Kirill A. Gureev[1], **Elena G. Gureeva**[2]

INTELLIGENT TECHNOLOGIES IN THE PROCESS OF BUSINESS UNITS BEHAVIOR MODELLING

The paper discusses the possibility of modelling individual factors determining inflation, using intelligent technology based on decision tree and matrix convolution. A simplified model of the "manufacturers' demand to profitability level" is constructed and various economic situations effects impacts are evaluated for the final assessment of the sensitivity level to individual factors.
Keywords: *inflation factors; qualitative assessment of model parameters; mechanisms of complex evaluation; intelligent simulation of technological markets; business entities behavior; environmental factors.*

Кирило О. Гурєєв, Олена Г. Гурєєва

ІНТЕЛЕКТУАЛЬНІ ТЕХНОЛОГІЇ В ПРОЦЕСІ МОДЕЛЮВАННЯ ПОВЕДІНКИ ПІДПРИЄМНИЦЬКИХ БІЗНЕС-ОДИНИЦЬ

У статті обговорено можливості моделювання часткових чинників, що визначають інфляційні процеси, з використанням інтелектуальних технологій на основі дерев критеріїв та матриць згортки. Розроблено спрощену модель «вимога виробниками рівня прибутковості» та оцінено різний вплив економічних ситуацій на підсумкову оцінку рівня чутливості до окремих чинників.
Ключові слова: *чинники інфляційних процесів, якісна оцінка параметрів моделі, механізми комплексного оцінювання, інтелектуальні технології моделювання ринків, поведінка бізнес-суб'єктів, чинники зовнішнього середовища.*
Рис. 4. Літ. 10.

Кирилл А. Гуреев, Елена Г. Гуреева

ИНТЕЛЛЕКТУАЛЬНЫЕ ТЕХНОЛОГИИ В ПРОЦЕССЕ МОДЕЛИРОВАНИЯ ПОВЕДЕНИЯ ПРЕДПРИНИМАТЕЛЬСКИХ БИЗНЕС-ЕДИНИЦ

В статье обсуждены возможности моделирования частных факторов, определяющих инфляционные процессы, с использованием интеллектуальных технологий на основе деревьев критериев и матриц свертки. Разработана упрощенная модель «требование производителями уровня доходности» и оценено различное влияние экономических ситуаций на итоговую оценку уровня чувствительности к отдельным факторам.
Ключевые слова: *факторы инфляционных процессов, качественная оценка параметров модели, механизмы комплексного оценивания, интеллектуальные технологии моделирования рынков, поведение бизнес-субъектов, факторы внешней среды.*

Introduction. The market systems behavior in most designed economic models is "rational", and deviations are considered as possible risk events. However, in other studies this approach is being criticized, emphasizing the imperfections of human modelling.

An alternative is to develop a player behavior tool modelling, which will require the assessment of rationality and human factors.

According the abovementioned modelling approach using qualitative assessments of any factor, decision tree and convolution matrix, defining the role of indi-

[1] Perm National Research Polytechnic University, Russia.
[2] Perm National Research Polytechnic University, Russia.

vidual parameters of the model, implemented, and tested many times, proved to be substantial and sufficiently complete to represent economic processes.

The developed simulation technologies of microeconomic processes, according to the latest scientific research, are to be applied in the evaluation of macroeconomic processes (Alekssev, Belih, Gureev and Shaydulin, 2010), which is consistent with the relationship of different levels of systems. One of the current problems is the forecast of inflation processes with their primary modelling as an alternative to the existing price measuring. The primary cause of this need is the heterogeneity of economic components even at very small spatial and temporal intervals.

Circumstances which are the premise of this heterogeneity, are so many that an attempt to analyze why, for example, sellers set different prices even within a single point of sale, or consumers do not make transactions in the same area, preferring to purchase some goods in bulk, and some goods in retail, is not possible (Kharitonov and Belih, 2007).

