The Integrated ERM Problem from the Classical Cybernetic Point of View

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Abstract

The paper considers the ERM problem as an adaptation and stability problem of complex system development. The basic approach of W. Ross Ashby and its development by S. Beer are applied.

The cybernetic approach of W. Ross Ashby and S. Beer is the most general view on complex systems' nature and structure with the aim to research its adaptation properties and stability. For this, the feedback provides synthesizing the integration issues, the adaptation-based view internally connects risk with the whole problem of enterprise's successful development and the functional scheme makes possible the risk consideration as both danger and leverage.

The author advances the cybernetic functional feedback model as applied to the integrated ERM structural mechanism. Such formulation of the ERM problems seems promising to correctly detail and structurally integrate the various issues, including operational and financial systems linkage, key adaptation parameter of time and its different periods, optimal activity and others.

The paper is **theoretical**.

1. Introduction

In the past, the comparatively stable conditions confined our concern of risk within a small range of mainly extraordinary events. Just a small range of concern made it possible to gather the applicable statistical data and do business by transforming an individual enterprise's loss event into the average one. The individual enterprise's loss is covered by all insured participants. It is, in essence, the first ERM successful technique.

At present, we find that risk is a through characteristic of all activities. Gathering the data on all relevant events at once does not seem reasonable or practical. Such an event-based approach is redundant and slightly suitable for integrated risk evaluation.

In this situation, the scenario method fits better, providing the theoretically correct choice of alternatives with no overlapping effects of principal factors. But this method is badly formalized, because principal factors can flow from case to case.

The classical cybernetics is the most general approach to control issues. The functional approach, proposed by Ashby and Beer, allows preventing overlapping effects and creates the hierarchical system. As to the ERM problem, there are the feedback contours with the separate regulators at different hierarchical levels, and the problem of their connection is resolved by the consideration of available mechanism of system's functionality (e.g., Ashby's functional mechanism of adaptation with two different hierarchical feedback contours of stability and ultrastability with their specific connection). The functional mechanism makes hierarchy and hierarchy, in turn, requires not summarizing the values of different functional contours, but inserting the upper-contour values as parameters, which are not arbitrary.

The theory of information is the most general approach to the problem of interaction. On the other hand, it makes the most natural grounds for presentation of data of all kinds. The founders of cybernetics very intensively applied some sections of this theory. Its successful application to physiology (Pavlov's signal theory of reflects) and psychology (Vekker's general theory of psychological processes) is the last argument for dealing with it. The more so, that drawing a parallel with the results obtained rather simplifies the research. The structural forms for every feedback contour promote the contours' qualitative identification and financial engineering.

At last, the application of Vince's theory of the optimal growth regulator allows for integrated risk profiles for every feedback contour and to deepen the RM theory.

The first section of the paper separates the basics of the theory of information and cybernetics with the aim of making the functional classification to be required for the ERM problem consideration. The second section contains the first preliminary results of applying the basic points from the ideas, approaches and theories mentioned above to the ERM problem. The conclusions outline the preliminary results with their future perspective.

2. The Basic Points from the Theory of Information and Cybernetics

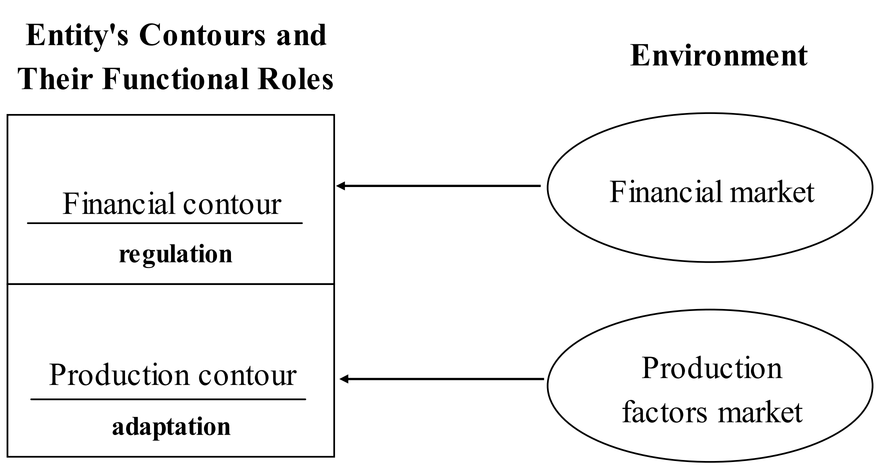
The basic points of the theory of information and cybernetics applied to the ERM issues are as follows.

