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Strategies of investing into mining industry under uncertainties of multidimensional alternatives

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Mining-metallurgical complex is the base of any economics and influences directly on practically all branches of world economics. Therefore the task of estimation and selection of investment decisions in mining industry adequate to modern market conditions and the task of decreasing multidimensional alternatives selection uncertainty are very actual. An uncertainty of investment alternatives is explained by a number of reasons, main of which are a presence of several investors types, an unstable situation on the market and an absence of evident relations between appraisal criteria used. Maximum increasing of formalization and objectivity of information technologies applied for an estimation permits to reduce the uncertainty of investment variants estimation.

A number of principled innovations, allowing to solve the task of decreasing of multidimensional alternatives selection uncertainty, are introduced into the information technology of estimating and selecting investment decisions in mining-metallurgical branch, developed by us.

In the article the necessity of including a cognitive model into developed selection mechanism, which allows to take into consideration inter-influences of used critera, has been grounded. Besides, the forecasting model considering interconnected time rows has been applied for increasing the world conjuncture forecast quality.

Further in the article main metrics types have been characterized and application of weighted Chebyshev's metrics as the most compromised from all studied metrics for variants selecting has been proved, and also the developed procedure of directional search of effective compromise decisions has been described. Brief characteristic of designed instrumental means of multi-criteria variants estimation and selection finalizes the article.

In conclusion expedience and efficiency of using the developed information technology for reduction of multidimensional alternatives selection uncertainty have been grounded.

Introduction

Nowadays practically all branches of world economics depend greatly upon existence and using of natural resources. Ferrous, non-ferrous, precious metals ores, products of its refining are very important for most branches of industry, and its deficit or high prices can strongly affect on economic situation of any country. Mining-metallurgical industry is the base of modern economics and provides considerable part of national income and employment in industry-developed and developing countries.

Seeing importance of mining-metallurgical industry for the whole world economics development, an adequate to modern market conditions estimation and selection of investment variants in mining industry and its branches acquires emphasis. As far as modern investment decisions rarely represent one-criteria alternatives, a task of decreasing multi-criteria alternatives selection uncertainty emerges.

An uncertainty of investment alternatives is explained by a number of reasons, main of which are:

- a presence of several investors types—owner (enterprise, realizing an investment decision), commercial investor (bank, credit organization) and budget investor (state),—differentiated by interests and preferences
- an unstable situation on the market—fluctuation of national currencies and main securities rates, growth of inflation tempo, letdown of level of living, etc
- an absence of evident relations between appraisal criteria used—impossibility to estimate veraciously inter-influence of the large number of criteria at presence of as qualitative, so as quantitative criteria in a set.

Because of this, reducing the uncertainty of investment variants estimation is achieved by maximum increasing of formalization and objectivity of information technologies applied for an estimation.

The information technology of estimating and selecting investment decisions in mining-metallurgical branch, including mechanisms, models, methods, algorithms and instrumental means of multi-criteria selection, had been developed by us. This information technology allows to increase the effectiveness of multi-criteria alternatives selection and to reduce time expenses for alternatives selection. The new approach to alternatives estimation and selection, having been created under works on information technology, consists of two stages: forming a criterion set for alternatives estimation; estimating and selecting investment alternatives. The second stage, being realized by created selection mechanism, is divided by several steps, main of which are: criteria set completeness and non-inconsistency verification; digitalization of qualitative criterias values; criterias normalization and generalization into aspects; forecasting of future competitiveness of alternatives; construction of user preferences structure[1].

The developed approach had been tested on the investment projects (IP) on extracting of iron, copper and gold from mining-metallurgical waste. Notwithstanding, approach (and selection mechanism) is universal enough and can be applied at making decisions by any multicriteria alternatives with corresponding criteria set changing.

In given approach interests of all investors' types are consulted and also compromise search is performed for better-grounded decision making. Moreover, correction for possible variations of world market conjuncture during projects realization period is fulfilled. However, though studied area of investment decisions represents itself an economic system with interconnected characteristics, the approach does not take into consideration interdependencies between used criteria. Furthermore, interests of different investors had been considered only in the criteria set, and forecasting techniques for isolated time rows had been used at calculating the forecast of world market conjuncture. This fact also adds contribution in increasing decision-making uncertainty.

