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DIFFUSION OF INNOVATIONS IN E-TRADE

In terms of market relations, the effectiveness of marketing systems is a decisive factor in the competitiveness of the enterprise. In today's world, enterprises cannot exist without the introduction of innovative processes into production or to existing goods or services. The application of innovations in marketing, which increases profitability by 10%, is extremely relevant today, so there is an urgent need to study the spread of innovations in e-trade, taking into account marketing management. The aim of the article is to determine the impact of marketing management on the spread of innovations in e-trade. The research was conducted using methods of theoretical generalization and grouping; formalization and synthesis; principles of scientific content analysis. In order to assess the significance of the influence of the components of the marketing complex on the spread of innovations in e-trade, for the reliability of the research results and the justified choice of strategies, the model of F. Bass was chosen, which is characterized by the universality of application and the classification of e-consumers into social groups: innovators, early followers, early majority, late majority and outsiders. Price and promotion (advertising) are found to affect the size of the e-trade market, taking into account the elasticity of demand and the growth dynamics of the e-trade market size. Innovations ensure the further development of successful business and maintaining competitive positions on the market, therefore demand forecasting is a priority area. Marketing mix management affects all key elements of the Bass model, including innovativeness and imitation rates, total e-trade market size, and diffusion rates. It was found that the price is the dominant factor in the diffusion of innovations, and the

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ДИФУЗІЯ ІННОВАЦІЙ В Е-ТОРГІВЛІ

В умовах ринкових відносин ефективність маркетингових систем є вирішальним фактором конкурентоспроможності підприємства. У сучасному світі підприємства не можуть існувати без впровадження інноваційних процесів у виробництво або до вже існуючих товарів або послуг. Надзвичайно актуальним на сьогодні є застосування інновацій у маркетингу, що підвищує рентабельність на 10%, відтак, виникає нагальна потреба дослідження поширення інновацій в е-торгівлі, враховуючи управління маркетингом. Метою статті є визначення впливу управління маркетингом на поширення інновацій в е-торгівлі. Дослідження проведено із застосуванням методів: теоретичного узагальнення та групування; формалізації та синтезу; принципів наукового контент-аналізу. З метою оцінки істотності впливу складових комплексу маркетингу на поширення інновацій в е-торгівлі для достовірності результатів дослідження та обґрунтованого вибору стратегій обрано модель Ф. Басса, що характеризується універсальністю застосування та класифікацією е-споживачів на соціальні групи: новатори, ранні послідовники, рання більшість, пізня більшість та аутсайдери. Ціна та просування (реклама) впливають на розмір ринку е-торгівлі, враховуючи еластичність попиту та динаміку зростання розміру ринку е-торгівлі. Інновації забезпечують подальший розвиток ведення успішного бізнесу та утримання конкурентних позицій на ринку, тому прогнозування попиту є пріоритетним напрямом. Управління комплексом маркетингу впливає на всі ключові елементи моделі Басса, включаючи коефіцієнти інноваційності та наслідування, загальний розмір ринку е-торгівлі та на швидкість дифузії. Виявлено,

effect of advertising is cumulative during the life cycle of the innovative product, which positively affects both the size of the market and the speed of diffusion of innovations.

Keywords: innovations, marketing complex, diffusion of innovations.

що ціна є домінуючим фактором поширення інновацій, а ефект від реклами є кумулятивним протягом життєвого циклу інноваційного продукту, що позитивно впливає як на розмір ринку, так і на швидкість розповсюдження інновацій.

Ключові слова: інновації, комплекс маркетингу, дифузія інновацій.

JEL Classification: M30, M31, M37, F10.

