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OPERATING RISK OF POLISH PUBLIC COMPANIES – SECTORAL DIFFERENCES

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ABSTRACT. All companies which have to pay fixed costs face the problem of operating risk measured by operating leverage. In the case of sales growth (fall), the mechanism of operating leverage accelerates a rise (decrease) in operating profit. The strength of the impact of the operating leverage effect depends on the share of fixed costs in the structure of operating costs. The bigger the share, the stronger the change in the sale volume multiplies the change in operating profit. This is the reason why companies that are heavily burdened by fixed costs, specifically depreciation, should be characterized as those having a higher level of operating risk. The aim of the research the results of which are presented in this article was to test two hypotheses: firstly, production companies are characterized by a higher level of operating risk than service and trade enterprises and, secondly, the lowest level of operating risk characterizes trade companies.

JEL Classification: G30 ***Keywords***: operating risk, degree of operating risk.

Introduction

Each business entity taking decisions how to distribute resources is exposed to the risk of volatile conditions in which the decision was taken. For example, the choice of a specific basket of goods by the consumer ceases to be optimal if at the time of the purchase the price of at least one of the goods is different than at the moment when the decision was taken. Another example, which is a common experience of all companies, is a level of sales that diverges from the plan. If entrepreneurs sell less than planned, they will make a lower operating profit, and the decrease will bring a lower net profit. The relationships between the decrease levels may be more, or less strongly correlated.

The impact of the changes in the sales volume on the change in operating profit depends on the scale of operating risk. "Operating risk is related to the uncertainty about future operating cash flows of the company" (Duliniec, 1997, p. 47). These in turn are strongly dependent on the operating profit (EBIT). Some authors define operating risk as the possibility of divergence of operating profit from its projected value (Brigham, 1996, p. 173).

The model used to analyze operating risk breaks down costs into fixed and variable, where the unit variable cost is fixed. This means that the function of the operating profit is linear:

$$EBIT(Q) = Qp - Qv - F \qquad (1)$$

where:
$EBIT$ – operating profit,
Q – sales volume,
p – price of goods sold,
v – unit variable cost,
F – fixed cost.

Since the days of pioneering research on operational risk in enterprises until today it has been measured by means of the degree of operating leverage (DOL – degree of operating leverage), defined as (Arellano, Scofield, 2014):

$$DOL = \frac{\%\Delta EBIT}{\%\Delta R} \qquad (2)$$

where:
R – sale revenues that changes only under the influence of changes in sale volume; analysis of operating leverage assumes a constant sales price *(R=Qp)*.

The degree of operating leverage measures how many times the growth rate of operating profit exceeds the growth rate of revenues caused by an increase in quantity sold, which is the primary cause of both changes. In the event of a decrease in sales a relative change in *EBIT* and *R* have a negative sign, however, the *DOL* still remains positive.

To identify the factors affecting the value of the degree of operating leverage a few simple transformations should be made:

$$DOL = \frac{\%\Delta EBIT}{\%\Delta R} = \frac{\Delta EBIT}{EBIT_0} \cdot \frac{R_0}{\Delta R} = \frac{\Delta Q(p-v)}{EBIT_0} \cdot \frac{R_0}{\Delta Qp} = \frac{(p-v)}{p} \cdot \frac{R_0}{EBIT_0} \qquad (3)$$

Formula (3) shows that the degree of operating leverage depends on the initial level of revenues and operating profit, but also on the contribution margin percentage. Following Vollmuth, the author understands the value contribution margin as the ratio of the difference between revenues and variable costs to total revenue (Vollmuth, 1995, p. 73). In relative terms, it can also be expressed as the quotient of the difference between the price and variable unit cost, and the price. Therefore, a hypothesis can be formulated that companies pursuing higher relative contribution margin will have a higher degree of operating leverage. It is commonly believed that trade companies are characterized by the lowest level of relative contribution margin, making profits on the low percentage of contribution margin and a high level of sales volume. Production companies and service providers will be characterized by a higher level of contribution margin coverage and hence a higher level of *DOL*.