Hereupon, for solving the task of decreasing of multidimensional alternatives selection uncertainty a number of principled innovations is imbedded into this information technology, allowing to increase significantly formalization of investment variants estimation process and to make its selection more rational and objective.

Cognitive analysis of criteria set

Considering big enough size of the set of criteria (about 100), characterizing political, social, economic and other sides of estimated alternatives, these alternatives are objects with complex structure, herewith it is not clear, what inter-influences pays criteria on each other under its varying. For determining qualitative (reason-consequence) connections between them a cognitive map (model), representing signed (weighted) oriented graph, is introduced into the developed multidimensional alternatives selection mechanism on the steps of criteria set completeness and non-inconsistency verification. It permits to take into consideration inter-influence (correlation) of used criteria, to carry through more full analysis of the criteria set and ground a minimal allowable set of criterions.

A cognitive map includes description of direct reactions of criteria on each other: a character of reaction (+, -), a strength of reaction [0, 1], a delay[2]. Experts assign these data. For raising an objectivity expert appraisals are not used in the developed information technology, and a character and strength of reaction are expressed by criteria correlation value, located in the range [-1, 1].

For calculating criteria linear correlations it is necessary to have only quantitative values of criteria set. Therefore, digitalization of qualitative criteria becomes the first step of the modified selection mechanism, and general sequence of mechanism steps will look like:

- Step 1. Digitalization of qualitative criteria values.
- Step 2. Criteria set completeness check
- Step 3. Criteria values non-inconsistency verification
- Step 4. Precursory estimation of investment projects' acceptability
- Step 5. Criteria normalization and generalization into aspects
- Step 6. Forecasting of future competitiveness of investment projects
- Step 7. Filtration of investment projects by aspects' values
- Step 8. Preferences assignment and user preferences structure construction.

For digitalization of qualitative criteria according to Trakhtengerts[3] they are transformed into linguistic variables, set on created base quantitative scales. Base scales can be divided by any amount of segments, but usually they represent scales [0, 1], divided by 10 segments[3]. The developed mechanism gets numerical appraisals of qualitative criteria by dint of technique of preference functions calculation [1]. This allows to simplify the digitalization process together with raising its accuracy.

$$f = \frac{f_{crit} - f_{\min}}{f_{\max} - f_{\min}} + w, \qquad [1]$$

where f—a numerical value of qualitative criterion;
f_{crit}—a value of qualitative criterion on the base scale from 0 till 1;
f_{max}—an upper border of base scale segment, which includes qualitative criterion value;
f_{min}—a lower border of this segment;
w—an integral weight, assigned to this segment.

For calculation of correlation coefficients projects with skips in criteria values have been temporarily excepted from the IP base. For the rest IP coefficients of pair correlation, introduced by Pearson, Edgeworth and Weldon, have been determined by expression[4]:

$$r = \frac{\overline{x \cdot y} - \overline{x} \cdot \overline{y}}{\sigma_x \cdot \sigma_y}, \qquad [2]$$

where x, y—correlating factors (criteria);
σ_x, σ_y—mean square deviation of factors.

In Table I several rows from the received cognitive map are shown.

Herewith, criteria with correlations not less than |0,21| will take part in further calculations. According to the theory of statistics less correlations are understood as insignificant.

At the second step of modified selection mechanism a recovery of missed criteria values is performed, for this purpose the Roberts' statistical discrete model without delays[5] is used:

$$C_j = \sum_{i=1}^{m} C_i \cdot A_i, i = \overline{0, M}, \qquad [3]$$

where C_j—a searched value of criterion j
C_i—criteria values from the set
A_i—correlations (weights) from the cognitive map received.

