Managing Sustainable Profit

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Abstract. Represented research was performed as a single case study on the performance measurement system (PMS) of the Ydria Motors LL Company (YM), which is engaged in manufacturing. The company is a competence centre of the ebmpapst group and focuses on the prototypes of new products and manufacturing machines. Its vision is to become the leading manufacturing and development location within the group in the field of Alternating Current (AC) motors and Electronically Commutated (EC) motors, pumps, fans and components for home appliances. In the Slovenian region, the company is an important manufacturer of electric motors and fans, which exports as much as 95% of its production for large and important manufacturers of upmarket white goods and household appliances such as Miele, Bosch-Siemens, Gorenje, Electrolux and AEG.

In their endeavour to increase profits, companies usually become aware that this is predominantly the result of employee competence and satisfaction, processes excellence and customer’s satisfaction. Based on that assertion, companies integrate different managerial tools in the PMS and therefore in their management system. One of the most dominant managerial tools is the Kaplan and Norton’s balanced scorecard (BSC).

Within our survey we have closely examined the development of a performance measurement model which supports the decision making process in real time. Our main finding relates to the fact that we empirically confirmed the error correction models (ECMs) which are supporting the cause and effect relations between the strategic goals (e.g. stake holder’s long term value-monthly profit). In this context the company has identified opportunities for improvement in the field of performance measurement.

Keywords: causal relations, error correction model, long term stability, performance measurement system, short term dynamic, strategy fulfilment, sustainable growth

1 Introduction

This paper represents the research of a case study on the performance measurement system (PMS) of a company engaged in manufacturing. The company is a competence centre of ebmpapst group and focuses its vision and strategy on becoming the leading manufacturing and development location within the group in the field of Alternating Current (AC) motors and Electronically Commutated (EC) motors, pumps, fans and components for home appliances. In order to fulfil the chosen strategy YM has been improving its PMS.

One of the main purposes of implementing PMS, such as the balanced scorecard (BSC), is to communicate strategy throughout the organization. Among the number of PMS approaches, a dominant position was achieved by Kaplan and Norton’s BSC; it has emerged as a new synthesis between the traditional financial-accounting system and efforts to achieve long-term competitive capability. Thus, the BSC system considers the traditional financial KPIs as well as leading KPIs of
future performance. In this way, it provides key information about the activities of the managers. The BSC is a performance measurement system theorised by Kaplan and Norton which was first created as a performance measurement tool, then it has evolved into a PMS, and subsequently becoming a comprehensive strategic management system (Barnabè 2011).

Practical experiences with the PMS show that it is difficult to determine transparent relations between the different perspectives. However, the implemented PMS doesn’t enable the identification of all information on the relations (i.e. correlations, causalities) between process Key Performance Indicators (KPIs). In this manner company doesn’t have transparent evaluation of resource inputs in efficiency of the implemented model in the management system (Janeš and Dolinšek 2010; Waruhiu 2014). In the light of its development, the company has to resolve the issues to outline its future organic growth. Thus, the YM Company has already faced the challenge of setting the KPIs, which are the central theme of our research.

Primarily, the research is focused on the layout of the BSC i.e. it’s the causal relations, using qualitative and quantitative methods. In this case study, the company’s business performance sustainability understanding, which is based on comprehensive data tests and semi-structured interviews with managers, contributed to the selection of Engle-Granger two-step method for assessment of the error correction mechanism between the KPIs. In addition, the data reveal an impact of global crisis on the company captured in a way that appears as not being substantial. According to Engle and Granger (1987), the error correction mechanism can be seen as a process that describes and validates the short-run dynamics of the observed KPIs towards their long-term equilibrium values and it includes the time lag. The approach is relatively easy to use and robust and it proved to be applicable on a relatively small data sample. Besides that, the Engle-Granger method mathematically describes qualitative layout of the BSC and enables forecasting (Janeš 2012, 2014).

The rest of paper is organised as follows. Section 2 contains review of the literature. In the Section 3 is described the chosen methodology. Empirical findings and discussion are represented in Section 4. At the end of the paper, in Section 5, are gathered conclusions, limitations and suggestions for further research.

