Diffusion of innovation in the Bulgarian dairy industry

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Abstract. This report presents a study of the factors that influence the diffusion of innovation in Bulgarian dairy businesses. Maintaining high innovation activity and positive innovation potential is the result of the effective functioning of the innovation system. The different types, functions and factors, prerequisites and mechanisms for implementing the process of innovation diffusion are explored. It is proved that the efficiency of investment is determined by external factors, primarily by the level of economic concentration of the market of innovative products. As a result, the external factors have a relatively greater impact on the economic efficiency of investing in innovation and hence a significant direct impact on the diffusion of innovation in the dairy industry. The "highest" level of correlation is determined with the factor of economic concentration of the industry and the market of innovation project.

1. Introduction

Keeping innovative activity creates the conditions for businesses to profit and maintain competitive advantages. Diffusion is of great economic importance, since only the widespread diffusion of an innovation can have a noticeable economic effect [1]. The existence of mechanisms for dissemination of innovation results and their subsequent refinement alters the targeted scope of innovation and, from a factor relevant to enterprises, transforms them into an engine of social development and the creation of competitive economies.

The purpose of this article is to present the essence and characterize the mechanisms for diffusion of innovation in enterprises and their influence on their innovation activity, efficiency and competitiveness.

The object of research is the nature and factors influencing on the diffusion of innovations in the national dairy industry.

The methodology of research - the task of correlation analysis was set to identify the factors that affect the performance indicator - the level of diffusion in innovative projects. The authors identified 8 internal and 4 external factors, hypothetically determining the profitability of investments in innovative projects. The choice of hypothetical factors is determined by the following criteria: the frequency of allocation in the scientific literature; measurability; relative independence from the scale of projects; the possibility of comparison in projects; availability of management accounting documents (business plans, investment projects and reports on marketing research).

The sample of the study is based on a survey of the retrospective of 241 innovative projects of enterprises from the food industry, implemented in the period 2010-2019. To clarify individual quantitative assessments and justify the nature of economic efficiency, in-depth interviews were conducted with the leaders of 27 innovative projects.

The practical side of the result can be formulated as a criterion for selecting markets or types of activities for investing in innovations by national enterprises from the dairy industry [2]. The results of the research are in solidarity with the scientific conclusions about the dominance of external factors in the formation of economic efficiency of investment in innovation: The formulation of the criterion: as optimal are determine the markets, where the level of economic concentration at the time of the start of sales of the innovative product is 15-45%, which characterizes the stage of "growth".
2. Literature review

In most studies, innovation is viewed in a broad and narrow sense [3]. In a broad sense, it is presented as a complex phenomenon of mutually conditioned and connected creative actions of people in the formulation of an idea, creation, implementation and use of something (product, service, process, etc.), by which they improve and transform the opportunities and conditions for business and your environment. In a narrow sense, it is considered as an act of actually introducing and commercializing new goods, services, technology, technology and organization. In both cases, innovation can be viewed in dynamics and in statics.

The theory of the diffusion and perception of market innovations was originally launched by Everett Rogers [10]. It defines diffusion as "a process in which information about innovation is disseminated through members of a social system" [5] and identifies four specificities of dissemination:

- This is a specific communication aimed at disseminating innovative ideas;
- The novelty of ideas creates uncertainty in the diffusion process - in terms of projections, structure, information, etc.
- Dissemination of information leads to a reduction of uncertainty in situations requiring the choice of alternative behaviors.
- Diffusion of innovation is a type of social change associated with changes in existing structures and functions.

Two interpretations of the term "innovation diffusion" have become commonly accepted in the economic literature. According to the first understanding, it is defined as a process with strictly defined parameters and boundaries in terms of its ability to be controlled. Researchers refer to this type of diffusion as an active spread that is planned, formal, often centralized and hierarchical [8, 9]. The second group of economists view diffusion as spontaneous, unplanned, informal, decentralized, and mainly through horizontal connections, the dissemination of new ideas. This is the so-called. "Pure diffusion". Practice shows that the implementation of diffusion processes is a combination of planned actions in certain situations and spontaneous ad hoc decisions - in others.

At its core, diffusion of innovation is the dissemination of successfully implemented innovations in the processes or products of other enterprises in the industry and / or in other areas of social practice [4]. Therefore, diffusion is "a macroprocess and is the dissemination of innovation from its source - the enterprise, to consumers (the target market) through communication channels (mass media, distributors, traders, etc.) over a period" [7]. It consists of four elements [6]: innovation; communication channels; time / period; social system.

