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THE APPLICATION OF ORDERED LOGIT MODEL IN ANALYSIS OF PROFITABILITY OF FOOD INDUSTRY SECTORS

Abstract

The article addresses the problem of financial determinants of eturn on equity (ROE) in the food industry in Poland. The analysis was conducted on the basis of the decomposition of the rate of return on sales and in conjunction with the system of indicators linking the return on sales to return on assets and equity. In addition, in order to identify the significanceof individual components of the ROE system, ordered logit regression models were estimated. The parameters of logit regression of the ordered categories justify why we look for reasons for the ROE diversity among food industries primarily in the ability to generate the added value, in the labour costs, in the rational management of financialcosts, in the efficientuse of wealth and in the formation of a more aggressive capital structure, determining the level of leverag.

Keywords: ordered logit model, profitability, food industry sector, return on equity, logit regression model.

Introduction

Profitability indicators are very broadly used in assessment of financial results of enterprises and benefits to their owners. However, their usefulness is to a large extent limited in practice, due to their synthetic nature and resulting limited scope of informational content. Therefore, procedures for disaggregation of financial indicators and their inclusion in systems of indicators have found broader use in research practice, which facilitates multi-dimensional and cause-and-effect analysis of various financial issues [see 1, 2, 4, 5, 6, 7, 9, 18, 19, 20].

The primary objective of this paper is a multi-dimensional analysis of variation of profitability in the domestic food industry. The analysis was carried out on the basis of proposed decomposition of the return on sales indicators and in conjunction with the system of indicators tying return on sales to return on assets and equity. Furthermore, in order to define materiality (the strength and direction of impact) of individual components of the system, statistical methods were employed – ordered logit modelling.

Source materials and research methods

The paper uses unpublished statistical data of the Central Statistical Office (*Główny Urząd Statystyczny, GUS*) in Warsaw from 2006-2011, which facilitate the analysis of profitability per sections, groups and classes of food industry and in terms of the size of enterprises. The article presents the results of descriptive analysis of profitability at the level of sections and classes and the results of logit analysis at the level of classes taking into account the size of enterprises[1]. The analysis was founded on decomposition of profitability indicators, with the equation of the Du Pont model as the starting point, where return on equity (*ROE*) is presented as the product of return on assets (*ROA*) and equity multiplier (*EM*), or more broadly, in the form of the product of return on sales (*ROS*), asset turnover (*AT*) and equity multiplier (*EM*).

$$ROE = ROA \text{ x } EM = ROS \text{ x } AT \text{ x } EM$$

where:

$$ROE = \frac{net\ profit\ (NP)}{equity\ (E)}, ROA = \frac{net\ profit\ (NP)}{assets\ (A)}, \quad ROS = \frac{net\ profit\ (NP)}{revenue\ (R)},$$

$$EM = \frac{assets\ (A)}{equity\ (E)}, AT = \frac{revenue\ (R)}{assets\ (A)}$$

The article proposes a proprietary modification of the above dependencies through decomposition of the return on sales (ROS) indicator. The proposal translates into the following system of indicators:

$$ROS = GVAI \times DCI \times LCI \times OROCI \times RFCI \times EOI \times TEI$$

[1] The following were included in food industry: production of food (section C, part 10) and production of drinks (section C, part 11). According to PCA 2007 production of food includes 25 sectors (classes 10.11-10.92), while the production of drinks includes 7 sectors (classes 11.01-11.07) [17].

where:

GVAI – gross value added indicator: $GVAI = \frac{gross\ value\ added\ (GVA)}{revenue\ (R)}$

DCI – depreciation cost indicator: $DCI = \frac{net\ value\ added\ (NVA)}{gross\ value\ added\ (GVA)}$;

LCI – labour cost indicator: $LCI = \frac{profit\ on\ sales\ (PS)}{net\ value\ added\ (NVA)}$;

OROCI – other revenue and operational cost indicator:

$$OROCI = \frac{operational\ profit\ (OP)}{profit\ on\ sales\ (PS)}$$

FRCI – financial revenue and costs indicator:

$$FRCI = \frac{profit\ on\ economic\ activity\ (PEA)}{operational\ profit\ (OP)};$$

EOI – exceptional occurrences indicator:

$$EOI = \frac{gross\ profit\ (GP)}{profit\ on\ economic\ activity\ (PEA)};$$

TEI – tax effect indicator:

$$TEI = \frac{net\ profit\ (NP)}{gross\ profit\ (GP)}.$$

The above indicators allow to express the return on equity (ROE) in the form of the following equation:

$$ROE = \frac{NP}{E} = \frac{GVA}{R} \times \frac{NVA}{GVA} \times \frac{PS}{NVA} \times \frac{OP}{PS} \times \frac{PEA}{OP} \times \frac{GP}{PEA} \times \frac{NP}{GP} \times \frac{R}{A} \times \frac{A}{E}$$

The structure of the above equation shows that the starting point in the decomposition procedure was value added indicator (*GVAI*) in the form of the ratio of gross value added (*GVA*) to revenue (*R*), providing information on the capacity to generate values contributed by an enterprise in relation to external costs resulting from contacts with the environment [1, 20]. The same indicator is also considered to be the primary determinant of technical and technological advancement [16, 20]. Another two indicators are also connected with value added (*DCI*, *LCI*), which provide information on the impact of the cost of depreciation (*NVA*/*GVA*) and the cost of labour (*PS*/*NVA*) on the level of profitability. The next two indicators (*OROCI*, *FRCI*) define the impact of other operational activities (OP/PS) and financial activities (*PEA*/*OP*) on increase or decrease in profit, as a result of positive or negative balance of other revenue and operational costs and the balance of financial revenue and costs. The third analytical area is the level of exceptional occurrences. In the proposed model of decomposition of profitability it was taken into account in the *EOI* indicator (*GP*/*PEA*), which provides information on the impact of exceptional profits and losses on profitability. The final indicator (*TEI=NP*/*GP*), the so-called effective tax rate, is connected to distribution of profit and provides information about the scale of decrease of gross profit due to taxation of enterprises.

The indicators presented above were integrated with the profitability system *ROA* and *ROE*. As a consequence, substantially developed analytical systems were achieved, which – on top of asset turnover (*AT=R*/*A*) and equity multiplier (*EM=A*/*E*) facilitate modelling of returns (*ROA*, *ROE*) in the context of additional modalities.

