The Business Diagnostics Model Addressing its Components Variation Dynamics

Introduction

The purpose of the reasoning described in this paper is not to solve any methodological issues of economic diagnosing, but to present the application of selected information technology methods in this field, addressing the internal dynamics of a system that any company constitutes. The economy-related issues have been referred to as far as required in order to:

– substantiate the purposefulness of taking up the subject of the study,
– formulate the economic problems to be solved, in a manner addressing the specific nature of the data exploration methods that have been selected.

The intention behind the approach presented in this paper is to improve the effectiveness of diagnostic methods being in use today, as they not always provide a complete picture of the situation well enough in advance, but identify some areas of risk only, based on indicators computed in a standard manner. To understand these correctly, a substantial experience and expert knowledge is needed. This view is supported by most of the authors specializing in economics and business management. According to Jae K. Shim i Joel G. Siegel [Shim 2001, p. 555]: “Although financial ratio analysis is useful in predicting failure, it is limited because methodology is basically univariate. Each ratio is examined in isolation, and it is up to the CFO to use professional judgement to determine whether a set of financial ratios are developing into a meaningful analysis.” Another critical opinion on using financial control as the sole indicator of growth in the age of information revolution is given by Kaplan and Norton [Kaplan, 2006] in their work presenting the balanced scorecard concept. Thus, we are facing a situation where a demand for more effective and broader approach has developed and on
the other hand, adequate IT tools responding to this demand have been created.

The incessant, ever-increasing global competition requires increasingly sophisticated methods to be used for assessing the situation and verifying business conceptions that have been accepted before. More feedbacks keep emerging and as a result, the initial goals, even if they have been specified correctly, when achieved – lead to self-annihilation of the expected success. Such situations occur in economy on both macro- and micro-scale. In the latter case, this happens directly on the primary level of added value creation, i.e. the company level. As far as the macro scale is concerned, the consequences of uncontrolled reduction of the employment cost can be referred to as a practical example. The citizens’ income, if reduced below a certain safety limit, translates into a decreased purchasing capacity of the society and sales drop. The resultant loss of revenue brings companies to bankruptcy and national economies – to recession. Under such circumstances its is necessary to create new jobs instead, i.e. to increase the employment cost in a way, instead of reducing it. Today, the major centres influencing the economic views all over the world agree that the deficit of jobs is becoming the main problem of the global economy these days. In its World Development Report of 2012, the World Bank points out that countries, including Poland, should activate their economies through securing the creation of new jobs instead of reducing employment in order to demonstrate apparent efficiency. Jesko S. Hetschel, the World Bank's South Asian Region’s Director for Human Development said: ”Jobs are cornerstone of development, as they make people come out of poverty and raise their living standards. People who are satisfied with their job increase their productivity.” He noted also that jobs are not an effect in fact, while the right jobs can transform entire societies. Moreover, the report states that the world will need 600 million new jobs over the nearest 15 years just to sustain the present employment rate. This may turn out unachievable with the current approach to the employment cost subject. Thus, the pursuit of efficiency without continual diagnosing of its real impact may backfire and produce results entirely opposite to what was expected.

Examples of essentially similar interrelations can also be found on the macroeconomic level. Many such situations are presented by Sterman [Sterman, 2000], along with simulation methods designed to identify such cases. These examples make one aware that some of the hazards
encountered in economy, although realistic and often very serious, not always can be recognized soon enough if a classic approach is used. Certainly, these problems were observed in the past too, but the lesser degree of mutual interrelations and the slower pace of “things happening” made them far less dangerous. Today, the situation is determined by intense processes activated by the increasing globalization on the one hand (affecting the financial market operation in particular) and on the other – by the growing gap between technologies used in technical and in economic spheres.

It is not the purpose of this article to provide any exhaustive solutions to the above issues, with all their complexity. The examples and their generalization have been referred to solely to stress the advisability of exploring more deeply the new opportunities the development of computer science brings offers in diagnosing the economic situation. Moreover, this is also about drawing attention to the growing importance of some requirements in this area. The following is needed in particular:

– using an approach as exhaustive and comprehensive as possible,
– addressing the dynamics of the processes being analysed,
– addressing the influence of the surrounding environment on the system being analysed and vice versa,
– analysing: *ex ante* (planning), *ex post* (implementation), and a plan simulation prepared “after” for an *ex post* situation,
– making the most of the knowledge hidden in transaction systems and their system environment.

A specific approach that would address these requirements has to be based on an appropriate definition of the economic diagnosis concept, as well as on the right configuration of inputs that can be accepted as a direct description of the subject being diagnosed needs to be identified.

1. **Definition of diagnosis**

Typically, the concept of diagnosis is identified in its medical, sociological or psychological meaning.