Obviously, the inflation simulation process (Golubeva and Gureev, 2012), on the one hand, as usual, is a macroeconomic issue, on the other hand, it is the enlarged microeconomic problem.

Unresolved issues. In earlier studies (Alekseev, Golubeva, Gureev, 2011) it was proposed to conduct a qualitative assessment of inflation processes, based only on the measurements of 2 indicators at different times: "the level of profitability required by manufacturers " (*X*), where *X1* is the current requirement of return, *X0* is its value in the past, and "willingness to pay requirements of return to customers" (*Y*), where *Y1* and *Y0* respectively, are the current value of the indicator and its value in the past, taking that as an important indicator and an alternative to the existing level of consumption based on prices and volumes.

Construction of the model parameter "consumption quality" of the abovementioned parameter *X* has been successfully implemented (Golubeva and Gureev, 2012); valuable experimental data was obtained, the analysis of which led to a number of important conclusions.

An unresolved issue is to construct a model of the "level of profitability required by manufacturers" using intelligent technology based on a decision tree and a matrix of convolution in the nodes (Gureev and Kharitonov, 2010).

The research objective is to describe the parameters of the modelling process "level of profitability required by manufacturers " with the intelligent technology based on a decision tree and a matrix of convolution in nodes (Gureev, 2009a).

Key research findings.

Model development. The process of model development is always preceded by a detailed description of terminal criteria requiring their registration in the estimated tree structure. The most important part is to find such criteria, which are more than sufficient for the generation of the final grade, and can meet the minimum requirements, i.e. described in basic theoretical models. Equally important is the ability to measure the representation of each individual criterion. In this case, it is possible to use physically measurable factors, the values of which will lead to a standard scale of assessment, and those that can be evaluated by using only different methods of expert evaluation.

First, as mentioned earlier, we need to choose a criterion, on the one hand measurable, and the other hand – independent of the current economic situation. We can take the marginal factor as a financial criterion from the position of decision-making methods. Its convenience is determined simultaneously by several factors:

- taking into account price movements by product or product group, and the manipulation of contractors;
- determining the acceptable level of this ratio for various products which is to be measured and evaluated;
- in terms of the tree structure and sensitivity analysis, building of a submodel for determining this factor.

Of course, the value of this indicator in the product and branch ranges may be different, but the scale of reduction will set the overall level of manufacturer's preferences. Integral (generalized) performance is the result of the construction of the known procedures of collective preferences.

On the one hand, we can be satisfied with the presence of only this criterion, given its completeness and the community, but the behavior of an entrepreneur is not limited to assessing the effectiveness of a functioning business, as shown in parallel with the analysis of the dynamics of the commercial sector, where the main point of reference is the alternative return. This performance will be a spectacular example of a qualitative assessment in the absence of a measurable value. This fact is explained directly from the position of the behavior of a decision-making individual, which, in turn, compares with the owning business unit.

Thus, growing markets will simultaneously change the indicator performance, the account of which is determined by comparison. The uniformity of increase or decrease, in this context, is not discussed, but it may be a separate problem.

The model presented in the criteria already includes human factors as the behavior of market players, determining the riskiness of certain events. However, completely abandoned are the additional parameters, thus the integral evaluation of risks is not possible. Therefore, this test should be introduced into the model by defining a group of higher level in the hierarchy tree of risk factors, transforming the efficient deterministic model that describes the behavior of players in the same analogy but of a higher class.

Using common classification, this criterion will be determined by the group of internal and external risks. To place a simplified version of the problem representation of manufacturer's behavior, the detailed consideration of risk circumstances is not required. The degree of perfection of a technology, with the understanding of the modelling process does not argue the feasibility of this aspect.

After describing the logic of choice in model parameters and the justification for their adequacy to the task, the procedure for determining the ranges and/or descriptions of qualitative assessments of the values of individual factors starts.