2.1 Classical Cybernetic Principle of Control through Environment: Two Feedbacks with Regulators

The environmental control principle, proposed by Ashby, is a version of the classical evolutionary concept with the consideration of evolution as a progress in mastering the external environment. Unlike the classical concept, this principle additionally takes into account the environmental feedback effect. This effect gives a system the additional opportunities, but significantly refers to its stability. It should be noted that in this case stability is a characteristic of a whole system, and so it requires the system approach.

As for economy, the industrial stage economy slightly uses the environmental feedback effects, with emphasis on the internal factors' productivity. The post-industrial economy, as a higher evolutionary stage, increases the environment interconnection by means of market control of production activity with the marketing as a key issue. For successful business of post-industrial stage, the recipe is as follows: to connect business to market and manage this connection (Brown and Eisenhardt, 1998).

Figure 1
Functional Roles of Entity's Contours

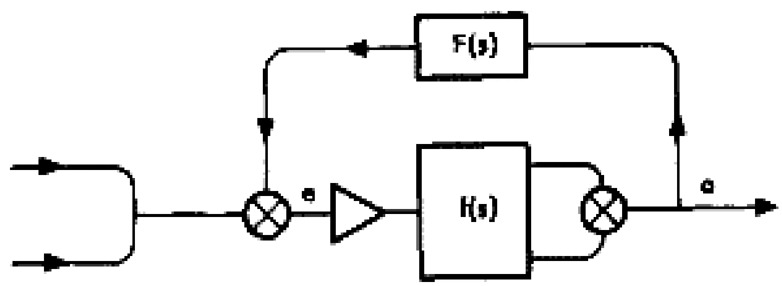


The sole feedback is insufficient, so for regulation we need another one. The first feedback is responsible for adaptation, i.e., keeping the main characteristics within the purposeful ranges. The latter is aimed to changing the type of behavior.

The follower of Ashby to economy, Beer connected the first-class feedback contour with the production factors market and the second-class one with the financial market. In actual fact, we see the next stage of the economy evolution of the financial regulations.

S. Beer regarded these contours as separated from each other, and with their specific, non-coinciding time periods and feedback regulators. (See Figures 1 and 2.)

Figure 2
The Functional Feedback Model of Enterprise With Two Feedbacks and their Regulators

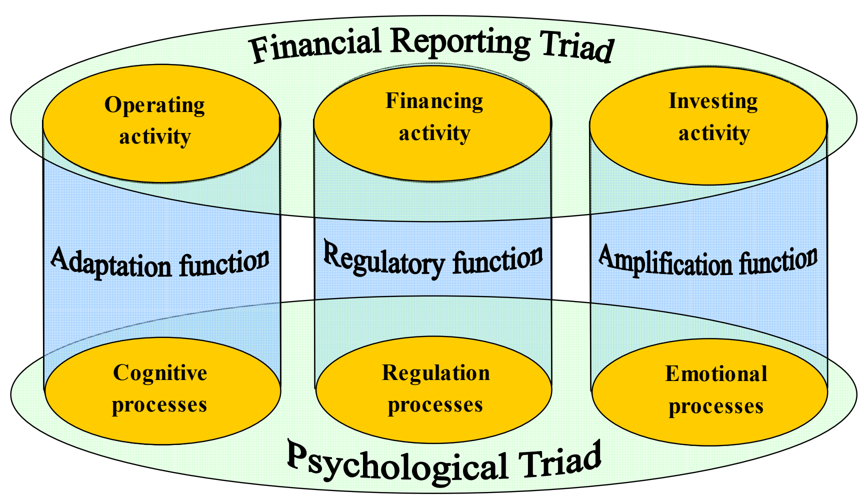


So, for the study of feedbacks, we should keep the functional integrity of the system and consideration of the relevant environment. This requires two feedbacks with different time functions and feedback regulators.