In the Polish language dictionary the term is described in this context namely. A more general definition can be found in Władysław Kopaliński’s dictionary of loanwords and foreign terms, where diagnosis is explained as a “identification, discerning, decision, distinguishing”. Ziemski defines the term more precisely [Ziemski, 1973], as an “identification of the situation being analysed by recognizing it as a type
or class known, by clarifying the cause and the purpose of the situation, identifying its current status and its expected further development”.

In [Nahotko, 1996], economic diagnosis is defined as a “branch of science, which enables identification and explanation of the company’s economic and financial standing in both statistical and dynamic sense”. Gouchowski, on the other hand, [Gołuchowski, 1997], defines diagnosis as a cognitive process – and its outcome – oriented towards developing a rational and as complete as possible explanation of observations of a certain economic reality”. The same author distinguishes five areas of economic diagnosis:

- system status (e.g., the economic system condition, the economic situation, the structure of a company),
- system operation (e.g., such business process as sales, investments and developments, production),
- system performance (e.g., company balance sheets and profit and loss account),
- system environment (e.g., changes in the tax system),
- system development (e.g., evolution of the recipient crediting system).

Considering the fact that the case at issue here is economic diagnosing with the use of data exploration methods, one should pay attention to an additional component to be taken into account: the knowledge hidden in data being processed by the company transaction systems. This is particularly important due to the fact that namely the volume of hidden knowledge that can be used will be an important criterion for selecting a suitable combination of transaction information as a direct basis for diagnosing.

In terms of economics, the problem of diagnosis exists, as it has already been mentioned before, on both the macroeconomic and the microeconomic level. In the first case this will be about evaluation of the economic standing of states and associations of states (e.g., EU), big supranational corporations, banking systems or major structures managed by foundations. As far as the microeconomic context is concerned, it basically includes companies, certainly, but also single banks or major investment projects for example. Thus, the area of economy-related activities is very extensive and diverse. The nature of needs varies much here, therefore no single, universal approach can be offered. It is necessary to provide specialist techniques, applicable to a
precisely specified nature of business operations to be diagnosed. Macroeconomic diagnosing is a matter of uttermost importance, no doubt, and it can be key to the overall economic situation both in individual countries and the world at large. But this field is extremely hermetic and therefore hardly accessible to any more detailed studies without special authority. The need to diagnose manufacturing companies that supply their products to the market is most universal and repeatable in this case. But even within this, very specialized scope, various approaches are possible. A most exhaustive definition of diagnosing a company standing is a necessary starting point for analysing them approaches and choosing the most relevant one. Eventually, bearing in mind the commonly known general definitions of diagnosing and considering the fact that we are looking for solutions applicable to a manufacturing company, as well as addressing the nature of methods where a large volume of information processing and analysis can be covered, the following definition has been accepted: diagnosing the economic standing of a company is identifying the causes and the effects that drive its change. Further on, the focus will be on the method of diagnosing a company within the scope implied by this definition.

2. Subject of diagnosis

To put it in most general terms, the subject of diagnosis follows directly from the definition quoted in chapter 1. It is simply a company’s economic standing and the way it changes in a specified period or at a given point of time. In the classic approach, the following elements are taken into consideration: trends in evolution of various outcomes, their mutual relations and comparisons of items selected from financial records to applicable model values or quotients (i.e. ratios – this is why the method is called “ratio analysis”). The conclusions concerning the situation of the company as a whole result from an expert evaluation of a complete set of all information referred to above. Therefore, regardless of the method, the quality of such diagnosis depends on the quality of inputs, the precision of computation, as well as on the expert’s knowledge and experience. However, even in most favourable conditions, his or her perception will be limited. Therefore, although it is the company that is being diagnosed, any manageable mapping of its processes will also be limited and very much approximate. Consequently, the diagnosis precision and depth of details will be adequate. Thus, the volume of
knowledge hidden in the limited amount of information that has been made available will be modest too. Hence, the essence of problem is how to equip the assessor with tools that would enable him/her to:

- take into account all data that is needed and obtainable,
- browse effectively the data sets that have been provided, in order to select those needed at the given stage of diagnosing,
- recognizing the interrelations between data being analysed,
- disclose as much of the knowledge hidden in available data as possible.

Yet, the selection of appropriate IT tools has to include configuration and systemization of the direct inputs to the process of diagnosing. Certainly, one might design special, dedicated systematics for these analyses, but this would add much difficulty to any future implementation, due to the need of imposing new data registration and – what is more complicated – data planning obligations on companies. Moreover, the need to test new procedures would be a serious and expensive barrier in such cases. Mainly for these reasons, it is more reasonable to use the existing, proven documentation, which meets the relevant criteria.