The main function of diffusion is to drive and reach innovation to the maximum number of users. Several additional functions can be specified as derivatives: economic function, social function, incentive function and psychological function.

| Table 1. Factors and prerequisites for diffusion of innovation |
|-------------------------------------------------------------|
| External: by industry affiliation of the enterprise | Internal: the average value of the indicator in the sample during the implementation of the innovative project |
| Market share by main business activity | The growth rate of the revenue of an industrial enterprise |
| Average market growth rate | Profitability of operating activities |
| Coefficient of economic concentration by the sum of 3 (CR3) | Proportion of staff engaged in R&D |
| Science intensity of the industry (average for OECD groups) | Margin coefficient |
| Information system for the supply and demand for innovation; | Science-intensive: costs of R&D in revenue |
| Reliable legal protection of technological transfer facilities; | The share of R&D costs in the budget of the innovation project |
| Efficient regulatory framework and court arbitration and contractual practice; | The ratio of innovation costs to annual revenue |
| Reliable measures of the relative advantages of the first successful innovation; | The share of innovation costs in total investment |

Closely related to the term "innovation diffusion" is the term "reinvention". According to Rogers, it reflects the extent to which innovation is altered or modified by the consumer and in the process of its adaptation or use. For Ivland, reinvention shows the extent to which the use of a new idea is moving away from the basic version of innovation originally marketed [8].

The dissemination of an innovation cannot be accomplished without the parallel flow of another important process - the adoption of innovation. According to Rogers and Schumaker, perception can be defined as "a decision to use it fully or to choose a new idea as the best course of action" [9]. The
adoption process has two main components: the decision to adopt / reject the innovation and the period of use [10]. Diffusion and the perception of innovation differ (see tabl 1). While diffusion refers to whether the proposed new or improved product (service) will be accepted by the market, the perception is related to how quickly the product (service) will be accepted (implemented) by the market. The diffusion mechanisms are [3]:

- **Indirect diffusion** - an increase in the scale of production or a new process in a company that is the first implemener in the world at all (Figure 1).
- **Direct diffusion** - Adaptation of already implemented innovation by related companies.
- **Mixed diffusion** - combines direct and indirect diffusion. Examples of mixed diffusion are the transfer of innovations from the military to the civilian sphere, from the chemical to the food industry.

Each innovation system is characterized by a certain degree of development. It can be tracked, analyzed and reported through the level of innovation and the accumulated innovation potential (IIA) of the economic system that determine the innovation (IA) and economic (EA) activities. In this regard, it is important to give a brief description of some basic concepts related to new trends, requirements and processes [6].

Research Potential (RP) is related to the capacity of the scientific and research system to generate a scientific product in a different form. Innovation potential (IP) is the accumulated economically significant innovations in the economic system and its opportunities for their development and implementation in the economic practice. According to Kerchev [3], innovation shows the possibility and the achieved level of the innovation potential of the innovation system, ie it is an indicator for the effective use of research and innovation potential. Innovation activity (IA) takes into account the dynamics and capabilities of the innovation system to feed production with ready-to-use innovations. Innovation's economic activity (EA) characterizes the capabilities and flexibility of the production system with the available resources to perceive and absorb innovations and to offer them as products in the form of goods, services or technologies.

The analysis of the relationship between IA and EA and their tracing over time gives an idea of the trends and the degree of development of the innovation potential [13]. When IA has values higher than Ca, an innovation reserve (IR) is formed. Otherwise, there is an innovation gap (IG). Charts 1 through 4 show the relationship between EA and IA in time (t). Many conditions and changes in the relationships between them are possible, but several are the basic ones.

1. **Chart 1. Imbalance in favor of the business activity**
   - Imbalance in favor of economic activity (Chart 1). The innovation potential has been negative throughout. The difference between EA and IA is always in favor of production, with larger (T1) or smaller (T2) differences between them.
   - Synchronous negative imbalance (Figure 2). In this case there is a correspondence between EA and IA for each period of time and the innovation potential is constant (permanent) but negative.
   - Balance and imbalance (Chart 3). Viewed in time, the development of production and the availability of innovation are very uneven, ie. the project receives positive and negative values.
   - Positive imbalance (Chart 4). If the innovation policy manages to keep in sync with IA and EA with a
positive IP, this is the best option for the company. On the one hand, production and innovation
develop in relation to each other, and on the other, there is always an II that can be used in production.
From these basic relationships between IA and EA, three conditions for a dynamically progressing
relationship between the innovation and production activity of the business, of the economic life and
of the whole economic system are deducted:
1) EA in T2 > EA in T1; 2) IA in T2 > IA in T1; 3) IA > EA for any meaning of T > 0.
As a result of active R&D, there is a positive IP and an accumulation of IR. They create the
conditions to satisfy the needs of the economic system for innovative products.