Introduction

In terms of market relations, the effectiveness of marketing systems is a decisive factor in the competitiveness of the enterprise. In today's world, enterprises cannot exist without the introduction of innovative processes into production or to existing goods or services. Bringing innovative products to the market is associated with significant risk, as it requires investment, powerful organization and coordination of actions. In particular, there is a need for forecasts of the speed and volume of sales of products, taking into account novelty (Barabanova, Bogatyrova, 2022, p.10). Modern methods of econometric forecasting of the product life cycle are impossible without the use of the most modern models of marketing forecasting, which can investigate the process of diffusion of innovative products based on the theory of complex systems. The first studies in this direction appeared in the 1960s and are still widely used today. These models represent the arrival of new products in the market and use the S-curve to characterize their diffusion. The class of diffusion models is very broad and well suited for practice. The diffusion of innovation in the market and the role of marketing management is the subject of research in many disciplines, including but not limited to marketing, economics, operations, statistics, and technology management. 50% of business profits are generated by products that are less than 5 years old, in particular the total demand for a new product and the shape of the demand curve influence the company's decisions regarding supply chain, production, inventory and marketing investments (Teach, Schwartz, 2003). Despite the fact that the approaches to modeling the diffusion of technology and innovative product are very similar, in recent years it is the study of modeling the demand for innovative products that dominates scientific research. After all, when launching and evaluating a project for the development of an innovative product, two unknowns have the greatest influence on its cost, and therefore on its attractiveness for investors: the amount of demand and risks. The more accurate the forecasting of these parameters, the more accurately the cost of the innovative project is predicted and the smaller its uncertainty. Considering this, the application of innovation in marketing, which increases profitability by 10%, is extremely relevant today, so there is an urgent need to study the spread of innovation in e-commerce, taking into account marketing management.

Modeling and forecasting the rate of spread or diffusion of innovations and innovative products has been one of the key topics of scientific discussions, since the first works of scientists Fourt A., Woodlock D. (1960), Mansfield E. (1961), Floyd A. (1962), Rogers E. (1962), Chou G. (1967) and Bass F. (1969). At the same time, Fourt and Bass operated with just such a concept as an innovative product.

The concept of "diffusion" was initially applied to the adoption of technological innovations in a social group (Stoneman, Battisti, 2010), (Melnikov, 2015), but over time this perspective of "technology implementation" regarding diffusion appeared in the influential theories of Rogers E. (1962), described in the framework of 5 factors affecting the diffusion of innovations: better product performance compared to alternative methods; compatibility with the client's values (for example, expensive wines should have corks, not screw caps); lack of complexity of the product; the possibility of convenient testing and transparent observation (for example, non-users can observe how others use the product) (Rogers, 1962).

In 1969, Bass F. published a model for predicting the first purchase of a new product category in the journal "Management Science" (Bass, 1969). Bass's theory has been described as a model of the diffusion of innovation because it hypothesizes that the increase in demand for a new product category is a function of how information about that product spreads through the social system.

In the 1970s, scientists began to expand models of the diffusion of innovations. Let's consider the main ones. Abernathy W., Townsend P. (1975) proposed a descriptive model of the spread of innovations based on scientific and technical achievements affecting labor productivity within the enterprise (Abernathy, Townsend, 1975). Dodson J.A. and Muller E. (1978) developed a modified exponential curve to model product growth and a logistic curve to model the increase in the total number of potential customers (Dodson, Muller, 1978).

Mahajan V. and Peterson R. (1979) put forward a model of the diffusion of innovations to durable goods, taking into account the change in market volume over a certain period of time (Mahajan, Peterson, 1979). The model proposed by Mahajan and Peterson is a general dynamic growth model, and the Dodson and Muller model is a mechanism for incorporating the advertising variable into the dynamic growth model.

In 1984, Asmus H. classified new product forecasting models into two types: trial repetition models (distinguishing the total volume of sales and trial purchases) and competitive structural models (estimating market share when introducing a new product) (Assmus, 1984).

The considered theory of Bass caused interest and the appearance of debatable issues regarding the fixed market potential and the possibilities of marketing influence on the diffusion of innovations.

The aim of the article is to determine the impact of marketing management on the spread of innovations in e-trade. The hypothesis

underlying this study is that price and advertising can alter the diffusion of innovations in e-trade.

The theoretical and methodological bases for writing the article were the works of foreign scientists on the issue of studying the diffusion of innovations. The methods of grouping, formalization and synthesis, the principle of scientific content analysis were used to select a model to forecast the spread of innovations.

The main part of the article is divided into sections, each of which reveals an aspect of the diffusion of innovations in e-trade through the influence of price and advertising. The chapters reveal the essence of innovation diffusion models, the influence of marketing on their diffusion, and changes in the volume of the e-trade market with changes in price and promotion. Each chapter succinctly presents the key findings, highlighting the dependence of the e-trade market on marketing, taking into account price elasticity. The research is the starting point in a series of articles aimed at highlighting the importance of forecasting demand for product innovations at the stage of their development.