2.2 Functional Role of Investing Activity as an Amplifier

In order to complete the functional triad of economic activities, we need to consider the investing processes in view of their functional roles. Considering the functional analog between the psychological triad and the financial reporting triad, the investing process takes the role of amplifier in the triad's functional integrity. (See Figures 2 and 3.)

Figure 3
Financial Reporting Triad—Psychological Triad Functional Correspondence



In Beer's functional scheme the investing components are, for certain, the regulators (see Figure 2), so there are two different investment components. In view of their risk nature, they are, naturally, a key point of the ERM problem. (See Section 3, "The Growth Regulator.")

So, from the functional point of view, we obtain the hierarchy system of the production contour to be aimed to adaptation of the system, the financial contour to be aimed to regulation. The investing processes act as their amplifier with two separate feedback regulators.

2.3 The Theory of Information: Structural Forms of Signal for Contours

The theory of information is the most general approach to interactions. With a signal as an element of the both interaction and control, it covers all the control issues too. The available functional relationship is evidence of an existing information channel.

As we know, a signal as the basic element of interaction transfers the control effect according to the form of the data which, in turn, is determined by its structure. In order to find the structural form we apply the International Financial Reporting Standards (IFRS); namely the structural elements are the intrinsic value and the time value. Their type and ratio fully characterize the general feature of the control effect transferred by the specific market to all its participants. To find the signal structural form for every contour requires defining of every contour's characteristic features. (See Table 1).

Table 1
Signal Structural Forms

Level	Signal Structure
Basic formula	(intrinsic value, time value, "intrinsic value/ time value" ratio)
Enterprise's production contour	(market price, - , -)
Bank Institution's operation contour	(- , interest rate, -)
Financial contour	(market price, interest rate, "market price/ interest rate" ratio)
Strategic level	(market price, interest rate, capital leverage)

As the theory of information deals with the sets, the signal structures for contours correspond to the levels of isomorphism with a set of possible solutions within the common signal structure. Moreover, we obtain a hierarchical and through classification of signal forms. The definition of invariant forms and groups of transformation corresponds to an approach of a theory of sets. It should be noted that Ashby followed the aim to obtain the result for possible application of the theory of groups.

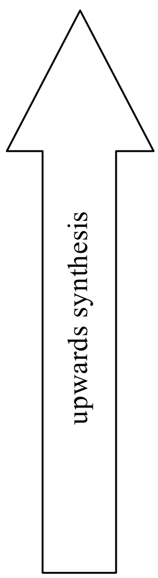
The results obtained in this item, as well as in the next one, are the analog of information theory application to psychology successfully made by the prominent psychologist L.M. Vekker. Psychology, without its own information system, cannot make the preferences of the theory of sets in full measure. The same approach applied to accounting, budgeting, programming and other transforming procedures, where the data is available and it is just necessary to reclassify it on the strict, definitive criterion is very promising in all aspects, including the new horizons to be discovered with analyzing the coding and decoding processes.

So, obtaining the function-based classification of the processes seems to be very ample and prospective too, for further formalization of work as well as analytical work and financial engineering.

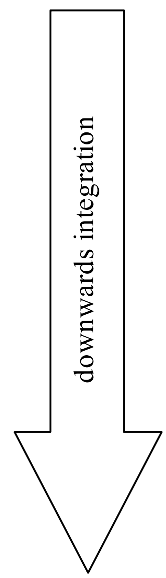
2.4 Upwards Synthesis and Downwards Integration: Structural Evolution and Strategic Management

In accordance with the evolutionary theory, the new evolutionary forms always appear on the grounds of developing, not eliminating, the previous ones. Hence, the evolutionary process occurs by the action of synthesis. As we know the structural form for each contour, we can precisely identify the level attained by the entity and its further possible development toward the next structural form (see Figure 4). In the case of structural components of different levels, it is possible to keep artificially the imposed relationship, but not for a long time. Otherwise, it demands the running in the corresponding signal form of the upper contour.

