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EMPIRICAL VERIFICATION OF SHARE PRICING MODELS FOR 250+ COMPANIES (WARSAW STOCK EXCHANGE)

The empirical results presented in the paper indicate that if balance sheet valuations of shares cannot be determined by active markets, valuation should use the HEV model based on the risk-free rate of return, and the HEV model based on annual inflation rates (characterised by the lowest values of the maximum error). On the other hand, in the periods of rising and falling prices the lowest values of the mean error are recorded for DCF models based on WIG20 annual rate of return and average monthly increases in WIG20 annual rate of return.

Keywords: stock market prices; fair value; balance sheet valuation; shares.

Павел Белявський

ЕМПІРИЧНЕ ОБҐРУНТУВАННЯ МОДЕЛЕЙ ВАРТОСТІ АКЦІЙ: НА ПРИКЛАДІ КОМПАНІЙ РЕЙТИНГУ 250+ ВАРШАВСЬКОЇ ФОНДОВОЇ БІРЖИ

У статті представлено емпіричні результати аналізу, який показав, що балансове оцінювання акцій не може бути визначено активністю ринку. Для такого оцінювання доцільніше використовувати моделі на основі безризикового прибутку та з урахуванням рівня річної інфляції (за найменшого значення максимальної погрішності). У періоди падіння та росту цін на ринку найнижчі значення середньої погрішності зафіксовано для моделей, основаних на річній нормі прибутку для WIG20 та на середньомісячному зростанні норм прибутку для того самого індексу.

Ключові слова: справедлива вартість; балансова оцінка; акції; ціни на фондовому ринку.

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ЭМПИРИЧЕСКОЕ ОБОСНОВАНИЕ МОДЕЛЕЙ СТОИМОСТИ АКЦИЙ: НА ПРИМЕРЕ КОМПАНИЙ РЕЙТИНГА 250+ ВАРШАВСКОЙ ФОНДОВОЙ БИРЖИ

В статье представлены эмпирические результаты анализа, который показал, что балансовая оценка акций не может быть определена активностью рынка. При такой оценке целесообразней использовать модели на основе безрисковой прибыли и с учётом уровня годовой инфляции (при наименьшем значении максимальной погрешности). В периоды падения и роста цен на рынке наименьшие значения средней погрешности зафиксированы для моделей, основанных на годовой норме прибыли для WIG20 и на среднемесячном росте норм прибыли для того же индекса.

Ключевые слова: справедливая стоимость; балансовая оценка; акции; цены на фондовом рынке.

Introduction. The basic objective of the paper is to compare, with the use of statistical methods, balance sheet valuations of shares estimated on the basis of economic and financial models to their active market fair value at the time of stock market rising and falling prices.

The use of the concept of fair value results in dividing shares into those whose prices are determined by active market and those for which such a market does not exist. The category of fair value, being a substitute of market value, does not only refer

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to market transactions but also to valuations based on appropriate techniques or expert opinions.

The paper presents the share pricing concepts based on general accounting principles, focusing on fair value determined by active markets and fair value estimations based on DCF (Discounted Cash Flow), CAPM (Capital Asset Pricing Model), and HEV (Historical Exchange Value).

The last part of the paper refers to statistical methods to assess balance sheet share estimates at the time of rising prices in 2002–2006, and in the period of falling prices in 2007–2011 at the secondary market from the perspective of their practical applications.

Balance sheet share pricing under fair value at active markets. Accounting standards are based on two methods of valuating financial instruments: the historical costs principle and the fair value concept. It implies that contemporary accounting makes use of mixed valuation models based on historical costs and fair value (International Financial Reporting Standards, 2011).

The mixed valuation model originates from seeking an alternative model of accounting based on historical costs. Accounting theoreticians and practitioners accept the concept of valuation based on historical costs and value (Wolk and Tearney, 1997; Riahi-Belkaoui, 2000; Hendriksen and Van Breda, 2002). However, the problem faced by accounting is the choice of one of the following values: fair value, market value, utility value, present value, economic value, or another type of value.

