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Forecasting the Sales of New Pharmaceutical Products Based on Bass Model (The Study of Pharmaceutical Companies in Tehran Stock Exchange)

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Abstract. Sales forecasting models show how an analyst forecasts the earnings of an investment and investigates new products in the valuation process .Therefore, these models are a support system for decision-makings of important company experts, investors and managers. Accurate forecasting helps managers develop strategies, identify priorities and allocate resources optimally. In order to conduct this study, the 10-year sales information of 18 new pharmaceutical products in these companies has been used. In this study, in addition to describing the theoretical foundations of the diffusion models of new products in the market including the highly innovative Fourt-Woodlock model, the imitative Fisher-Perry model and integrated Bass diffusion model, influencing parameters are introduced. Then, the model has been tested by multiple regression in order to estimate the level of the confidence of model and its coefficients, Afterwards, based on the parameters of innovation (P) and imitation (q), the results of Bass model have been used in order to forecast the sales of new products in the pharmaceutical industry in the of companies of Tehran Stock Exchange.

Keywords: Bass model, sales forecasting, knowledge-based company, valuation

1. INTRODUCTION

The issue of valuation and financial analysis of intellectual assets in knowledge-based companies which is often referred to as intellectual capital or technical knowledge is of great importance in financial management and it is widely used in developed capital markets due to the considerable importance in determining its value. Sales forecasting as a support system of financial decisions and marketing is important for experts, even investors and managers especially when an attempt has been made to commercialize a new product or service. Accurate forecasting helps managers develop strategies, identify priorities and allocate resources optimally and consider the proposed policies in marketing such as competitive status, increasing total market demand, protecting the stock market and increasing stock market through the prediction of product sales.

In the capital market, the analysts of financial issues and stock valuation who study companies' future development plans will be able to achieve the figures of forecasting product sales which play a fundamental role in determining the sales revenue of companies in order to study more closely the future profits of companies according to their new and diverse products. Despite the existence of diverse methods of forecasting new product sales regarding valuation and decisions on stock value and the value of technical knowledge, accurate models that are able to make accurate and low-error prediction of the future of companies' business, sales and earnings have not been approved by the scientific community and experts. Indeed, this is due to the existence of a complex and ever changing business environment. One of the models tested in this study is Bass diffusion model which has been designed with two main factors of consumers' imitation and their innovation- seeking index.

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1.1. STATEMENT OF PROBLEM

In order to make accurate and analytic estimations in the field of stock valuation in exchange and non-exchange companies particularly among companies with knowledge-based activities which are the reflectors of ability and advantage of these companies in producing new products and innovative technologies, it is necessary to answer some questions such as: "how is new product sales forecasting", "what are the product sales forecasting model?", "what are their theoretical foundations?" and "whether coefficients and parameters used in the prediction model presented as BASS model for pharmaceutical products are statistically valid among Tehran Pharmaceutical exchange companies?". In fact, the main problem in our research is that whether we are able to derive Bass model coefficients for new pharmaceutical products in the country and use its results in order to conduct a forecast of other new pharmaceutical products and the process of technical knowledge valuation by conducting this study.

2.2. THE IMPORTANCE AND PURPOSE OF THIS RESEARCH

Currently, with the development of intellectual property in Iran's OTC, the lack of standard and scientific methods for the valuation of intellectual property of new products particularly among companies with up-to-date knowledge and technology in the money and capital market of the country is quite perceptible. Conducting negotiations and making financial and investment contracts which depend on buying and selling new technology products have recently been given special attention in our country.

The necessity of reinforcing and supporting knowledge-based companies and of course developing OTC in order to launch idea exchange requires a more specialized study. On the other hand, it should also be noted that the development and continuous improvement of a company's products or services is an essential factor in the field of commercial competition. In order to succeed in the competitive strategies and market leadership, these companies must consider the proposed policies in marketing such as competitive status, increasing total market demand, protecting the stock market and increasing market stock through forecasting product sales.