Figure 4
Upwards Synthesis and Downwards Integration



Processes	Signal Structure	Activities
Strategic Process Financial Process	(fair value, IRR, growth regulator) (investment value, discount rate, HPR)	Strategic Activity Financial Activity* *despite the available strategic component
Production Process	(EBIT, - , -)	Production Activity** **despite the available financial component



The evolutional development is not of a quantitative nature, but of a qualitative one. The difference lies in the specific form of production and financial contours' signal structure. As we see, the signal structure has three components, such as two operands (intrinsic value and time value) and an operator (translating one operand into another one).

Within the production contour, an action flows mainly with the signal structure of the intrinsic value prevailing (one operand). The time value is undeveloped. It should be noted that the intrinsic value signal is more specific and carries more information than the time value signal at the banking institutions (see Table 1). Just this point is a cause of the more optional nature of the time value regulation.

Within the financial contour, an action flows under the signal structure with the intrinsic value, time value and their ratio. From the evolution point of view, the regulation contour appeared with spreading of transferability of actions. Within the production contour there in no operation function and the "slight" time value and the intrinsic value are not isolated. But the financial contour's nature is an operation one connected with transferability.

The operation-based signal programs and regulates the action in advance, which is the feature of the regulation contour.

After the upwards synthesis, the next stage is the downwards integration. Figure 4 shows that the feature of downward integration is the feedback effect, but just beginning with the financial contour the downward integration carries a new quality. With no total transferability it seems to be impossible to make correct integration, at least, for a long time (only for the time of effective ratio of the corresponding intrinsic value and the interest rate).

The strategic level corresponds to total transferability of the operands provided fair market conditions. Thinking of the strategic process as the analog of mental process in psychology we can, following Vekker, call the strategy process a total integrator of all the things with each other. Some researchers on the strategic management proposed such definitions as "synergy is an administration of the Lord's Supper for a strategist" (Goold et al., 1994). Just at this upper level with the total transferability we can begin to use the theory of groups, then pass to more particular forms.

So, being the upper level of the financial contour, the strategic level carries the upper regulation function of integration, and it is expected to provide the most transferability between the some intrinsic value and the some time value, up to the total one. In financial terms, such transferability corresponds to liquidity. The strategic level forms the more informative nature of the intrinsic value and the more operational nature of time value.

2.5 The Cybernetic Formulation of the Integrated ERM Problem

Summarizing all the points discussed, we can formulate some general positions as for the integrated ERM problem.

Firstly, the functional designation of entity's activities makes their hierarchical classification possible, with qualitative difference between the financial and production contours. The different contours connect to each other by means of synthesis. Therefore their characteristics cannot be summarized. This position relates to the integrated risks too, provided for the right functional classification of risks. As for risks of the same contour, they can be summarized under the proper technique.

Secondly, from the function point of view, investment activity is not within hierarchical classification and plays the role of amplifier for the both production and financial activities, such that there are two separated feedback regulators. It should be noted that the adaptation and regulation contours have very different rates. This point confirms their hierarchical relationship.

Thirdly, the structural form of the signal from the environment to each contour is a source for inside coding and decoding processes. Results of these processes depend on the state of the enterprise's contours. This state represents the inside dynamics and remains properties of the environment. The mechanism of such transformation can differ from case to case, but just the interaction with the environment is the basis for the signal structure forming.

Table 2 arranges these general positions and other specific points into some order. The position "possible tasks" in the table gives the examples of problems to be resolved at the contour levels in accordance with their structural forms. Section 3 contains the example of the consideration of the invested capital optimization problem.