3. Object and Methodology of research

The subject of the research: the nature and factors influencing on the diffusion of innovations in
the national food industry.

The object of research: Bulgarian enterprises from the dairy industry.
Method of research: correlation analysis. The task of correlation analysis was set to identify the
factors that affect the performance indicator - the level of diffusion in innovative projects. The authors
identified 4 main external factors (see table 1), hypothetically determining the profitability of investments
in innovative projects in dairy industry. The choice of hypothetical factors is determined by the following
criteria: the frequency of allocation in the scientific literature; measurability; relative independence from
the scale of projects; the possibility of comparison in projects; availability of management accounting
documents (business plans, investment projects and reports on marketing research).
The sample of the study is based on a survey of the retrospective of 241 innovative projects of
enterprises from food industry, implemented in the period 2010-2019. The population statistics was
obtained from Bulgarian Chamber of Commerce and Confederation of the Employers and
Industrialists in Bulgaria – CEIBG. A stratified random sample was a useful blend of randomization
and categorization, which enabled both a quantitative and qualitative process of study to be undertaken.
Statistics on internal investment indicators of projects are supplemented with information
on external indices of the industry obtained from business plans of innovation projects, marketing
research and official statistics (in particular, NSI and Eurostat). To clarify individual quantitative
assessments and justify the nature of economic efficiency, in-depth interviews were conducted with
the leaders of 27 innovative projects. The study used a structured questionnaire in data collection.
The questionnaire was carefully designed and administered to the respondents. The questionnaire
was designed on a four point Likert-Scale which ranged from strongly agree (4 points), agree (3
points), disagree (2 points) and strongly disagree (1 point). The items were structured to capture
information on the dependent variable (diffusion of innovations) and the independent variables
(Average market growth rate; Coefficient of economic concentration by the sum of 3 (CR3); Science
intensity of the industry (average for OECD groups); Market share by main business activity).
4. Analysis and results

The territorial distribution of the surveyed dairy enterprises in Bulgaria is shown in Figure 1. This distribution indicates that the sample is sufficiently representative for this survey, as enterprises from all regions of Bulgaria are included. The analysis of the legal status of the surveyed enterprises shows that 80 of the enterprises are Sole LTD, 120 of them are LTD, 15 are joint stock companies, and at least the enterprises with legal status are general partnership - 6 piece (see fig.2). 49% of the surveyed enterprises are small, 31% are medium-sized, large enterprises are 12% and micro-enterprises are 8% (see fig.3).

Pearson’s measures the strength and direction of the linear relationship between variables. From the results, a significant relationship exists between the variables (table 2). Science intensity of the industry was shown to contribute 76.3% of the diffusion of innovations as indicated by the correlation coefficient value of 0.763 which is significant at $\alpha = 0.01$. Coefficient of economic concentration by the sum of 3 (CR3) rate was positively correlated to innovation’s diffusion as indicated by correlation coefficient value of 0.571 indicating that the Coefficient of economic concentration by the sum of 3 (CR3) was a significant factor and contributed up to 57.1% of the change in diffusion of innovations. Average market growth rate was also shown to contribute 44.7% of the change in diffusion of dairy innovations as indicated by the correlation coefficient value of 0.447 which is significant at $\alpha = 0.01$.

| Table 2. Correlations statistic for relationship between variables |
|---------------------------------------------------------------|
| Variable                                      | Diffusion of innovation | Average market growth rate | Coefficient of economic concentration by the sum of 3 (CR3) | Science intensity of the industry (average for OECD groups) | Market share by main business activity |
| Diffusion of innovation                  | 1                       |                           |                                                           |                                                      |
| Average market growth rate              | 0.447                   | 1                         |                                                           |                                                      |
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The correlation for coefficient of economic concentration by the sum of 3 (CR3) showed that 43.2% of the change in diffusion of dairy innovations was significantly accounted for by Coefficient of economic concentration by the sum of 3 (CR3) as shown by correlation coefficient value of 0.432 (significant at α = 0.01). This paves way for multiple regression analysis.

