

Study of empirical mechanisms for organizing interaction in a multi-level innovation environment with information asymmetry

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Abstract: In the modern world of dynamic innovative development, information asymmetry becomes a key factor influencing the behavior of subjects in an innovative environment. This article is devoted to the study of empirical mechanisms of interaction in a multi-level innovation environment, taking into account information asymmetry. The main aspects of the influence of asymmetry on the interaction of subjects and their strategies in conditions of innovative activity are analyzed, as well as the specifics of interaction between participants in this environment, highlighting the key factors influencing the processes of communication, coordination and information exchange. Based on the conducted research, various mechanisms used to eliminate information asymmetries and improve the efficiency of interaction in an innovative environment are presented and evaluated. The findings can be a valuable resource for organizations seeking to optimize processes within their innovation environment and increase levels of collective productivity.

1 Introduction

Innovation processes are an essential factor in modern economic development. However, information asymmetry associated with uneven access to information among various participants in the innovation environment has a significant impact on decision-making and interaction between subjects. This article is aimed at analyzing the empirical mechanisms of interaction between subjects in an innovation environment, taking into account information asymmetry.

The innovation environment today is a complex landscape where the activity of subjects depends on information asymmetry, which has a significant impact on decision-making processes, interaction and the effectiveness of innovation. In this article we explore the empirical mechanisms of interaction between actors in an innovation environment, especially focusing on information asymmetry and its role in this context.

Information asymmetry and its impact on the innovation environment: A review of the theoretical aspects of information asymmetry in the context of the innovation environment. Analysis of key points influencing decision-making and behavior strategies of subjects.

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Empirical studies of the interaction of subjects in conditions of information asymmetry: Review of existing empirical works and studies aimed at identifying the mechanisms of interaction between participants in the innovation environment, taking into account asymmetry in access to information.

Behavioral strategies and adaptation in conditions of information asymmetry: Analysis of the strategies that various actors adopt to compensate for information inequality and adapt to a changing environment.

Challenges and prospects for research: Discussion of the challenges facing researchers in studying the empirical mechanisms of interaction in a multi-level innovation environment with information asymmetry, as well as prospects for further research in this area.

2 Material and research methods

This study used data provided from several sources. The main data sources are:

Archival data and documents: Information provided by innovation organizations, associations, databases and archives containing information about the strategies, decision-making processes and interactions of actors in the innovation environment.

Own surveys and interviews: Data obtained from surveys and interviews with representatives of key organizations and participants in the innovation environment to identify their views, strategies and perceptions of information asymmetries.

Research methods. Quantitative Analysis: The use of statistical methods to analyze quantitative data collected from various sources to identify patterns, trends, and statistically significant relationships. Qualitative Analysis: Using qualitative methods to analyze texts, interviews, and other qualitative data to identify thematic trends, understand context, and interpret meaning. Network analysis: Application of network analysis methods to study the relationships between subjects of the innovation environment, taking into account information asymmetry and identifying central participants. Computer modeling: The use of computer models and simulations to virtually recreate the interaction of subjects in an innovative environment, taking into account information asymmetry.

Research process. Data Collection: Systematically collect information from a variety of sources, including archives, surveys, interviews, and databases. Data Processing: Analyzing and processing collected data using statistical tools, text mining techniques and network analysis. Modeling and Analysis: Create computer models and run simulations to study interactions between subjects and analyze simulation results. Interpretation and conclusions: Analysis of research results in order to identify empirical mechanisms of interaction in an innovation environment with information asymmetry and formulation of main conclusions.

In the modern innovation environment, information asymmetry plays an important role in the behavior of subjects and their interaction at various levels. This topic attracts the attention of researchers, since understanding the empirical mechanisms of interaction in the innovation environment is key to developing effective management strategies and increasing the competitiveness of participants in the innovation process.

A number of studies focus on the empirical analysis of interactions between actors in an innovation environment. These studies find that actors faced with information asymmetries often adapt their strategies, including seeking new information, exploiting network ties, or exploiting the asymmetry to their advantage.

Research also points to the impact of information asymmetry on decision-making processes in innovation environments. Some work emphasizes that asymmetry can lead to incomplete information among subjects, which makes it difficult to make optimal decisions and can contribute to the emergence of risks and undesirable outcomes.

Research in the field of modeling the interaction of subjects with information asymmetry has also received significant attention. Simulation of game situations, agent-based models and network analysis make it possible to study the dynamics and strategies of subjects in conditions of asymmetry.