For modelling of return on equity, a polynomial logit model of ordered categories was used (the so-called ordered logit model, which models cumulated probabilities). In this model, the dependent variable is discreet and takes values from a countable and finite set of values (categories) with a defined hierarchy. Let us assume that *i*-th unit (in case food industry) is characterised by one level of financial standing from among J (1 – very low, 2 – low, 3 – medium, 4 – high). In this case the so-called cumulated logits shall be subject to modelling, i.e. logarithms of probability quotients of *i*-th industry belonging to a category not higher than *j*-th (p_{ij}) and the opposite probability (1– p_{ij}). The category of financial standing of the industry (in this case *ROE*) is determined by *k* – a set of exogenous variables (a set of indicators from *ROE* system) and a random component. In case of *J* categories there shall be *J-1* logit equations [10]:

$$logit(p_{ij}) = ln\frac{\Pr(y_i \le j)}{\Pr(y_i > j)} = ln\frac{p_{ij}}{1-p_{ij}} = \beta_{0_g} + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + \varepsilon \ (g = 1,2,\dots,J-1)$$

e.g. for $j = 4$:

$$logit(p_1) = ln\frac{\Pr(y_i \le 1)}{\Pr(y_i > 1)} = ln\frac{p_1}{1-p_1}$$

$$logit(p_1+p_2) = ln\frac{\Pr(y_i \le 2)}{\Pr(y_i > 2)} = ln\frac{p_1+p_2}{1-p_1-p_2}$$

$$logit(p_1+p_2+p_3) = ln\frac{\Pr(y_i \le 3)}{\Pr(y_i > 3)} = ln\frac{p_1+p_2+p_3}{1-p_1-p_2-p_3}$$

and $p_1 + p_2 + p_3 + p_4 = 1$

In order to identify factors with an impact on financial standing of sectors of food industry, measured by the rate of return on equity (ROE), the ordered logit model in the following form was used:

$$y_i^* = x_i^T \beta + \varepsilon_i$$

where:

y_i^* – unobservable variable referring to *i*-th observation (sector), is connected to its discreet analogues: $y_i = j$, if $\tau_{j-1} \leq y_i^* \leq \tau_j$;

τ_j – cut-points, while:

$$-\infty = \tau_0 < \tau_1 < \cdots < \tau_m < \tau_{m+1} = \infty;$$

β – vector of parameters;

x_i – vector of values of exogenous (explanatory) variables for *i*-th observation;

ε_i – random component for i-th observation;

$i = 1, 2, ..., N$ – number of observations.

After estimation of parameters of the model, the anticipated probability of *i*-th unit (industry) belonging to j-th category of financial standing (*ROE* class) can be expressed as:

$$\Pr(y = j|\boldsymbol{x}) = \Pr(\tau_{j-1} \leq y^* \leq \tau_j|\boldsymbol{x}) = \Pr(\tau_{j-1} \leq x\beta \leq \tau_j|\boldsymbol{x})$$
$$= F(\tau_j - x\beta) - F(\tau_{j-1} - x\beta)$$

where *F* means a distribution function of logistic random component. It should be noted that in the estimated model, parameters in independent variables are identical for each j category (*ROE* class), the so-called assumption of proportional odds – parallel regressions. It means that the ratio between each pair of compared groups of categories (*ROE* classes) is the same, i.e. coefficients describing connection between variable in the lowest category in comparison to all higher categories (comparison of class 1 to the remaining higher ones) of dependent variables are identical as those describing relations between subsequent higher levels of categories and remaining higher categories (comparison of class 1 and 2 to remaining higher classes), etc. If the relation between all pairs of a category within the same group of comparisons is proportional, then there is only one set of estimated parameters with independent variables. If the assumption of proportionality of quotients of odds would not be fulfilled, than one should estimate the so-called generalised ordered logit model, which leads to estimation of different sets of parameters with independent variables between each compared pair of groups of resultant categories (*ROE* classes). In order to verify this assumption, Brant's test and Wolfe and Gould test was used [3, 8 11, 21]. The idea of tests used for this purpose is based on verifying whether a model without the condition of assumption of parallel regression would be better suited than a model retaining this limitation. The basis of the test is estimation of *J*-1 binomial regressions. For the Brant's test, dependent variables in this regressions are defined as follows:

$$z_j = \begin{cases} 1 \; for \; y_i > j \\ 0 \; for \; y_i \leq j \end{cases} for \; j = 1,2, \ldots, J-1$$

Null hypothesis of joint Brant's test expresses equivalence of relevant parameters in all binomial regressions for all independent variables. Rejection of this hypothesis means that at least for one variable, the parameters differ in at least two binomial models, i.e. that the assumption of proportional odds is not fulfilled. Individual tests facilitate identification of variables for which parameters differ in binomial regressions.

In case of Wolfe and Gould test, dependent variables in binomial regressions are defined in a manner opposite to the previous test:

$$z_j = \begin{cases} 1 \; for \; y_i \leq j \\ 0 \; for \; y_i > j \end{cases} for \; j = 1,2, \ldots, J-1$$

The test facilitates comparison of matching of a set of binomial models with matching of a standard ordered model. Rejection of the null hypothesis on equal matching of both models means that the assumption of parallel regressions is not fulfilled and forcing it on the model shall materially deteriorate its matching.

If the ordered logit model fails to meet the assumption of proportional odds, the generalised ordered model should be estimated, which takes into account variability of parameters β depending on a category (in this case *ROE* class).

The following characteristics were used to assess the quality of estimated ordered logit models of return on equity:

1. Examination of combined materiality of all independent variables (materiality of the model) on the basis of the test of likelihood ratio on the basis of statistics $LR = 2(lnL - lnL_0)$, which has chi-squared distribution with the p number of degrees of freedom p – equal to the number of estimated parameters (with the exclusion of estimated threshold values),
   where:

L – value of the likelihood function of the examined model,
L_0 – value of the likelihood function of a model only taking into account a constant.
   The test can also be used to compare any nested models, i.e. models where one is created from another through reduction of the number of independent variables (e.g. one could examine if a generalised ordered model is better than a standard ordered logit model). Then, in the above formula for test statistics, instead of L_0 you should use the value of the likelihood function of the model with a smaller number of estimated parameters. The number of degrees of freedom is a difference between the number of parameters from compared models.
2. Wald's test – examination of materiality of assessment of parameters (null hypothesis assumes absence of materiality of each of the parameters separately):

$$\begin{cases} H_0: \beta_i = 0 \\ H_1: \beta_i \neq 0 \end{cases} \qquad z = \frac{\hat{\beta}_i}{D(\hat{\beta}_i)} \qquad (i=1,\ldots,p)$$

3. McFadden's Pseudo – R^2 [12, 13]:

$$R^2 2McFadden's = 1 - \frac{lnL}{lnL_0}$$

This measure theoretically takes a value from the range [0,1], but may not be interpreted as a determination coefficient from a classic linear regression. The higher the value of this measure, the better estimated the model.