2 Review of the literature and research studies

Kaplan and Norton’s (1992, 2004) BSC provided relevant information about the performance of the organization, particularly in relation to the key strategic objectives. At that time, the new management tool enabled the description and communication of strategies to all employees and a link to budget of the organization (León-Soriano, Muñoz-Torres and Chalmeta-Rosaleñ 2010). In the 1990s, the theories about the hypothesis that are used by managers were implemented in order to identify the relations between strategic objectives i.e. they were classified into the system of the BSC, which enabled the identification of indicators for monitoring the objectives. As the identified strategic objectives were the basis for the management of organizations, the BSC soon included relations between strategic objectives and their respective KPIs. This kind of representation was termed a “strategic map”. With a limited number of indicators monitored by managers, the BSC supported the transparency of the operations (Barnabè 2011; Kaplan and Norton 2004; Cobbold, Lawrie and Issa 2004).

Pfeffer and Sutton (2006) identified several implementation principles from evidence-based management in order to help companies that are committed to sustainable profit. They suggest treating the company as an unfinished prototype, to consider facts, to take into account the external-stakeholders view, slow the spread of bad practices and collect the best evidence and confront the hard
facts. Evidence-based management is designed for management on all levels and like everything else; products or services still need to be sold. When customers’ voices are being heard by management and their needs are being responded then customers feel satisfied and hence put the positive words on the product or service and return to get more of that. This is where profitability generates for the company (Mehrjerdi 2011). However, even though company relationships with customers can be greatly improved by employing information technology, customer relationship management (CRM) should be seen as a core business strategy that integrates employees, internal processes and functions and external networks to create and deliver value to targeted customers and, finally, increase profits (Wu and Lu 2012 by Sarmaniotis, Assimakopoulos and Papaioannou 2013; Kaplan and Norton 2004). Profit, despite its changing accounting definitions, always concerns a rate over time. In addition to serving as a medium of competition its main task is to organize capital’s continuous circulation (Levy 2014).

Many authors argue that the establishment of a PMS begins with an overview of the strategy and is not based on actual outputs of business processes (Kaplan and Norton 1992; Bititci et al. 2006; Thakkar et al. 2007). Therefore, KPIs should be directly related to the strategy of the organization; it is mandatory to choose them on the basis of the strategic objectives of the organization.

Approach of setting practical objectives is being performed through a series of approximations. Keeping the maximization of the rate of return as the stakeholder’s long term value, companies usually develop a number of subsidiary objectives which contribute in different ways to improvement in the return and which are also measurable in business practice. A company which meets high performance in most of its subsidiary objectives will substantially enhance its long-term rate of return. But it cannot be proved that the result will be a maximum possible overall return. Namely the problem of reconciling claims of conflicting objectives is common across all sectors. In business practice company’s objectives are what the company wants from its key stakeholders. Essential nature of company objectives makes a logical connection between what stakeholders want from a company, i.e. “strategic factors”, and what the company wants from its stakeholders, i.e. “organization objectives”. Both sides together provide real strategy framework. For example one of the stakeholder groups represents customers from which company wants to achieve profitable revenue. If an objective is an expression of what an organization wants from a key stakeholder, it must involve behaviour by a stakeholder and, a desired behavioural outcome (Ansoff 1965, 47 by Kenny 2012, 42-43; Shinkle 2012). Once developed, strategic objectives will shape an organization’s strategies effectively, leading to sustainable success. It’s important to remember that targets on organization objectives shape strategies; they also provide a means of assessing the effectiveness of those strategies. Namely, without clear and quantified objectives, any strategy can be set (Kenny 2012, 45)! Measurement of the organization’s performance represents a good practice and is an integral part of the organization’s management in the accomplishment of its strategies and objectives. The PMS and associated KPIs are treated in practice as a process that supports the reviewing and changes of the measurement system in relation to changes in the business environment of the organization.