In the capital market, the analysts of financial issues and stock valuation who study the company's future development plans will also be able to achieve the figures of forecasting product sales which play a fundamental role in determining the sales revenue of companies in order to study more closely the future profits of companies according to their new and diverse products. The most important objectives of this research are: predicting and testing the validity of the statistical BASS model in order to estimate the revenues from the sales of new pharmaceutical products in active pharmaceutical companies in Tehran Stock Exchange for new products, providing the tested Bass model for conducting sales forecasts for other new products of exchange companies which helps financial analysts and professional valuators more accurately estimate the interest rate of companies' sales revenue and also be able to more accurately estimate the technical knowledge of new products.

2. REVIEW OF LITERATURE AND THEORETICAL FOUNDATIONS

The basic models which resulted in more development and research were introduced by Fourt and Woodlock in 1960 [1]. In these models, the used coefficient which was supposed to be constant was the coefficient of the impact of external factors on customers' purchase which is called "the coefficient of innovation" of customers and includes advertising and introducing a product by the company. Later, Mansfield took a different approach and described the constant coefficient of his model as "the coefficient of imitation "influenced by internal factors and

changes in customers' behavior and based on the recommendations of former customers regarding deciding on buying a new product [2]. Therefore, contrary to the model of Fourt and Woodlock, this coefficient has been considered as constant and zero external factor.

Later on, Frank Bass sought to integrate the above two models for the first time and as we will see later, he used both coefficients in his model. Through mathematics and conducting the related calculations, by regression analysis of functions and differentiation and by studying similar companies and products, Bass could derive used parameters and coefficients in the model and use them for other similar products in the model [3].

The purpose of new product diffusion models in the market is to study the extent of customers in terms of different degrees of their innovation-seeking to purchase a new product by mathematical functions during the time a product is on the market. In fact, in these models, the curve of increase or growth of the number of buyers of a new product is described and drawn [4] and the process of continuation of diffusion growth in the market for a specified period is forecasted [5]. Most of these models stem from the similarities with the models of life and survival circle [6].

Dynamic models of the system take into consideration all factors that may cause the systematic behavior like internal or endogenous elements. These models explain the behavior of a system through feedback of each of the factors.

It was from this point onwards that diffusion models were expanded and developed. Robinson in 1975 assumed coefficient of innovation as a function of price and coefficient of imitation so as to be constant [7]. Horsky considered coefficient of innovation as being constant and coefficient of imitation as a function of advertising [8].

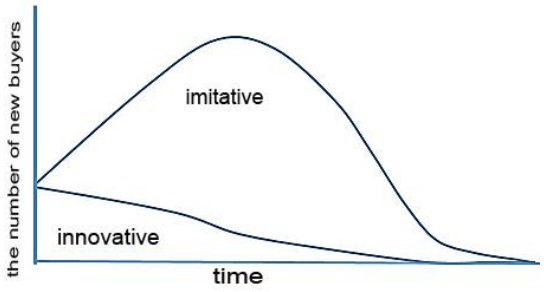

Figure 1. The Distribution Curve of New Customers' Behavior towards New Products based on Bass Imitative and Innovative Index.

Without assuming both coefficient of innovation and coefficient of imitation, Bass again considered them as a function of the elasticity of demand, and the factors of learning and price in 1978 in simulated studies [9]. Exactly in the same year, Mahajan and Peterson [10], and Dodson and Muller [11], each by assuming one of the coefficients as being constant, considered the other coefficient as being a function of advertising, price and profit to sales ratio.

The types of new product diffusion models to the market: there are at least three main models to forecast new product sales which will be studied as follows: 1) highly innovative models like Fourt-Woodlock model [1], 2) highly imitative Fisher- Perry and Mansfield models [2,13], 3) integrated models like Bass's model [3].