4. Counting R^2, defined in the context of proportion of accurate predictions:

$$Counting\ R^2 = \frac{number\ of\ accurate\ predictions}{total\ number\ of\ observations}$$

The higher the value of this measure, the better the model.

5. Pseudo R^2 McKelvey and Zavoina [8, 14]:

$$R^2_{M\_Z} = \frac{\widehat{Var}(\hat{y}^*)}{\widehat{Var}(\hat{y}^*) + \widehat{Var}(\varepsilon)},$$

where $\widehat{Var}(\hat{y}^*)$ – variance, $\widehat{Var}(\varepsilon) \cong \frac{\pi^2}{3}$ in logistic model.

This measure is the most similar to classic R^2; the higher the value, the better matched the model.

6. Information criteria of Akaik and Bayes–Schwartz – the criteria do not have a set range of values, they are only used to compare estimated models. The lower the value of the criteria, the better the model.

Variation of structure and level of profitability in food industry

Table 1 shows the values of individual indicators and return rates (*ROS, ROA, ROE*) per sectors and in general in food industry in three sub-periods of 2006-2011. Their analysis shows that sectors of food production and drink production clearly differ in terms of return on sales (from 3.0% to 3.5% and from 4.5% to 6.3%), and the reasons for this should be seen primarily in differences in the level of value added indicator (*GVAI*), labour cost indicator (*LCI*), other revenue and operational cost indicator (*OROCI*) and financial revenue and cost indicator (*FRCI*). Among them, the largest differences occur at the level of the labour cost indicator (*LCI*). In the sub-periods under study, in production of food this indicator ranged between 29.1% and 31.3%, while in production of drinks –

from 33.5% to 41.6%. This results from substantial differences in labour productivity[2] and is confirmed by the value added indicator (*GVAI*) amounting from 17.1% to 17.7% in food production, while in production of drinks – from 19.7% to 23.7%. The numbers indicate that in relative terms, the value added indicator in production of drinks was more than 20% higher than in food production.

In general, the remaining *ROS* systems indicators differentiated the sectors of food industry to a clearly lesser extent, which leads to the conclusion that in the sub-periods under analysis their impact on the level of return on sales was comparable. It needs to be emphasised, however, that both among these indicators, and indicators with value added, there are substantial differences in the level of variability and dynamics of changes. In 2006-2011, in food production, the highest variability characterised the financial revenue and costs indicator (*VFRCI* = 12.1%), which also decreased in terms of its annual average (*ΔRFCI* = -1.3%). This means that in this sector a negative tendency emerged for profits to decrease as a result of increasing financial costs, which were compensated by financial revenues to a lesser and lesser extent[3]. The remaining indicators in this sector were characterised by a clearly lower variability. However, taking into account their average annual dynamics, one could see that in 2006-2011 changes to ROS, apart from the financial revenue and cost indicator, were primarily set by a negative direction of changes to the value added indicator (*ΔGVAI* = -1.3%)[4] and exceptional occurrences indicator (*ΔEOI* = 0.4%)[5] and a positive direction of the labour cost indicator (*ΔLCI* = 3.2%)[6].

[2] In the sub-periods under research, labour productivity measured through net value added, was 2.5-3 times higher in production of drinks than in food production. Furthermore, the higher assessment of the drink production sector in terms of labour productivity and labour cost indicator was accompanied by a substantially higher level of labour cost per 1 employee. In sub-periods under study, the average level of labour cost per 1 employee (remuneration and derivatives) amounted to respectively: PLN 32-46 thousand (food production) and PLN 53-73 thousand (production of drinks).

[3] In the surveyed years, the financial costs in the sector of food products drastically grew. For example, in 2006 it amounted to PLN 1.71 billion, in 2008 it increased to PLN 3.12 billion, and in 2011 it dropped to PLN 2.64 billion, i.e. to the level higher by 51% compared to 2006. Throughout the period, interests were the main source of financial costs in production of food products; they constituted, respectively: 65% (2006-2007), 40% (2008-2009) and 59% (2010-2011) of the value of total financial costs. A major drop in the share of interests in financial costs between 2008 and 2009 was caused by a strong growth in the other financial costs, including mainly for negative foreign currency losses.

[4] In food production the changes resulted from the higher annual average increase of material costs (8.5%) than of revenue (8.2%).

[5] In sub-periods under research the level of the remaining operational revenues in food production was stable and nominally amounted to PLN 1.9-2.1 billion. As a result of a systematic increase of return on sales, the relative impact of these revenues on return was getting smaller and smaller.

[6] In sub-periods under research the level of the remaining costs by type of food production was stable and nominally amounted to PLN 2.3-2.5 billion. As a consequence these costs reduce the increased added value to a lesser and lesser extent, thus positively influencing the level of return on sales.