The concept of fair value was introduced in accounting to bring the measurements of items presented in financial statements closer to their actual value. The concept makes a distinction between two basic financial instruments – those whose prices are quoted at active markets, and those for which such prices and markets do not exist. The initial valuation is based on fair value. This concept ensures the stability of balance sheet items, and continuous attention is given to fair value changes and referring them directly to profits and losses facilitate the ongoing control of share-generated revenues. When changes in fair value from period to period are determined by active markets, the fair value concept does not pose any problems to the process of valuating financial instruments (Bielawski, 2007, 2008, 2010; Bielawski and Garlinska-Bielawska, 2008).

The balance sheet valuation is based on the shares of 10 listed companies belonging to the 250+ segment, and classified as financial assets valued at fair value with changes in the profit and loss account. This type of classification indicates that shares are valued at the balance sheet date at fair value according to active market prices. The balance sheet valuation at fair value at the end of each year in the period of stock market rising prices is presented in Table 1, and in the period of falling prices – in Table 2.

Estimation of balance sheet valuations of shares – listed companies in the period of rising and falling prices at the stock market. Share value estimates are based on 3 economic and financial models: DCF (Brealey and Myers, 1991; Jajuga and Jajuga, 1998; Luenberger, 2003), HEV (Dobija, 1995; Bielawski, 2013), and CAPM (Mossin, 1966; Sharpe, 1964; Lintner, 1965).

The set of data for estimating fair value with the use of DCF, HEV and CAPM comprises the quotes from two periods: increases in share prices (2002–2006) and

decreases in share prices (2007–2011) in one-month periods. Fair value estimates are based on the shares of 10 companies listed at Warsaw Stock Exchange: BRE, Boryszew, BPH, Budimex, Kety, KGHM, Orbis, Stalprodukt, Swiecie and Zywiec.

Fair value is estimated on the basis of the above models at the end of each period (from 31 December 2002 to 31 December 2006 – the period of increases; and from 31 December 2007 to 31 December 2011 – the period of decreases). Fair value estimates in the analysed periods are also based on the following values: WIG index annual rates of return, WIG20 annual rate of return, annual inflation rates and annual risk-free rates of return, average monthly increase in WIG rate of return, and average monthly increase in WIG20 rate of return.

The first model used for estimating the fair value of shares is based on discounted cash flows (DCF). The DCF model is used in 6 variants. Cash flows are discounted by the particular factors in the following order: WIG annual rate of return, WIG20 annual rate of return, average monthly increase in WIG annual rate of return, average monthly increase in WIG20 rate of return, annual risk-free rate of return, and annual inflation rate.

The balance sheet estimates of share values based on DCF are presented in Tables 3–14.

CAPM is the second model used to estimate the fair value of shares. This model identifies the expected rate of return as the sum of the risk-free rate of return and asset risk premium.

The capital asset pricing model is applied in two variants. The first variant assumes that the market rate of return is based on the WIG index, i.e. the entire market. The other variant of CAPM is based on the WIG20 index.

The risk-free rate of return is the annual interest rate on treasury bonds. The above two approaches to the market rate of return, and the adoption of the risk-free rate of return allows for using CAPM to estimate the expected rate of return and, consequently, to value the shares of the analysed listed companies at the end of the respective periods (2002–2006 and 2007–2011). The results of share value estimates based on CAPM, accounting for WIG and WIG20 annual rates of return, are presented in Tables 15–18.

The third model for estimating the fair value of shares is HEV (Historical Exchange Value). HEV relies on the analysis of historical trends of the actual share prices determined on the basis of exponential smoothing. Fair value estimates are based on two filtering factors: inflation rates and risk-free rates of return. The balance sheet valuations of shares in the analysed periods are based on the assumption that smoothing coefficient α should be determined by inflation rates and risk-free rates of return. The results are presented in Tables 19–22.

The assessment of models for estimating balance sheet share valuations based on statistical methods. The results of the empirical study give valuable insights into the applied models for estimating balance sheet valuations of shares issued in the periods of rising and falling prices by 250+ companies in the context of comparability and reliability of their financial statements. Fair value estimates are based on DCF, HEV and CAPM models. The results of balance sheet estimates are referred to the actual fair value determined by active markets and assessed with the use of statistical methods. The assessments are based on two statistical measures of maximum and mean errors.