Table 2
Entity's Contours Hierarchy: Their Characteristics and Possible Tasks

Entity's Contour Hierarchy	Functional Role	Structural Formula	Feedback Regulator (See Picture 2)	Possible Tasks	Integrated Risk at the Contour
Strategic Level	Integration, or synergy	(fair value, IRR, capital leverage)	c=F x f	Obtaining the fair value, optimizing the invested capital	Strategic risk
Financial Contour	Regulation	(investment value, discount rate, HPR)	F	Attaining the efficiency of the capital (investments and credits), calculating the reserve capital	Financial risk
Production Contour	Adaptation	(market value, -, -)	f	Keeping the regular break-even operation	Business risk

3. The Evaluation of the Integrated Risks at Different Contours

This section contains the adaptation of Ralph Vince's approach to the integrated ERM problem. It considers the problem from the view of the stock-nature values, using the separate growth regulator for every feedback contour and the geometric mean as a target function. As the results, the integrated risk profile for every feedback contour is empirically plotted and the specific integrated risk is estimated in view of its deviation and risk appetite. In addition, the systematic risk of the market effect is under consideration.

3.1 Geometric Mean: The Stock-Nature Values and the Accumulated Effect

The principle of continuity of an entity's activity, that is adopted as the basic one under the IFRS, requires not just uninterrupted operation of the works, but the accumulated effect too, where the gains are the accumulated result of the previous efforts. Such formulation is essential for capital, assets, sales and other stock-nature values.

The general RM practice is using the flow-nature values, namely prices, values and their derivatives. They directly connect to the rates and the factors of activities. They are the best for forecasting, but not for decision-making or estimating the state of things. J.W. Forrester demonstrated this point and warned of using the instantaneous rates. The flow-nature values estimate dynamics or intensity of activity and pass the structure and relations between its components over in silence. So, the integrated ERM problem, more than likely, relates to the stock-nature values with their growth factors, proposed by R.Vince for different contours (see Table 3).

Table 3
Accumulated Values' Growth Factors

Entity's Contour	Accumulated Value	Growth Factor Formula
Strategic Level	Ownership Capital, OC	$HPR_{OC} = (1+ \Delta OC/OC)$
Financial Contour	Total Assets, TA	$HPR_{TA} = (1+ \Delta TA/TA)$
Production Contour	Sales, Sls	$HPR_{Sls} = (1+ \Delta Sls/Sls)$

Further, we need the terminal wealth relative (TWR), the indicator of the accumulated variables' change for the series of years. In view of the accumulated nature its formula is as follows:

$$\mathbf{TWR} = \prod_{i=1}^{N} HPR_i$$, where TWR <1 means that the growth function is broken.

At last, in the accumulated, or geometric, conditions the average growth factor is the geometric mean:

$$\mathbf{G} = \sqrt[N]{TWR}$$, where G <1 means the same as for TWR, i.e. the entity suffers losses.

So, the geometric mean characterizes the efficiency of the reinvesting system and can stand duty as both the indicator of system's efficiency, with internal including of the deviation, and the target function for system's investments optimization problem.

3.2 The Integrated Risk Profiles: Production, Financial and Strategic Contours

In view of the functional role of investing activity as an amplifier, the growth regulators for different feedback contours were introduced in Section 2. (See Figures 2 and 3 and Table 2.) A growth regulator, in essence, is a function of the entity's gains, i.e., the accumulated value of the system, and the risk factors. Because the efficiency indicator TWR includes the deviation effect (see Table 3), the uncovered risk factor is the risk appetite. Taking the worst change in the accumulated value, which was given from the statistical data or adopted for the future, as the risk appetite factor, the growth regulator GR formula could be as follows:

GR = - max Loss in Accumulated Value/ Accumulated Value

Because of the accumulated nature of both parameters, TWR and GR, the TWR-GR plot presents the variant of an integrated risk profile. In view of the hierarchy classification of risks, there are separate integrated risk profiles for production, financial and strategic contours. (See Table 2.) Such risk profiles show the general tendency or direction of the entity's efficiency-risk position, as well as the risk appetite factor (GR), the growth factor

(TWR) and the average growth rates for a time period (G) as for the corresponding accumulated values.