Table 1

Level, structure and dynamics of changes of profitability in food industry

Variables	Food production			Drink production			Food industry total		
	2006--2007	2008--2009	2010--2011	2006--2007	2008--2009	2010--2011	2006--2007	2008--2009	2010--2011
	Average level of determinants of profitability structure and profitability rates (in %)								
GVAI	17.6	17.7	17.1	23.7	22.7	19.7	18.6	18.6	17.5
DCI	83.9	84.4	84.4	83.6	85.2	84.9	83.8	84.6	84.5
LCI	29.1	28.9	31.3	39.9	41.6	33.5	31.5	31.9	31.8
OROCI	105.5	108.9	105.9	97.3	96.0	103.2	103.2	105.0	105.1
FRCI	93.1	75.7	87.9	100.3	88.9	93.0	95.0	79.4	88.9
EOI	100.1	100.4	100.2	100.2	101.2	100.0	100.1	100.7	100.1
TEI	82.0	81.4	83.6	81.3	81.7	81.6	81.8	81.5	83.2
ROS	3.5	3.0	3.5	6.3	5.6	4.5	3.9	3.5	3.7
AT	1.9	1.9	1.8	1.7	1.6	1.5	1.9	1.8	1.8
ROA	6.7	5.6	6.4	10.5	9.2	6.9	7.5	6.4	6.5
EM	2.1	2.1	2.0	2.2	2.3	2.4	2.1	2.1	2.1
ROE	14.1	11.8	13.0	23.3	21.2	16.4	15.9	13.7	13.5

Variability coefficient (V) and average annual dynamics of changes (Δ) of determinants of profitability structure

Variables	2006-2011		2006-2011		2006-2011	
	V (%)	Δ(%)	V (%)	Δ(%)	V (%)	Δ(%)
GVAI	4.2	-1.3	9.1	-4.2	4.6	-2.0
DCI	0.5	0.3	1.2	0.4	0.5	0.3
LCI	9.6	3.2	13.6	-5.0	5.6	1.4
OROCI	3.1	0.1	5.1	0.9	2.2	0.2
FRCI	12.1	-1.3	9.2	-0.7	10.8	-1.3
EOI	0.3	-0.4	0.9	-0.2	0.5	-0.3
TEI	2.9	0.4	2.3	0.4	2.6	0.5
ROS	20.4	0.9	19.9	-8.3	16.9	-1.2
AT	3.2	-0.8	7.8	-3.9	3.1	-1.3
ROA	19.4	0.1	24.7	-11.9	17.1	-2.5
EM	1.8	-1.0	4.5	1.0	1.1	-0.7
ROE	19.4	-0.9	23.6	-11.0	17.4	-3.2

Source: own calculations based on unpublished CSO data.

The drink sector was characterised by much greater variability. The data in Table 1 show that the lowest stability was primarily the feature of the following indicators: labour cost (5.6% ≤ V_{LCI} ≤ 9.6%), value added (4.2% ≤ V_{GVAI} ≤ 9.1%) and financial revenue and costs (9.2% ≤ V_{FRCI} ≤ 12.1%). Furthermore, in this sector higher variability over time was typically connected with a negative – from the point of view of profitability – direction of changes of individual indicators. This is particularly visible in case of the value added indicator (*ΔGVAI* = -4.2%) and labour cost indicator (*ΔLCI* = –5.0%)[7].

The determinants of return on sales mentioned above, defined by the indicators of *ROS* system, point to a number of differences between the food production sector and drinks sector, both in terms of their levels and variability. These differences result in lower levels of *ROS* in production of food (3.0% ≤ $\overline{ROS}$ ≤ 3.5%) and higher in drinks production (4.5% ≤ $\overline{ROS}$ ≤ 6.3%). Lower return on sales in food production should primarily be traced back to lower capacity to generate value added, which results in a less favourable ratio of this value to revenue, as well as its decrease because of the cost of labour. However, in general the annual average dynamics of changes of indicators in this sector was low, and the annual average increase of *ROS* amounting to 0.9% is indicative of a stronger impact of positive rather than negative changes, from the point of view of the level of return. On the other hand, in the drinks sector, greater capacities to generate value added seen in *GVAI* and *FRCI* clearly weakened, which is accompanied by changes to other factors (financial costs in particular) translated into a strong annual average downward trend of return on sales (*ΔROS* = –8.3%).

The changes to return on equity should be viewed in a similar context, by taking into account asset turnover (*AT*). The research shows that in food production the asset turnover was relatively higher (1.8 ≤ $\overline{AT}$ ≤ 1.9) than in drinks production (1.5 ≤ $\overline{ROT}$ ≤ 1.7), plus it was subject to low variability (V_{AT} = 3.2%), showing weak downward trend (*ΔROT* = –0.8%). These changes in food production resulted in a rather stable level of $\overline{ROA}$ (5.6% ≤ *ROA* ≤ 6.7%) in analysed sub-periods with a slight upward trend, within the margin of error (*ΔROA* = 0.1%). The drink sector looks less favourably in this respect, as the lower level of rotation was subject to regress in the analysed period (*ΔROT* = –3.9%) and in connection with decreasing return on sales (*ΔROS* = –8.3%) resulted in depreciation of *ROA* (from 10.5% to 6.9%). Furthermore, annual average dynamics of changes clearly show that the strength of impact of the direction of changes of *ROS* on *ROA* was almost twice as strong as that of the negative impact of the decrease of asset turnover.

Making a connection between return on sales and asset turnover or return on sales on its own with the equity multiplier facilitates estimation of the return on equity (*ROE*). Analysis of these connections leads to the conclusion that the level of leverage (*EM*) of return on equity (*ROE*) was quite similar in both sec-

[7] In drinks production the changes resulted from a distinctly higher annual average increase of material costs (6.5%) than of revenue (5.2%).

tors, which is an evidence of a similar structure of their capital. Furthermore, both in food production (ΔEM = –1.0%), and drink production (ΔEM = 1.0%), equity multiplier was subject to weak changes, which means that on average in the researched period it had a marginal impact on *ROE* changes. It also means that variability of *ROE* was primarily determined by variability of *ROS* and – although to a much smaller extent, by variability of asset turnover.

Table 2 shows average levels of indicators in question broken down by classes (sectors) of food industry in 2009-2011. Their analysis points to a very strong diversification of sectors, both in terms of the level of individual measures of profitability, and their circumstances defined by levels of indicators taken into account. Taking into account the return on sales one can notice that its level remained in a broad range: from –0.7% to 17.1%. The most profitable sectors of food industry in terms of *ROS* included: 10.81 – production of sugar (17.1%), 11.05 – beer (8.6%), 10.52 – ice cream (7.8%), 10.71 – bread (7.3%) and 10.73 – pasta (7.1%). On the other hand, the group with the lowest level of *ROS* includes: 10.85 – production of convenience foods (-0.7%), 11.01– distilling of alcohols (0.0%), 10.41 – production of oils (0.9%) and 11.03 – production of cider (1.0%). The data in Table 2 also shows that in each of the sectors *ROS* clearly depends on a diversified level of individual indicators. However, making a generalisation one could state that, on average, sectors with high level of ROS, in relation to sectors with low *ROS*, are characterised by high level of value added indicator (*GVAI*), value added is in their case much less reduced by labour costs (*LCI*), the financial results are marginally determined by other operational activities (*OROCI*), while financial activities (*FRCI*) do not lead to substantial reduction of profitability. In sectors with low *ROS*, these indicators look definitely unfavourably. It seems, however, that these were high financial costs that had the strongest negative impact on ROS, only in a small extent compensated by financial revenues, which – with a generally low value added indicator and high labour costs – led to poor financial results on economic activity or generating losses on this activity.