Further transforming the formula (3) we get:

$$DOL = \frac{(p-v)}{p} \cdot \frac{R_0}{EBIT_0} = \frac{(p-v)}{p} \cdot \frac{Qp}{EBIT_0} = \frac{Q(p-v)}{EBIT_0} = \frac{EBIT_0+F}{EBIT_0} = 1 + \frac{F}{EBIT_0} \qquad (4)$$

This form of the formula defining the *DOL* indicates a significant positive correlation with the level of fixed costs. The higher is the fixed costs, the higher is the operational risk. In the production sector the burden of tangible fixed assets generates high depreciation costs, which constitute the dominant part of fixed costs. Hence, the hypothesis that production companies are characterized by higher levels of the degree of operating leverage than service and trade companies is taken in this article.

The goal of empirical research which constitutes the core of this article is to test the hypothesis which proposes that among Polish companies listed on the Warsaw Stock

Exchange the production sector companies will have the highest level of DOL, while the trade companies the lowest.

1. Earlier studies

Estimating the degree of operating leverage based on empirical data was initially carried out by means of Lev's (1974) pioneering method. He examined the relationship between the levels of operating and financial leverage and the systematic risk for 121 US public companies from the sectors of: electricity, steel and fuel production. The homogeneity of products in these industries enabled Lev to estimate regression equations for each company (Lev, 1974, p. 633):

$$TC_{jt}(Q_{jt}) = a_j + v_j Q_{jt} + \varepsilon_{jt}, \qquad (5)$$

where:
TC_{jt} – total cost of the company *j* in period *t*,
a_j – fixed cost of the company j,
v_j – variable cost per unit of product of the company j,
Q_{jt} – amount of goods sold in the company j in period t,
ε_{jt} – value of the random factor.

The choice of industries with homogenous production brought very high average values of determination coefficients, R^2=0.98 in the energy and fuel sectors, and 0.96 in the steel production sector. The values of fixed cost and theoretical *EBIT* allowed the author to determine the *DOL* for the companies surveyed. The test result indicated that the lower the variable cost per unit, the higher the degree of operating leverage. Later studies did not confirm this relationship (Boetsman, Revsine, 1978; Gahlon, 1981).

Another approach to *DOL* estimation was adopted by Mandelker and Rhee (1984). Starting with the treatment degree of operating leverage as a measure of elasticity they estimated the *DOL* using the regression equation (Mandelker, Rhee, 1984, p. 50):

$$lnEBIT_{jt} = a_j + L_j lnR_{jt} + \varepsilon_{jt}. \qquad (6)$$

The factor L_j is closely linked to the degree of operating leverage. It is also a slope of the linear regression equation in which the dependent variable is the natural logarithm of operating profit and the explanatory variable is the revenues' logarithm. The Mandelker and Rhee method is simple to use, but it brings results that are difficult to interpret from a theoretical point of view. For 10 industries analyzed, the authors obtained the *DOL* of less than 1 in seven cases (Mandelker, Rhee, 1984, p. 50). If fixed costs are present in the cost structure of companies, and it is so in nearly every case, the degree of operating leverage should be higher than 1. It should be noted that the authors needed the *DOL* to detect the relationship of this variable with the variable β describing the systematic risk. For this purpose what is important is the variation and not a value.

The second canonical approach to estimating the degree of operating leverage is – O'Brien and Vanderherheiden's idea (1987). They proposed estimating *DOL* in two stages. First, they estimated the trend equation for natural logarithms of operating profit and sales revenue (O'Brien, Vanderherheiden, 1987, p. 47):

$$lnEBIT_t = lnEBIT_0 + gt + \mu_t, \qquad (7)$$

where:
g – growth rate of the expected level of operating profit,

t – subsequent period number in the time span of the analysis,
μ_t – relative deviation of the expected value of operating profit from the actual value; compound percentage by which the change in EBIT compared with the expected value.

The authors designated a similar equation trend for sales revenue:

$$lnR_t = lnR_0 + ht + \lambda_t, \qquad (8)$$

where:
h – growth rate of the expected level of operating profit,
λ_t – relative deviation of the expected value of revenue from the real value; compound percentage of sales compared to expected value.

Estimation of μ_t and λ_t parameters allows us to determine the regression equation, in which the degree of operating leverage is the parameter:

$$\mu_t = D\lambda_t + \varepsilon_t. \qquad (9)$$

where:
D – a variable closely related to the degree of operating leverage.