1. The essence of innovation diffusion models

Innovations can spread through social systems only through the perception of individual elements of the system: consumers, when new products enter the market. Rogers E. called this cognitive process innovation adaptation. The central place in the theory of diffusion of innovations is occupied by the modeling of the decision-making process regarding the adaptation of the elements of the social system due to the wide recognition of the idea of the spread of technological innovations as a social phenomenon, so this concept is adopted by strategists and marketers in different countries.

Over time, innovations spread through communication in social systems. In this regard, the following key elements of the theory can be identified:

Innovation is defined by E. Rogers as "an idea, practical activity or object that is perceived as something new by an individual."

Communication channels are means of transmitting messages from one person to another.

Adaptation time is the relative speed with which members of the social system adapt their innovations.

A social system is a set of interconnected communities that solve problems together to achieve a common goal (Bazhal, Bakushevych, Venesaar, 2015, p. 110–111).

The Bass model, widely known in the academic literature, has been chosen as one of the ten most influential works in the 50-year history

of management science (Ofek, 2005), (INFORMS ONLINE, 2004). Bass's generalized model studies the impact of such variables of the marketing mix as pricing and promotion (advertising) on the level of demand. In Bass's generalized model, changing these elements of the marketing mix shifts the demand curve, given the fact that market size is constant (Bass, Krishnamoorthy, Prasad, Sethi, 2004).

2. The influence of marketing on the diffusion of innovations

To understand how the marketing mix affects consumer buying behavior and overall market opportunities, it is necessary to study the behavior of e-users. The basic assumption of the Bass model is that the acceptance of a new product category by members of a social system leads to an increase in unit sales. Assuming that Bass's hypothesis is correct, the question arises as to how the social system affects those who do not use the product and what factors influence them (Gurumurthy, Mukherjee, 2020; Chenavaz et al., 2020).

Bass F. assumed that the possibility of purchasing a new product (service, technology) by consumers is a linear function of the number of previous buyers. Bass interpreted the model's linear coefficients as a tendency toward innovation and imitation. The probability that someone will buy a new product at time t (assuming that the person has not bought this product before) is represented by the equation:

$$P+qF(t)=(f(t))/(1–F(t)), \quad (1)$$

where P – is the coefficient of initial perception of the innovation, often referred to as the "advertising effect";
q – imitation coefficient, word-of-mouth effect;
F(t) – is the cumulative distribution function (probability of accepting the product at time t);
f(t) – is the probability function of a random variable;
t – is the time of acceptance of a new product (adaptation).

Based on open statistical data of e-trade enterprises for 2021 (UkrStat, 2024), their estimated parameters are given, where p = 0.022, q = 0.384, m = 5 628 (the number of e-enterprises on the territory of Ukraine that are consumers of innovative products). The coefficient of initial adoption of innovations and the coefficient of imitation are constant values that are taken as a basis for new innovative products. Let's try to refute the assumption that the market potential is fixed and does not depend on the management of the marketing complex (*Figure 1*).

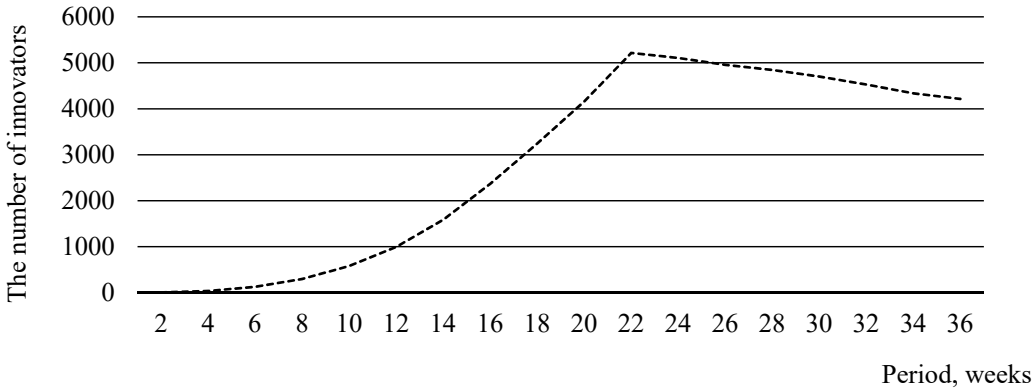

Figure 1. Number of innovators for new innovative products

Source: compiled by the author based on data (UkrStat, 2021).