Table 3. Multicollinearity analysis test for independent variables

| Diffusion of innovation | Tolerance | VIF |
|-------------------------|-----------|-----|
| Average market growth rate | 0.821 | 1.576 |
| Coefficient of economic concentration by the sum of 3 (CR3) | 0.865 | 1.099 |
| Science intensity of the industry (average for OECD groups) | 0.787 | 1.321 |
| Market share by main business activity | 0.421 | 1.730 |

Results in table 3 showed that the VIF value for all the estimated parameters was found to be less than 4 and the tolerance values are more than 0.2 which indicate the absence of multi-collinearity among the independent variables of the study. This implies that the variation contributed by each of the independent factors was significant independently and all the factors should be included in the prediction model.

Table 4. Multiple regression model

| Predictor: (Constant) |
|-----------------------|
| R | R² | Adjusted R² | Std. error of the estimate | Durbin Watson |
|---|----|-------------|-----------------------------|--------------|
| 0.931* | 0.828 | 0.771 | 0.843 | 1.626 |

Table 5. F test results (ANOVA)

| Sum of squares | Df | Mean square | F | Sig |
|----------------|----|-------------|---|-----|
| Regression | 8,435 | 4 | 9,421 | 26,721 | 0.000** |
| Residual | 9,002 | 187 | 7,87 | |
| Total | 17,437 | 191 | | |

* Dependent variable: diffusion of innovations

In addition, Durbin Watson test had value less than two indicating minimal autocorrelation with no effect on the study output (Watson value = 1.626). The rule of thumb was applied in the interpretation of the variance inflation factor which states that a principle with broad application that is not intended to be strictly accurate or reliable for every situation. The results of survey of the sample of innovative projects are presented as a table 6 of correlation coefficients (r) of hypothetical factors with diffusion of innovations as a resultant indicator. The analysis allows to formulate the following conclusions:

- External factors have a relatively greater impact on the economic efficiency of investing in innovation and hence a significant direct impact on the diffusion of innovation in the dairy industry.
- The «highest» level of correlation is determined with the factor of economic concentration of the industry and the market of innovation project (coefficient by the sum of 3, CR3).

Table 6. Multiple regression model

| Variable | Coefficient | Std. error | Beta | t-statistics | Sig. | Tolerance | VIF |
|----------|-------------|------------|------|--------------|------|-----------|-----|
| Constant | 3.419 | 0.499 | | 4.211 | 0.198 | |
| Average market growth rate | 0.436 | 0.001 | 0.303 | 2.291 | 0.006 | 0.821 | 1.576 |
| Coefficient of economic concentration by the sum of 3 (CR3) | 0.554 | 0.087 | 0.345 | 3.239 | 0.003 | 0.865 | 1.099 |
| Science intensity of the industry (average) | 0.386 | 0.122 | 0.331 | 2.367 | 0.032 | 0.787 | 1.321 |
5. Conclusion

Hypothesis one (H01) estimated that average market growth rate has no significant effect on diffusion of innovations. However, research findings showed that average market growth rate had coefficients of estimate which was significant based on $\beta_1 = 0.303$ (p-value = 0.001 which is less than $\alpha 0.05$) implying that we reject the null hypothesis stating that there is no significant effect of average market growth rate on diffusion of innovations in the companies from dairy industry in Bulgaria. This indicates that for each unit increase in the positive effect of average market growth rate, there is 0.303 units increase in diffusion of innovations. Furthermore, the effect of average market growth rate was stated by the t-test value =3.291 which implies that the standard error associated with the parameter is less than effect of the parameter.

Hypothesis two (H02) stated that coefficient of economic concentration by the sum of 3 (CR3) has significant effect on diffusion of innovations. Findings showed that coefficient of economic concentration by the sum of 3 had coefficients of estimate which was significant based on $\beta_2 = 0.345$ (p-value = 0.003 which is less than $\alpha 0.05$) hence we reject the null hypothesis and conclude that coefficient of economic concentration by the sum of 3 (CR3) has significant effect on the diffusion of innovations of dairy industry in Bulgaria.

Hypothesis three (H03) stated that Science intensity of the industry (average for OECD groups) has no significant effect on organizational performance. Research findings indicated we reject the null hypothesis and conclude that this factor has significant effect on the diffusion of innovations of dairy industry in Bulgaria.

Hypothesis four (H04) stated that market share by main business activity has no significant effect on organizational performance. However, findings of the study revealed that the factor had coefficients of estimate which was significant based on $\beta_2 = 0.243$ (p-value = 0.024 which is less than $\alpha 0.05$) hence we reject the null hypothesis and conclude that market share by main business activity has significant effect on organizational performance in the diffusion of innovations of dairy industry in Bulgaria.

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