Table 1. The balance sheet valuation of shares at fair value at the end of each year according to active market prices in 2002–2006, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	88.00	13.50	16.90	29.40	390.00	50.80	271.50	7.45	13.00	36.90
31.12.2003	92.50	26.20	27.70	35.60	434.00	135.00	355.00	73.00	26.00	77.20
31.12.2004	114.00	31.30	24.80	43.00	452.00	131.00	510.00	20.10	78.50	58.00
31.12.2005	169.00	62.50	33.00	38.10	484.50	125.50	750.50	23.40	78.00	51.00
31.12.2006	336.00	89.00	63.10	73.10	490.00	200.00	926.50	22.98	540.00	104.00

Table 2. The balance sheet valuation of shares at fair value at the end of each year according to active market prices in 2007–2011, PLN, author's own research

Data	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	505.00	105.80	69.50	92.00	640.00	160.00	104.00	11.92	750.00	69.90
31.12.2008	196.50	28.12	32.55	51.10	468.40	60.00	35.20	2.10	295.10	39.70
31.12.2009	260.00	106.00	44.36	73.00	480.00	121.10	84.00	6.53	594.00	76.25
31.12.2010	304.00	173.00	41.00	99.50	566.00	127.10	71.00	2.00	276.10	77.50
31.12.2011	246.00	110.60	37.90	76.50	515.00	104.50	31.70	0.63	230.00	58.05

Table 3. Fair value estimates in the period of rising prices based on DCF according to WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	121.77	13.42	18.16	25.49	237.34	47.68	237.34	4.85	10.99	29.72
31.12.2003	127.53	19.56	24.49	42.61	565.19	73.62	393.46	10.80	18.84	53.48
31.12.2004	118.34	33.52	35.44	45.54	555.24	172.71	454.17	93.39	33.26	98.77
31.12.2005	152.37	41.83	33.15	57.47	604.12	175.09	681.64	26.86	104.92	77.52
31.12.2006	239.31	88.50	46.73	53.95	686.07	177.71	1062.73	33.14	110.45	72.22

Table 4. Fair value estimates in the period of falling prices based on DCF according to WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	370.90	98.25	69.65	80.69	540.90	220.78	1022.74	25.37	596.09	114.80
31.12.2008	247.09	51.77	34.01	45.02	313.15	78.29	50.89	5.83	366.97	33.22
31.12.2009	288.57	41.29	47.80	75.04	687.86	88.11	51.69	3.08	433.36	58.30
31.12.2010	308.79	125.89	52.68	86.70	570.08	143.83	99.76	7.76	705.47	90.56
31.12.2011	240.66	136.96	32.46	78.77	448.07	100.62	56.21	1.58	218.57	61.35

Table 5. Fair value estimates in the period of rising prices based on DCF according to WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	114.81	12.65	17.12	24.03	223.78	44.95	223.78	4.57	10.36	28.02
31.12.2003	117.82	18.07	22.63	39.36	522.16	68.02	363.51	9.97	17.41	49.40
31.12.2004	115.21	32.63	34.50	44.34	540.58	168.15	442.18	90.93	32.38	96.16
31.12.2005	154.38	42.39	33.58	58.23	612.09	177.40	690.63	27.22	106.30	78.54
31.12.2006	209.14	77.34	40.84	47.15	599.57	155.31	928.74	28.96	96.52	63.11

Table 6. Fair value estimates in the period of falling prices based on DCF according to WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	353.44	93.62	66.38	76.89	515.44	210.38	974.60	24.17	568.03	109.40
31.12.2008	261.52	54.79	35.99	47.64	331.43	82.86	53.86	6.17	388.39	35.16
31.12.2009	262.26	37.53	43.44	68.20	625.16	80.08	46.98	2.80	393.86	52.99
31.12.2010	298.69	121.77	50.96	83.86	551.43	139.12	96.50	7.50	682.39	87.60
31.12.2011	237.57	135.19	32.04	77.76	442.31	99.32	55.48	1.56	215.76	60.56

Table 7. Fair value estimates in the period of rising prices based on DCF according to monthly increases in WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	121.77	13.42	18.16	25.49	237.34	47.68	237.34	4.85	10.99	29.72
31.12.2003	127.53	19.56	24.49	42.61	565.19	73.62	393.46	10.80	18.84	53.48
31.12.2004	118.34	33.52	35.44	45.54	555.24	172.71	454.17	93.39	33.26	98.77
31.12.2005	152.37	41.83	33.15	57.47	604.12	175.09	681.64	26.86	104.92	77.52
31.12.2006	239.31	88.50	46.73	53.95	686.07	177.71	1062.73	33.14	110.45	72.22