Taking the corresponding data from the financial reports of some Ukrainian industrial companies for the time period of 2000-2005, the author obtained the integrated risk profiles that are illustrated well, despite the many separated numbers of points. (See Figures 5, 6 and 7.)

Figure 5
The Integrated Risk Profile: Production Contour

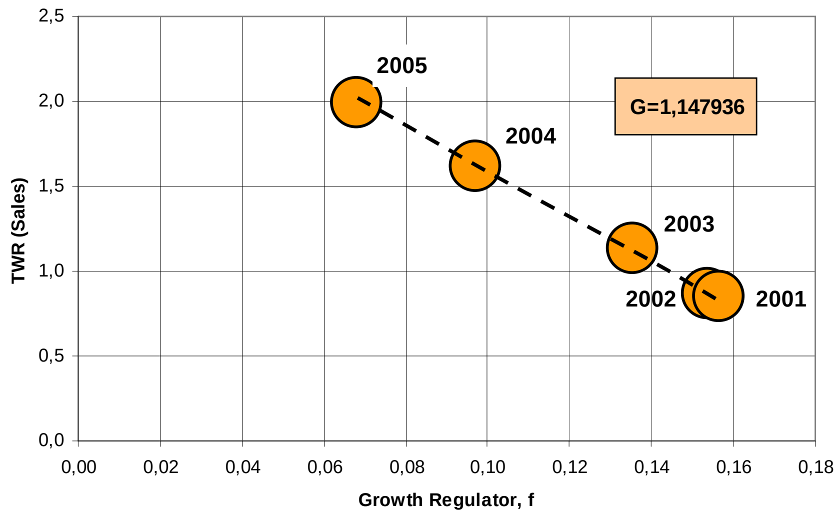
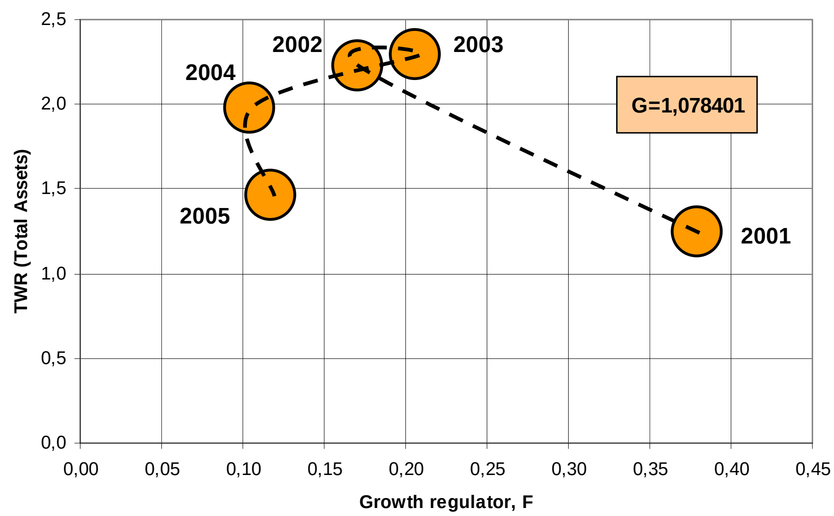