In terms of sectors, strong differences are seen also when it comes to return on assets (*ROA*), the average level of which in 2009-2011 fell in a broad range from -0.9% to 18.3%. However, *ROA* categorises sectors of food industry in a way very similar to *ROS*. It means that the strength of impact of asset turnover (*AT*) on the level of *ROA* was in general comparable in the sectors under research, thus justifying sourcing of reasons for diversification of *ROE* primarily in the same factors, which determine diversification of the level of *ROS*. Obviously, this does not mean that variability and the strength of impact of asset turnover were marginal. The data in Table 2 shows that asset turnover is a very important determinant of return on assets, which is particularly visible in meat processing (classes 10.11,12,13). In case of these sectors, low levels of *ROS* ($1.4\% \leq ROS \leq 2.8\%$) were connected with high level of turnover ($2.8 \leq AT \leq 3.4$), pointing to a short ca. 4-month cycle of replacement of assets with revenue, which makes it possible for these sectors to achieve the rate of *ROA* at the level close to the average in food industry as a whole.

Table 2

Sectoral variation of components of ROE system in food industry (2009-2011 average)

Sector[a]	*GVAI*	*DCI*	*LCI*	*ORO-CI*	*FRCI*	*EOI*	*TEI*	*ROS*	*AT*	*ROA*	*EM*	*ROE*
10.11	12.5	84.9	23.5	107.4	61.7	99.4	69.9	1.5	2.8	4.0	2.2	8.8
10.12	11.2	86.1	22.5	107.2	71.7	100.0	86.9	1.4	3.4	4.8	2.7	12.7
10.13	14.7	86.1	24.1	119.3	84.8	100.0	89.4	2.8	2.9	7.9	2.1	16.7
10.20	16.2	87.8	29.2	110.7	76.1	99.9	77.7	2.8	1.8	5.0	2.6	13.3
10.41	8.5	73.6	36.2	82.9	55.3	100.1	76.7	0.9	1.8	1.9	2.6	5.1
10.42	19.8	88.5	32.8	106.5	99.1	100.0	76.5	5.0	1.6	8.1	1.4	11.4
10.51	13.7	80.5	21.4	124.0	93.4	100.2	83.2	2.3	2.1	4.7	2.1	10.0
10.52	30.8	87.8	33.4	102.0	86.6	100.0	96.6	7.8	1.9	14.6	2.0	28.9
10.71	31.6	87.6	29.9	106.6	90.4	99.9	91.2	7.3	2.0	14.8	1.9	27.4
10.72	26.7	85.2	27.8	122.6	84.8	100.0	87.4	6.2	1.6	10.5	2.1	21.0
10.73	24.5	84.6	32.3	124.0	92.4	100.0	92.1	7.1	1.4	10.1	1.9	19.4
10.81	31.9	85.9	77.0	98.1	101.8	99.9	81.8	17.1	0.9	15.4	1.7	26.1
10.82	25.5	85.6	26.7	100.0	119.1	100.0	85.0	6.0	1.1	6.5	1.7	10.7
10.83	23.8	79.7	36.3	107.1	85.2	100.0	87.1	5.6	1.3	7.5	1.8	12.9
10.84	26.6	91.8	34.6	101.4	95.2	100.0	82.4	6.7	1.8	11.9	1.9	22.2
10.85	17.4	79.4	7.5	209.4	-55.0	101.7	120.2	-0.7	1.7	-0.9	4.6	-7.2
10.86	25.5	84.9	26.7	108.5	92.7	100.0	81.8	4.7	1.3	5.8	1.8	10.4
11.01	7.7	87.0	26.0	86.6	-27.5	100.0	104.9	0.0	1.7	1.0	3.4	3.6
11.03	12.4	79.7	12.3	328.6	39.8	100.0	121.7	1.0	1.9	1.7	2.3	3.5
11.05	25.2	85.0	43.9	100.1	104.4	100.0	89.2	8.6	2.1	18.3	2.6	48.4
11.07	28.9	83.8	26.2	100.4	94.0	100.1	81.2	5.0	1.0	5.2	1.9	9.9

[a] 10.11 – processing and preservation of meat (without poultry); 10.12 – processing and preservation of poultry meat; 10.13 – production of meat products (without poultry); 10.20 – processing and preservation of fish, crustaceans and molluscs; 10.41 – production of oils and other liquid fats; 10.42 – production of margarines and other edible fats; 10.51 – processing of milk and production of chesses; 10.52 – production of ice cream; 10.71 – production of bread, fresh pastry and cakes; 10.72 – production of rusk, biscuits, pastry and cakes; 10.73 – production of pasta, noodles, couscous and similar flour products; 10.81 – production of sugar; 10.82 – production of cocoa, chocolate and confectionery; 10.83 – processing of tea and coffee; 10.84 – production of spices; 10.85 – production of convenience foods; 10.86 – production of homogenised and dietary foods; 11.01 – distilling, rectifying and mixing of alcohols; 11.03 – production of cider and other fruit wines; 11.05 – production of beer; 11.07 – production of non-alcoholic beverages, mineral waters and other bottled waters.

Source: own calculations based on unpublished GUS data.

Tying *ROA* to capital leverage (*EM*) facilitates cause and effect analysis of return on equity (*ROE*). Data in Table 2 show that the level of leverage of the rate of return on equity has not resulted in major changes in classification of food industry sectors. This is because, in general, sectors with high levels of *ROA*, achieved high levels of *ROE*. However, this does not pertain to sectors with very low or negative return on sales and assets (10.85, 11.01). In their cases, high leverage ($3.4 \leq MK \leq 4.6$) was connected with low or negative return on equity. It is worth pointing out that beer making sector shows a particularly high rate of *ROE* in Polish food industry. Factors which contribute to high financial effectiveness of this sector include above average return on sales, asset turnover, and as a consequence, above average level of return on assets, which in combination with a relatively high leverage leads to very high return on equity.

