subsequently, its final coefficients are obtained.

3. Improved Competitive Capacity

A company achieves a competitive advantage when it creates more value for its customers than its rivals, so that customers know better than other companies about their products and services. Creating value can be achieved by supplying products and services at lower prices or through the supply of higher quality products and services and increased added value (2010, Ambe). In this research, the promotion of competitive ability is a coefficient of the sum of the three-fold ratio (price / cost, quality, and innovation enhancement coefficient) derived from the 2018 Livotupo model, which was compiled using information from eight knowledge based companies and a questionnaire tool for 24 months.

4. Product Development Scope

There are a myriad number of activities in each product development process. A certain amount of information is also shared once by some activities, each activity has capabilities that are applied in the product development process and generates output information. Therefore, the relationship between activities plays an important role in computing the development time of the entire process. Activities can have consecutive or conjugated relationships with other activities. In addition, there is overlap between development activities in terms of time dependence. Hence, product development is a function of time. In this study, according to Wang T et al., 2013 model, which calculated the coefficient of development of products and services according to the following relationships. The product development rate is a function of cost and time that has been collected over the course of 24 months from knowledge based companies, which has been adapted from the following relationships.

$$T = \sum_{i=1}^{N} T_i + \sum_{i=1}^{N}\sum_{j=1}^{N}\left(T_{ij}^{ro} + T_{ij}^{rc} + T_{ij}^{roc} - T_{ij}^{o}\right)$$

$$C = \sum_{i=1}^{N} C_i + \sum_{i=1}^{N}(C^r + C^n)\,K_i + R_c T_T$$

Conditions:

$T_T \geq T - T_d$

$T_T \geq 0$

$K_i = 0,1, \dots, n$

$K_j = 1 - \alpha ij$

$$K_j \geq \alpha ij$$

Table 2
Indicators for Calculating Product Development Rates

Rc	$Tijro$	Ki	αij	Cn	Cr	T_{ij}^{rc}	T_{ij}^{roc}	Ti	T
The cost of delayed risk	The time for the operation of j activity	The maximum number of rework due to the overlapping or congestion of each activity	The amount of overlapping of i and j activities	The cost of negotiating activities for rework	Redeeming activity i	The time to re-work j activity for conjugation with activity i	Time to re-engage j activity with activity i in conjunction	The normal time is the process i	Completion time of the project

5. The Growth Rate of Technological Capability

The assessment of technology capability is a process in which the current level of organizational capabilities is measured to identify both the strengths and weaknesses of an organization's technology, and it is possible to compare the organization's technological capabilities with competitors by the ideal level and to compensate for undesirable events (Khamseh et al., 2010). In this research, by using the standard questionnaire of technological capability, we measure the growth rate of the ability of the monthly technology in the 24-month period of eight knowledge companies.

6. Growth Rate of Productivity

Given the fact that research and development trends and outputs affect production performance in a given time frame, it is necessary to calculate the productivity coefficient for measuring productivity growth in research and development projects (Morgan P, et al. 2018). For this purpose, in order to calculate the productivity growth factor over a period of 24 months, eight knowledge based companies are calculated.

7. Growth of Brand Value

Considering the fact that the output of R & D projects has led to the strengthening of cash flows in, knowledge based companies. For this reason, in order to calculate the value of a brand in knowledge-based companies, it is necessary to use the method by which the company is more complex from the intellectual property, since these assets, instead of generating cash flows for a particular product or service, generate cash flows for the entire company and their revenues affect the entire company. This category is the company's brand, which affects all aspects of the company from the amount of sales of each product to the cost of company capital (Sharma Py et al., 2016). For this purpose, the ratio of the capital cost to the sale of products and the calculation of its growth rate compared to the previous month has been used to calculate the growth of brand value in knowledge based companies over a period of 24 months.

8. The Growth Rate of the Qualitative System

One of the most important and most sensitive types of manufacturing industries is the high-tech industry, which knowledge-based companies are classified into this category. In this category, the quality control process is, according to their nature, highly sensitive, which includes a precise and comprehensive control process to prevent any inconsistency, rework and any waste of resources in the process of production (Livendouska E et al., 2017). Hence, in this study, the model of Lybandoska et al. is used to assess the quality of the manufacturing system in the process of research and development in companies, which is calculated from the following in eight knowledge based companies over a period of 24 months.

$$\text{Qualitative Growth System} = (\text{First Monthly Costs Collection} - \text{Second Monthly Costs Collection})/1$$

The costless inventory includes: the cost of rework, the cost of waste products, the cost of returning products, the costs incurred due to non-compliance with the structure of production.

9. Success Rate of Research and Development Projects

Given that every research and development project is done to solve a problem or to improve and develop a process, success rates for research and development projects will be calculated to the same extent that they can meet the goals for which the research and development process is structured (Morgan P, et al., 2018). In this study, the monthly research was carried out on a 24-month basis from eight companies considering the progress of the research and was calculated and collected by experts and custodians of R & D projects in knowledge-based companies.