The absolute term of the equation (9) equals zero, because the growth rates, which are variables here have means equal zero. *DOL* is the regression coefficient of the equation because it measures the average sensitivity of the operating profit deviation from the trend to the average deviation of sales from the trend.

The authors compared the results of applying this method (O&V) and Mandelker and Rhee's method (M&R) on a sample of 100 US companies. The conclusions spoke in favour of the new approach. The *DOL* values did not fall around 1 on average when the new method was applied, as in the case of the M&R method. Moreover, the vast majority of companies (73) showed a level of *DOL* greater than 1, which is closer to the theoretical indication. Thirdly, in the case of 64 companies the estimated *DOL* meet the assumption of constant measure of operational risk (O'Brien, Vanderherheiden, 1987, p. 49).

From the perspective of this article, it is important that O'Brien and Vanderherheiden also tested the hypotheses about the impact of tangible fixed assets on the level of *DOL*. They built four indicators describing this factor: the relationship of assets to sales revenues, the relation of depreciation to sales revenues, the share of fixed assets in total assets, and the relation of depreciation to total assets. Unfortunately, in none of the four cases did they observe a statistically significant relationship (O'Brien, Vanderherheiden, 1987, p. 50).

An independent comparison of the methods (M&R) and (O&V) was made by Dugan and Shriver (1992). Using the data from 245 companies in seven industries they counted their *DOL* using both methods. They adopted two hypotheses. First, the degrees of operating leverage for a given industry are the same for both methods. Secondly, the share of companies with DOL factor higher than 1 is the same, regardless of the method used (Dugan, Shriver, 1992, pp. 314-315). The first hypothesis was rejected. So was the second one. The (O&V) method brought a much larger percentage of companies with *DOL*> 1.

The inability to obtain financial data on the division of operating costs into fixed and variable ones forced the researchers who studied relationships between accounting measures of risk and market systematic risk to use a surrogate measure for the degree of operating leverage (*proxies*). Novy-Marx used the ratio of operating costs to assets (2011, p. 110). Gulen, Xing and Zhang accepted the share of fixed assets in total assets as a surrogate variable (2008, p. 21). None of these attempts brought DOL estimates that can be interpreted from a managerial point of view.

In the further part of this article we will propose a method of calculating the degree of operating leverage using available accounting data for companies listed on the WSE. To test it, an empirical study was conducted to verify the differences in DOL levels among industries: manufacturing, trade and services.

2. Description of the test method

The research sample comprised 84 companies listed on the main market of the Warsaw Stock Exchange (35 manufacturing, 37 services and 12 trade companies). The sample structure corresponds to the structure of the population. Additionally, the sample selection process aimed at identifying those companies that could show a sufficiently long reporting history as the public market entity.

The first step was the estimation of linear regression equations describing the total operating cost for each of the analyzed companies. To eliminate the impact of price changes on the volatility of revenues and operating costs, the quarterly time series were limited to the prices in the first quarter of 2014, using quarterly indices of CPI. Counting the operating costs in fixed prices depreciation was left out for the time of multiplication by appropriate deflators. As an expense that is not subject to the current impact of inflation until the next investment, depreciation behaves differently than other operating costs. In order to minimize the distortion of results, it was assumed that depreciation in financial statements is already expressed in fixed prices[1]. This resulted in a series of revenues and operating costs whose volatility arises solely from changes in the quantity sold.

Then, regression equations were estimated for each company:

$$TC_{it}(R_{it}) = F_i + v_i R_{it} + \varepsilon$$

where:
TC_{it} – theoretical total cost of operating the company *i* in a quarter *t*,
F_i – quarterly theoretical total fixed cost of the company,
R_{it} – revenues of the company *i* in a quarter *t*,
v_i – theoretical variable cost per unit per 1 zloty revenue in the company *i*,
ε – random error.

The absolute term and the slope (the *regression coefficient*) of the regression equation allow to divide the operating cost into fixed and variable ones. Potentially, time series covered the period from the 1Q1998 to the 1Q2014. Regression equations were estimated for the periods for which it was possible to obtain statistically significant parameters of the linear equation (α=0.05). Problems with estimating the regression equation for the whole time span of the analysis occurred, for example, while in its course a huge investment was being made which dramatically increased the production capacity. A sample graphic interpretation of the estimated regression equation for the Kompap company in the period of the 1Q2004 - 1Q2014 is shown in *Figure 1*.