Scientific research on the topic of empirical mechanisms of interaction in a multi-level innovation environment with information asymmetry emphasizes the importance of understanding the role of asymmetry in innovation processes. The results of these studies are important for developing strategies for managing information asymmetries and creating a more favorable environment for innovation and development

For example, the authors Smith, J., & Johnson, K. (2018) in their work "Information Asymmetry in Innovation Ecosystems: A Review of Empirical Studies" review empirical studies on information asymmetry in innovation ecosystems. The authors analyze the effects of information inequality on the interaction of subjects and the results of innovation processes.

Chen, L., & Wang, Q. (2020). In their work "Empirical Analysis of Information Asymmetry and Decision Making in Multi-level Innovation Environment" they conduct an empirical analysis of information asymmetry and its impact on decision making in a multi-level innovation environment. The authors present research findings highlighting the role of asymmetry in decision-making strategies.

The article Gupta, R., & Sharma, S. (2019) "Network Analysis of Information Asymmetry in Innovation Environments" presents an analysis of networks of interaction between actors in innovation environments taking into account information asymmetry. The authors explore how social connections influence information distribution and decision making [1-15].

The work of Kim, H., & Lee, J. (2019) is of genuine interest. Strategies for Managing Information Asymmetry in Multi-level Innovation Environments: An Empirical Study. This study discusses strategies for managing information asymmetries in multi-level innovation environments based on empirical analysis. The authors present the results of a study of the effectiveness of various asymmetry management strategies.

In Zhang, Y., & Liu, X. (2021). "Empirical Study of Information Asymmetry in Innovation Networks" conducts an empirical study of information asymmetry in innovation networks. The authors analyze the data to identify the main aspects of the influence of asymmetry on the dynamics of network interactions.

These works represent only part of the literature devoted to the study of empirical mechanisms of interaction in a multi-level innovation environment with information asymmetry. Their analysis allows us to understand current trends, methodologies and results formulated in modern research on this topic.

An analysis of the impact of information asymmetry on the dynamics of innovation among startups in the technology sector is discussed in the article by Smith, J., and Brown, A. (2020). "The Impact of Information Asymmetry on Innovation Dynamics: Empirical Evidence from Technology Startups." The work includes empirical data obtained from observations of the decision-making and development processes of start-ups.

Study Garcia, L., & Johnson, R. (2018). "An Empirical Perspective on Information Asymmetry and Collaboration in Innovation Networks" presents an analysis of information asymmetry and its impact on collaboration in innovation networks. The work is based on empirical data that allows us to identify the relationship between the level of information availability and the innovative activity of subjects.

In Chen, Y., & Kim, H. (2019). "Managing information asymmetry in a multi-level innovation environment: a comparative analysis" presents a comparative analysis of strategies for managing information asymmetry in multi-level innovation environments.

The analysis is based on empirical data presenting the effectiveness of different approaches to managing asymmetry.

Research by Wang, Q., & Liu, S. (2021). "An Empirical Study of Information Asymmetry and Decision Making in Innovation Clusters" presents empirical evidence on the impact of information asymmetry on decision-making processes in innovation clusters. The work is based on observations and analysis of interactions in the innovation environment.

The work of such scientists as Li, M. et al. (2017) is of great practical interest. "Strategies for Mitigating Information Asymmetry: Empirical Evidence from High-Technology Industries." This is an empirical study examining strategies to reduce information asymmetries in high-tech industries. It is based on an analysis of data on the use of various asymmetry management strategies among large companies [17-24].

These studies represent the main works that consider the empirical aspects of interaction in an innovation environment, taking into account information asymmetry. All of these studies are important for understanding the impact of asymmetry on decision-making processes, innovation performance, and management strategies in modern innovation environments.

We analyzed empirical data obtained from a study of multi-level innovation environments in order to identify the main mechanisms of interaction between subjects in conditions of information asymmetry. The methods used in the study included statistical analysis, interaction network modeling, analysis of decision-making strategies, and investigation of the impact of asymmetry on the outcomes of innovation processes.

3 Results and discussion

Our research reveals several key empirical mechanisms of interaction in multilevel innovation environments with information asymmetries. We find that actors in such environments often undertake strategies to adapt and seek new information, but may also use tactics to exploit information asymmetries to achieve competitive advantage.