Variables such as the amount of sales of products and services, the amount of capital spent on the research process, the amount of software and hardware utilization, and the use of specialized teams have financial nature (rial), and based on their units, which are hours, units, or numbers, they have been collected from the eight knowledge based companies for 24 months at a monthly rate.

Statistical Population

In this research, an expert community consisting of 16 experts in the Alborz Science and Technology Park, Tehran University and Tehran Campus, as well as academic professors and top executives of knowledge based companies have been used, and in order to gather information from eight knowledge based companies in Alborz and Tehran Science and Technology Parks, and the reason for choosing these eight companies is that there are a range of service companies in the spectrum of companies and relatively modest firms. In this regard, they are in the same category in terms of size and turnover, as well as the size of the market. Furthermore, due to the need for information gathering over the past two years, the eight companies did not have the possibility of checking the number of companies. It has also been difficult to gain companies' confidence in providing their information in the research process. Hence, to simulate and test the dynamic model of research, the researcher has completed the information of eight companies in a 24-month interval.

4. Data Analysis

4.1. DEMATEL Technique

By studying past research and experts' opinions, the 16 main factors are as follows, using the DEMATEL technique, to calculate the impact and intensity of the factors and the relationships between them. These results have been used in the development of a dynamic model.

Table 3
Encoding Factors in the DEMATEL Technique

Variable Name	Factors affecting	Variable Name	Factors affecting
A_9	the amount of hardware and software usage	A_1	the amount of capital spent on the research process
A_{10}	profit	A_2	cost
A_{11}	enhancement of competitive capacity	A_3	productivity growth
A_{12}	product development rate	A_4	the success rate of research projects
A_{13}	the growth rate of technological capability	A_5	the use of specialized teams
A_{14}	the rate of innovation growth	A_6	sales and service sales
A_{15}	risk	A_7	the rate of reduction of production costs
A_{16}	growth of brand value	A_8	quantitative and qualitative growth rates

After determining the severity of the relationships between the variables, the following table is obtained based on the experts' opinion and the steps taken by the fuzzy DEMATEL. The order of the penetration of the elements from an issue onto other elements or under their influence definitely determines the possible structure of the elements of the hierarchy in improving or solving the problem. To this end, in order to access the possible structure of direct and indirect relations, the arrangement of the elements in terms of influence on other elements, as well as their arrangement in terms of influence, are presented in the following matrix.

Table 4
Diaphragmatic Matrix of Direct and Indirect Relationships

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
A1	0.050	0.200	0.225	0.107	0.064	0.064	0.060	0.069	0.061	0.071	0.058	0.058	0.067	0.056	0.057	0.059
A2	0.052	0.047	0.054	0.170	0.066	0.059	0.056	0.063	0.058	0.065	0.052	0.052	0.060	0.050	0.052	0.059
A3	0.050	0.052	0.044	0.181	0.066	0.057	0.053	0.059	0.053	0.062	0.050	0.050	0.058	0.048	0.049	0.050
A4	0.060	0.054	0.054	0.057	0.170	0.068	0.062	0.053	0.064	0.051	0.051	0.058	0.049	0.049	0.050	0.051
A5	0.146	0.074	0.076	0.078	0.054	0.170	0.200	0.058	0.062	0.089	0.059	0.060	0.071	0.057	0.059	0.060
A6	0.050	0.053	0.053	0.064	0.053	0.049	0.052	0.221	0.054	0.086	0.051	0.052	0.062	0.050	0.051	0.052
A7	0.049	0.051	0.051	0.062	0.051	0.055	0.044	0.059	0.052	0.156	0.050	0.051	0.071	0.049	0.048	0.050
A8	0.050	0.052	0.052	0.063	0.052	0.056	0.052	0.053	0.053	0.204	0.051	0.053	0.080	0.051	0.050	0.051
A9	0.058	0.060	0.060	0.226	0.078	0.066	0.062	0.228	0.053	0.094	0.058	0.058	0.070	0.056	0.057	0.058
A10	0.050	0.053	0.053	0.065	0.053	0.057	0.052	0.061	0.056	0.058	0.053	0.067	0.208	0.0.67	0.051	0.054
A11	0.047	0.049	0.060	0.049	0.179	0.049	0.077	0.051	0.061	0.042	0.048	0.055	0.043	0.039	0.047	0.048
A12	0.051	0.054	0.054	0.091	0.057	0.058	0.054	0.088	0.221	0.068	0.052	0.045	0.061	0.053	0.056	0.057
A13	0.053	0.056	0.056	0.071	0.056	0.061	0.056	0.067	0.075	0.080	0.067	0.158	0.057	0.169	0.055	0.067
A14	0.056	0.059	0.059	0.072	0.059	0.077	0.059	0.071	0.061	0.181	0.162	0.062	0.084	0.052	0.067	0.162
A15	0.049	0.051	0.051	0.063	0.051	0.055	0.051	0.059	0.055	0.063	0.051	0.062	0.176	0.062	0.042	0.052
A16	0.048	0.051	0.053	0.062	0.059	0.054	0.058	0.052	0.061	0.049	0.053	0.068	0.048	0.101	0.146	0.042

The highest sum of the R rows represents the variables strongly influencing the intrusive variables and the highest sum of the columns (J) represents the elements that are influenced.