[1] In the original version of the study depreciation was included into fixed cost as a subject to the constant prices recalculation (Kalinowski, 2011).

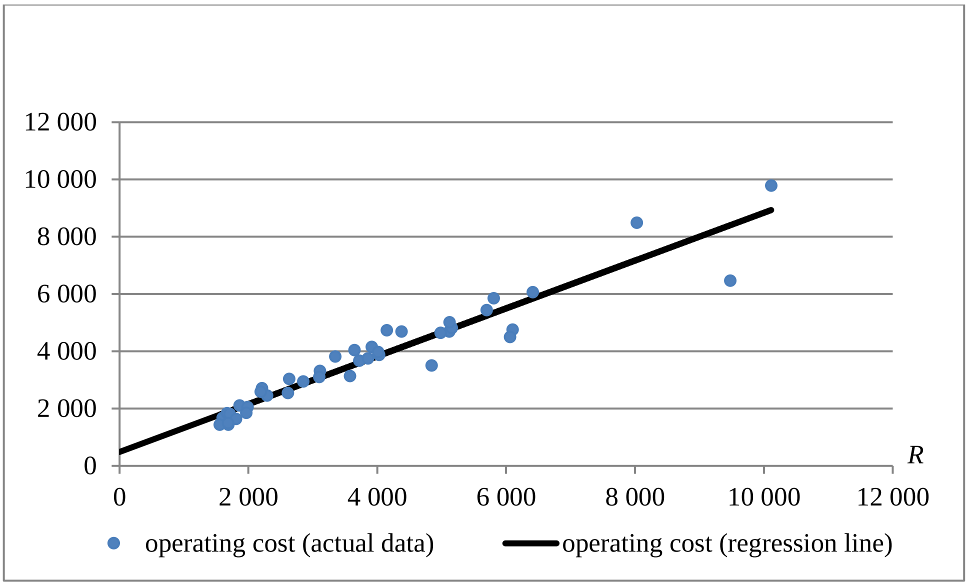

Figure 1. Relationship between operating costs and revenues in Kompap S.A. (thousand PLN)
Source: own research.

It became possible to obtain a series of operating profits calculated from the theoretical values of operating cost. The *DOL* was calculated for each quarter according to the formula (4):

$$DOL_{it} = 1 + \frac{F_i}{EBIT_{it}}$$

where:
DOL_{it} – degree of operating leverage of the company *i* in the quarter *t*,
$EBIT_{it}$ – theoretical operating profit of the company *i* in the quarter *t*.

Subsequently, we omitted those quarterly *DOL* values that were incompatible with the essence of operating leverage, namely those negative (changes in revenue and operating profits with different characters) or positive, but lower than 1 (operating profit changes more slowly than revenues, despite the presence of fixed costs in the structure of operating costs). The maximum and minimum values were also removed from the list of values of operating leverage degree for each company. In fact, quite frequently near zero positive *EBIT* values occurred, which resulted in enormously high values of operating leverage degree. An arithmetic mean was calculated based on the remaining values.

3. Results of the study

As noted earlier, the subject of the analysis was the financial statements of 84 companies from the main trading floor of the Warsaw Stock Exchange. They were subdivided into three industry subsets:

- trade (12 companies):
  - retail trade (had),
  - wholesale traders (hah),
- production (35 companies):
  - car parts production (mot),
  - production of energy (ene),
  - building materials industry (mbu),
  - metal production (met),

  - production of clothes and fabrics (lek),
  - production of plastics (tws),
  - production of electrical equipment (ele)
  - chemical industry (che),
  - wood processing (drz),
  - cosmetics industry (far),
  - fuel industry (pal),
  - food industry (spo),
- services (37 companies):
  - construction (bud),
  - developers (dew),
  - software services (inf),
  - media (med),
  - telecommunication (tel).

Table 1 presents the estimation results of regression equations for operating costs and operating leverage for companies in the sample. It also presents a specified time interval for which regression equations were estimated.