So, from the maximum number of possible innovators (e-enterprises that are the first to introduce innovative products), the peak of demand for new innovative products fell on week 22 and reached the mark of 5 214 people, and then the dynamics began to decrease, which may mean that the attention of innovators switched to other products and saturation of the e-trade market, calculations were made based on the presented formula. Some scholars believe that e-trade refers to the innovation of enterprises to develop fragmented value chains without a system of industrial relations regardless of business models (Kharchenko, 2023).

3. Diffusion of innovations when price and promotion change

AnyLogic (2023) software was used to simulate the simplest innovation diffusion model. This software allows you to model system dynamics using simulation simulations. In the simulation model, there are two stock variables and one flow variable, which will form the basis of the Bass model. In addition, three parameters and two dynamic variables have been added. The same model can be used to test the effect of prices and advertising on the market volume of innovative products. So, let's consider the dynamics of demand for new innovative products according to the cumulative distribution (*Figure 2*).

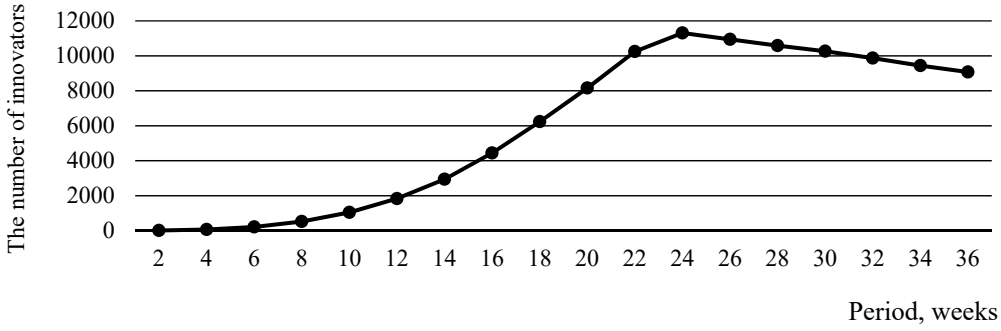

Figure 2. Number of cumulative innovators for new innovative products

Source: compiled by the author based on data (UkrStat, 2021).

Bass's model suggests that the process of a new idea depends on two factors: the coefficient of innovation and the coefficient of imitation. Pricing affects the speed of diffusion (innovation rate, imitation rate) and overall market potential. The effects of pricing may differ for durable and non-durable goods, for expensive and inexpensive goods, but the general effect of pricing is to increase diffusion and market opportunities (Boehner, Gold 2012).

We will try to identify the influence of such components of the marketing complex as: price and promotion (advertising) on the size of the e-trade market.

As a result, we will check the influence of low, medium and high values both on price elasticity and on advertising values. We propose the following multiplicative expression for market potential, where m is a function of price (P) and advertising (A):

$$m = sP–eAf, \quad (2)$$

where m – is the market potential (size);
s – scaling factor;
P – price;
A – advertising expenses;
e – price sensitivity (elasticity) coefficient;
f – is the coefficient of sensitivity (elasticity) of advertising.

The functional form for the market potential was chosen because it is the standard Cobb-Douglas function, which is widely used in economic research due to its robust stability properties and ease of parameter estimation. Coefficient e is the price elasticity of demand; coefficient f is advertising elasticity (*Table*).

Table

Parameters of marketing complex management
in the Cobb-Douglas demand function

Parameters	Sensitivity coefficient		
	low	medium	high
e	0.35	1.00	3.00
f	0.25	0.50	0.75

Source: compiled by the author from (Cobb, Douglas, 1928).

In *Figure 3*, the price and advertising levels are normalized for ease of illustration and comparison, where an index value of 100 represents the average value.