In this study, the models of the initial purchase of a new product which is newly introduced to the market are focused on. Figure 2 shows the different types of diffusion models of new products to the market which includes the well-known and accepted model "Bass". In Bass model, the features of innovation and imitation of a product are integrated and applied in a more general model.

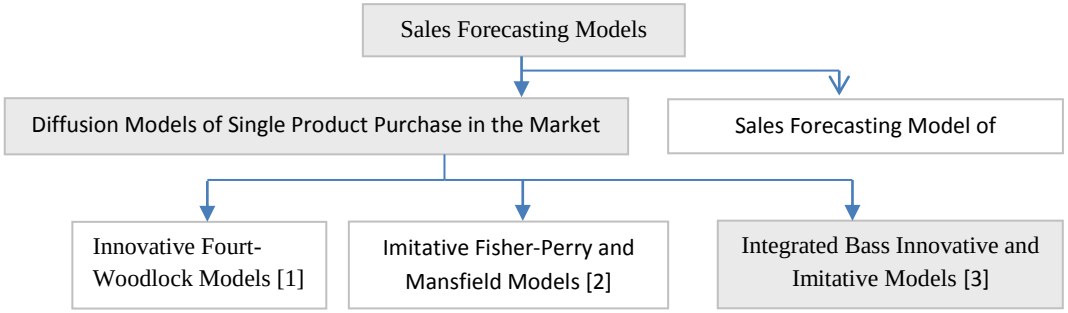

Figure 2. The types of Forecasting Models of New Product Diffusion in the Market.

The innovation model of Fourt and Woodlock is the market diffusion curve which has been developed after carrying out revisions and analyzing market diffusion curves of a number of new products [1]. In highly innovative models, it is assumed that cumulative sales have exponential curve, and the origin of adoption of these products is a function of individuals' external reaction to the innovations and attractions of external information sources apart from the change in the inner attitudes rather than being verbal, linguistic or imitative advertisements. It is like advertising costs spent in a public media.

The equation which they found for the reasonable estimation of the curve of such products is as follows [13]:

$$x_t = p \times N_t \quad (1)$$

x_t = is product sales at time t, p = is the probability of a new product purchase in a specific period, (the rate of diffusion in the market) or coefficient of innovation, N_t = is net total potential market of the remaining product.

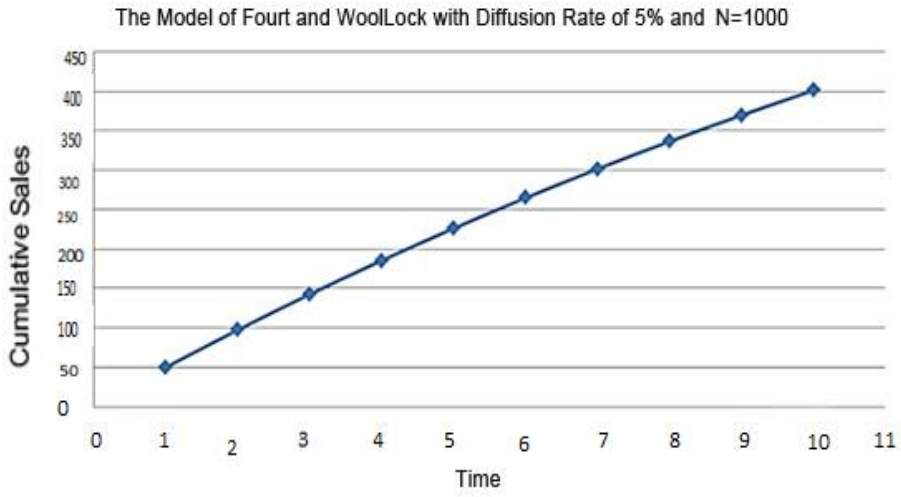

Figure 3. The types of Forecasting Models of New Product Diffusion in the Market

Everett Rogers in his book entitled "The Diffusion of New Products in the Market" believed in the normal distribution of acceptance of new products by customers in the coming years and introduced customer range in the form below:

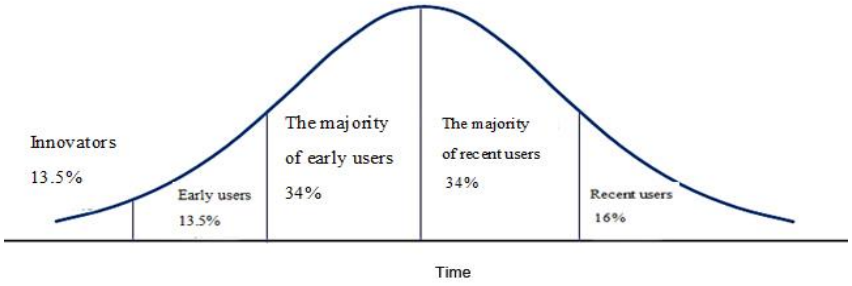

Figure 4. The Types of Customers in Normal Distribution of Purchase

Mansfield's imitative model is a function of the inner reaction to external information sources such as friends' advertising and recommendation regarding buying which arouses individuals' inner motivations. This is done through communication of the customers who have not been the buyers yet. Q factor is product purchase probability as a result of this communication (coefficient of imitation).

$$x_t = q \times X_{t-1} \times (N - X_t) \quad (2)$$

Bass new product diffusion model is the summary and synthesis of the above-mentioned innovative and imitative models which takes both dimensions of the external and internal influences on customers' purchasing decisions in to consideration. Bass integrated both the models of Fourt and Woodlock and that of Mansfield.

The constant parameters p and q are the coefficients of innovation and imitation in this model.

$$x_t = p \times (N - X_t) + q \times \frac{X_t}{N} \times (N - X_{t-1}) \quad (3)$$

$$x_t = p \times N + (q - p) \times X_{t-1} - \left(\frac{q}{N}\right) \times X_t^2 \quad (4)$$

The curves of the three models are as follows:

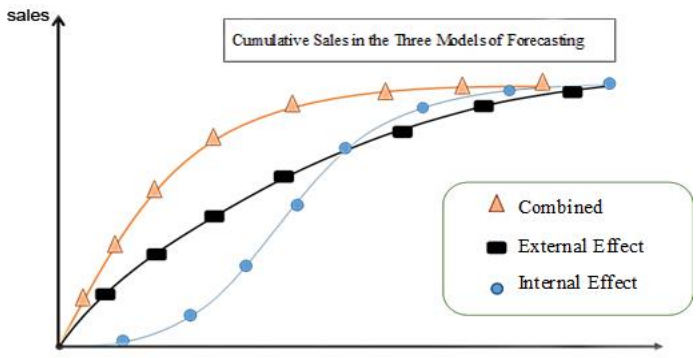

Figure 5. The Types of Customers in Normal Distribution of Purchase.

It should be noted that since in these models, other parameters influencing the decision-making of customers including price, quality and delay time in the distribution of goods , etc. are not taken into consideration, they will not be enough in the decision-making process. For this purpose, this model should be extended in order to take advantage of other above-mentioned variables.

The first researcher who studied the methodology of new product diffusion process as a dynamic model in a monopolistic market was Milling. His model was structurally similar to the model of Bass. The difference lies in the fact that he added some of the mentioned variables to it.

Coefficient of innovation / imitation = f (price, advertisement, quality, etc.)