Table 1. Degrees of operating leverage for Polish public companies listed on the WSE

	Company	Branch	Test of significance (p)		R^2	Data from period	***DOL***	sector
			F	*v*				
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	BOMI	had	0,0044	0,0000	0,9505	4Q2003-4Q2008	**4,78**	trade
2	EMPERIA	had	0,0437	0,0000	0,9753	1Q2003-3Q2006	**3,01**	trade
3	KOMPUTRONIK	had	0,0152	0,0000	0,9988	1Q2006-1Q2009	**3,19**	trade
4	OPONEO	had	0,0043	0,0000	0,9974	4Q2006-4Q2010	**3,18**	trade
5	TELL	had	0,0304	0,0000	0,9623	1Q2008-4Q2011	**3,20**	trade
6	AMPLI	hah	0,0003	0,0000	0,9954	4Q2006-4Q2013	**4,58**	trade
7	ATLANTA POLAND	hah	0,0100	0,0000	0,9891	3Q2003-1Q2013	**2,48**	trade
8	COGNOR	hah	0,0000	0,0000	0,9821	2Q1999-2Q2007	**3,92**	trade
9	EFEKT	hah	0,0185	0,0000	0,5833	1Q2008-4Q2013	**2,91**	trade
10	INTERCARS	hah	0,0091	0,0000	0,9968	1Q2003-1Q2008	**2,81**	trade
11	KRAKCHEMIA	hah	0,0213	0,0000	0,9957	3Q2006-1Q2014	**3,10**	trade
12	STALPROFIL	hah	0,0053	0,0000	0,9876	1Q1998-1Q2014	**3,46**	trade
13	AZOTY	che	0,0030	0,0000	0,8392	2Q2007-4Q2013	**5,07**	production
14	BORYSZEW	che	0,0018	0,0000	0,9748	1Q1998-4Q2004	**3,70**	production
15	POLICE	che	0,0000	0,0000	0,7679	2Q2004-1Q2014	**7,40**	production
16	PUŁAWY	che	0,0009	0,0000	0,9750	2Q2004-1Q2014	**4,14**	production
17	SYNTHOS	che	0,0139	0,0195	0,2241	1Q2008-4Q2013	**7,07**	production
18	FORTE	drz	0,0357	0,0000	0,9330	3Q2006-1Q2014	**5,89**	production
19	GRAJEWO	drz	0,0008	0,0000	0,8041	1Q1998-4Q2002	**3,61**	production
20	KOMPAP	drz	0,0132	0,0000	0,9091	1Q2004-1Q2014	**10,35**	production
21	APATOR	ele	0,0126	0,0000	0,7986	1Q2000-1Q2008	**4,39**	production
22	KABLE	ele	0,0036	0,0000	0,9905	1Q1998-1Q2010	**4,56**	production
23	BEDZIN	ene	0,0000	0,0000	0,9227	1Q1998-1Q2014	**5,15**	production
24	KOGENERACJA	ene	0,0000	0,0000	0,8977	4Q1999-1Q2014	**3,36**	production