For the model with respect to the marginal rate it is offered to take the average economic value in general, given the interest of various sectors to the overall result. This assessment will direct both individual market participants and decision-makers. If the marginal rate specific participant is around 25% below the industry average, the qualitative assessment of his "satisfaction income" corresponds to 1, and for 25% higher it would be 4 (Gureev, Vinokur and Tretyakova, 2008).

Separate participants can also under go through business risk assessment. If the total rate of return corresponds to positive qualitative estimates, the risk factors may reduce the "level of satisfaction with business profitability". Another option is to use in evaluation the risk of expert opinion, the probability of success of an event, with different ways of calculating the level of riskiness. Thus, we need only to specify the scale of assessments for risk reduction. The dependence should be reversed, i.e., if a risk event occurs, then the qualitative assessment of "general satisfaction with business income" should be reduced. To demonstrate the model performance, we assume that the maximum degree of probability of all risk events is 40%. Consequently, the absence of probability is the qualitative assessment of the maximum, that is 4, and 40% is 1, in accordance with the method used.

Determining the level of profitability and feasibility of alternative business, according to the name, should be based on two factors: the minimum level of input into a business and risk-free rate of business return. Without discussing the completeness of the approach to the evaluation of alternatives, we want to show how to determine the expected qualitative evaluation of this parameter. The basis of this display is the assumption about the dependence of yield on input costs.

This inverse dependence (Figure 1) shows that using the minimum values of input into business, it is not possible to obtain the highest possible level of profitability.

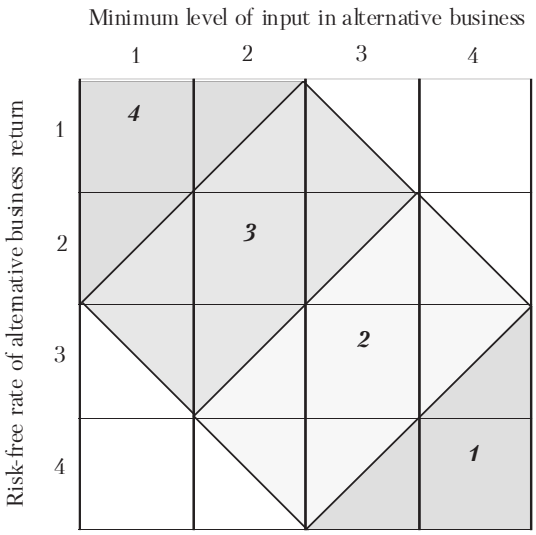

Figure 1. **The scale for determination of profitability and feasibility of business,** *developed by the authors*

Thus, in the lined up criteria tree (Figure 2) two reverse scales of reduction and one line scale (for the considered criteria) will be used. A line scale, as stated earlier, will describe the impact on the final evaluation of changes on the level of marginal profitability, which, in turn, will be adjusted by the risk, and, further, by the ratio of alternative business areas.

With all the positive aspects of the described tool we can identify technically unrealized potential, however, which can be successfully managed by modifying the set of parameters of the model itself. Such circumstances may be different types of

convolution matrix filling in the nodes of the tree of criteria that describe the object in question in different economic conditions. Considering the fact that while the economic coexistence of different classes of business entities, the process of modelling the "level of profitability required by manufacturers" includes models and optional parameters in this criteria tree.

As requiring registration, external factors are evaluated by the owner of a business unit, and first of all, it is necessary to mention the level of competition. Obviously, the higher it is, less profitable is business. By specifying a scale for this criterion, we reflect the most intense competitive segment with the value 1 and the least is 4. Competitive situation in any environment can be neutralized by major capital against market participants or to promote their own business. So, we want to enter the parameter "availability of financial resources," described by the direct dependence and defining high availability of borrowed funds in the area of small values. The convolution of the last two factors describes the "overall level of economic barrier". As we know, barriers are divided into economic and administrative ones. Priced at the scale used by the direct reduction "administrative barrier level" (the value of 4 is the highest degree of market closedness, 1 is the lowest one) in combination with the "general level of economic barrier" for other participants the closed nature of market will be determined ("Barrier Level"), which certainly will be taken under consideration by market participants.