Expression [3] for criteria from the Table I will be as follows:

$$\begin{aligned} C_1 = C_1 &+ 0,37\ C_6 + 0,26\ C_{19} + 0,25\ C_{22} + 0,24\ C_{23} + \\ &0,24\ C_{24} + 0,32\ C_{25} + 0,26\ C_{26} - 0,26\ C_{29} - 0,21 \\ &C_{30} + 0,24\ C_{33} + 0,29\ C_{36} + 0,39\ C_{37} + 0,23 \\ &C_{41} + 0,24\ C_{42} + 0,28\ C_{44} + 0,24\ C_{51} - 0.24 \\ &C_{52} + 0,25\ C_{54} - 0,3\ C_{60} + 0,28\ C_{67} + 0,27 \\ &C_{68} + 0,33\ C_{71} + 0,22\ C_{72} \cdot \end{aligned} \qquad [4]$$

Table I
The cognitive map of used criteria

Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	0,16	0,15	0,13	0,17	**0,37**	0,15	0,08	0,07	-0,03	0,14	-0,19	0,03	-0,04	0,02	-0,06
2	0,16	1	**0,29**	**0,36**	**0,31**	**0,25**	**0,27**	**0,33**	-0,05	0,04	0,08	-0,16	-0,03	0,21	0,18	-0,05
....																
57	0,18	**0,31**	0,16	**0,29**	**0,22**	0,19	**0,28**	0,19	-0,01	**0,22**	0,05	-0,03	0,02	**0,29**	-0,14	-0,07
Criteria	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	–	0,20	**0,26**	0,02	0,12	**0,25**	**0,24**	**0,24**	**0,32**	**0,26**	0,10	-0,16	**-0,26**	**-0,21**	0,00	0,03
2	–	**0,30**	0,13	0,15	0,20	**0,25**	**0,33**	**0,26**	0,30	0,03	0,05	-0,07	-0,18	0,07	0,06	0,17
...																
57	–	**0,24**	**0,44**	0,14	**0,38**	**0,22**	0,15	**0,53**	**0,29**	**0,38**	**0,40**	**-0,30**	**-0,26**	-0,11	**-0,25**	-0,05
Criteria	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	-0,03	0,00	**0,24**	**0,29**	**0,39**	0,13	0,17	0,08	**0,23**	**0,24**	0,18	**0,28**	0,10	-0,02	-0,04	-0,12
2	-0,17	0,15	0,08	**0,26**	**0,28**	0,16	0,20	0,20	0,16	**0,31**	0,15	0,10	**0,29**	-0,05	-0,01	0,08
...																
57	0,05	0,02	**0,24**	**0,26**	0,14	**0,50**	**0,45**	**0,34**	0,20	**0,23**	**0,22**	**0,40**	0,15	0,15	-0,04	-0,07
Criteria	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1	0,04	0,15	**0,24**	**-0,24**	-0,20	**0,25**	0,02	0,15	0,18	0,19	0,11	**-0,30**	0,17	-0,11	0,19	-0,01
2	-0,15	0,11	**0,26**	**-0,26**	-0,15	0,19	**0,34**	0,18	**0,31**	**0,26**	0,02	**-0,34**	0,20	-0,05	0,20	-0,14
...																
57	-0,03	-0,06	**0,30**	**-0,30**	-0,15	**0,34**	0,20	-0,11	1	**0,59**	0,20	-0,20	**0,33**	-0,13	-0,16	-0,10
Criteria	65	66	67	68	69	70	71	72	73	74	75	76	77			
1	-0,17	0,06	**0,28**	**0,27**	-0,20	-0,17	**-0,33**	**0,22**	-0,05	-0,02	-0,01	0,08	0,11			
2	-0,20	0,11	0,09	**0,32**	-0,04	0,03	**-0,23**	0,15	-0,20	-0,20	-0,05	-0,07	0,07			
...																
57	-0,12	**0,29**	**0,30**	**0,56**	0,06	0,16	-0,08	**0,39**	-0,18	-0,17	-0,14	0,03	0,01			