Given the framework of the strategy map, which consists of four perspectives, and within them a large number of related strategic objectives, the added value of the business processes is manifested in the form of chains of cause-effect relations ranging from nonfinancial and quantifiable KPIs in the learning and growth perspective via processes and customers to a finance perspective (Ittner and Larcker 1998; Kaplan 2012, 543). Cause-effect relations can be understood as a set of hypotheses that are taken to meet the strategic objectives (Laitinen 2004, 2005). A strategy map is a diagram that describes how an organization creates value by connecting strategic objectives that are in explicit cause-effect relations with each.
One of the main areas that both the relevant literature and Kaplan and Norton themselves identified as being critical, is related to the identification, assessment and the quantification of causal relations which are, according to authors, essential within the BSC (Barnabè 2011; Barnabè and Busco 2012; Kaplan 2012; Nørreklit 2000; Waruhiu 2014, 119). In this context, the causal relations have been in the centre of survey interest, because they are providing better relations model between the four BSC perspectives (Bukh and Malmi 2005, 96).

Kaplan and Norton’s BSC provides a comprehensive framework that translates the strategy objectives of the organization into a coherent set of KPIs. As a rule, the KPIs are determined based on previous experience and by regular review. Where appropriate, an expanded range of KPIs may be confirmed or some of them may also be phased out. With this approach, it is possible to find measurable perspectives of the current business processes, because the selected KPIs are likely to be important for determining the outcome of business processes in the future. Analysis of many qualitative and quantitative research studies about the implementation of KPIs, performed globally, showed the generally favourable influence of the KPI’s on the fulfilment of the sustainable strategy. Specifically, a recent trend in the performance evaluation of companies is the increasing emphasis on intangible measures and non-financial perspectives (Charéonsuk and Chansa-ngavej 2010; Jerman, Kavčič and Korošec 2012; Kaplan and Norton 2004; Kaplan 2012).

One way for organizations to become more innovative is to capitalize on their employees’ ability to be innovative. As de Jong and Den Hartog (2007) stated, managers vary in the extent to which they typically display consulting, delegating and monitoring operational performance (i.e. behaviour). These practices are likely to have an impact on both employees’ idea generation and application behaviour. In order to enhance individual innovation among employees, managers could attempt to consult them more often, ensure that employees have sufficient autonomy in decision making, and support and recognize people’s initiatives and innovative efforts. Creating a positive and safe atmosphere that encourages openness and risk taking seems to encourage idea generation and application. Although excessive monitoring is likely to have a negative effect, some degree of monitoring may be necessary to secure the effectiveness and efficiency of the company’s current operations. Creating a balance between stimulating innovative behaviour and ensuring short-term effectiveness and efficiency forms a challenge.

The biggest advantage of the BSC, as compared to other approaches or models, is its ability to integrate the capabilities of the various perspectives of the company: financial and non-financial, as well as internal and external. From the business practice, it is also known that approximately 80% of organizations are not successful in the execution of their chosen strategy. The reason, according to the users, experts and authors of the BSC, relies in the fact that such organizations do not know how to properly describe, measure, implement and manage their strategies (Barnabè 2011; Norton and Russell 2011; Waruhiu 2014). Although it is much, of the written above, acclaimed, there seems to be some confusion, both in practice and among academics, with respect to how this cause-effect principle should be interpreted and implemented (Bukh and Malmi 2005; Nørreklit 2000). Implementation of the BSC has triggered many debates and academic-professional publications that were looking for solutions to the lack of clarity regarding the definition of BSC causal relations and the selection and classification of KPIs (Bititci et al. 2006; HBSPC 2010; Janeš and Faganel 2013; Janeš 2014).

For example, Laitinen (2004, 2005) analysed the theoretical foundations of the BSC with the aid of a simple dynamic microeconomic model. This model was constructed on the case of the Nokia Corporation in order to reflect the characteristics of knowledge-based companies.

Neely, Gregory and Platts (2005) stated that it is widely accepted that the manufacturing task, and hence the key dimensions of manufacturing’s performance, can be defined in terms of quality, delivery
speed and reliability, price (cost), and flexibility. Based on the results of several studies, it appears that, manufacturing organizations in Europe are beginning to realize the need to respond to the changes in their competitive environment by adopting a more balanced approach to PMS (Gomes, Yasin and Lisboa 2011).

Barnabè (2011) has focused his case study on the combined use of the BSC approach and system dynamics principles and modelling techniques which have the potential to be developed into a comprehensive strategic management tool. The system dynamics-based BSC represents the business environment of a company (called “Alpha”) providing commercial services for its clients.