Although in Bass' model, the coefficients of innovation and imitation are not constant and they vary if the factors influencing customers' purchasing change, these coefficients can be extracted when non-cumulative sales of the product is at its maximum value. In this study, verifying the model and its coefficients is avoided.

$$X_L = N \times \frac{1-e^{-(p+q)t}}{1+\left(\frac{q}{p}\right)e^{-(p+q)t}} \quad (5)$$

$$x_L = N \times \frac{\frac{(p+q)^2}{p}e^{-(p+q)t}}{\left(1+\left(\frac{q}{p}\right)e^{-(p+q)t}\right)^2} \quad (6)$$

N = market potential, p= coefficient of innovation, q= coefficient of imitation, X_L= cumulative sales at time t

3. A REVIEW OF EMPIRICAL LITERATURE OF NEW PRODUCT DIFFUSION MODELS

Many empirical studies have been conducted regarding testing and the developing Bass standard model in the world. A lot of papers and reports have been prepared and published in this regard. Due to the large proportion of studies, in this section, the most important articles and studies are briefly referred to:

In order to evaluate Bass model in various industries and technologies, this model has been put to the test. For example:

Gosso, Dalawala and Guidolin have simply analyzed Bass standard diffusion model for new pharmaceutical products in Italy. He has considered Bass model appropriate for estimating the amount of future sales of pharmaceutical products. This study has been conducted for new pharmaceutical products from the year 2005 to 2007 according to a period of less than one year whose sales data has been received from Information Company and Medical Services in Italy.

Malcolm Wright and A. Pritchard in a study that has been conducted in New Zealand sought to discover the performance and power of Bass model in forecasting sales of some new products. They concluded that Bass model can forecast desirably with a slight error.

In another study conducted in Australia, 103 new medicines from 803 million medical prescriptions between the years 1992 and 2010 were studied. The purpose of Adam Dunn, Berth Watt, Gallego, Oadi in this study was to test the validity of Bass model in forecasting the amounts of using new drugs in Australia. The results of this study suggested that Bass model has been advantageous due to using multiple statistical analysis.

In a study conducted in America, Homer has examined the degree of consistency of forecasting the sales of new pharmaceutical product of Antibiotic Clindamycin (including the types of ampoules, capsules and ointment) with the brand "Cleocin" in America from the years 1970 to 1984 and has tested Bass diffusion model. According to this article, the original data of new product sales is consistent with the predicted values .

In a more extended and transnational study, another researcher compared the sales of new pharmaceutical products in 15 developed and developing countries. According to the results of this study, the diffusion rates of new pharmaceutical products in the market of these products in developed and developing countries are compared with each other. In another study, the researcher has conducted an econometric analysis of the Bass diffusion model and other models and has achieved statistical results, different hypotheses tests and comparison of forecasting methods based on data frequency and the integration of models. Another scientific study in this regard has been conducted by Dr. Christian Schäfer. He has examined more than 5,000 new drugs from different emerging and developed countries with developed markets. The result of this study suggests that Bass model has been able to provide more accurate prediction and better performance in emerging countries. In another PhD theses about the study of different prediction models, testing and statistical validations of the predictions made in relation to new medicines in America, the value of parameter p for different types of prescribed medicines, non-branded medicines and branded medicines with high consumption preference, etc. have been examined.

.3.1. Research Hypotheses

Main Hypothesis: Bass model is significantly able to forecast the sales of new pharmaceutical products of Tehran Stock Exchange companies for the purpose of validation.

Secondary Hypothesis: BASS model coefficients are significant for forecasting the sales of new pharmaceutical products of Tehran Stock Exchange companies and are statistically valid.

3.2. Time and Place of the Research

Identifying customers' behavior and reaction to new products requires reviewing information and sales and purchase statistics of these products at the appropriate time interval in order evaluate the significance of the model and the accuracy of the predictions based on sufficient and available evidences. For this purpose, pharmaceutical companies in this study have been asked to provide the researcher with the sales information of new pharmaceutical products for a variety of pharmaceutical products in10-year time interval. The companies were studied regardless of the place of their activity in the country and were from different provinces. However, all of them were selected from pharmaceutical companies in Tehran Stock Exchange.