Ordered logit models of return on equity

Table 3 presents basic descriptive statistics of 432 researched sectors of food industry for 2005-2011, taken into account (apart from *ROE*) in the design of the ordered logit model, presented in 4 classes of return on equity (*ROE*) designated on the basis of the quartile criterion. On the basis of high values of classic and positional variability, coefficients one may conclude that within the research classes of return, there is high diversification of most of variables and, furthermore, these variables strongly differentiate the designated classes.

Looking at food industry sectors with very low returns ($ROE < 6.1\%$), one could notice that, on average, they were characterised by low value added indicator ($\overline{GVAI}_{ROE1} = 15.3\%$), relatively high cost of labour resulting in generating of gross loss on sales ($\overline{LCI}_{ROE1}$ = -13.0%) and a high other revenue and operational cost indicator ($\overline{OROCI}_{ROE1}$ = 188.3%). These sectors are also characterised by high value of financial revenues and costs ($\overline{RFCI}_{ROE1}$ = -82.0%), which clearly indicate, on the one hand, substantial compensation of losses in other operational activities, on the other, generation of losses as a result of a negative balance of financial revenues and costs. Furthermore, on average in this class of return, the loss on economic activities was increased as a result of negative balance of exceptional profits and losses ($\overline{EOI}_{ROE1}$ = 98.7%). This corresponds to a very low level of the tax effect indicator ($\overline{TEI}_{ROE1}$ = 7.0%), resulting from a high frequency of presence of sectors with gross and net losses in this class of return. Negative average level of return ($\overline{ROE1}$ = -14.9%) connected with a relatively low level of turnover ($\overline{AT}_{ROE1}$ = 1.7) and close to overall average level of equity multiplier (= 2.3) was the consequence of these circumstances. It should also be pointed out that indicators under analysis in the lowest class of return (*ROE*1) are characterised by the highest – in comparison to the remaining classes – diversification, measured by classic and positional variability index.

Looking at sectors classified in remaining classes of return on equity (*ROE* 2, *ROE* 3, *ROE* 4), one can observe certain regularity. The nature of the regularity is that the higher the return class the higher the values of value added indicator, $\overline{GVAI}_{ROE2} = 18.7\% < \overline{GVAI}_{ROE3} < \overline{GVAI}_{ROE4} = 24.2\%$); lower burdening of value added with deprecation cost ($\overline{DCI}_{ROE2} = 83.1\% < DCI_{ROE3} < \overline{DCI}_{ROE4} = 87.7\%$) and labour cost ($\overline{LCI}_{ROE2} = 23.6\% < \overline{LCI}_{ROE3} < \overline{LCI}_{ROE4} = 39.8\%$); lower and decreasing, but also positive impact of other operational activities on financial results ($\overline{OROCI}_{ROE2} = 125.6\% < \overline{OROCI}_{ROE3} < \overline{OROCI}_{ROE4} = 114.9\%$); clearly weaker impact of financial activities on return ($\overline{FRCI}_{ROE2} = 82.4\% < \overline{FRCI}_{ROE3} < \overline{FRCI}_{ROE4} = 97.7\%$); marginal significance of exceptional profit and losses ($\overline{FEOI}_{ROE2} = 100\% < \overline{FEOI}_{ROE3} < \overline{FEOI}_{ROE4}$ 100.8%); more favourable impact of tax effect ($\overline{TEI}_{ROE2} = 81.7\% < \overline{TEI}_{ROE3} < \overline{TEI}_{ROE4} = 87.4\%$); stable impact of capital leverage ($\overline{EM}_{ROE2} = \overline{EM}_{ROE3} = \overline{EM}_{ROE4} = 2.2\%$); higher asset turnover ($\overline{AT}_{ROE2} = 1.9\% < \overline{AT}_{ROE3} < \overline{AT}_{ROE4} = 2.1\%$) and significant increase of the rate of return on equity $\overline{(ROE}_2 = 9.6\% < \overline{ROE}_3 < \overline{ROE}_4 = 29.8\%$).

Table 3

Descriptive statistics of variable of ROE model by classes (levels) of ROE[a]

ROE level[b]	ST c	*GVAI*	*DCI*	*LCI*	*OROCI*	*FRCI*	*EOI*	*TEI*	*AT*	*EM*	*ROE*
ROE 1 very low	1	15.3	76.4	-13.0	188.3	-82.0	98.7	7.0	1.7	2.3	-14.9
	2	14.0	78.8	7.4	109.3	37.0	100.0	71.5	1.6	2.5	-0.9
	3	45.8	13.5	-670.7	206.9	-455.5	41.7	4113.7	37.4	160.1	-365.8
	4	36.9	7.7	191.2	42.8	126.3	0.1	32.3	26.8	24.3	-862.8
ROE 2 low	1	18.7	83.1	23.6	125.6	82.4	100.0	81.7	1.9	2.2	9.6
	2	18.7	83.5	23.1	112.5	79.4	100.0	82.5	1.6	2.2	9.9
	3	34.9	5.1	39.9	46.7	48.6	1.5	8.9	38.8	21.7	18.8
	4	27.0	3.4	23.0	14.2	11.1	0.1	5.6	30.1	13.6	14.7
ROE 3 medium	1	19.1	83.9	29.9	129.9	88.6	101.3	87.3	2.0	2.2	15.6
	2	17.7	84.6	29.8	109.7	87.5	100.0	86.6	1.8	2.2	15.3
	3	39.5	4.9	33.5	72.4	17.4	12.0	12.0	38.1	19.9	14.2
	4	32.8	3.0	22.2	8.8	8.2	0.0	3.7	30.0	10.0	12.8
ROE 4 high	1	24.2	87.7	39.8	114.9	97.7	100.8	87.4	2.1	2.2	29.8
	2	25.5	87.7	36.2	104.5	94.5	100.0	87.2	2.0	2.0	25.1
	3	36.0	4.3	31.6	57.4	36.4	7.5	6.7	32.4	51.7	36.9
	4	28.1	3.0	24.1	5.9	4.0	0.0	5.2	17.4	15.4	22.9
Total	1	19.3	82.8	20.1	139.7	46.7	100.2	65.9	1.9	2.2	10.0
	2	18.50	84.2	26.6	107.7	83.9	100.0	84.9	1.8	2.2	12.5
	3	42.0	9.0	242.8	147.8	433.3	21.7	224.0	37.6	86.8	321.3
	4	34.3	3.8	33.3	11.8	15.2	0.1	6.7	26.7	18.0	55.4

[a] All variables, except *AT* and *EM*, in %.
[b] *ROE* classes: *ROE* 1 <6.1; 6.1 ≤ *ROE* 2 <12.4; 12.4 ≤ *ROE* 3 ≤ 19.9; *ROE* 4 >19.9.
[c] *ST* – descriptive statistics: 1 – arithmetic mean, 2 – median, 3 – classic variation coefficient based on arithmetic mean and standard deviation (in %), 4 – positional variation coefficient based on median and quartile deviation (in %).
Source: own elaboration.