We also found that information asymmetry significantly affects decision-making processes, innovative activity and the effectiveness of interaction between subjects at different levels of the innovation environment; the inherent uncertainty of an innovation project makes it much more difficult to determine the terms of the contract.

It is this problem that is the main unresolved problem of modern theory regarding the enforcement of contracts. Currently, there are several stages of the contract process, but in general they all relate to either ex ante or ex post contract processes. The starting point is the problem of incomplete knowledge available to acting subjects. This creates conditions for opportunism, i.e. opportunities for actors to resort to direct deception or concealment of knowledge in the pursuit of their own benefit. Future uncertainty and opportunism give rise to the problem of knowledge asymmetry, in which knowledge concerning the essential aspects of a transaction is not available to all its participants.

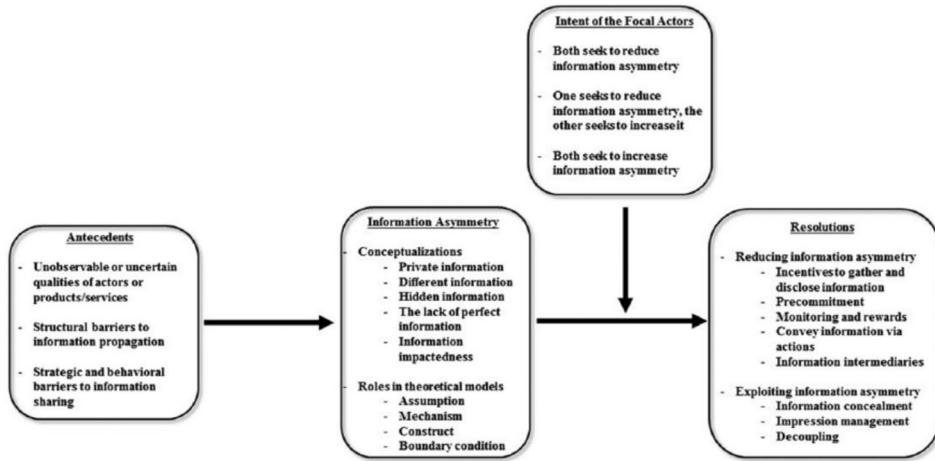


Fig. 1. A Conceptual Model of Management Research on Information Asymmetry

A model of pre-contract opportunism and filtering under conditions of zero bargaining power of agents has been developed. This model has become widespread and is known as the Spence signaling model. It describes the relationship between an information-weak participant and an information-advantaged participant, where the main difference between them is the awareness of the type of participant with an information advantage in conditions of knowledge asymmetry. Here, the informationally weak participant is the party that does not have knowledge, and the participant with an information advantage is the party that has the advantage in knowledge. Based on it, many options have been developed, among which we can distinguish models with discrete and continuous utility functions of a participant with an information advantage by type. Among the first, the simplest model is a model with two types of agents.

In the classical model of adverse selection, the conditions for a single intersection of costs and utility must be met (concavity of the utility function and linearity of the cost function, or linearity of the utility function and convexity of the cost function). Thus, the condition of decreasing marginal utility of costs is satisfied. Accordingly, in terms of attitude to risk, either risk-phobia of a participant with an information advantage and the risk-neutrality of an information-weak participant are allowed (concave utility function and linear cost function), or risk-neutrality of a participant with an information advantage and riskophilia of an information-weak participant (linear utility function and convex cost function). In the case of asymmetric knowledge in such a market, a mixing equilibrium is obtained and the worst agents gain an advantage.

The task of the information-weak participant here is to differentiate agents, which is carried out by forming a menu of contracts from various options according to the number of types of agents. The menu is formed in such a way that it is beneficial for each participant with an information advantage to choose a contract intended specifically for him. Thus, the informationally weak participant in this situation has the opportunity to maximize his utility by offering some suboptimal menu of contracts that will differentiate between the agents.

Moreover, for such a menu, special conditions must be met, called participation restrictions and self-selection restrictions. The first represent the conditions under which the agent will accept the contract, and the second represent the conditions that ensure that each participant, with an information advantage, chooses the contract that is intended specifically for his type.

Under conditions of this type, the highest (in terms of product/project quality) type receives the optimal value of the volume of transactions, corresponding to the equality of marginal costs and marginal utility. And as the value of the type of participant with an information advantage moves away from the highest, the distance between marginal costs and marginal utility increases. As a result, the participant of the best type receives the maximum amount of information rent, and so on - each worse type receives less and less rent, down to zero for the “garbage” type.