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
25	TAURON	ene	0,0245	0,0000	0,9897	1Q2010-1Q2014	**13,01**	production
26	POLLENA	far	0,0000	0,0000	0,9672	1Q1998-1Q2010	**5,15**	production
27	LUBAWA	lek	0,0000	0,0000	0,9503	1Q1998-1Q2014	**3,86**	production
28	PRÓCHNIK	lek	0,0000	0,0000	0,9746	1Q1998-1Q2014	**9,23**	production
29	SANWIL	lek	0,0394	0,0000	0,7661	1Q1998-4Q2008	**5,01**	production
30	VISTULA	lek	0,0287	0,0000	0,8121	4Q2006-1Q2014	**6,60**	production
31	DECORA	mbu	0,0301	0,0000	0,8446	3Q2006-4Q2013	**8,64**	production
32	YAWAL	mbu	0,0038	0,0000	0,9849	1Q1998-1Q2014	**8,10**	production
33	ALCHEMIA	met	0,0001	0,0000	0,9910	1Q1998-4Q2010	**7,29**	production
34	FERRUM	met	0,0454	0,0000	0,9749	1Q1998-1Q2014	**3,84**	production
35	KGHM	met	0,0000	0,0000	0,8643	1Q1998-1Q2014	**4,72**	production
36	GROCLIN	mot	0,0367	0,0000	0,9906	1Q1998-1Q2014	**3,55**	production
37	PKN ORLEN	pal	0,0039	0,0000	0,9638	1Q2000-4Q2006	**6,42**	production
38	BEEFSAN	spo	0,0000	0,0000	0,9970	1Q1998-1Q2010	**5,23**	production
39	INDYKPOL	spo	0,0263	0,0000	0,9653	3Q2000-2Q2007	**7,17**	production
40	JUTRZENKA	spo	0,0081	0,0000	0,9381	1Q1998-3Q2005	**5,07**	production
41	KOFOLA	spo	0,0002	0,0000	0,9900	4Q2001-4Q2007	**5,97**	production
42	MIESZKO	spo	0,0219	0,0000	0,9860	1Q1998-1Q2014	**4,57**	production
43	PEPEES	spo	0,0002	0,0000	0,9588	1Q1998-1Q2014	**6,93**	production
44	WILBO	spo	0,0061	0,0000	0,9834	1Q1998-1Q2014	**6,78**	production
45	ŻYWIEC	spo	0,0214	0,0000	0,7687	2Q2004-1Q2009	**6,69**	production
46	LENTEX	tws	0,0000	0,0000	0,8931	1Q1998-4Q2013	**6,52**	production
47	SUWARY	tws	0,0230	0,0000	0,9808	1Q1998-1Q2010	**4,17**	production
48	BUDIMEX	bud	0,0032	0,0000	0,9362	1Q1998-4Q2006	**10,13**	services
49	BUDOPOL	bud	0,0001	0,0000	0,9362	1Q1998-1Q2014	**6,34**	services
50	ELEKTROBU-DOWA	bud	0,0252	0,0000	0,9741	1Q1998-2Q2006	**2,38**	services
51	INSTAL KRAKÓW	bud	0,0000	0,0000	0,9823	1Q1998-1Q2014	**10,07**	services
52	MOSTOSTAL EXPORT	bud	0,0000	0,0000	0,9362	1Q1999-1Q2014	**2,94**	services
53	MOSTOSTAL PŁOCK	bud	0,0000	0,0000	0,9534	1Q1998-4Q2013	**6,24**	services
54	MOSTOSTAL WARSZAWA	bud	0,0240	0,0000	0,9632	1Q1998-3Q2006	**5,74**	services
55	PROCHEM	bud	0,0200	0,0000	0,9960	1Q2006-1Q2014	**3,26**	services
56	PROJPRZEM	bud	0,0060	0,0000	0,9839	1Q1998-1Q2014	**2,50**	services
57	ULMA CONSTRUCTION	bud	0,0000	0,0000	0,8724	1Q1998-1Q2014	**7,44**	services
58	ECHO	dew	0,0097	0,0000	0,9686	2Q2008-4Q2011	**3,00**	services
59	TRITON DEVELOPEMENT	dew	0,0025	0,0000	0,9966	1Q1998-1Q2014	**3,48**	services
60	WIKANA	dew	0,0001	0,0000	0,9534	1Q1998-1Q2006	**7,58**	services
61	ORBIS	hir	0,0176	0,0000	0,8261	1Q1998-3Q2013	**3,17**	services
62	ARCUS	inf	0,0166	0,0000	0,9935	3Q2006-1Q2014	**3,80**	services
63	ASSECO POLAND	inf	0,0265	0,0000	0,9337	1Q1998-1Q2014	**2,00**	services
64	ATM	inf	0,0314	0,0000	0,9598	1Q2003-4Q2011	**3,06**	services
65	BETACOM	inf	0,0445	0,0000	0,9896	2Q2002-1Q2014	**3,32**	services