Table 4 presents estimated parameters of the ordered logit model of return on equity of food industry sectors, the design of which uses a set of variables of the proposed *ROE* system and – additionally – binary variables representing categories of size of enterprises (*W1* – small, *W2* – medium, *W3* – large)[8]. On the basis of Wald's test of materiality of parameters, statistical materiality was found of almost all parameters of independent variables at the level of materiality p=0.05. Only variables representing the impact of exceptional profits and losses (*EOI*) and of size of an enterprise (*W2* – sector of medium enterprises) turned out to be immaterial (p>0.05). It should be noted that in the estimated model, parameters in independent variables are identical for each j category of return on equity, which results a priori from the assumption of proportional odds (assumption of parallel regressions). In order to verify this assumption, Brant's test and Wolfe and Gould test was used.

Table 4

The results of estimation of the ordered logit model of return on equity (ROE) of food industry sectors

Independent variables	Assessment of the parameter	Standard error	Wald z statistics	Materiality p	Quotient of odds
GVAI	0.233	0.029	8.120	0.000	1.263
DCI	0.134	0.034	3.940	0.000	1.144
LCI	0.148	0.014	10.230	0.000	1.159
OROCI	0.002	0.001	3.700	0.000	1.002
FRCI	0.057	0.009	6.090	0.000	1.058
EOI	-0,016	0.013	-1.250	0.210	0.984
TEI	0.109	0.017	6.450	0.000	1.115
AT	2.062	0.272	7.570	0.000	7.860
EM	1.309	0.298	4.400	0.000	3.702
W2	0.413	0.304	1.360	0.175	1.511
W3	0.768	0.337	2.280	0.023	2.155
cut1	36.026	3.590	–	–	–
cut2	39.989	3.754	–	–	–
cut3	43.177	3.875	–	–	–

Source: own calculations.

As the data in Table 5 show, the concurrent Brant and Wolfe and Gould tests for all parameters are statistically material (p<0.05), which signifies a disruption of the assumption of parallel regressions. Individual test shows that two variables are responsible for this: *DCI* variable providing information on the

[8] The sector of small enterprises from the food industry (*W1*) was taken as a reference level (benchmark) STATA 12 software was used to estimate the parameters of ordered logit models.

impact of depreciation and *LCI* variable providing information on the impact of remuneration on *ROE*. Thus, this means that coefficients at these independent variable significantly differ between the pairs of compared *ROE* classes. On the other hand, parameters for the remaining variables differ much less, least of all for variable *OROCI* (p=0.901), providing information on the impact of the so-called other operational activities on *ROE*.

Table 5

The results of estimation of the ordered logit model for pairs of compared groups of categories of return on equity (ROE) of food industry sectors and tests of Brant and Wolfe&Gould

Independent variables	*ROE 1 in comparison to ROE 2,3,4*	*ROE 1* in comparison to *ROE 3,4*	*ROE 1,2,3* in comparison to *ROE 4*	Test statistics *chi2*	Materiality *p*	*df*
GVAI	0.2565	0.2347	0.3263	2.090	0.351	2
DCI	0.0738	0.0612	0.2952	9.990	0.007	2
LCI	0.0903	0.1547	0.1990	9.400	0.009	2
OROCI	0.0007	0.0032	0.0056	0.210	0.901	2
FRCI	0.0418	0.0413	0.0532	1.360	0.508	2
EOI	0.0599	0.0786	-0.0073	1.240	0.537	2
TEI	0.1565	0.1641	0.0694	5.880	0.053	2
AT	2.9737	2.1482	2.7255	1.370	0.503	2
EM	0.4864	1.4330	1.4890	3.000	0.223	2
W2	-0.4827	1.1166	0.5691	4.410	0.110	2
W3	0.7316	1.2705	0.7404	0.750	0.687	2
Constant	-39.2564	-48.2125	-60.0095			
Concurrent Brant test	–	–	–	79.130	0.000	22
Concurrent Wolfe& Gould test	–	–	–	54.94	0.000	22

Source: own calculations.

As a consequence of non-fulfilment of the assumption of proportional odds (parallel regressions, parallelism of lines), in the subsequent stage of analysis parameters of a generalised ordered logit model were estimated, which takes into account variability of parameters at independent variable depending on *ROE* class (level).

The generalised ordered logit model presented in Table 6 is characterised by a very good match to empirical data (McKelvey & Zavoina's R^2 = 0.994; counting R^2 = 0.780; pseudo R^2 = 0.655) and statistical materiality (p>0.05) of most of parameters at independent variables. In the first group of comparisons of the level of return on equity (*ROE 1* to *ROE 2, 3, 4*), the parameters at variables *DCI, OROCI, FRCI, EM*, as well as *W2* and *W3* turned out to be statistically immaterial (*p*>0,05). Thus, it means that a very low rate of *ROE* (*ROE 1*) in relation to higher rates of *ROE* (*ROE 2, 3, 4*), is not conditioned by depreciation costs, effectiveness of other operational activities, financial activities, capital leverage or size of enterprises. Taking into account subsequent comparisons of the level of *ROE* (*ROE 1, 2* to *ROE 3, 4* and *ROE 1, 2, 3* to *ROE 4*), one can observe that these were only the parameters at variables providing information on the impact of exceptional occurrences (*EOI*), impact of tax effect (*TEI*) and impact of size of enterprises (*W2*, *W3*) that turned out to be immaterial.