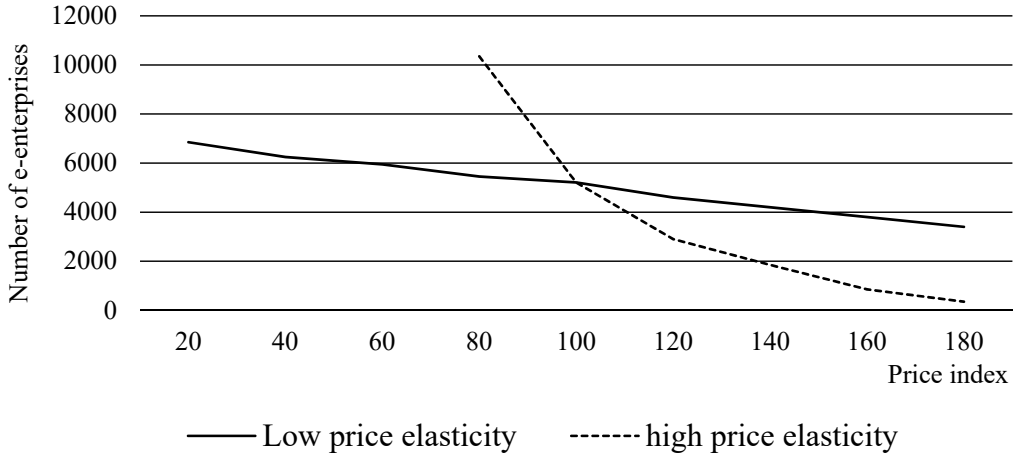

Figure 3. The influence of price on the size of the e-trade market

Source: developed by the author based on data (UkrStat, 2021).

A low price elasticity of demand is a relatively more direct trend and shows the effect of price on the overall size of the e-trade market, which is growing much faster. For example, for a price index of 100, the market size is 5 213 for both curves. If the price falls to 80, the size of the highly elastic demand market doubles to about 10 350 (*Figure 4*).

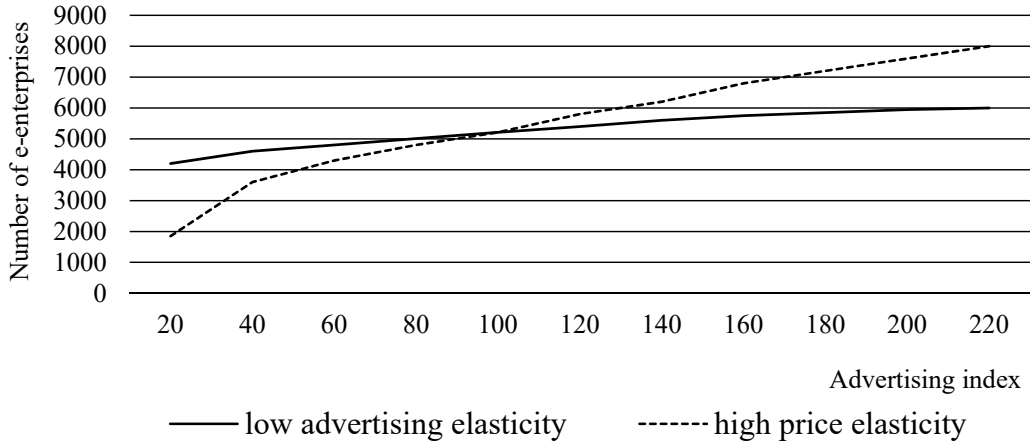

Figure 4. The impact of advertising on the size of the e-commerce market

Source: compiled by the author based on data (UkrStat, 2021).

The impact of advertising on the total size of the e-trade market grows much faster, given the low advertising elasticity. Also, the returns to advertising diminish as advertising increases, so the low-elasticity demand curve becomes much steeper (more vertical), indicating that the increase in market demand eventually becomes very small as advertising increases. For example, with an advertising index of 100, the market size is approximately 5 213 for both curves. If advertising increases to 200, the size of the

e-trade market is highly elastic, demand nearly doubles to about 8 000, while with low price elasticity, the market increases to 6,000. In general, the effect of advertising is cumulative over the life cycle of the innovative product, which positively affects both the size of the market and the speed of diffusion of innovations.

Conclusions

Innovations ensure the further development of successful business and maintaining competitive positions on the market, therefore demand forecasting is a priority area. Marketing mix management affects all key elements of the Bass model, including innovativeness and imitation rates, total e-trade market size, and diffusion rates. It was found that price is the dominant factor in the diffusion of innovations, and advertising has a cumulative effect and affects not only the size of the e-trade market, but also the speed of diffusion of innovations. The results of the research show that the management of the marketing mix (price and promotion) affects all the key elements of the Bass model, taking into account the coefficients of innovation and imitation, the total size of the e-trade market and the speed of diffusion, which will allow qualitative forecasting of the demand of e-users and simplify the choice of business – strategies.

Prospects for further research should be to study the significance of the influence of innovative marketing management (lean management, quality management, reengineering, change management, benchmarking, business time management, effective customer service, computer integrated production, innovation provision) on the diffusion of innovations.

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