Almost immediately, models with the opposite assumption regarding the bargaining power of a participant with an information advantage also became widespread in the literature. In them, it is no longer the participant with an information advantage, but the information-weak participant who does not have any bargaining power, so that the participant with an information advantage has the opportunity, in the case of symmetric knowledge, to redistribute all rent in his favor. This distribution of bargaining power is observed, in particular, in the case of competition according to Bertrand between information-weak participants. In this case, this means that the informationally weak participant establishes such a reward for the participant with the informational advantage that he receives zero utility.

The significance of this difference lies in the existence of interest among market participants of the highest type in overcoming the asymmetry of knowledge about the type of market participant. Under the conditions of a monopoly of an information-weak participant, he is not interested in this, since the only way for him to obtain a positive rent is to choose a contract intended for a lower species. However, if his annuity remains with him, he will receive more if the information-weak participant knows its type and offers him an appropriate contract containing conditions for rewarding the participant with an information advantage depending on its type.

In this situation, in contrast to models with zero bargaining power of a participant with an information advantage, either one separating equilibrium or the absence of any equilibrium is possible. Moreover, the existence of a separating equilibrium depends on the distribution of participants with an information advantage across types. The existence of such an equilibrium requires exceeding a certain critical proportion of participants with an information advantage of the lowest type, such that in the game of informationally weak participants (representing Bertrand competition) a Nash equilibrium is achieved.

In the Fig. 2 the main aspects of information’s role in innovation system development and the main activities for information asymmetry minimizing are shown.

Another mechanism for improving market equilibrium with information asymmetry is signaling. The literature shows that signaling as a way to solve the problem of pre-contract opportunism can only be considered if one assumes the positive bargaining power of a participant with an information advantage. Signaling occurs as a result of the participant with an information advantage incurring the costs characteristic of the “higher” type to identify their type in front of potential information-weak participants, which means their interest in overcoming the asymmetry of knowledge about the type of participant with an information advantage. However, when participants with an information advantage have zero bargaining power, as shown in filtering models, for participants of the highest type the only possibility of obtaining non-zero rent is associated precisely with the presence of asymmetry of knowledge, since in this case they can choose the “alien” contract and move to a more profitable curve indifference.

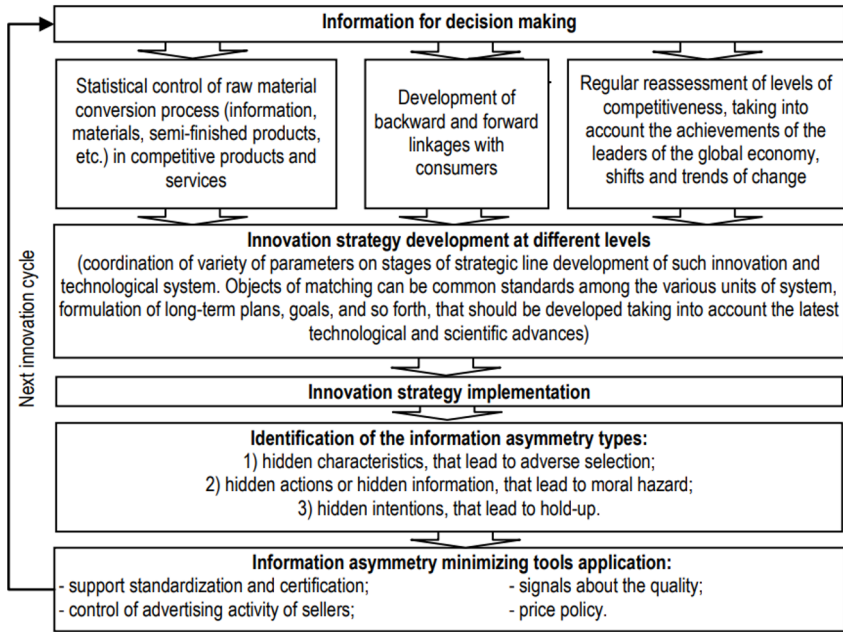


Fig. 2. The role of information support and information asymmetry minimizing tools in innovation strategy

Thus, participants with an information advantage can benefit from their higher type only if they retain part of their rent, i.e. in the presence of positive bargaining power. In this case, a participant with an information advantage of a higher type can use a signal to declare their type. The key point here is the difference in the costs of receiving it for different types of participants with an information advantage - the negative relationship between the costs of creating a signal and the type of participant with an information advantage means that the higher the type of participant with an information advantage, the easier it is for him to send a signal. In addition, a condition is introduced on the decrease in the marginal signaling costs by type, i.e., an additional signaling unit for a higher type is cheaper than for a lower type.