Table 5
Calculating the Intensity of Direct and Indirect Relationships

	R	J	R+J	R-J
A_1	1.326	0.920	2.245	0.406
A_2	1.017	1.013	2.030	0.004
A_3	0.983	1.040	2.023	-0.058
A_4	1.019	1.492	2.510	-0.473
A_5	1.400	1.029	2.429	0.372
A_6	1.050	1.183	2.233	-0.134
A_7	0.951	1.019	1.969	-0.068
A_8	1.022	1.381	2.402	-0.358
A_9	1.342	1.068	2.411	0.273
A_{10}	1.055	1.462	2.517	-0.407
A_{11}	0.948	0.954	1.902	-0.006
A_{12}	1.106	0.974	2.081	0.132
A_{13}	1.205	1.305	2.511	-0.100
A_{14}	1.339	0.952	2.91	0.386
A_{15}	0.995	0.934	1.929	0.061
A_{16}	0.937	0.968	1.905	-0.031

The actual location of each element in the final hierarchy is determined by the columns (R-J) and (R + J), therefore, (R-J) represents the position of an element along the width of the latitude axis, and this position, if positive (R-J), is definitely a penetrator and, if negative, will be severely influenced. (R + J) represents the sum of the intensity of an element along the length of the axis, both in terms of penetration and in terms of influence. In general, based on the amount (R-J) of the variables used by specialized teams, the amount of capital spent on the research process and the degree of innovation growth, and the variables of the success rate of research projects, the profit and the quantitative and qualitative growth of production have the most impact.