Barnabè and Busco (2012) researched the methodological principles and the operational tools that can support the development of a comprehensive strategic management approach centred on the BSC layout. This, according to authors, brings two-fold value: first, it shows that relying on system dynamics tools and methodological principles is possible to better define the concept of causality in BSC frameworks; second, it shows that by integrating system dynamics modelling principles and the BSC framework it is possible to develop a comprehensive approach to performance management and strategy formulation and implementation (Kaplan 2012).

Hoque and Chia (2012) performed a field study focused on business unit level analysis in a manufacturing setting. The company adopted a KPI system in its PMS in order to link the latter to the company’s strategies. In regards to the introduction of a strategic PMS, many studies also provide evidence that strategy should be aligned with the PMS and its KPIs, and improved performance will result.

Morard, Stancu and Jeannette (2013) developed and empirically validated comprehensive framework of a BSC model which is based on the Partial Least Square equations and supports a modern understanding of perspectives underlying the actual corporate strategy. The proposed approach is represented on a case study of the Swiss electricity institution.

Behery, Jabeen and Parakandi (2014) developed one of the first studies of contemporary PMS within a middle-eastern context. They suggested that many of the roles played by traditional performance management can be supported by other mechanisms at the corporate level like the BSC system and the detailed design of a potential BSC and strategy map for the company will act as a guide to help in bringing the modern performance management tools into the other Eastern fast-growth small-to-medium enterprises.

Janeš (2014) performed a single case study research of modelling the BSC system for the manufacturing company which was founded on complementary use of quantitative and qualitative methods. A strategic map of the company that contains the causal relations between KPIs has been developed with the method of semi-structured interviews and confirmed by the executive management. The central part of the case study is an empirically evaluated layout of the BSC with the Engle-Granger two step method.

It is necessary to clarify why, what and how often we need to measure before we decide how to measure. Managers should be first asked questions about what they want to achieve, what their objectives are and how they can describe them. From the academic literature is evident that relatively few companies engage in formally testing their causal models, finding the hypothetical causal links either self-evident or such analysis is regarded as being time and finance consuming; Kaplan and Norton originally estimated that it would take approximately two years for an organization to fully implement the BSC system throughout the organization (Waruhiu 2014, 122).
Any PMS has its own set of interrelated KPIs, and its success depends on compliance with the qualitative and quantitative perspectives. Very few scholarly researches, which have attempted statistical analysis on hypothetical causal links, establish significant causality. Such research does not include the time lag, i.e. they are not taking into account that some activities have an immediate impact, while the impact of some others is manifested only after a certain time (Banker, Potter and Srinivasan 2000; Faganel and Trnavčevič 2012, 22; Janeš and Faganel 2013; Kasperskaya and Tayles 2013, 428, 430, 435; Thakkar et al. 2007). Meanwhile, longitudinal and dynamic research for developing theories in this area is very rare. Completion of qualitative research with statistical tools holds great potential. In cases where companies have time series data related to their BSC with which to validate the hypothesis from the strategy map, proper statistical procedures could be applied (Brock and Durlauf 2001; Bukh and Malmi 2005; Janeš 2014).

3 Methodology

This applicative research was performed as a single case study of modelling the BSC system for a manufacturing company and founded on complementary use of quantitative and qualitative methods (Gummesson 2000, 88; Yin 1994). For this purpose, we obtained and used KPIs that were already monitored by the company on a monthly basis and ranges from 2004M01 to 2011M12. Since we do not know the exact legalities between the observed KPIs, which were taken into account, we expressly applied the information contained in the time series of observed KPIs. Based on the selected Engle-Granger two-step method, we defined a framework for the layout of the BSC including EVIews statistical software (Engle and Granger 1987). The central part of the case study is the part in which we attempted to empirically evaluated layout of the BSC with the Engle-Granger two-step method.

Before starting with the ECM modelling, we performed several basic statistic tests of the KPIs’ time series, i.e. stationarity, cointegration and Granger causality test in order to exclude the possibility of false regression (Engle and Granger 1987; Granger 2004; Gujarati 1995, 730; Janeš 2013; Janeš and Faganel 2013).

From the purpose originates our main objective that aimed at developing a quantitative approach that would be complementary with a qualitative approach of the BSC layout.