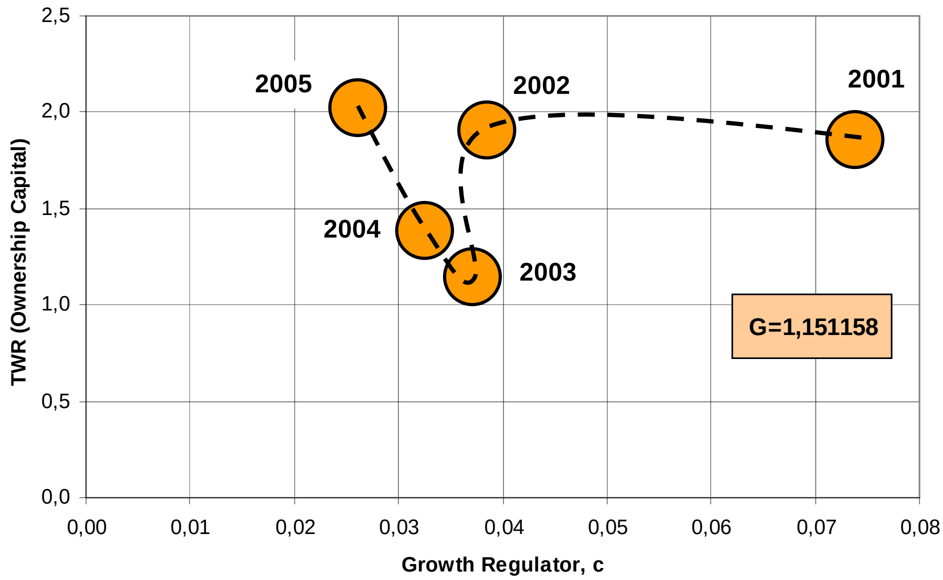
Figure 5 shows the practically linear TWR-f relation for the production contour with the obvious positive tendency, despite the bad beginning (losses in 2001 and 2002). The risk appetite factor falls. The linear relationship was unexpected to the author. It corresponds to the balanced investment policy carried out by the company at its production contour.

Figure 6
The Integrated Risk Profile: Financial Contour



The financial contour has the insignificant average growth rate, namely 7.8 percent. Figure 6 demonstrates the weakness of the company's financial contour and the lack of effective financial policy. The balance sheet data confirms the available problems with the credit policy.

Figure 7
The Integrated Risk Profile: Strategic Contour



The strategic contour has the highest growth rate, but in view of hierarchy nature of the contours and obvious financial weakness, this point is suspicious. The reevaluation reserve position in the balance sheet explains the results obtained. Hence, the corresponding correction is required.

In such empirical form, the integrated risk profiles for production, financial and strategic contours are limited by financial analysis purposes.

3.3 The Optimal Growth Regulator and Risk Leveraging

The empirical integrated risk profile has no functional TWR-GR relationship, with the exception of the linear function that was detected for the production contour (see Figure 5). To balance the system's efficiency and its integrated risk requires their functional relationship. For this purpose, we set the growth regulator into the HPR formula, and obtain the following equation:

$\mathbf{HPR_Y = (1 + \Delta Y/Y) = (1 + GR * \Delta Y/(max\ Loss\ in\ Y))}$, where Y is an accumulated value.

It should be noted that there is a problem of choosing the maximum loss for the systems, where the corresponding environment is not occasional, i.e., there is no competitive market.

Then, entering the new formula into the TWR equation, we obtain the optimization problem for choosing the GR_{opt} of the highest growth rate, i.e., the maximum geometric mean. The optimal growth regulator is the benchmark for the risk parameter: at $GR < GR_{opt}$, the system is underevaluated; and at $GR > GR_{opt}$, the system is overevaluated. In the last case, the most dangerous are the growth regulators after the convexity, where the growth rate falls at the higher risk parameter (a square risk tolerance). So, the location of the growth regulator relative to its optimal value defines the specific risk α. The systematic risk β is under consideration below.