Nevertheless, it is essential for such systematics to be:

- rather commonly used, for the sake of future implementation and compatibility with the existing solutions,
- repeatable (identical) at the stage of both planning and implementation as well,
- where records follow logically one from another,
- covering a possibly most extensive, consistent and comprehensive set of information on plans and performance,
- addressing all the items that affect the cash bottom line.

Bearing these requirements in mind, one may take the following documents into consideration, all of them being required by the law and rather commonly used, although not always compulsory:

- the balance sheet,
- the profit and loss account,
- the cash flow statement,
- the cost account,
- the company budget.

The requirements listed above are best reflected in a set of data recorded in a complete budget of a company (including the cash flows) –
a detailed discussion of this statement can be found in [Olejniczak, Kubiak, 2012]. The budget covers all data recorded in all of the remaining documents. Moreover, it combines them in a logical computational sequence at the stage of planning and performance as well and, which is not meaningless, the process of its preparation also consists in diagnosing to some extent. Hence, taking the company budget as a direct subject of diagnosis, the following has been assumed:

1. Causes of changes and their quantitative impact on the economic standing of the company will be systematized in monthly and annual cycles, where discrepancies between the individual budget performance and plan items will be analysed in the annual evaluation exercise and the adjusted budget plan items – in the monthly evaluation,

2. Any change within any budget item as well as its impact on each of the cash flow statement items and on the bottom line outcome will be regarded as relevant for the diagnosis,

3. Budget planning will address both the company data and any relevant information on the company’s economic environment, such as: the demand, the purchasing capacity, the supplier market, the recipient market and the labour market where the company personnel is employed.

4. If the company supplies more than one product, its budget will be represented by a total of independent component budgets drawn up for individual products and such cost items as: company overheads, total sales and shared infrastructure. The budget performance data will be recorded in a similar system.

5. The annual budget planned for the next year (the base budget) will be produced in a breakdown into individual months of the year it covers.

6. After the end of each i-th month, budget performance will be analysed in a similar arrangement as in the base budget and an adjusted monthly budget will be drawn up based on the adequate monthly section of the base budget, as an operational plan for month i+2.

7. In the process of diagnosing, causes of the individual items deviation from the base budget and from the adjusted budget will be identified, with changes in the economic environment characteristics taken into account together with their determinants.
For such a diagnosis to be possible, all of the three forms referred to here have to be available. Budget performance is a set of statistical information in a way, with data being collected in a pre-defined arrangement and for pre-defined periods (annual and monthly). The base budget is the company’s annual budget plan produced in the same form as the budget performance (a year in a breakdown into months). The monthly adjusted budget is an operational plan, i.e. a monthly section of the planned annual budget for month i+2, which has been updated based on the i-th month’s performance. Certainly, some of the standard analytical methods can be used for compiling various section of the base budget. As a matter of fact, to collect the budget performance information, nothing else is required than simply implementing the standard financial reporting methods in the company. Yet, as some additional requirements will have to be included, especially in order to address the economic environment evolution, the artificial intelligence methods can turn out very useful here. This will be the case for searching information which is not covered by the available statistics, but can be obtained through approximation, especially when the company’s surrounding is concerned. Thus, the base of information necessary to ensure effective diagnostics will be rather comprehensive and not at all easy to create. Not only all standard items of a classic budget will be needed, but also extensions in the field of costs and information about the immediate surroundings of the company. Moreover, an appropriate period of time will have to be analysed. As a result, the budget designed as a set of data constituting a direct basis for diagnosis will consist of the following sections that are normally specified in any budget:

At the individual product level:
- sales,
- production,
- inventories as of the period end,
- consumption of materials,
- labour,
- production overhead costs,
- cost of planned sales,
- cost of sales.

At the company level:
- total cost of all product groups (manufacturing cost + cost of sales),
- company overheads,
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- profit and loss account,
- capital expenditure,
- balance sheet,
- cash flow statement.

Additional data, not recorded in the traditional budget and describing:
- the supplier market,
- the recipient market,
- the employment market,
- the capital market.

The period of time to be taken into account cannot be less than 2 years (the performance estimated for the year preceding the base year and the base year plan). The artificial intelligence methods can be very much useful also when these documents are produced.

3. Methods

With the methodology designed here, the procedure of diagnosing will be structured into a sequence of the following stages:

A. The stage of planning, consisting of:
   1. Specifying the performance of tasks envisaged for the year preceding the base year.
   2. Collecting the set of information needed for planning the base year budget (the base budget).
   3. Compiling the base budget.

B. The stage of actual diagnosing, consisting of:
   1. Cyclical, monthly diagnoses, where the i-th month’s performance deviations from the base budget, the respective adjusted budget items and the previous month’s (i-1) performance, as well as their causes are identified.
   2. Calculation of adjustments for the next month, based on the monthly diagnosis.
   3. Preparing the annual diagnosis based on monthly diagnoses.
   4. Checking the correctness of simulation programs (budget plan simulation for the next month, at the moment when the performance is known and the discrepancies are compared and evaluated).