For this purpose and objective we developed a single equation Error Correction Models (ECMs) with the Engle–Granger (1987) two-step method. In the first step, we evaluated the cointegration according to the Engle-Granger method. The linear combination of observed KPIs represents a co-integration vector that could be stationary. If the cointegrating vector is unique, then we can apply the ordinary least squares (LS) method to estimate the relation among KPIs. In this case, the residuals from LS regression equation can be used in place of the error correction term (ECT(t-i)) to proceed with the estimation of the short-term dynamic model. To this end, we set the initial model of KPIs; we calculated the regression by the LS method and saved the residual values of the potential co-integrating vector. The residual values were tested for stationarity, which is needed for the stability of the final model but it also confirms co-integration relations between the KPIs.

In the second step, we set up the ECMs using the seasonal differences and different time lags of KPIs and residuals. According to Engle and Granger (1987), when the variables are cointegrated, there must be an error correction mechanism that describes the short-run dynamics of the cointegrated variables towards their long-run equilibrium values. In the presentation of the ECMs (see Table 1), ECT(t-i) is a lagged error correction term that measures the speed of adjustment to long-run equilibrium. In order to restore equilibrium, the sign of the coefficient of the, ECT(t-i) is expected to be negative (Engle and Granger 1987; Hylieberg and Mizon1989; Gujarati 1995).
With the ECM approach we performed application on the KPIs and estimated short and long term effects between them. Final ECM (see Equation 1) indicates that that there is a certain level of nonlinearity at the microeconomic level between KPIs and that a two-step method should be used for the KPIs analyses (Janeš 2012, 2013, 2014; Waruhiu 2014).

During the research a strategic map of the YM Company that contains the causal relations between the KPIs has been set and confirmed with the executive management (Angrosino and Mays de Pérez 2000; Bititci et al. 2006; Bukh and Malmi 2005, 95-96; Gosselin 2005; Kaplan 2012). Interpretation of analytical results and the layout of the research findings have allowed us the successful solution of the research problem, which was related to the possibility of developing a BSC with quantitative analysis of the causalities between the KPIs.

4 Empirical findings and discussion

4.1 Empirical analysis of the monthly profit

Due to limited space, we have represented only a part of the findings from the ECM analysis in detail (for more details about the research see Janeš 2014). The use of the ECM approach can be seen on the case of the monthly profit (MPROF). From the equation (1) is evident that MPROF of the company depends only on internal KPIs and on the right side of the equation is also a dependent indicator-MPROF. Dependence on the internal KPIs rises from the fact that the YM Company acts as a contract manufacturer; the production price of products is based on costs and is determined by the YM Company, but the market price of products is determined by the ebmpapst group. The establishment of global governance institutions, allows corporations to resolve the conflicting relationship between short-term and long-term success i.e. without losing their short-term competitiveness. Thus, increasing competitiveness and flexibility through a decentralisation of decision making processes and the responsibility makes global governance, corporate governance, and sustainable profits closely inter-related (Lin-Hi and Blumberg, 2011; Nielsen and Nielsen, 2008).

\[
\Delta \text{MPROF}_t = \beta_0 + \beta_1 \Delta \text{MPROF}_{t-1} + \beta_2 \Delta \text{KPI}_1 + \beta_3 \Delta \text{KPI}_2 + \beta_4 \Delta \text{KPI}_3 + \beta_5 \Delta \text{KPI}_4 + \beta_6 \Delta \text{KPI}_5 + \beta_7 \Delta \text{KPI}_6 + \epsilon_t
\]  

(1)