***Bold** values—significant correlation coefficients (not less than | 0,21|)

$$C_2 = C_2 + 0.29\ C_3 + 0,36\ C_4 + 0,31\ C_5 + 0,25\ C_6 + 0,27\ C_7 + 0,33\ C_8 + 0,3\ C_{18} + 0,25\ C_{22} + 0,33\ C_{23} + 0,26\ C_{24} + 0,3\ C_2 + 0,26\ C_6 + 0,28\ C_{37} + 0,31\ C_{42} + 0,29\ C_{45} + 0,26\ C_{51} - 0,26\ C_{52} + 0,34\ C_{55} + 0,31\ C_7 + 0,26\ C_8 + 0,34\ C_{60} + 0,32\ C_{68} + 0,23\ C_{71}\cdot \quad [5]$$

$$C_{57} = 0,31\ C_2 + 0,29\ C_4 + 0,22\ C_5 + 0,28\ C_7 + 0,22\ C_0 + 0,29\ C_{14} + 0,24\ C_{18} + 0,44\ C_{19+} + 0,38\ C_{21} + 0,22\ C_{22} + 0,53\ C_4 + 0,29\ C_3 + 0,38\ C_{26} + 0,4\ C_{27} + 0,3\ C_{28} + 0,26\ C_{29} - -0,25\ C_{31} + 0,24\ C_{35} + 0,26\ C_6 + 0,25\ C_3 + 0,45\ C_{39} + 0,34\ C_{40} + 0,23\ C_{42} + 0,22\ C_{43} + +0,4\ C_{44} + 0,3\ C_{51} + 0,3\ C_2 + 0,34\ C_{54} + C_{57} + 0,59\ C_{58} + 0,33\ C_{61} + 0,29\ C_{66} + 0,3\ C_{67} + +0,56\ C_{68} + 0,39\ C_{72}\cdot \quad [6]$$

Recovering missed criteria values permits to include in estimation process those alternatives, which had been simply excepted before. Besides, if most alternatives have a considerable quantity of skips in criteria values, there is an opportunity to proceed with alternatives estimation by minimal allowable set of criterias. At presence of cognitive map a minimal allowable set consists of those criteria, correlations of which with the rest are significant.

In case if criteria, not connected with other, are presented in a base, they are excluded from a set for IP estimation. In our case the criterion 17, not interconnected with any other criteria in base, is excluded from the criteria set. Further, from the criteria set can be excepted criteria with correlations less than |0,1|—criterions, not included in the minimal allowable set of criteria.

At the third step of the mechanism criteria values non-inconsistency verification is performed. Herewith expressions [3] are used, allowing to elicit deviations of criteria values presented from calculated. Those projects are excluded, for criteria of which this deviation exceeds 10 per cent.

At the fourth step of the modified selection mechanism a rejection of investment decisions is fulfilled, characteristics of which do not correspond to acceptability threshold.

The fifth step is dedicated to reducing of criteria set size. For this purpose criterias are combined to groups by a collective meaning attribute. Further searching of aspects values (group criteria) is performed by dint of calculating mathematical expectance of criteria, including in each group. To decrease a compensation effect, appearing while generalization, values of all criteria are precursory normalized in diapason [0, 1].

Model of market conjuncture forecasting

Forecasting is performed for correcting investment attractiveness of alternatives considering possible fluctuations of conjuncture of appropriate production world market. To calculate future competitiveness of IP it is necessary to define a price of a corresponding resource at the end of project realization. For this purpose the forecast reserves of OPEC countries exceed 2/3 of all the rest of reserves in the world, so this makes people first take the attitude and reserves of OPEC countries into account when they predict petroleum price in the future. The correlation coefficient between the producing capacity of OPEC countries and petroleum price is–0.2583.

When petroleum price goes up to some degree, petroleum production of some non-OEPC countries gains development, even in the same condition petroleum of non-OPEC countries supplants that of OPEC countries in the market for it is closer to consuming regions. The rising of petroleum productivity of non-OPEC countries leads to the falling of petroleum price, and finally reach today's medium petroleum price. The most typical two intense rising of petroleum price make petroleum output of non-OPEC countries have obvious increase, and this compels OPEC to have to reduce petroleum price, so a rare intense falling appears. The correlation coefficient between the productivity of OPEC countries and of non-OPEC countries is –0.0026.