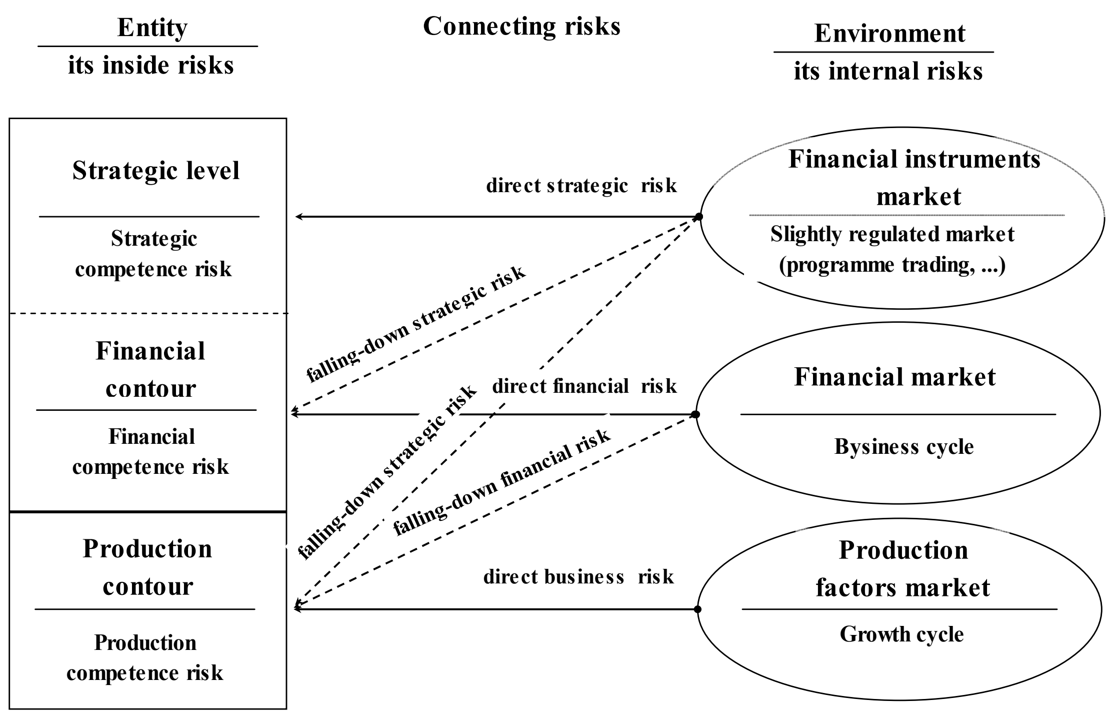
The closeness of the growth regulator to the optimal value is of special attention, because it defines the system's leveraging. As the optimal growth regulator corresponds to maximum growth rate, according to the HPR formula it has the maximal deviation, i.e., risk.

So, the integrated risk management as for specific risks means the leveraging of the growth regulator, or investing activity factor, relative to its optimal value. As we see, the leverage notion can be applied not just to crediting, but all investing activity.

3.4 Risk Classification

From the theory of information, all the risks should be divided into groups by their reference to an object, a subject and their connecting channels, namely the environmental risks, the competence risks and the communicating risks, such as strategic, financial and business risks (see Figure 8).

Figure 8
Entity's Risk Scheme



Of special attention for classification are the falling-down risks (e.g., the bank credits directly to production level). The reverse, increasing risks are out of the figure, because of their unreasonable character. The problem of inconsistency in signal structures has been discussed already (see Section 2, n. 4). The key points are their excessive sensibility to environment, which is susceptibility to failure with no integrated RM (see Example 1:

currency risk and other available financial risks). As we see in the figure, the solution is arising of the competence up to the next contour. So, the direct nature of risk means the due RM competence of the entity.

The environmental risks are under regulation. The market risks should be a subject of regulatory supervision for keeping the fair market conditions (e.g., anti-monopolistic law, Basel II, etc.). They are spread among all market participants. So, the environmental risks are the systematic ones. They are reflected in the input signals and their effects depend on the competence.

4. Conclusions

In order to resolve the ERM problem the hierarchical system of an entity's economic activities with separate feedback contours and the growth regulators was built on the grounds of ideas, approaches and theories developed by cyberneticians Ashby and Beer, psychologist Vekker and financial analyst Vince. Such approach makes it possible to plot, on the empirical data, the specific integrated risk profiles for the production, financial and strategic contours of the entity; and consider the main risk characteristics. The systematic risk is under development, with designated general risk scheme and defined signal structural forms for every feedback contour.

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