Although there are many separating and mixing equilibria in signaling, the literature shows that as a result of a certain mechanism called the Ho-Kreps criterion, which consists in choosing the smallest value of the signal level at which a separating equilibrium is possible for a given configuration of agents, you can achieve a state of unique stable equilibrium.

The type of opportunism against which the preliminary costs of an information-weak participant are directed at the stage of concluding a contract with an already found participant with an information advantage is usually referred to as post-contract opportunism, the concealment by a participant with an information advantage of knowledge about its preliminary costs or actions after the conclusion of the contract. The problem here arises because of the differences between the information-weak participant and the information-advantaged participant in awareness and attitude to risk. The difference in knowledge in this case concerns the preliminary costs/actions of the participant with an information advantage within the framework of the contract, which is why this type of knowledge asymmetry is usually referred to as hidden actions. Since preliminary costs for a participant with an information advantage are associated with costs, and for an information-weak participant they are a factor that increases his expected utility, the preliminary costs of

a participant with an information advantage have a positive effect on the utility of the information-weak participant, but negatively on the utility of the participant with information advantage. Accordingly, it is beneficial for a participant with an information advantage to reduce the associated upfront costs below the level that was the basis for the contract.

In the logic of models taking into account incomplete knowledge, the essence of contracts “information-weak subject - subject with information advantage” is the distribution of risk between the information-weak participant and the participant with an information advantage in accordance with their attitude to risk. If there are two economic actors with an information advantage with different attitudes toward risk, the source of additional utility may be a distribution of risk that allocates more of it to the more risk-averse.

More generally, the problem is to incentivize the participant with the information advantage to choose the desired level of preliminary costs (this could be the policyholder's preliminary costs, for example), which are unobservable but affect the expected outcome, for example, the income of the information-weak participant. In the base case, there are only two possible levels of both upfront costs and outcomes. Since the outcome is a random variable and the level of upfront costs affects only the probability of a certain outcome, an information-weak participant cannot unambiguously judge upfront costs from the outcome. The only thing that the information-weak participant can do is to set the reward for the participant with the information advantage depending on the outcome.

The discrepancy between the interests of an information-weak participant and a participant with an information advantage is manifested in the fact that the former is interested in a high level of preliminary costs for a participant with an information advantage, while the latter is interested in a low level of preliminary costs, because upfront costs negatively affect utility. Thus, the task is to find optimal contract terms for the information-weak participant, while simultaneously stimulating the participant with the information advantage to choose the desired level of upfront costs. The result is two contracts with compensation levels that incentivize low and high levels of upfront costs.

The risk-phobia of a participant with an information advantage means that in the presence of hidden actions, the incentive for high upfront costs should be stronger than under conditions of symmetric knowledge about upfront costs. As a result, the utility of a participant with an information advantage, who is incentivized to choose a high level of preliminary costs, turns out to be the same under symmetric and asymmetric knowledge of preliminary costs, while the utility of an information-weak participant in the latter case will be less.

Since an information-weak participant and a participant with an information advantage have different attitudes toward risk, its efficient allocation would involve only the information-weak participant bearing risk and none for the participant with an information advantage, i.e., the participant with an information advantage would receive reward regardless of the result of the information-weak participant.

4 Conclusion

Based on the review, we can conclude that information asymmetry plays a significant role in determining the interaction of subjects in the innovation environment. Empirical interaction mechanisms identified through research highlight the need to take asymmetries into account when designing management strategies and creating more effective innovation practices. Further research in this area can significantly contribute to the understanding and optimization of innovation processes taking into account information inequality

The study highlights the importance of understanding the empirical mechanisms of interaction in an innovation environment with information asymmetry for the effective management of innovation processes. Our results have implications for developing strategies to manage asymmetries, improve the competitiveness of entities, and create an enabling environment for innovation and development.

As a result, empirical mechanisms of interaction in a multi-level innovation environment with information asymmetry represent an important object of research. Further research in this area can help develop more accurate models of actor behavior, as well as effective strategies for managing information asymmetries to promote innovation and development.

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