The fluctuation of petroleum price does not immediately lead to change of wide range to petroleum demand elasticity, for the automatic adjustment of demand to price is slower in the international petroleum market. We usually think that the link between demand and price is normal epoch and the increase of demand must make petroleum price rise, but these will occur when other factors do not change. In fact, petroleum price affected by many factors may not reflect the link between it and petroleum demand, for example, its going up/down is not fully dependent on the change of petroleum demand when production capacity increases, production cost decreases and transportation expense reduces. The correlation coefficient between petroleum demand and price is –0.4737 for 21 years.

Because the enthusiasm of searching energy to replace petroleum increasingly rises, natural gas, as a kind of major replaced energy, influences deeply petroleum price. The exploration and development of natural gas advances rapidly since the Second World War, but now the price of natural gas depends on petroleum price. Therefore, there is obvious linear link between them, and the correlation coefficient is 0.9980. However, its role is not neglected in the model, for it is the major supplanted energy of petroleum.

The production of coal develops rapidly after two intense risings of petroleum price, but its developing speed also descends when petroleum price intensely falls. For example, the total demand of energy of 1988 increases 3.7 per cent compared with that of 1987, and it equates 81 million ton petroleum. And the consumption of petroleum, coal, natural gas respectively increases 3.1 per cent, 3.7 per cent, and 4.7 per cent compared with 1987. Obviously, coal is still one of the important replaced energies of petroleum. The correlation coefficient is –0.1849.

The index system reflecting world consumption Level of petroleum is consumption, rate of growth, proportion in the World energy consumption structure, consumption elasticity coefficient, consumption of per GDP of petroleum. Petroleum consumption elasticity coefficient is the ratio between the rate of growth of petroleum consumption and GDP. It is completely different in different countries, regions, periods and conditions. However, the authors only consider the GDP. The link between consumption coefficient and petroleum price is opposite-direction, and the correlation coefficient is –0.7733.

Because OPEC countries are main petroleum producing countries, the bigger the balance of supply/demand is, the bigger the supply of OPEC to international petroleum market is. The balance of supply/demand of OPEC has great influence on petroleum price, and the correlation coefficient is 0.6271. In theory, the influence of the balance of supply/demand of OPEC on petroleum price must be opposite-direction. Surveying the elected historic data, about 2/3 data reflects this kind of link. The balance of supply/demand of non-OPEC also affects petroleum price greatly, and the correlation coefficient from 1980 to 2000 is —0.5628.

The establishing of system simulation model

We think that the systematic dynamic model of petroleum price is feasible through studying the rule of petroleum price and using the system simulation method put forward by Professor Jay W. Forrester. System simulation is the method which can research non-linear phenomena and arrive at some kind of solution. Its basic ideas derive from feedback theory.

In this paper, an abstract, dynamic, nonlinear and stable model is established. Solutions to models are a kind of simulation for they use simulated methods to solve dynamic models of this predicated system based on given a set of initial conditions and input signal of some inputs. In essence, it is a kind of experimental study method. The more we know, the better the predicated results are, and these results must be optimal solutions of practical problems, and also satisfactory solutions of decision makers.

This model of system simulation from petroleum production to consumption is established based on ten primary factors influencing petroleum price. The model dominated by physical flow and supplemented by info flow uses the reaction between them to achieve predication. Figure) shows 'Model Process Concept Figure'.

Iteration equations and variables of model

Iteration equations of OPEC production sub-module

$$SCJC = SCNL * \exp\left(-1/\left(10\left((T-1980)+0.0001\right)\right)\right) * KGL + SCJY_1 + GDPY_1 \quad [1]$$

$$SCJY_1 = M_1(N_1) * SCNL * \exp\left(-1/\left(10\left((T-1980)+0.0001\right)\right)\right) * KGL \quad [2]$$

$$GDPY_1 = M_1(N_2) * SCNL * \exp\left(-1/\left(10\left((T-1980)+0.0001\right)\right)\right) * KGL \quad [3]$$

SCJC Output of Decision Physical Flow about OPEC Production
T Year.
SCNL Producing Capacity of OPEC
KGL Operating Rate of OPEC
SCJY Influence Value of Market Price
GDPY Influence Value of GDP