Table 8. Fair value estimates in the period of falling prices based on DCF according to monthly increases in WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	370.90	98.25	69.65	80.69	540.90	220.78	1022.74	25.37	596.09	114.80
31.12.2008	247.09	51.77	34.01	45.02	313.15	78.29	50.89	5.83	366.97	33.22
31.12.2009	288.57	41.29	47.80	75.04	687.86	88.11	51.69	3.08	433.36	58.30
31.12.2010	308.79	125.89	52.68	86.70	570.08	143.83	99.76	7.76	705.47	90.56
31.12.2011	240.66	136.96	32.46	78.77	448.07	100.62	56.21	1.58	218.57	61.35

Table 9. Fair value estimates in the period of rising prices based on DCF according to monthly increases in WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	114.81	12.65	17.12	24.03	223.78	44.95	223.78	4.57	10.36	28.02
31.12.2003	117.82	18.07	22.63	39.36	522.16	68.02	363.51	9.97	17.41	49.40
31.12.2004	115.21	32.63	34.50	44.34	540.58	168.15	442.18	90.93	32.38	96.16
31.12.2005	154.38	42.39	33.58	58.23	612.09	177.40	690.63	27.22	106.30	78.54
31.12.2006	209.14	77.34	40.84	47.15	599.57	155.31	928.74	28.96	96.52	63.11

Table 10. Fair value estimates in the period of falling prices based on DCF according to monthly increases in WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	353.44	93.62	66.38	76.89	515.44	210.38	974.60	24.17	568.03	109.40
31.12.2008	261.52	54.79	35.99	47.64	331.43	82.86	53.86	6.17	388.39	35.16
31.12.2009	262.26	37.53	43.44	68.20	625.16	80.08	46.98	2.80	393.86	52.99
31.12.2010	298.69	121.77	50.96	83.86	551.43	139.12	96.50	7.50	682.39	87.60
31.12.2011	237.57	135.19	32.04	77.76	442.31	99.32	55.48	1.56	215.76	60.56

Table 11. Fair value estimates in the period of rising prices based on DCF according to annual risk-free rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	127.48	14.04	19.01	26.68	248.47	49.91	248.47	5.08	11.51	31.11
31.12.2003	92.58	14.20	17.78	30.93	410.28	53.44	285.62	7.84	13.68	38.82
31.12.2004	98.50	27.90	29.50	37.91	462.17	143.76	378.04	77.74	27.69	82.21
31.12.2005	119.51	32.81	26.00	45.08	473.83	137.33	534.63	21.07	82.29	60.80
31.12.2006	175.93	65.06	34.35	39.66	504.36	130.65	781.27	24.36	81.20	53.09

Table 12. Fair value estimates in the period of falling prices based on DCF according to annual risk-free rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	350.88	92.94	65.90	76.34	511.71	208.86	967.54	24.00	563.92	108.61
31.12.2008	534.69	112.02	73.59	97.41	677.63	169.41	110.12	12.62	794.10	71.89
31.12.2009	206.62	29.57	34.23	53.73	492.52	63.09	37.01	2.21	310.30	41.74
31.12.2010	270.84	110.42	46.21	76.04	500.02	126.15	87.50	6.80	618.77	79.43
31.12.2011	317.56	180.72	42.83	103.94	591.24	132.77	74.17	2.09	288.41	80.96

Table 13. Fair value estimates in the period of rising prices based on DCF according to annual inflation rate, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	118.94	13.10	17.74	24.90	231.84	46.57	231.84	4.74	10.74	29.03
31.12.2003	89.50	13.73	17.19	29.90	396.63	51.66	276.12	7.58	13.22	37.53
31.12.2004	96.57	27.35	28.92	37.17	453.10	140.94	370.62	76.21	27.14	80.60
31.12.2005	114.80	31.52	24.97	43.30	455.16	131.92	513.57	20.24	79.05	58.41
31.12.2006	171.37	63.38	33.46	38.63	491.28	127.26	761.01	23.73	79.09	51.71