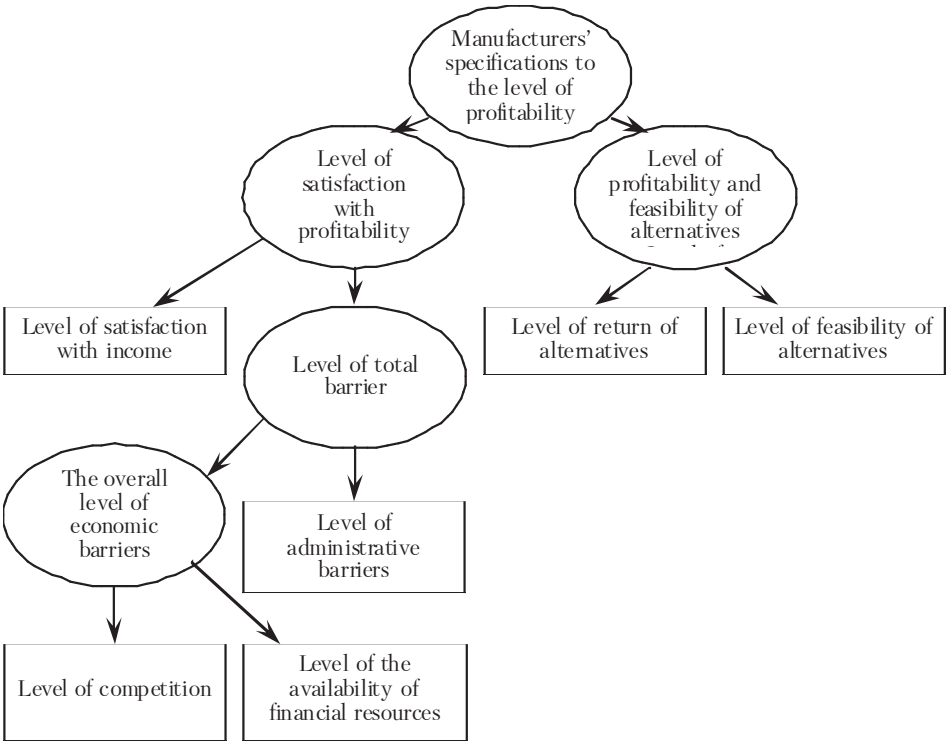

Figure 2. **General view of the criteria tree of "manufacturer's requirements to the profitability level",** *developed by the authors*

As a result, a high "level of satisfaction with profitability" in combination with a high "level of barrier" will lead to generally high "profitability satisfaction" by business owners. Referred to the abovementioned parameter "level of profitability and feasibility of alternatives" will be adjusted accordingly, understating assessment during the convolution. This parameter can also be expanded under the names "the level of profitability of alternatives" and "level the feasibility of alternatives". The latter is used to bring back the scale, where the score 4 means low availability of alternatives, and 1 is high availability of alternatives. The general look of the tree of the criteria is presented in Figure 2.

Analysis of the model's features. Depending on the economic situation, entrepreneurs with different business sizes respond to changes and are sensitive to specific parameters in various degrees. Empirically, there are 4 situations in economic development (formation, rapid growth, stagnation and decline), thus, the model should be able to reflect the criteria dependence in each of the proposed situations. This statement restricts the versatility and uniqueness in the use of the model. Thus, after building a model of a particular economic situation it is required to get the data for each subject and combine them with the corresponding value.

The process of filling the convolution matrix for a specific economic area begins with a definition of what each type of entity offers to its own range of values: for small business – the small field of values, for medium – the medium field of values and for big – the large field of values. As far as we use a combination of criteria conjunctions with direct scales and, in some cases, with direct and reverse, it would be sufficient to identify only delimited number of combinations for different economic situations.