1	2	3	4	5	6	7	8	9
66	COMARCH	inf	0,0442	0,0000	0,9854	4Q1999-4Q2011	**2,00**	services
67	COMP	inf	0,0167	0,0000	0,9548	4Q2007-1Q2014	**5,27**	services
68	ELZAB	inf	0,0102	0,0000	0,9393	1Q1998-1Q2014	**2,21**	services
69	PC GUARD	inf	0,0008	0,0000	0,5524	4Q2006-1Q2013	**4,78**	services
70	PROCAD	inf	0,0012	0,0000	0,9846	4Q2005-1Q2014	**7,96**	services
71	QUANTUM	inf	0,0168	0,0000	0,5680	3Q2006-1Q2014	**6,19**	services
72	QUMAK	inf	0,0282	0,0000	0,9844	2Q2008-3Q2012	**4,24**	services
73	SIMPLE	inf	0,0137	0,0000	0,8249	1Q1998-1Q2014	**5,56**	services
74	SYGNITY	inf	0,0021	0,0000	0,9212	1Q1998-4Q2013	**4,41**	services
75	TALEX	inf	0,0163	0,0000	0,9870	1Q1999-1Q2014	**3,20**	services
76	UNIMA	inf	0,0481	0,0000	0,9933	4Q2011-1Q2014	**5,39**	services
77	AGORA	med.	0,0474	0,0000	0,6803	1Q1998-1Q2014	**6,96**	services
78	K2INTERNET	med.	0,0415	0,0000	0,6998	4Q2008-1Q2014	**3,92**	services
79	MUZA	med.	0,0002	0,0000	0,7792	3Q2004-1Q2010	**3,46**	services
80	PM POINT GROUP	med.	0,0000	0,0000	0,7053	1Q2007-1Q2014	**7,35**	services
81	TVN	med.	0,0024	0,0000	0,8331	4Q2003-1Q2014	**2,14**	services
82	HYPERION	tel	0,0016	0,0004	0,3341	4Q2005-4Q2013	**5,36**	services
83	DROP	uin	0,0203	0,0000	0,9998	4Q2006-1Q2014	**1,31**	services
84	PEKAES	uin	0,0000	0,0000	0,6386	1Q1998-3Q2006	**7,40**	services

The results of determination measurement for estimated equations are quite promising. According to Aczel's classification (Aczel, 2000, p. 493), 59 regression equations are characterized as very well adapted ($R^2 > 0.9$), 11 well adapted ($0.9 > R^2 > 0.8$) and 9 satisfactory ($0.8 > R^2 > 0.6$). Only 5 companies are described by the R^2coefficient lower than 0.6.

Column 8 in *Table 1* is the most important one because it presents average values of the operating leverage degree for each of the companies analyzed. The highest value was recorded for Tauron SA, one of the main producers of electricity in Poland. The company has been listed since 2010. The financial data made it possible to calculate the quarterly *DOL*, in which, after the removal of the maximum (48.2) and minimum (1.8) values, there were still cases of 44.2 and 25.7. These high *DOL* values result from the low level of EBIT in respective quarters. The lowest value of the operating leverage degree represents the level of operational risk in Drop SA (1.31). This company operating in the area of waste management, owes the low level of operational risk to the low value of fixed costs in relation to operating profit.

To examine the samples compared, the basic statistics were initially calculated for each of them. Although it is insignificant from the perspective of statistical inference, test averages are arranged in accordance with the accepted hypotheses.

Table 2. Basic measures of DOL values in samples compared

	N valid	Mean value	Minimum	Maksimum	Standard deviation
trade	12	3,3857	2,4791	4,7808	0,6988
production	35	5,9780	3,3631	13,0052	2,1130
services	37	4,7445	1,3070	10,1256	2,2698

Source: own research.

It is important to note that the *DOL* values in each of the three trials met the test of distribution normality. The results are inconclusive. Both tests gave an indication of compliance with normal distribution for the sample of trading companies. In the case of production companies, Shapiro-Wilk's test allows to reject the null hypothesis of compliance with normal distribution. The Kolmogorov-Smirnov's test with Lillefors correction gives the opposite indication. The tests change their indications for the sample of service enterprises.

Table 3. Distribution normality test for samples

	Shapiro-Wilk test α=0,05		Kolmogorow-Smirnow test with Lillefors correction α=0,05	
	W from sample	critical W	d from sample	critical d
trade	**0,873**	**0,859**	**0,2691**	**0,2420**
production	0,899	0,934	**0,1532**	**0,1498**
services	**0,939**	**0,937**	0,1439	0,1457

Source: own research.

The results of the test of distribution normality caused that the hypotheses adopted in the study were tested both with parametric and nonparametric tests.