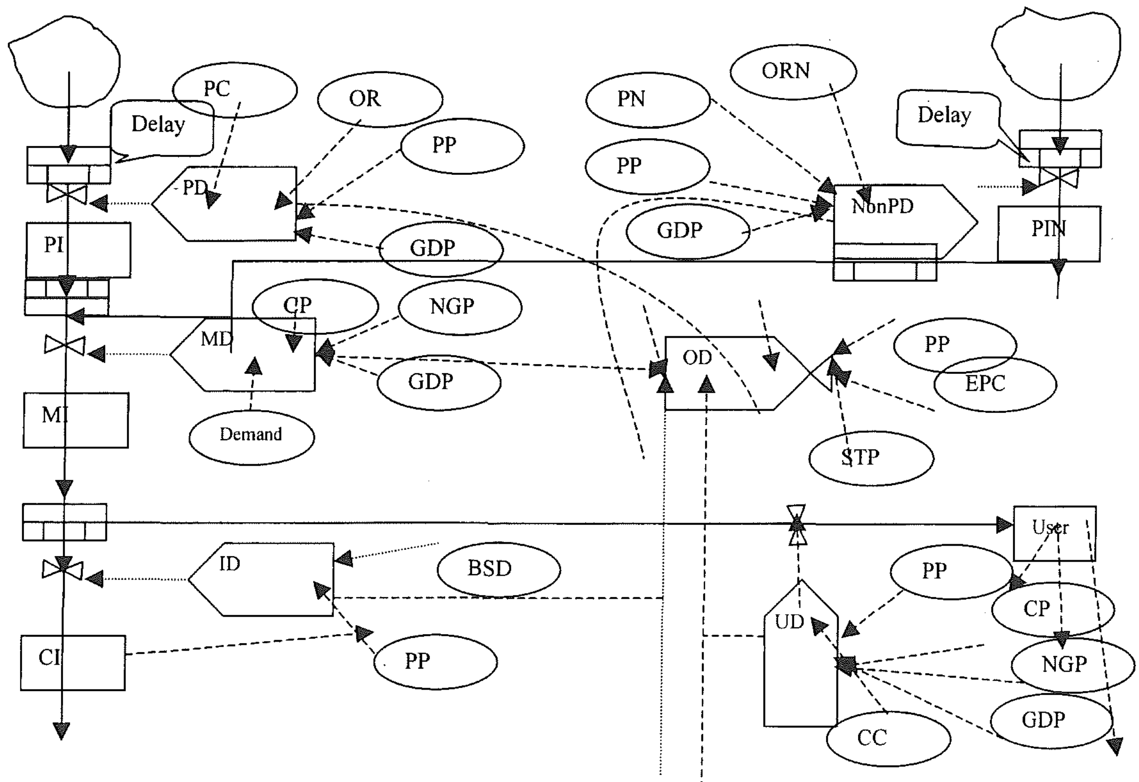
Iteration equations of non-OPEC production sub-module

$$NSCJC = NCN * \exp\left(-1/\left(10\left((T-1980)+0.00001\right)\right)\right) * NKGL + SCJY + GDPY_2 \quad [4]$$

Table I
Correlation coefficients matrix between each influencing factor and petroleum price

	PP	PC	GDP	CP	NGP	D	CC	BSD	PN	DN
PP	1.0000	-0.2583	-0.2155	-0.1849	0.998	-0.4082	-0.7733	-0.6271	-0.0026	-0.5628
PC	-0.2583	1.0000	-0.0403	-0.2243	-0.2789	0.9498	0.2036	0.6772	-0.5725	0.7135
GDP	-0.2155	-0.0403	1.0000	-0.2733	-0.1905	0.1921	0.4388	0.2395	0.6559	0.2743
CP	-0.1849	-0.2243	-0.2733	1.0000	-0.1828	-0.3130	0.1404	-0.1516	-0.3268	-0.2562
NGP	0.9980	-0.2789	-0.1905	-0.1828	1.0000	-0.4210	-0.7690	-0.6368	0.0289	-0.5765
D	-0.4082	0.9498	0.1921	-0.3130	-0.4210	1.0000	0.3207	0.8132	-0.3512	0.8566
CC	-0.7733	0.2036	0.4388	0.1404	-0.7690	0.3207	1.0000	0.4664	0.0626	0.4167
BSD	-0.6271	0.6772	0.2395	-0.1516	-0.6368	0.8132	0.4664	1.0000	-0.2347	0.9252
PN	-0.0026	-0.5725	0.6559	-0.3268	0.0289	-0.3512	0.0626	-0.2347	1.0000	-0.1426
DN	-0.5628	0.7135	0.2743	-0.2562	-0.5765	0.8566	0.4167	0.9252	-0.1426	1.0000