Since we had available monthly data, we included 12th time lag of the KPI’s in the initial model. The structure of the lags was evaluated with the criteria for determining the order of time lags, as are autocorrelation function, Q-statistics and correlograms. In the case of MPROF, the 12, 0, -9 and -12 time lags have proven to be suitable, which were been approved on the basis of the minimum value of Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) criteria. By testing various time lags of KPIs on the right side of the equation and the reduction of autocorrelation, respectively, monitoring the Durbin-Watson statistics, we come to the final ECM (see Table 1):
Table 1: ECM for monthly profit (MPROF)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPROF</td>
<td>0.782705</td>
<td>0.062779</td>
<td>12.46764</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(ABSE,0,12)</td>
<td>110.6187</td>
<td>31.88681</td>
<td>3.469104</td>
<td>0.0009</td>
</tr>
<tr>
<td>ACCW(-9)</td>
<td>-2075.693</td>
<td>917.4174</td>
<td>-2.262540</td>
<td>0.0265</td>
</tr>
<tr>
<td>D(LPROD,0,12)</td>
<td>831.2585</td>
<td>89.45182</td>
<td>9.292808</td>
<td>0.0000</td>
</tr>
<tr>
<td>LPROD</td>
<td>-809.5302</td>
<td>69.69200</td>
<td>-11.61583</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(YMPPM,0,12)</td>
<td>-4.538648</td>
<td>0.512174</td>
<td>-8.861540</td>
<td>0.0000</td>
</tr>
<tr>
<td>ECTt-12</td>
<td>-0.995906</td>
<td>0.008044</td>
<td>-123.8086</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>19619.59</td>
<td>1918.288</td>
<td>10.22766</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R²                           | 0.995342    | Akaike criterion | 17.08468 |
| Adj. R²                     | 0.994913    | Schwarz criterion | 17.31619 |
| S.E. of regression          | 1185.838    | Hannan-Quinn criterion | 17.1774 |
| Sum squared resid           | 1.07E+08    | Durbin-Watson stat | 2.190392 |
| Log likelihood              | -709.5566   |                       |        |
| F-statistic                 | 2320.066    |                       |        |
| Prob(F-statistic)           | 0.000000    |                       |        |

Adapted from Janeš (2012, 173)

Notes: Dependent indicator is a monthly profit, which is differentiated from the twelfth seasonal difference D(MPROF, 0.12); the LS method is used; the data sample ranges from 2005M01 to 2011M12; included 84 observations after adjustments; in analyses the following KPIs were used: monthly profit (MPROF), absenteeism (ABSE), accidents at work (ACCW), labor productivity (LPROD) and parts per million (YMPPM).

From Table 1 it is evident that all the regression coefficients and constant are statistically significant at the 1% or 5%. The ECTt-12 is negative and statistically significant. The error correction term shows how quickly the model returns to the equilibrium in the case of a disturbance or a shock in the business environment.

From the results of the error correction model can be seen a high coefficient of determination (Adj. R² = 0.994913), which reduces interference in the estimated cointegrated vector. In addition, the Durbin-Watson statistics have the value around two, which means that we have significantly reduced the impact of autocorrelation and serial correlation. Whereas on the right side of the ECM equation is also a dependent indicator i.e. MPROF, we attribute greater importance to the results of Q-statistics and Breusch-Godfrey LM test of serial correlation than the Durbin-Watson statistics.

Results represented in Table 1 can be interpreted as follows: optimization of the MPROF is under the impact of monthly profit from previous periods, absenteeism (ABSE), accidents at work (ACCW), improvement in labour productivity (LPROD) and a decrease in the number of pieces per million produced (YMPPM). Short-term changes in the independent indicators are collapsing the equilibrium between indicators in a model for monthly profit and causing that the change of indicators in the next period is corrected by the error correction mechanism which, again, tends to long-term equilibrium. Namely, in the long-term equilibrium of the observed ECM, the error correction term equals to zero.
In the business practice an indicator of absenteeism and accidents at work are regularly monitored as they support the measurement of organizational climate, competencies of managers and employee satisfaction and indirectly reflect in employee satisfaction and climate in the company. On reducing absenteeism and accidents at work certainly has a significant impact the training of employees, ergonomic workplaces and concern for safety at work. Both indicators that support monitoring of leaders competencies are improving in the observed period, because their values are declining. The trend of decreasing also promotes the reduction of the target values of the indicators of absenteeism and accidents at work.

Labour productivity is improving with constant number of employees which in the observed period gradually increases. Reduction of the number of pieces per million produced in the observed period is evident from measurements of the YMPPM indicator. Target values for this indicator are decreasing from period to period.

The ECM model result represented in Table 1 confirms the presence of an error correction mechanism, which indicates a relatively stable model of short-term dynamics of the factors that affect the monthly profit. The final error correction model for monthly profit reflects Granger’s causality caused by monthly profit from previous periods, absenteeism, accidents, labor productivity and the number of pieces per million produced and it is reflected in monthly profit, which represents the long-term value for stakeholders.