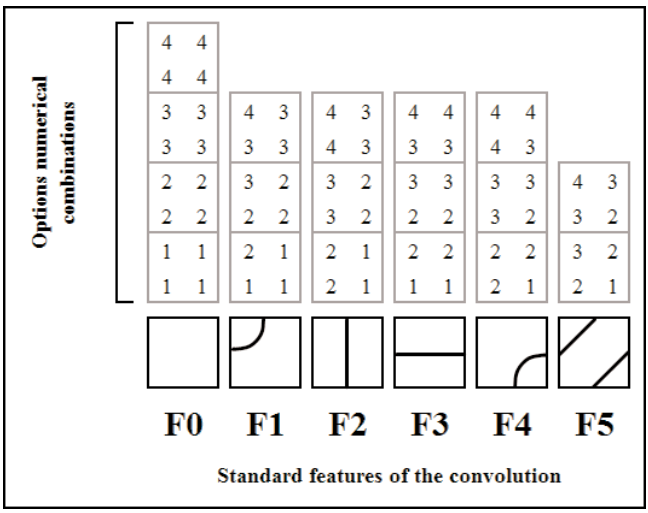

Figure 3. **The set of possible fillings of the matrix with the corresponding graphical interpretation,** *developed by the authors*

The proposed DECON software system passed the certification procedure and allow the convolution matrix building process in the nodes of the criteria tree while watching a graphical interpretation, which greatly facilitates the understanding of the architecture model. Figure 3 shows a set of possible fillings of the matrix filled in accordance with the rules of the procedure (Gureev, 2009b), and the corresponding