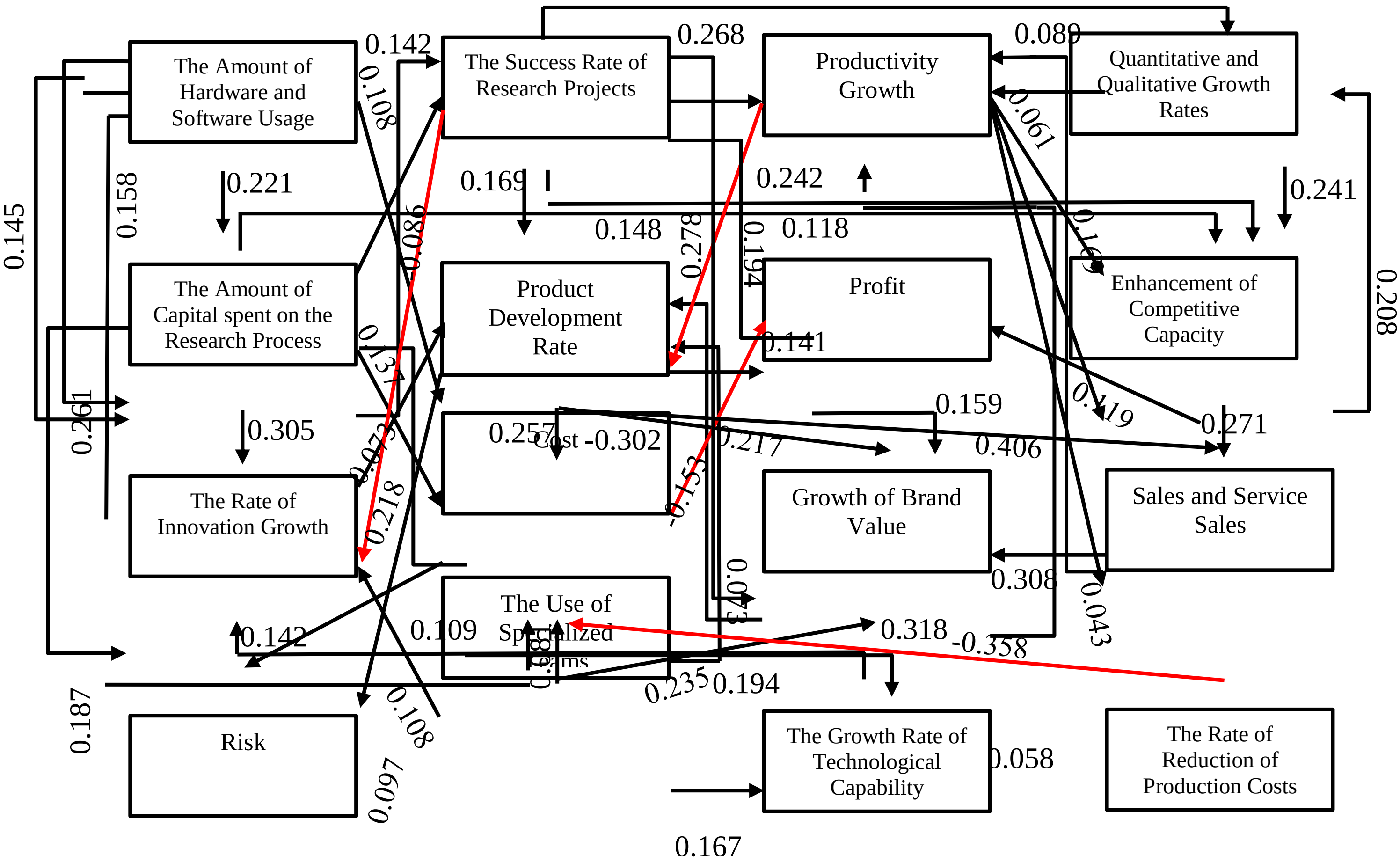


Figure 1: The Relationships Between Variables and the Severity of Their Impact on Each Other

4.2. Dynamic Model of Economic Valuation of Research and Development Costs

After investigating previous studies and obtaining effective factors and causal relationships between them to explain the dynamic model based on theories presented in previous studies, the design of the research model has been schematically illustrated, in this regard, we have attempted to formulate the variables of state, auxiliary, constant and rate. It should be noted that the process of compilation of the cause and effect model of the research in addition to referring to other results of the researchers in terms of experts in this field has also been used. Meanwhile, after identifying the cause and effect of the research and drawing it, it has been plotted to chart the flow and accumulation of programming in the software. In Figure 2, flow diagrams and accumulation are based on the positive and negative relationships existing as well as the type of variable. In table 3, the type of variables and the type of their exogenous and endogenous are presented in form, auxiliary, rate, constant and level.

Table 6
Dynamic Model Variables of Economic Valuation of Research and Development Costs

Indicators	Unit of measurement	Variable attribute	
		Endogenous / exogenous	Level / Rate / Aid / Fixed
Risk	Percentage	Exogenous	Level
The rate of innovation growth	Percentage	Endogenous	Auxiliary
The success rate of research projects	Percentage	Endogenous	Auxiliary
The quantitative and qualitative growth rate of production	Percentage	Endogenous	Auxiliary
Competitive Capacity Enhancement	Percentage	Exogenous	Auxiliary
The amount of sales of products and services	Number per unit	Exogenous	Auxiliary
The rate of reduction in production costs	Percentage	Endogenous	Auxiliary
Productivity Growth	Percentage	Endogenous	Auxiliary
The growth rate of technological capability	Percentage	Endogenous	Auxiliary
Product development rate	Percentage	Endogenous	Auxiliary
Cost	Rial	Exogenous	Level
Growth of brand value	Percentage	Exogenous	Auxiliary
Using specialized teams	People / Cost	Exogenous	Fixed
Utilization rate of hardware and software	Number / Cost	Exogenous	Fixed
The amount of capital spent on the research process	Rial	Endogenous	Fixed
Profit	Percentage	Exogenous	Level
Economic valuation of research and development costs	Rial / Course	Endogenous	Auxiliary

After designing the model by using Vensim software, the model outputs for the state and auxiliary variables in the model are examined in order to show their behavior patterns. Behavioral change of the curve of each of the graphs in the dynamic model is determined over time, and in this regard, with respect to the behavior of latency, there is a function √ x, which initially has a positive gradient with a high coefficient and runs the ascending trend, but in a steady-gradient zone, and ultimately towards zero The reason for this is that, given the results of the research and development activities in the system cycle, the economic value of research and development activities is growing more and more positively. This growth will continue to be used to fully integrate the effects and results of the research into the system, and to consider all its dimensions in the system. At this point, the slope is zero and it is necessary to resume new research activities of a different nature to resume the process of economic growth. Moreover, policy makers and decision makers of the company can recognize the behavior of this curve that it is necessary to develop new research and development strategies. To synchronize the time span of all variables in the research, the aggregated data is based on the knowledge of the eight knowledge companies over a period of 24 months, it is expressed as a percentage, with the X axis being the following charts. After designing the model, various scenarios that focus on the economic valuation of research and development costs have been