3.3. The Population and Sample

In this study, all the pharmaceutical companies who manufacture, supply, sell and export new medicinal products are included in the statistical population. Currently, about 20 medicine manufacturing and distributing companies have been registered in Tehran Stock Exchange. The researcher has corresponded with all of them and has given them the questionnaire. From these companies, some completed the questionnaires and sent the requested information. Therefore, after receiving responses from some companies which have provided the information about some of their sold products, the information are obtained from 121 annual reviews of 18 new pharmaceutical products provided by Hakim, Sobhan Darou and Razak pharmaceutical companies which are the sales data of new pharmaceutical products and are statistically analyzed using panel data techniques.

3.4. Research Hypotheses Testing

The statistical method used in this study is multiple regression. Accordingly, we have used the software package Eviews. In order to test the research hypotheses, we have used appropriate statistics and methods of determining the level of confidence of the performance model which will be discussed later.

The Main Hypothesis Testing: in the main hypothesis, the test of significance of Bass model is performed using F-statistics. First, the value of statistics is determined through the software "E-views" and then based on results and calculations, the null and alternative hypotheses are tested through F-statistics in order to see if the null hypothesis is rejected or confirmed.

The Test of Significance of F-Statistics: First, null hypotheses and alternative ones are written. Then, F-statistics value is compared with the critical values table of this statistics at the significance level of 95%.

$$\begin{cases} H_0: \beta_1 = \beta_2 = 0 \\ H_1: \beta_1 \neq \beta_2 \end{cases} \qquad F^* \geq F_{0.05,k,n-k-1}$$

(Critical Region)

The output results of the statistical analysis using the software is described in Table 1:

Table 1. Main Hypothesis Testing Using Fisher Statistics.

Cross-section fixed (dummy variables)			
R-squared	0.774361	Mean dependent var	41448017
Adjusted R-squared	0.731915	S.D. dependent var	69811493
S.E. of regression	36146278	Akaike info criterion	37.79395
Sum squared resid	1.32E+17	Schwarz criterion	38.25607
Log likelihood	-2266.534	Hannan-Quinn criter.	17.98164
F-statistic	18.24307	Durbin-Watson stat	0.810812
Prob(F-statistic)	0.000 000		

As the results of statistical analysis of the Fisher statistics shows and according the value of this statistics which is $F^* = 18.24$, if it compared to the critical values table of this statistics at the significance level of 95%, the result suggests that with the minimal P-Value obtained for this statistics, the hypothesis H_0 is rejected and by confirming the main hypothesis ,it can be

said that "Bass model is able to forecast the sales of new pharmaceutical products of Tehran Stock Exchange companies for the purpose of valuation with 95% confidence level".

3.5. Goodness-of -Fit and Correlation Tests

The Coefficient of Multiple Determinations: After estimating the regression coefficients, there are some criteria that must be tested since they test the hypotheses of regression models and show that the whether the obtained model is a good one or some errors exist. One of the criteria for evaluating the regression model is the coefficient of multiple determinations.

The results obtained from the output of the software indicate that the value of this coefficient is equal to:

$R^2 = 0.77$

Therefore, it can be concluded that "Bass model is a good model because the dependent variable of the model is well fitted by the two independent variables. Accordingly, this model is reliable and is able to forecast the amount of sales for new products over the next few years at an acceptable level".

3.6. The Adjusted Coefficient of Multiple Determination

Large R^2 does not necessarily result in a good regression because by adding an independent variable to the model, R^2 will increase. In order to consider the effect of reducing the degrees of freedom by increasing the number of independent or explanatory variables, the adjusted R^2 or $\bar{R}^2$ is calculated. The obtained value is equal to:

$\bar{R}^2 = 0.73$

Therefore, this test also shows that" Bass model is an appropriate model and Y is well fitted by both of the independent variables. Thus, it can be concluded that this model is able to forecast the amount of sales for new products over the next few years at a reliable level".

Secondary Hypothesis Testing: In order to test the significance of the estimated regression parameters, t-distribution can be used to test the hypotheses. The secondary hypothesis states that the Bass model coefficients is significant for forecasting incoming cash flows of new medicines in companies listed in Tehran Stock Exchange and are statistically valid.