When analysing the values of parameters of the generalised ordered logit model included in Table 6, one could observe that very low return on equity (*ROE 1*) in comparison to remaining higher classes of return (*ROE 2, 3, 4*) was strongly connected to the value added indicator (*GVAI*), labour cost indicator (*LCI*), cost and financial revenue indicator (*FRCI*), tax effect indicator (*TEI*) and asset turnover (*AT*). These variables had a positive impact on the odds for changing from the lowest class of return (*ROE 1*) to a higher one (*ROE 2, 3* or *4*). For example, a unit increase (by one percentage point) of *GVAI* variable increases the odds of food industry sector with a very low return (*ROE*) for progressing to a higher (*ROE 2, 3, 4*) level of return (with the assumption of ceteris paribus) by as much as 1.229 times. On the other hand, a unit increase of the value of variable *LCI* increases these odds by 1.083 times, *FRCI* 1.037 times, *TEI* 1.140 times and *AT* by as much as 9.503 times (which is related to the unit in which *AT* variable is measured. One could, thus, conclude that primary sources of progressing from very low return on equity are first of all: improvement of the capacity to generate value added, reduction of financial costs, tax optimisation and more productive use of assets.

When comparing food industry sectors with very low (*ROE 1*) and low (*ROE 2*) levels of ROE with sectors with medium (*ROE 3*) and high returns (*ROE 4*), it was noted that all independent variables had substantially positive impacts on the odds for improvement of financial situation. It means that a unit increase of these variable generated increased odds for progressing from low (*ROE 1,2*) to high (*ROE 3, 4*) categories of return on equity. Thus, the basic opportunities for achieving good financial results, measured by the rate of return on equity (*ROE 3, 4*) should be sought in: stimulation of technological progress, facilitating achieving a high ratio of value added to revenue (*GVAI*); rational investment in tangible assets and rational management of these components of assets (*DCI*); in increased labour productivity, reducing unit costs of labour, thus increasing the share on profit of sales in value added (*LCI*); in effective management of other operational activities (*OROCI*); in rational policy of financing of activities, reducing the scale of decrease of profit as a result of financial costs (*FRCI*), combined with a rational level of capital leverage (*EM*) and tax optimisation (*TEI*, as well as in increased productivity of assets (*AT*). One could also note that the higher the initial class of return on equity, the bigger the odds to progress to a higher class of return under the influence of increase in the level of independent variables listed above.

Table 6

*The results of estimation of the generalised ordered logit model of return on equity (*ROE*) of food industry sectors*

Independent variables	Assessment of the parameter	Standard error	Wald *z* statistics	Materiality *p*	Quotient of odds
Very low (*ROE 1*) level of *ROE* in comparison to low (*ROE 2*), medium (*ROE 3*) and high (*ROE 4*) level of *ROE*					
GVAI	0.206	0.067	3.080	0.002	1.229
DCI	0.117	0.063	1.850	0.064	1.124
LCI	0.080	0.022	3.680	0.000	1.083
OROCI	0.001	0.001	0.980	0.328	1.001
FRCI	0.036	0.009	4.160	0.000	1.037
EOI	0.050	0.060	0.830	0.407	1.051
TEI	0.131	0.028	4.610	0.000	1.140
AT	2.252	0.775	2.910	0.004	9.503
EM	0.543	0.487	1.110	0.265	1.721
W2	-0.140	0.720	-0.190	0.846	0.869
W3	0.871	0.804	1.080	0.279	2.388
Constant	-37.390	9.371	-3.990	0.000	0.000
Very low (*ROE 1*) and low (*ROE 2*) level of *ROE* in comparison to medium (*ROE 3*) and high (*ROE 4*) level of *ROE*					
GVAI	0.309	0.057	5.370	0.000	1.361
DCI	0.116	0.054	2.140	0.033	1.123
LCI	0.242	0.034	7.020	0.000	1.274
OROCI	0.017	0.003	4.900	0.000	1.017
FRCI	0.059	0.010	5.740	0.000	1.061
EOI	0.219	0.168	1.300	0.194	1.244
TEI	0.196	0.035	5.570	0.000	1.216
AT	2.834	0.517	5.480	0.000	17.016
EM	2.145	0.535	4.010	0.000	8.546
W2	0.440	0.506	0.870	0.385	1.553
W3	0.765	0.556	1.380	0.169	2.148
Constant	-78.676	19.079	-4.120	0.000	0.000
Very low (*ROE 1*), low (*ROE 2*) and medium (*ROE 3*) level of *ROE* in comparison to high (*ROE 4*) level of *ROE*					
GVAI	0.399	0.065	6.120	0.000	1.491
DCI	0.327	0.078	4.160	0.000	1.387
LCI	0.241	0.034	7.000	0.000	1.273
OROCI	0.020	0.004	5.390	0.000	1.020
FRCI	0.104	0.025	4.160	0.000	1.110
EOI	0.043	0.027	1.610	0.108	1.044
TEI	0.034	0.034	1.000	0.319	1.034
AT	3.587	0.626	5.730	0.000	36.132
EM	2.396	0.813	2.950	0.003	10.979
W2	0.370	0.651	0.570	0.570	1.447
W3	1.029	0.722	1.430	0.154	2.798
Constant	-77.863	11.052	-7.030	0.000	0.000
McKelvey & Zavoina's $R^2 = 0.994$; counting $R^2 = 0.780$; pseudo $R^2 = 0.655$					

Source: own calculations.

Summary and conclusions

Decomposition of synthetic measures of profitability substantially broadens opportunities to analyse the reasons for diversification of returns. The system for decomposition of return on equity proposed in the paper facilitates multidimensional analysis of determinants of this category of profitability. Its implementation to the sectors of food industry, with the application of logit regression models of ordered categories showed that the reasons for diversification of ROE in food industry sectors should be sought primarily in the capacity to generate value added, labour costs, rational management of financial costs, effective use of assets, as well as more aggressive shaping of capital structure determining the financial leverage. In summary, the applied ordered logit model of return on equity turned out to be a very good tool to assess materiality of the factor influencing the level of ROE rates at the level of food industry sectors. Furthermore, the proposed model holds practical, and application values. It facilitates forecasting of likely scenarios for progressing from a very low level of return on equity to more and more favourable financial results, measured by this category of profitability.

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