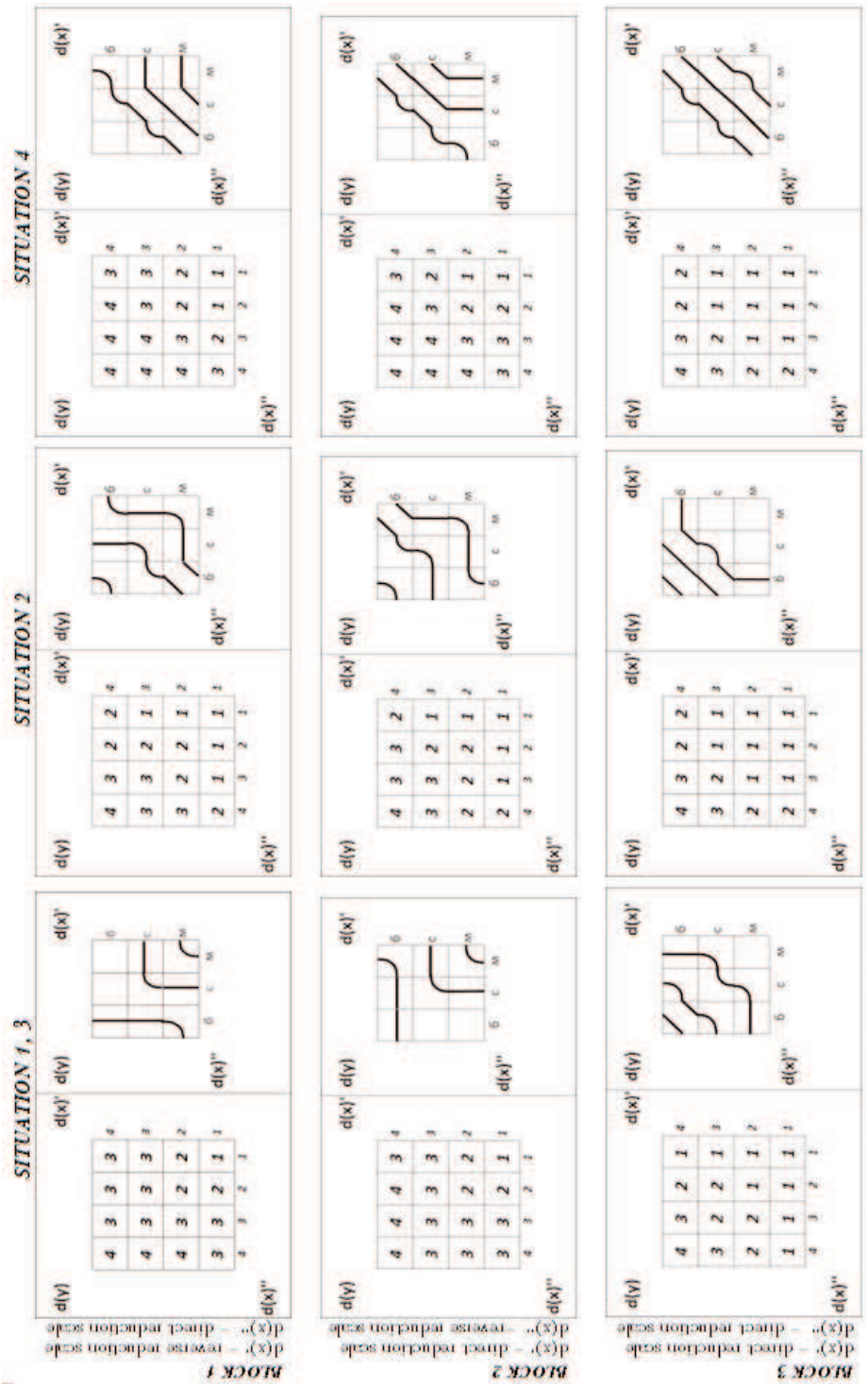

Figure 4. **Dynamics of changes in the sensitivity of the subject to specific criteria, depending on the particular economic system,** *developed by the authors*

graphical interpretation and name. In particular, the researcher takes a filling of one of the proposed combination. According to the size of the matrix we need to select 9 parts, observing the following rules: the main diagonal extreme values are 1 and 4, respectively, the displacement in vertical and horizontal growth of the value cannot exceed 1, and the diagonal – 2.

The proposed options for filling the line up in 3 basic configurations (combinations of criteria with direct assessment scales of the criterion on the left in the tree structure represented by the direct estimation scale and the right – the reverse scale, the right criteria – direct assessment scale, the left – the reverse scale), sufficient for use in all criteria tree. In turn, each of the 3 options matrixes was lined applicable in different economic environments.

The logic of the principles of the "depth" of crisis circumstances reflected how the relationships between subjects and certain factors change under the conditions of rapid development and stagnation. In turn, the matrix F0 shows the indifference of individual subject to a change of terminal criteria. F1 reflects its dynamics in the overall assessment of the situation, if both factors are undergoing transformations. The change of the final evaluation using matrixes F2 and F3 is solely based on one criterion. F4 combines the property in response to any of the abovementioned dynamics, and F5 completes with its synergistic effect (Gureev, Kharitonov, Alekseev, Shaydulin and Belih, 2010).

Figure 4 shows the result of the construction of matrixes within different economic conditions and criteria conjunctions. The aim was to reflect the wave dependence on the depth of economic formations in different ranges of values associated with the magnitude of the simulated business. It should be understood that various combinations of criteria according to the type of scale highlight the need for major axis determination of the matrix, which will be outstanding representatives of certain business value. The block 1, suggesting that the criterion on the left uses a reverse reduction scale; its main axis takes a diagonal from the extreme low left position to the top right position. Accordingly, the motion on this diagonal enhances sensitivity to changes in the values of individual criteria, depending on the economic situation. Similarly, the "mirror" interpretation of the block 2 holds its position on the main axis, just changing the direction of motion. Finally, the block 3 reflects the relationship between two direct criteria and as the main axis takes direction from the upper left to the lower right values.