Table 14. Fair value estimates in the period of falling prices based on DCF according to annual inflation rate, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	349.44	92.56	65.62	76.02	509.60	208.00	963.56	23.90	561.60	108.6
31.12.2008	521.67	109.29	71.79	95.04	661.12	165.28	107.43	12.31	774.75	70.4
31.12.2009	203.38	29.10	33.69	52.89	484.79	62.10	36.43	2.17	305.43	41.09
31.12.2010	268.06	109.29	45.74	75.26	494.88	124.85	86.60	6.73	612.41	78.61
31.12.2011	317.98	180.96	42.89	104.08	592.04	132.95	74.27	2.09	288.0	81.07

Table 15. Fair value estimates in the period of rising prices based on CAPM according to WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	119.83	12.22	17.87	25.13	238.68	45.44	227.92	3.18	8.62	28.47
31.12.2003	139.41	29.73	26.77	46.08	546.58	93.82	484.82	32.53	42.61	66.62
31.12.2004	125.08	44.17	37.46	47.82	544.06	201.69	518.67	208.36	58.93	113.62
31.12.2005	163.53	58.94	35.57	61.16	588.47	212.89	806.20	69.42	209.08	92.52
31.12.2006	260.85	132.95	50.93	58.20	664.24	224.83	1301.20	97.58	245.10	89.37

Table 16. Fair value estimates in the period of falling prices based on CAPM according to WIG annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	377.71	108.30	70.93	81.99	537.39	232.70	1069.51	35.42	744.19	120.36
31.12.2008	149.37	-62.48	20.57	29.43	356.93	-12.92	0.71	-44.02	-1599.13	-1.46
31.12.2009	316.41	63.53	52.41	81.38	664.39	113.16	64.13	9.52	999.84	73.15
31.12.2010	321.69	155.23	54.88	89.87	561.66	161.52	110.15	14.76	1104.57	100.54
31.12.2011	214.53	53.98	28.94	71.28	465.27	68.44	40.99	-2.13	-102.90	43.77

Table 17. Fair value estimates in the period of rising prices based on CAPM according to WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	109.43	9.75	16.32	23.03	225.37	39.36	199.97	0.60	4.69	24.88
31.12.2003	128.54	26.13	24.68	42.56	514.95	84.45	438.60	26.80	35.89	60.17
31.12.2004	122.31	42.48	36.63	46.78	535.52	195.65	504.01	194.75	55.67	110.34
31.12.2005	169.18	62.29	36.80	63.22	603.17	222.58	841.03	75.62	225.34	96.58
31.12.2006	223.24	102.88	43.59	49.99	593.43	183.11	1070.92	65.15	172.51	73.30

Table 18. Fair value estimates in the period of falling prices based on CAPM according to WIG20 annual rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	354.53	95.03	66.58	77.11	515.20	212.10	981.40	25.55	588.41	110.20
31.12.2008	145.53	-64.22	20.04	28.75	353.74	-14.74	-0.38	-44.59	-1622.94	-2.19
31.12.2009	285.89	54.09	47.36	73.69	616.62	99.24	56.59	7.48	808.15	64.42
31.12.2010	310.51	145.38	52.98	86.83	548.11	153.75	105.17	13.01	997.79	95.90
31.12.2011	203.60	40.53	27.46	67.82	451.91	61.61	37.47	-2.58	-144.41	39.83

Table 19. Fair value estimates in the period of falling prices based on HEV according to annual inflation rates, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	117.52	13.01	17.59	24.77	232.54	46.27	230.66	4.74	10.69	28.93
31.12.2003	88.15	13.92	17.26	29.61	391.47	53.61	274.29	9.64	13.43	38.25
31.12.2004	94.31	26.63	27.46	36.22	435.52	134.66	368.07	68.54	30.43	75.58
31.12.2005	114.76	31.73	24.91	42.93	452.45	130.92	513.34	20.15	78.49	57.90
31.12.2006	173.61	63.23	33.83	39.07	484.65	127.56	755.36	23.39	90.76	52.46