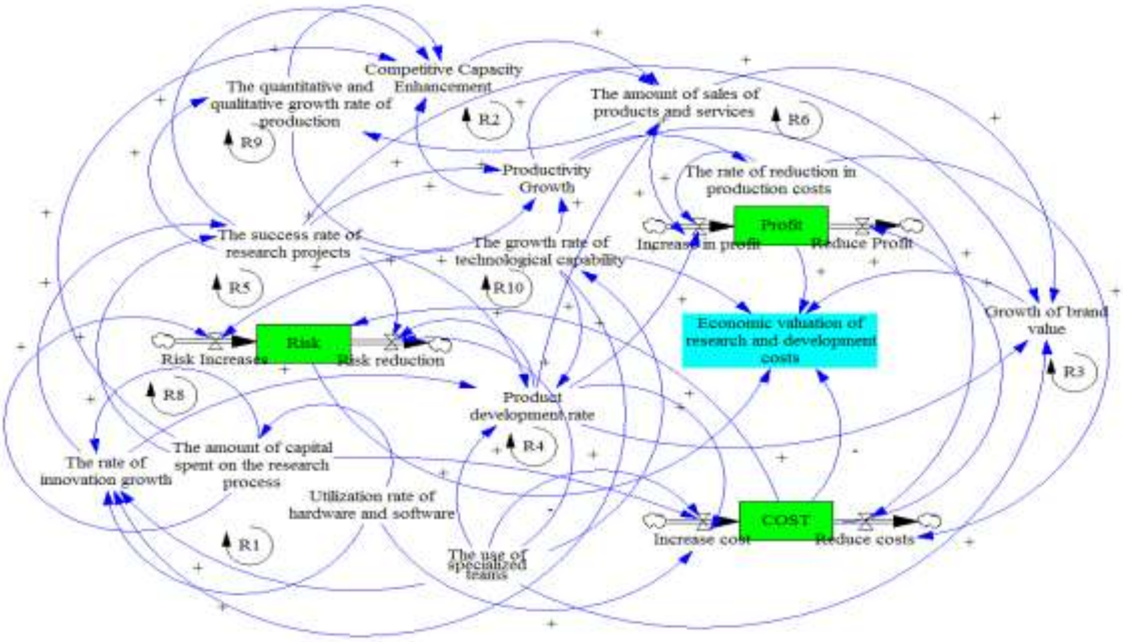
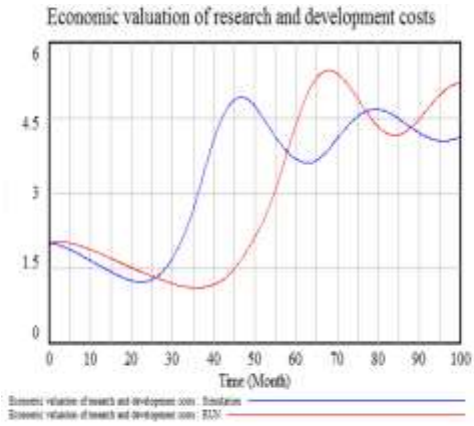
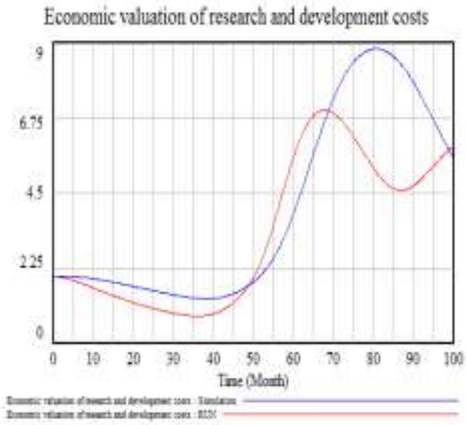


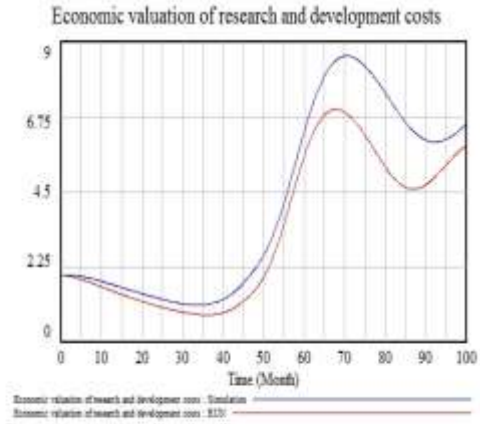
Figure 2: Flow Chart and Accumulation of Economic Valuation of Research and Development Costs



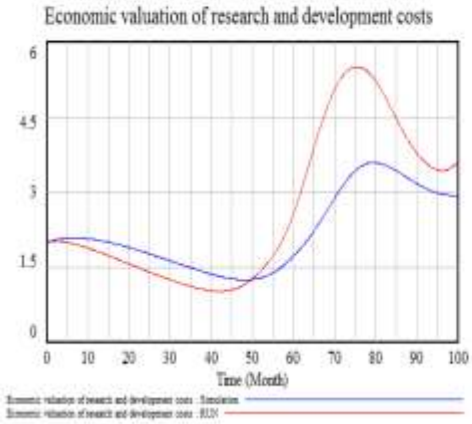
(Figure 3) Variable fluctuation scenario for product development