In this regression model with two independent variables, the goodness of its coefficients are examined by t-tests.

3.7. The Level of Confidence of the Constant Value of Model

First, the necessary level of statistical confidence for the constant value of the model (C) is examined.

Based on the obtained statistical results as shown in Table 2, it is observed that error of probability of rejecting the hypothesis H_0 is less than 5% and equal to 0.009 and the constant value of the model (C) is statistically valid because with the probability of error over 95 %, it is at an acceptable and reliable level of the estimation of the constant value of the model.

Variable	Coefficient	Std. error	t-statistic	Prob.
C	14393465	5400199	2.665358	0.0090
X?	0.192654	0.037848	5.090158	0.0000
$X?^2$	$-5.45E^{-11}$	$1.82E^{-11}$	-2.996249	0.0034

Figure 7. The Secondary Hypothesis Testing Using t-Statistics.

3.8. The Level of Confidence of the First Coefficient (β1)

The output obtained from the statistical analysis conducted using t-statistics as shown in Figure 7 suggests that the hypothesis H_0 is not confirmed because with the probability of error less than 5 %, the hypothesis H_1 is confirmed. Therefore, it can be concluded that the first coefficient (β1) is also at a significant level with the probability of more than 95 %.

3.9. The Level of Confidence of the Second Coefficient (β2)

Likewise, it is observed that based on the output obtained from the statistical analysis conducted using t-statistics as shown in Figure 7, the error of probability of rejecting the hypothesis H_0 is less than 5% and equal to 0.003, therefore, the hypothesis H_0 is rejected and it can be concluded that this coefficient is also at a significant level with the probability of more than 95 %. Accordingly, the estimated coefficients of the model are significant at 95% level of confidence and by confirming the secondary hypothesis, it can be concluded that "the coefficients of Bass model are significant for forecasting the sales of new pharmaceutical products in companies listed in Tehran Stock Exchange and are statistically valid".

4. CONCLUSION AND RECOMMENDATIONS

In this study, after reviewing and familiarizing with the generalities of economy and knowledge-based companies and emphasizing the importance of accuracy in the calculation of the amount of sales by financial analysts for the purpose of valuation, new product sales forecasting models which are used as diffusion models of new products are examined and studied. The historical background of different types of new product diffusion models in the market were reviewed, the theoretical foundations of these models were described and the effective parameters were introduced. After introducing the innovative models of Fourt and Woodlock and the imitative model of Mansfield, Bass model was introduced and was later tested through the main and secondary hypotheses.

The test result of this study is consistent with most scientific results in terms of the acceptable level of confidence of Bass model which have earlier been mentioned in the empirical literature section with examples from America, Italy, New Zealand and Australia. In these examples, Bass model was introduced as a good model for forecasting the sales of new products and the present study also reached the same conclusion.

Not only the sale of new pharmaceutical products, but generally any new product can be studied and scientifically tested by other researchers. Due to the ability of Bass model in this study to estimate the acceptable level of amount of sales over the next few years, this model can be used in order to forecast the cash flows of new pharmaceutical products and valuate the technical knowledge of these products.

Now, it is a good time to review the output results of the software "E-views" in order to estimate the reliable coefficients of Bass model.

The constant estimated value in the model is: $\hat{\alpha}$=14393465, the value of the first coefficient of the model is: $\hat{\beta}_1$=0.192654 ,and the value of the second coefficient of the model is : $\hat{\beta}_2$=-5.45E^(-11).

After calculating this 3x3 equation, the parameters are as follows:

N=3.608×〖10〗^6 , p=0.004 , q=0.1966

The parameter values of Bass model obtained in this model along with the values in different studies conducted in other countries suggest that although, for various reasons, the lack of consistency of markets, economic and behavioral factors of customers and product difference influence these values , this model is statistically valid and is included in a similar acceptable level.

In conclusion, due to the development of scientific studies regarding the factors which influence forecasting the sales of new products, it is recommended that respected researchers promote the information accuracy of sales forecasting of new products in other areas of industries such as the automotive, chemical products, electronics and other industries by conducting other related studies in this field.