Table 20. Fair value estimates in the period of falling prices based on HEV according to annual inflation rates, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	349.00	90.29	63.59	74.55	501.54	196.92	863.23	22.13	556.15	101.22
31.12.2008	485.29	100.84	67.14	89.39	629.04	153.61	99.60	11.29	720.94	66.10
31.12.2009	200.79	33.39	33.35	52.58	469.18	64.13	38.50	2.40	315.32	42.17
31.12.2010	262.65	110.03	44.16	74.59	485.17	121.46	83.22	6.26	574.88	76.33
31.12.2011	298.90	167.51	40.73	97.48	561.51	125.11	67.54	1.88	272.05	75.79

Table 21. Fair value estimates in the period of rising prices based on HEV according to annual risk-free rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2002	113.54	13.07	17.50	25.40	253.79	46.88	236.17	5.11	11.00	30.00
31.12.2003	88.44	14.76	17.97	30.01	394.35	59.12	279.75	13.93	14.29	40.88
31.12.2004	95.12	26.82	27.35	36.50	436.19	134.51	373.89	66.55	32.40	74.86
31.12.2005	119.07	34.18	25.56	42.55	454.99	130.49	532.16	20.40	78.45	57.35
31.12.2006	182.15	64.59	35.37	40.86	484.93	131.37	764.36	23.37	114.39	55.17

Table 22. Fair value estimates in the period of falling prices based on HEV according to annual risk-free rate of return, PLN, author's own research

Date	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
31.12.2007	350.34	90.43	63.64	74.70	502.73	196.61	856.72	22.04	557.82	100.94
31.12.2008	470.74	97.17	65.40	87.46	620.94	148.89	96.36	10.83	699.47	64.77
31.12.2009	202.72	35.75	33.71	53.25	469.54	65.99	39.98	2.53	324.38	43.28
31.12.2010	263.52	111.36	44.09	75.12	486.89	121.58	82.96	6.17	568.55	76.35
31.12.2011	299.05	167.67	40.74	97.54	561.65	125.17	67.64	1.88	272.16	75.84

Table 23. The assessment of models for estimating balance sheet valuations of shares based on the mean error in 2002–2006, %, author's own research

Model	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
DCF1	8.29	10.50	2.66	7.39	15.73	1.72	1.43	60.71	29.13	8.31
DCF2	2.50	15.67	2.28	2.55	9.20	2.75	7.24	53.95	31.59	4.08
DCF3	8.29	10.50	2.66	7.39	15.73	1.72	1.43	60.71	29.13	8.31
DCF4	2.50	15.67	2.28	2.55	9.20	2.75	7.24	53.95	31.59	4.08
DCF5	9.12	25.40	14.23	12.33	7.76	15.54	19.67	32.34	40.62	10.68
DCF6	12.89	28.30	17.53	15.68	10.94	18.75	22.72	28.58	43.20	13.90
CAPM1	14.20	17.77	8.39	13.25	12.91	18.99	14.02	269.04	23.74	25.34
CAPM2	7.43	4.58	2.80	8.20	8.10	11.66	4.74	224.07	13.18	19.09
HEV1	13.77	28.72	18.76	16.44	12.31	19.66	23.14	21.15	41.98	15.55
HEV2	13.45	26.78	17.57	15.37	10.94	18.31	21.50	21.53	39.48	14.23

Legend: DCF 1 (DCF – WIG annual rate of return), DCF 2 (DCF – WIG20 annual rate of return), DCF 3 (DCF – average monthly increase in WIG annual rate of return), DCF 4 (DCF – average monthly increase in WIG20 annual rate of return), DCF 5 (DCF – annual risk-free rate of return), DCF 6 (DCF – annual inflation rate), CAPM 1 (CAPM – WIG annual rate of return), CAPM 2 (CAPM – WIG20 annual rate of return), HEV 1 (HEV – annual inflation rate), HEV 2 (HEV – annual risk-free rate of return).