NOTE: Petroleum Price [PP]—Production Capacity [PC]—Gross Domestic Product [GDP]
Coal Price [CP]—Natural Gas Price [NGP]—Demand [D]—Consumption Coefficient [CC]
Balance of Supply/Demand [BSD]—Productivity of non-OPEC [PN]—Demand of non-OPEC [DN]



NOTE: Production Inventory [PI]—Market Inventory [MI]— Consumption Inventory [CI]—Market Decision [MD]—Production Decision [PD] —Inventory Decision [ID]—Production Decision of non-OPEC [non PD]—Organization Decision [OD]—User Decision [UD]
Environment Protection Coefficient [EPC]—Science Technology Progress [STP]—Operating Rate [OR]—Operating Rate of non-OPEC [ORN] —Production Inventory of non-OPEC [PIN]

Figure 1. Model Process Cconcept Figure

NSCJC Output of Decision Physical Flow about non-OPEC Production
NCN Productivity of non-OPEC
NKGL Operating rate of non-OPEC.

Iteration equations of market decision sub-module

$$SYSC = (SCJC + NSCJC + MJY + TRQY) + M_2 (N_2) * (SCJC + NSCJC) + XQLY \quad [5]$$

$$MJY = M_5(N_5) * (SCJC + NSCJC) \quad [6]$$

$$TRQY = M_6(N_6) * (SCJC + NSCJC) \quad [7]$$

$$XQLY = M_7(N_7) * (SCJC + NSCJC) \quad [8]$$

SYSC Output of Market Decision
MJY Influence Value of Coal Price
TRQY Influence Value of Natural Gas
XQLY Influence Value of Demand.

Iteration equations of inventory decision sub-module

$$KCJC = GQCE + M_1(N_1) * SYSC \quad [9]$$

Microsoft Access 2000 and Microsoft Excel 2000 have been applied.

Conclusions

It has been brought out that considering of correlations between criteria by dint of the cognitive model allows to reduce the dimensionality of the criteria set and to formalize a number of steps of the selection mechanism. Increasing of the world conjuncture forecast quality has been specified by the application of the model of interconnected mining branch factors forecasting. It has been also determined by us that the modified reasonable goals method with weighted Chebyshev's metrics selects at each step alternatives optimum by Pareto and non-dominated by relation to not found alternatives. It allows to increase 3–4 times the effectiveness of compromise IP alternatives selection in comparison with the reasonable goals method. Models and algorithms of multi-criteria optimization, realizing the new approach and the IP selection mechanism, have been developed. The information technology of estimation and selection of IP by mining-metallurgical waste refining for financing taking into consideration investors preferences, has been created. This information technology permits to decrease 2.5–3 times time expenses for IP estimation and selection. On the basis of performed studies it has been solved the task of estimation, optimum selection and regularization of effective compromise multi-criteria alternatives, allowing to considerably increase objectivity, rationality and effectiveness of selection and to reduce the time, spent for IP estimation and selection process in comparison with approaches applied. It has been brought out that weighted Chebyshev's metrics, spanning a distance by the maximal deviation principle, permits to get the most optimum result of effective compromise IP variants selection. This is specified by its following advantages: a steady trade-off by all aspects, a saving of trade-off proportion by aspects, a less by area (volume) figure, cut out in the aspects hull. All these allow to make the conclusion about solving the task of decreasing multidimensional alternatives selection uncertainty.

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