Table 4. Results of Student's t-test for samples of trade and production companies

Mean value for trade companies	Mean value for production companies	t	df	p	F statistics for variances	p for variances
3,3857	5,9780	-4,1464	45	0,0001	9,1443	0,0004

Source: own research.

The values of the degree of operating leverage for production companies are higher in comparison with the values for the trade sample. This result is consistent with the adopted hypothesis. The test of variances conformity does not allow to reject the nul hypothesis that the variances are different.

Table 5. Results of Student's t-test for samples of production and service companies

Mean value for production companies	Mean value for service companies	t	df	p	F statistics for variances	p for variances
5,9780	4,7445	2,3832	70	0,0001	1,1539	0,6769

Source: own research.

The values of the degree of operating leverage for production companies are higher compared with the values in the sample of service companies. This result is consistent with the adopted hypothesis. The test of variances conformity allows for the rejection of the hypothesis that values vary.

Table 6. Results of Student's t-test for samples of trade and service companies

Mean value for trade companies	Mean value for service companies	t	df	p	F statistics for variances	p for variances
3,3857	4,7445	-2,0298	47	0,0001	10,5519	0,0002

Source: own research.

The values of the degree of operating leverage for the service companies are higher in comparison with the values in the sample of trade companies. This result is consistent with the second hypothesis that was put forward. The test of variances conformity does not allow for the rejection of the hypothesis that their values vary.

The first hypothesis proposing that production companies have the highest values of the degree of operating leverage, is strongly supported by the results of the Student's t-tests. What raises doubts is only the statistically significant difference between the values of the variance for production and trading companies. The second hypothesis that trade companies have the lowest *DOL* values has passed the test with the reservation that the variances are significantly statistically different.

Certain shortcomings of parametric test results prompted the author to carry out nonparametric Mann-Whitney U tests (1947). The reason for this were inconclusive test results of distribution normality and statistically significant differences in pairs of variances with the sample of commercial companies.

Table 7. Mann-Whitney U test for trade and production companies

Sum of ranks trade companies	Sum of ranks production companies	U	Z	p	corrected Z	p	2-sided exact p
108	1020	30	-4,3794	0,0000	-4,3794	0,0000	0,0000

Source: own research.

Table 8. Mann-Whitney U test for production and service companies

Sum of ranks production companies	Sum of ranks service companies	U	Z	p	corrected Z	p	2-sided exact p
1494	1134	431	2,4336	0,0150	2,4336	0,0150	0,0143

Source: own research.

Table 9. Mann-Whitney U test for trade and service companies

Sum of ranks trade companies	Sum of ranks service companies	U	Z	p	corrected Z	p	2-sided exact p
224	1001	146	-1,7553	0,0792	-1,7553	0,0792	0,0791

Source: own research.

In a statistically significant manner the nonparametric Mann-Whitney U test confirmed the superiority of the degree of operating leverage in companies in the production sector over the risk level in the other two samples. Higher share of the fixed costs within operating cost in the production sector induced by the higher depreciation and other fixed production costs causes statistically significant higher operating risk. Unfortunately, with 5% significance level one cannot reject the hypothesis that operational risk is greater in service companies than in trade ones. However, raising the level of significance to 10% improves the statistical significance of the expected hypothesis.

Conclusions

At the beginning of the article two hypotheses were adopted. The first one proposed that production sector companies are characterized by the highest level of operational risk. The second one was the assumption that the lowest operational risk occurs in trade companies. The first of these hypotheses was confirmed by statistically significant test results, particularly the results of the nonparametric Mann-Whitney U test. The second hypothesis was supported by the Student's t-test results in two independent samples. Unfortunately, at the same time it turned out that there was a significant difference of variances between service and trade companies.

Empirical data tests for public companies were also aimed at verifying the new method of estimating the degree of operating leverage. The method proposed by the author has two important advantages. First, it brings values greater than one that can be interpreted from the managerial point of view. Secondly, it can be applied using generally available financial data. Particularly, the first advantage favourably distinguishes the proposed method from those previously used. The proposed method can't be applied in the cases of enterprises making considerable investments relatively often. This makes deriving statistically significant F_i coefficient impossible.

Further research may investigate the influence of the business cycle dynamics on the level of the operating risk. The hypothesis could be: economic slowdown rises the level of the operating risk, hence EBIT is falling down and fixed cost remains fixed.

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