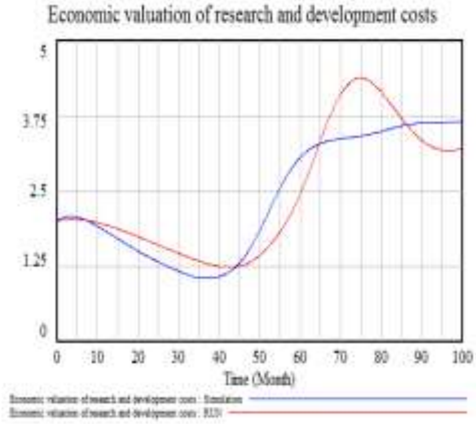
(Figure 4) Variable fluctuation scenario of technological capability



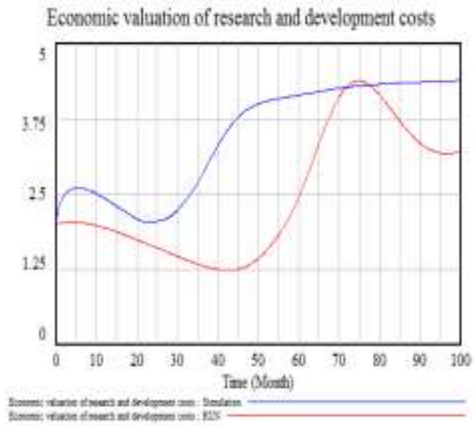
(Figure 5) Variable fluctuation scenario for the succes research projects



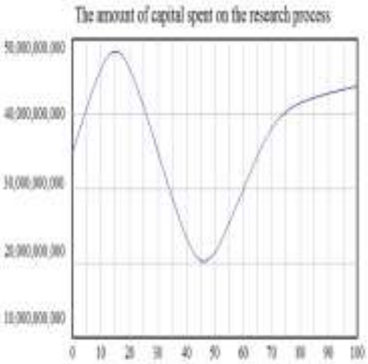
(Figure 6) Variable-Rate Risk scenario



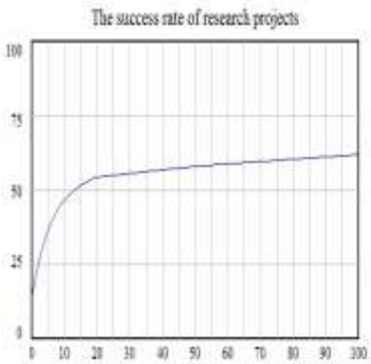
(Figure 7) Variable-rate variation scenario



(Figure 8) Variable fluctuation scenario of brand

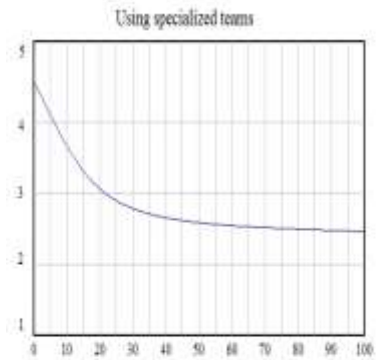


(Figure 9) The amount of capital spent on the research process

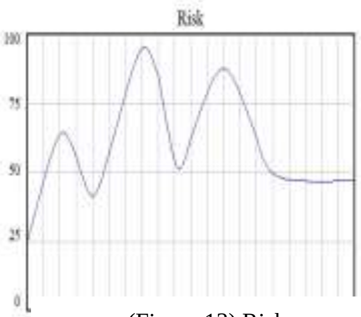


(Figure 10) The success rate of research projects

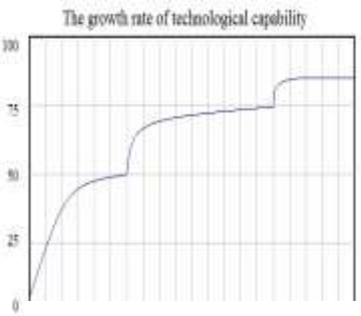
(Figure 11) the amount of sales of products and services



(Figure 12) the use of specialized teams

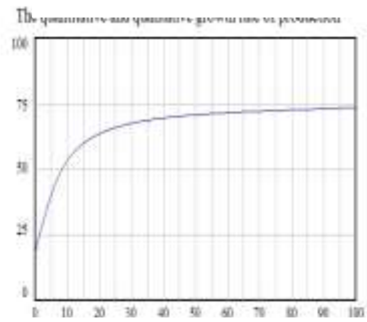


(Figure 13) Risk

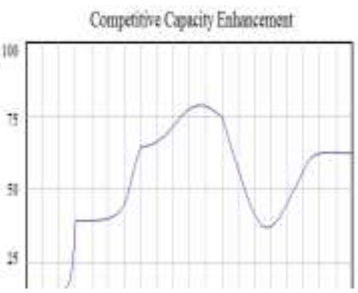


(Figure 14) The growth rate of technological capability

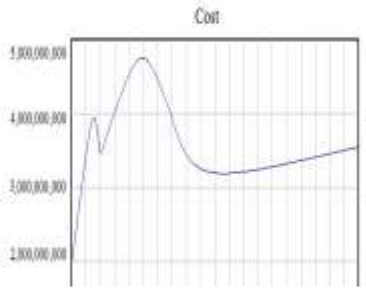
(Figure 15) the amount of hardware and software usage