C. The consolidated evaluation stage, consisting of:
   1. Annual ratio analysis.
2. Consolidated evaluation, addressing the correspondence between the initial diagnosis and the ratio analysis outcomes.

3. Identification of the company mobility, based on the budget performance of the year preceding the base year and on the forecasted performance of the base year.

The data exploration methods can be used (although not necessarily, if normal arithmetic or deterministic methods are satisfactory) at each of the stages specified above, for each of the procedures referred to. Table 1 presents methods recommended for each of the diagnosing procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>ERP system reporting functionalities</td>
</tr>
<tr>
<td>A2</td>
<td>ERP system reporting functionalities, selected classification methods (e.g., artificial neural networks, classification trees or other methods)</td>
</tr>
<tr>
<td>A3</td>
<td>ERP system planning functionalities</td>
</tr>
<tr>
<td>B1</td>
<td>Identification of association rules, e.g., by means of the apriori algorithm</td>
</tr>
<tr>
<td>B2</td>
<td>TREND functionality</td>
</tr>
<tr>
<td>B3</td>
<td>TREND functionality</td>
</tr>
<tr>
<td>B4</td>
<td>TREND functionality simulation</td>
</tr>
<tr>
<td>C1</td>
<td>Arithmetic methods, ratio analysis</td>
</tr>
<tr>
<td>C2</td>
<td>Classification methods: artificial neural networks, classification trees</td>
</tr>
<tr>
<td>C3</td>
<td>TREND functionality</td>
</tr>
</tbody>
</table>

Source: Own elaboration.

If the methodology proposed here is to be used, not only diagnostic methods are required, but also a forecasting method enabling current modification and control of the forecast, so as to achieve the effect of addressing the system’s feedbacks. The TREND function described by John Sterman [Sterman, 2000, p. 635] and used in relation to system dynamics meets such criteria. Figure 1 outlines the logic of this function application in the approach presented here.
The TREND function presented here enables the forecasted values to be controlled and adjusted on a current basis against data being recorded in the ERP system. The function can be used for forecasting any components of the budget, with various time horizons. Figure 2 presents the process of the forecasted outputs stabilization, depending on the forecast period.

**Figure 1. The TREND forecasting function used in budget approach**

**Figure 2. Stabilization of forecasted values depending on the forecast period**

**Source:** Based on [Sterman, 2000, p. 635].
The figure shows that the longer forecasting horizon imposes using a longer period for deviations being analysed. This indicates that it makes much sense to adopt the forecast lead time up to one year.

Conclusion
The approach proposed here presents the benefits of using data exploration methods in combination with the computer simulation techniques in diagnosing the company economic standing. It should be stressed that under the existing circumstances it is particularly justifiable to intensify activities in this field, as beside the reasons referred to before, one should also mention the increasing number of bankrupting companies: with the growing dynamics of changes in their business environment, they are not able to identify – soon enough and precisely enough – the impact of risks to be faced. Many of the bankruptcies come as a surprise to companies’ authorities and bodies. More precise diagnosing methods may significantly reduce the risk of bankruptcy. Hence, we are talking here about an almost costless boost to the pace and stabilization of the economic development. What is new in the method based on the budget plan and performance analysis presented here, is – besides using IT tools – supplementing the performance evaluation practiced so far with an assessment addressing the dynamics of events that determine the financial performance. This is possible due to using the knowledge hidden in standard records of the company financial operations and iterative processing these data in search of mutual dependencies. Moreover, taking the budget as a basis for diagnosing enables one to analyse the situation at the stage of planning the company’s business activities. In case of the BI class package systems that currently prevail among this type of solutions on the market [Tiedrich, 2003], a strong interrelation between the actual BI system and the transaction systems from which it sources information exists. Often, systems supplied by one and the same manufacturer are required. The budget-based solution proposed here can be implemented independently on the transaction systems existing in the company and the extent of their integration. For the approach described here to be applied, specific data mining procedures need to be developed in order to analyse in detail the cause and effect relationships, as well as the knowledge base model supporting the BI system.
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Variation Dynamics (Summary)

Company diagnostics is a vital element of its safe operation on the competitive market. Among the existing IT solutions, diagnostics is most often used in the Business Intelligence (BI) class systems designed for monitoring company business activities on a current basis (Business Activity Monitoring BAM). But solutions of this type reflect the current situation of the company without addressing the changes in its environment or any feedbacks existing in the company. The approach presented in the paper adopts a diagnostic method based on analysis of the dynamics of changes and interrelations between the relevant elements.

Keywords

diagnostic system, system dynamics, budget, data mining