It is also advisable that venerable scholars and researchers consider other factors influencing Bass general forecasting model in the future studies and promote the validity of the model. Some factors such as product price, advertisements and product quality in Bass new model which is called Bass general model have recently been the subject of study of many researchers.

REFERENCES

1. Fourt, A. Woodlock, L. F. (1960). Early prediction of market success for grocery products. Journal of Marketing, 31-38.
2. Mansfield, E. (1961). Technical Change and the Rate of Imitation. Econometrica, 741-766.
3. Bass, F. (1969). A new product growth model for consumer durables. Management Science, 215-227.9.
4. Silk, A. J. and G. L. Urban. (1978). Pre-Test Market Evaluation of New Packaged Goods: A Model and Measurement Methodology. Journal of Marketing Research, 171-191, 15.
5. Horsky, D. a. (1978). Advertising in a Model of New Product Diffusion. *presented at the TIMS/ORSA National Meeting.* New York City
6. Alexander I. Poltorak, P. J. (2011). Essentials of Intellectual Property. Wiley.
7. Robinson, V. a. (1975, June 21). Dynamic Price Models for New Product Planning. Management Science, 1113-1132.
8. Horsky, D. a. (1978). Advertising in a Model of New Product Diffusion. Presented at the TIMS/ORSA National Meeting. New York City
9. Bass, F. (1978). An Integration of the New Product Growth Model with the Experience Cost Function and Optimal Pricing. Presented at the Times/Orsa National Meeting in. New York City
10. Mahajan, V. a. (1978). Innovation Diffusion in a Dynamic Potential Adopter Population. *Management Science*, 1589-1597.
11. Dodson, J. a. (1978). Models of New Product Diffusion through Advertising and Word-of-Mouth. *Management science*, 1568-1578.
12. Maier, F. (1992). R&D Strategies and the Diffusion of Innovations. *International System Dynamics Conference*, (pp. 395-405). eds. J. A.M. Vennix. Utrecht, the Netherlands.
13. Bass, F. (1978). An Integration of the New Product Growth Model with the Experience Cost Function and Optimal Pricing. Presented at the Times/Orsa National Meeting in. New York City.
14. Rogers, E. M. (2003). *Diffusion of innovations.* New York: Free Press of Glencoe.
15. Milling, P. (1986). Decision support for marketing new products. *System Dynamics: On the Move. The System Dynamics Society, Sevilla, Spain*, 787-793.
16. Keith E. Maskus, C. F. (2005). *Intellectual Property and Development: Lessons from Recent Economic Research.* World Bank; Oxford University Press.

17. Guidolin, Mariangela. (2008). *Aggregate and agent-based models for the diffusion of innovation.*
18. Malcolm Wright, C. U. (1997). A Validation of the Bass New Product Diffusion Model. *Marketing Bulletin, 1997*.
19. Adam, D. G. (2012). Nation-scale adoption of new medicines by doctors: an application of the Bass diffusion model. *BMC Health Serv Res*, 248.
20. Homer, J. B. (1987). A Diffusion Model with Application to Evolving Medical Technologies. *Elsevier Science Publishing Co, Volume 31,*(Issue 3), Pages 197–218.
21. Cong, Z. (2009). *Value of Pharmaceutical Innovation.The Access Effects, Diffusion Process, and Health Effects of New Drugs.* Pardee Rand Graduate School.
22. Desiraju, R. N. (2004). Diffusion of New Pharmaceutical Drugs in Developing and Developed Nations. *International Journal of Research in Marketing*, 341-357.
23. Schäfer, C. (2012). New Product Forecasting with Analogs Does the Uptake curve of Pharmaceuticals differ by Region? International Symposium of Forecasting
24. Satoh, D. (2001). A discrete bass model and its parameter estimation. Journal of the Operations Research, 18.