(Figure 16) the quantitative and qualitative growth rate of production

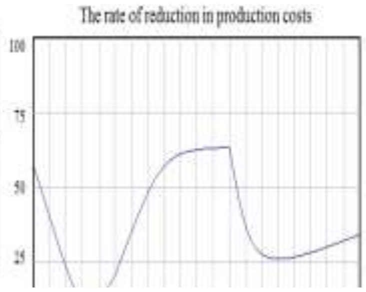
(Figure 17) Productivity Growth



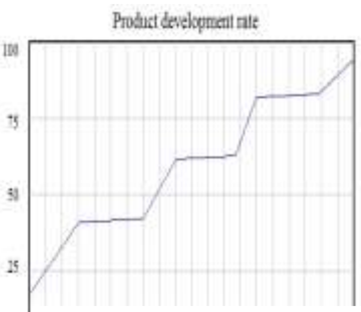
(Figure 18) Competitive Capacity Enhancement



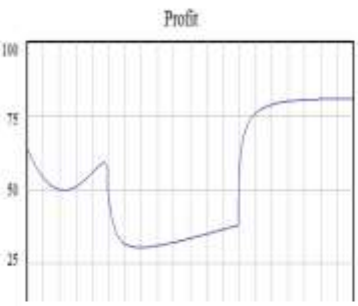
(Figure 19) Cost



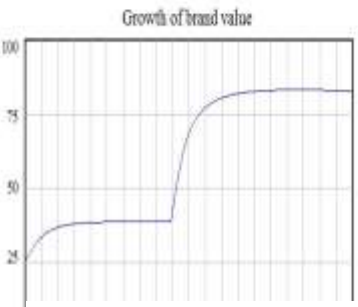
(Figure 20)The rate of reduction iproduction costs



(Figure 21) The extent of product development



(Figure 22) Profit



(Figure 23) The growth of brand value

(Figure 24) The rate of innovation growth

4.2.1. Model Sensitivity Analysis

The purpose of the sensitivity analysis is to evaluate changes in the values of constant variables to the final model's response. In this research, according to the research variables, simulation has been done. Regarding the problem and purpose of research and the study of the relationship between the economic value of R & D costs and the output of the system in these patterns, the key variable of innovation, the success of research projects and risk as the input and effective variable of the system is considered. The goal is to evaluate the effect of changing the value of this variable to ± 5% of actual data on the important valuation indicators.

Accordingly, with the probability of 50% maximum and minimum changes around the yellow zone, 75% will occur in the green zone, 95% in the blue zone and eventually 100% change in the gray range.