Conclusion. Figure 4 graphically illustrates the dynamics of changes in sensitivity to specific criteria of the final grade, depending on the particular economic system: situations 1, 3 describe the start and the end of economic growth (situation 1) and fall (situation 3), the situation 2 – rapid economic growth, and the situation 4 – stagnation. This representation, with some additional refinements require deeper investigations that do not affect the results of this study. In particular, assessing external economic environment and using the developed model are needed to determine the level of satisfaction with profitability of owner units of the representatives of business. Some limitations in the method of filling the convolution matrix leave a little frustration, but the overall effect can be considered as achieved. The latter is reflected in the behavior of heterogeneous representations of the described and measured subject, which will determine the final assessment and will be included in the valuation model

of inflation. In combination with the model of "consumer willingness to pay for the required level of profitability", the result is to allow correcting numerical expression to the actual inflation rate by market participants according to changes in economy.

References:

Алексеев А.О., Белых А.А., Гуреев К.А., Шайдулин Р.Ф. Принципы многомодельности в задачах моделирования индивидуальных предпочтений // Управление большими системами: Сборник трудов ИПУ РАН.– Спец. вып. 30.1 Сетевые модели в управлении. – М., 2010. – С. 112–118.

Алексеев А.О., Голубева О.С., Гуреев К.А. Интеллектуальные технологии в процессах моделирования цикличных инфляционных изменений // Вестник Самарского государственного экономического университета.– Серия: Экономика.– 2011.– №10. – С. 25–29.

Голубева О.С., Гуреев К.А. Систематизация теоретических основ интеллектуальной технологии моделирования инфляционных процессов // Казанская наука.– 2012.– №2. – С. 70–74.

Гуреев К.А. Моделирование и учет потребностей рынка аренды коммерческой недвижимости при формировании политики администрации по поддержке малого бизнеса // Высшее профессиональное образование, бизнес, власть: опыт и перспективы взаимодействия в подготовке управленческих кадров, ориентированных на инновации: Сборник статей и тез. докл. Всерос. науч.-прак. конф. с междунар. участием, посвящ. 15-летию НОУ ВПО Зап.-Урал. ин-ту экономики и права (г. Пермь, 12–13 мая, 2009 г.). – Пермь: НОУ ВПО Зап.-Урал. ин-т экономики и права, регион. об-ние работодателей Перм. края «Сотружество», 2009. – С. 57–63.

Гуреев К.А. Моделирование и учёт потребностей рынка аренды коммерческой недвижимости при планировании городского строительства // Современные технологии в строительстве. Теория и практика: Материалы науч.-практ. конф. аспирантов, молодых учёных и студентов строит. фак. (г. Пермь, 20–21 мая. 2009 г.). – Пермь: Федерал. агентство по образованию, ГОУ ВПО Перм. гос. техн. ун-т, 2009. – С. 69–76.

Гуреев К.А., Винокур И.Р., Третьякова А.Н. Управление позиционированием товаров и услуг с использованием модели рынка // Инновационный потенциал аграрной науки – основа развития АПК: Материалы Всерос. науч.-практ. конф. (г. Пермь, 21.11.2008). – Пермь: ФГОУ ВПО Перм. ГСХА, 2008. – Ч. II. – С. 113–117.

Гуреев К.А., Харитонов В.А. Аналитические исследования моделей рынка арендных отношений на основе линеаризации функций спроса и предложения // Вестник Самарского государственного экономического университета.– Серия: Экономика.– 2010.– №7. – С. 83–85.

Гуреев К.А., Харитонов В.А. Регулирование арендных отношений в задачах поддержки малого бизнеса // Вестник Самар. гос. экон. ун-та.– 2010.– №4. – С. 83–85.

Гуреев К.А., Харитонов В.А., Алексеев А.О., Шайдулин Р.Ф., Белых А.А. Принципы многомодельности в задачах моделирования индивидуальных предпочтений // Управление большими системами: Сборник трудов. – М.: ИПУ РАН, 2010. – С. 74–80.

Харитонов В.А., Белых А.А. Технологии современного менеджмента. – Пермь: ПГТУ, 2007. – 190 с.

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