Table 24. The assessment of models for estimating balance sheet valuations of shares based on the mean error in 2007–2011, %, author's own research

Model	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
DCF1	1.92	2.50	5.32	6.26	3.52	10.13	201.47	135.37	25.47	10.35
DCF2	0.25	2.27	2.57	8.77	7.03	8.04	191.40	132.57	22.92	7.31
DCF3	1.92	2.50	5.32	6.26	3.52	10.13	201.47	135.37	25.47	10.35
DCF4	0.25	2.27	2.57	8.77	7.03	8.04	191.40	132.57	22.92	7.31
DCF5	27.85	48.27	24.75	11.90	6.08	38.26	228.89	201.57	49.21	27.55
DCF6	26.07	46.08	23.13	10.55	4.83	36.44	226.27	197.76	47.24	26.19
CAPM 1	6.89	19.83	1.28	11.66	2.37	6.29	178.24	176.13	73.52	15.67
CAPM 2	12.17	27.69	6.84	16.61	6.19	1.11	175.47	135.86	55.18	7.83
HEV 1	20.24	38.10	17.62	6.08	1.03	29.47	197.82	174.27	39.61	19.98
HEV 2	41.93	74.70	33.39	23.91	14.34	51.23	393.84	244.27	82.58	31.46

See legend to Table 23.

Table 25. The assessment of models for estimating balance sheet valuations of shares based on the maximum error in 2002–2006, %, author's own research

Model	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
DCF1	38.37	33.07	42.90	50.85	40.01	45.47	14.70	364.64	79.55	70.29
DCF2	37.76	32.18	39.12	52.83	42.62	49.62	17.58	352.37	82.13	65.79
DCF3	38.37	33.07	42.90	50.85	40.01	45.47	14.70	364.64	79.55	70.29
DCF4	37.76	32.18	39.12	52.83	42.62	49.62	17.58	352.37	82.13	65.79
DCF5	47.64	47.50	45.56	45.74	36.29	60.41	28.76	286.75	84.96	49.72
DCF6	49.00	49.57	46.97	47.15	40.55	61.73	31.57	279.16	85.35	51.39
CAPM 1	50.71	49.38	51.03	60.52	38.80	69.63	40.44	936.63	168.05	95.89
CAPM 2	38.96	35.71	47.68	65.93	42.21	77.35	26.35	868.89	188.90	90.24
HEV 1	48.33	49.23	46.38	46.56	40.37	60.29	31.60	241.00	83.19	50.46
HEV 2	45.79	45.32	43.94	44.11	34.93	56.20	29.09	231.10	78.82	47.04

See legend to Table 23.

Table 26. The assessment of models for estimating balance sheet valuations of shares based on the maximum error in 2007–2011, %, author's own research

Model	BRE	KGHM	Orbis	Budimex	Zywiec	Kety	BPH	Boryszew	Stalprodukt	Swiecie
DCF1	26.55	84.10	28.50	12.86	43.30	37.98	883.41	287.77	155.51	69.08
DCF2	33.09	94.84	24.29	16.42	83.09	38.09	837.11	275.08	147.15	61.12
DCF3	26.55	84.10	28.50	12.86	43.30	37.98	883.41	287.77	155.51	69.08
DCF4	33.09	94.84	24.29	16.42	83.09	38.09	837.11	275.08	147.15	61.12
DCF5	172.11	298.37	126.07	90.63	44.67	182.35	830.33	501.00	169.10	81.09
DCF6	165.48	288.66	120.56	85.98	41.14	175.47	826.50	486.35	162.54	76.68
CAPM 1	25.21	51.20	36.82	42.40	38.42	63.77	928.38	637.77	300.06	77.26
CAPM 2	29.80	63.35	38.44	43.73	28.46	41.04	843.65	550.36	261.39	62.30
HEV 1	146.97	258.59	106.26	74.93	34.29	156.02	730.03	437.74	144.30	66.49
HEV 2	146.97	258.59	106.26	74.93	34.29	156.02	843.65	550.36	261.39	66.49

See legend to Table 23.

The first method compares the mean errors of balance sheet valuations determined by the adopted models. The assessment of the models for estimating fair value in the periods of rising and falling prices according to the mean error is presented in Tables 23 and 24.

The second model is based on the maximum error – the difference between estimated share values and the actual fair value. The assessments of the models for estimating share value in the analysed periods based on the maximum error are presented in Tables 25 and 26.

The assessments of models for estimating the fair value of shares with the use of the maximum and mean errors are based on the assumption that the best method is the one for which the maximum and mean errors have the lowest values.