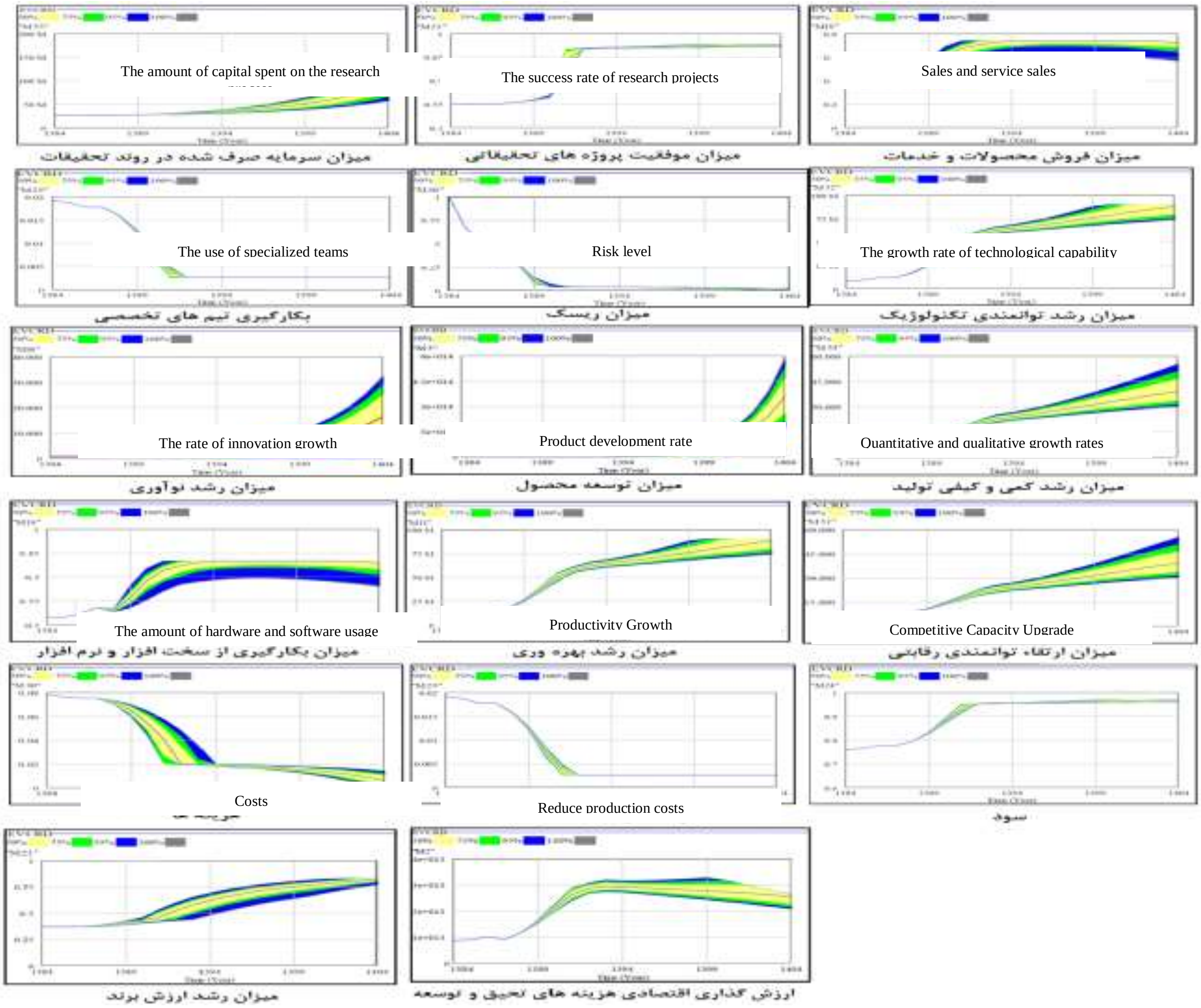


Figure 25 Sensitivity analysis of research variables

5. Discussion and Conclusion

The simulation results show the first scenario with the focus on product development changes (Fig. 3), in the process of calculating the economic valuation of research and development costs, it is deduced that the faster the process of product development, the output of the research and development process will create a higher value. However, this does not fully complete the maturity of the technology and does not reach its maximum (Yu, H, 2017), due to the introduction of products and services into a market that has not been properly verified and evaluated, it causes customers to have problems in the process of using products and services in the product development process, which would reduce satisfaction and eventually reduce the profit and economic value of the research project. In the second scenario, which focuses on changes in the level of technological capability (Fig. 4), in the process of calculating the economic valuation, the costs of research and development are deduced that whatever the company attempts to implement in the form of its hardware, software, and infrastructure after the outputs of the research process, and actually develops its technological capability, the slope of the economic value curve will increase dramatically and the roof will increase (Khoshnevis, P, elt.2017). The reason for this is the more effective and efficient use of research results and the introduction of products and services with a higher level of reliability and higher capacity for research results, which results in the maximum benefit from the research results of the system. In the third scenario, with the focus of variable variations, the success rate of research projects (Fig. 5) is deduced in the process of calculating the economic valuation of research and development costs, the more companies achieve success in their research results, the greater the slope of the economic value graph of research costs (Suresi A, 2017), and hence, the percentage of the research goals achieved by the company is higher. In the fourth scenario, which is based on the variation of risk (Fig. 6), in the process of calculating the economic valuation of the research and development costs is inferred that the higher the risks of research projects, the more they go beyond the normal risk limits and enter the risk-prone risk area, which will overstep all the research results as well as the results of the implementation of research projects. This will reduce the slope of the economic value graph of research costs (Suzuki, K., et al., 2017) which is due to the control of the company and the many risks involved, such as production, market, sales and even application dimensions. In the fifth scenario, which focuses on changing cost variation (Fig. 7), in the process of calculating the economic value of R & D costs, it is deduced that the higher the cost of research, the more the implementation and production processes based on the output of research projects is required, so that it goes beyond the normal range, primarily leads to the sale of a particular product market, and if used in general, it would be categorized as luxury products and services. It also limits the target market and reduces the company's profit margin (Engsner, H, elt, 2017). All of these factors affect the economic value of R & D costs and modulates the gradient of the graph as well as its value ceiling. In the sixth scenario, which is based on the changing value of brand value (Fig. 8), in the process of calculating the economic valuation of research and development costs, it is deduced that whatever the brand value grows in the research process, it makes it possible for customers and applicants to obtain a relative assurance of the quality and application of new services and products, therefore, the overall brand value of the company in the target market will increase, thus it increases the sales of products and services based on the output of economic valuation of research and development costs (Martín-Barrera, G, elt, 2017). This affects both the good record of the company in this market and the extent of its innovation and product development to competitors, which can provide an acceptable level of competitive advantage in terms of customers in the target market, and it will cause the economic value of the research and development costs to be overshadowed.

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