### 4.2 Testing the error correction model for monthly profit

MPROF, which in this model appears on the left and right side of the equation (1) is statistically and substantively, based on Wald’s test of independence, recognized as independent indicator. In the indicators of monthly profit (MPROF), absenteeism (ABSE), labor productivity (LPROD) and number of pieces produced per million (YMPPM) is also present seasonal component and some random errors.

Correlograms of residuals showed that the latter do not cause autocorrelation, since Q statistics are not statistically significant (no autocorrelation from 1st to 12th lag at 1%, 5% and 10% level). Breusch-Godfrey serial correlation LM test showed that between the residuals of the time series is no serial correlation, because we could not reject the null hypothesis of serial correlation absence in the twelfth time lag.

With the use of the Breusch-Pagan-Godfrey, Harvey, Gleyser and White tests, we had been able to reject the hypothesis of the presence of residual heteroskedasticity.

Examination with Chow’s test in relation to the stability of the model for a period of economic crisis in Slovenia (Verbič and Črnigoj 2014) in the years 2009 to 2011 showed that we cannot reject the null hypothesis of a breakpoint date, which shows that the coefficients of the equations of the model are stable during that period. In case of rejection of the null hypothesis, the Chow’s test would indicate structural changes; the data reveal that impact of global crisis appears as not being substantial on the YM Company.

Quandt-Andrews stability test showed that we can reject the null hypothesis of a breakpoint date, so we conducted a second test i.e. Chow’s Forecast Test for structural changes, which showed the stability of the coefficients of the indicators in the period from 2009 to 2011.

Stability of the KPIs coefficients in the period from 2008 to 2011 was confirmed by recursive estimation. Thus, the various experiments with error correction model confirmed its relative stability. Of course, it is appropriate to test and evaluate such a model with the most recent data and recalculate
the error correction term, which would further improve our model. Tests of the final MPROF’s error correction model, which was represented, can be tied to the testing procedures of models in studies performed by various authors (Engle and Granger 1987; Macunovich and Easterlin 1988; Miller 1991; Stock and Watson 1988).

With the ECM approach we performed application on the KPIs and estimated short and long term effects between them. Final ECM indicates that there is a certain level of nonlinearity at the microeconomic level between KPIs and that a two-step method should be used for the KPIs analyses.

5 Conclusions

The literature has identified the necessity to further define the concept of causality within the layout of the BSC, in the direction of relying on specific quantitative tools needed to convert the BSC into a mathematical model. Therefore, based on the reviewed literature on ECM, we have depicted the main characteristics of this approach and, in particular, we have stressed the potentialities of using ECM for exploring the concept of causality in BSC and, consequently, to gain a deeper understanding about the relations between financial and non-financial KPIs (Barnabè and Busco 2012; Janeš 2014; Kaplan 2012). Engle-Granger’s two-step method for explanation of the error correction mechanism comprises the dynamic short-term deviation of KPIs values, provides an overview of the timing regarding the anteriority of indicators and information about their long-term relations. The error correction mechanism can therefore be seen as a process that describes and validates the long-term equilibrium between the observed KPIs. Using the error correction modelling in order to identify KPIs is suitable for assessment of the causality between the KPIs, because it considers the time lag between causes-and-effects and supports scholarly characteristics under the four perspectives of BSC. Simulations of the represented approach are possible on all levels of management, by combining the KPIs and consecutively acquire new knowledge about their relations. Developed quantitative approach supports improving the monitoring of operational efficiency of an organization and achievement of the strategic objectives.

A key finding in this regard is that the development of the BSC, supported by the Engle-Granger method, makes a contribution to the empirical supported explanation of the BSC’s causal relations. However, we must emphasize that we had to limit the generalization of research findings to the only one manufacturing company which acts as a contract manufacturer. Based on the results it is recommended that further research is oriented on expanding the BSC on other companies that operate independently on the markets, because the key issue about the KPIs causal relations is, whether and in which proportion they really contribute to the benefits of the business processes exploitation and strategy fulfilment (Bukh and Malmi 2005).

References