The empirical results presented in Tables 23–26 for listed companies in the periods of rising prices indicate that the HEV model based on the risk-free rate of return is characterised by the lowest value of the maximum error (231.10%), while the lowest values of the mean error are recorded for DCF models based on WIG20 annual rate of return (13.18%) and average monthly increases in WIG20 annual rate of return (13.18%). In the period of falling prices the best results reflecting fair values determined by active markets are obtained on the basis of the HEV model and annual inflation rates (the maximum error – 730.03%), and DCF models based on WIG20 annual rate of return (the mean error – 38.31%), and annual monthly increases in WIG20 annual rate of return (the mean error – 38.31%).

Further research in this area, especially on long-time horizons and based on a large number of companies, is likely to empirically verify the techniques of estimating balance sheet valuations of shares on the basis of economic and financial models and to assess the practical applications of the adopted techniques.

Concluding remarks. Share valuation poses a number of problems in the theory and practice of accounting. This fact results from the use of the category of fair value in the valuation process. According to the fair value concept shares can be divided into those whose prices are determined by active markets and those for which such prices and markets do not exist. Shares belonging to the first group are valued on the basis of accounting principles and categories, while the value of shares in the other group is determined on the basis of valuation techniques.

The empirical results presented in this paper indicate that if balance sheet valuations of shares cannot be determined by active markets, valuation techniques should use the HEV model based on the risk-free rate of return, and the HEV model based on annual inflation rates (characterised by the lowest values of the maximum error). On the other hand, in the periods of rising and falling prices the lowest values of the mean error are recorded for DCF models based on WIG20 annual rate of return and average monthly increases in WIG20 annual rate of return.

References:

- Bielawski, P.* (2007). Wycena bilansowa instrumentow finansowych na przykladzie strategii strangle. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, 752: 67–81.
- Bielawski, P.* (2008). The Theoretical Structure of the Accounting of Financial Instruments – an Outline. In: *General Accounting Theory. Evolution and Design for Efficiency* (pp. 91–108). Ed. I. Gorowski. Warsaw, Academic and Professional Press.
- Bielawski, P.* (2010). Modele wyceny bilansowej instrumentow finansowych w swietle ogolnej teorii rachunkowosci. *Zeszyty Naukowe, Seria specjalna: Monografie*, No. 197. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Krakow.

- Bielawski, P.* (2013). Wycena bilansowa akcji w teorii i praktyce rachunkowosci. Zeszyty Naukowe, Seria specjalna: Monografie, No. 227. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Krakow.
- Bielawski, P., Garlinska-Bielawska, J.* (2008). Metody wyceny instrumentow finansowych w swietle miedzynarodowych standardow sprawozdawczosci finansowej (MSSF). Zeszyt Naukowy No. 8 Finanse i Bankowosc (WSZiB), 8: 98–110.
- Brealey, R.A., Myers, S.C.* (1991). Principles of Corporate Finance. McGraw-Hill, New York.
- Dobija, M.* (1995). Antyinflacyjna interpretacja zasady kosztu historycznego. Zeszyty Teoretyczne Rady Naukowej (SKwP, Warszawa), 32: 49–57.
- Hendriksen, E.S., Van Breda, M.F.* (2002). Teoria rachunkowosci. PWN, Warszawa.
- Jajuga, K., Jajuga, T.* (1998). Inwestycje. PWN, Warszawa.
- Lintner, J.* (1965). Security Prices, Risk and Maximal Gains from Diversification. The Journal of Finance, 20: 587–615.
- Luenberger, D.G.* (2003). Teoria inwestycji finansowych. PWN, Warszawa.
- Miedzynarodowe Standardy Sprawozdawczosci Finansowej (2011). IASB – SKwP, Warszawa.
- Mossin, J.* (1966). Equilibrium in a Capital Asset Market. Econometrica, 34: 768–783.
- Riahi-Belkaoui, A.* (2000). Accounting Theory. Business Press Thomson Learning, London.
- Sharpe, W.F.* (1964). Capital Asset Prices: A Theory of Market Equilibrium Under Condition of Risk. The Journal of Finance, 19: 425–442.
- Wolk, H.I., Tearney, M.G.* (1997). Accounting Theory – A Conceptual and Institutional Approach. South-Western College Publishing, Cincinnati, Ohio.

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