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CRITICAL REVIEW OF MODELS OF EARNINGS MEAN REVERSION

The hypothesis that earnings are mean reverting was suggested 90 years ago and has been extensively tested since then. Expectations of earnings' mean reversion (hereinafter "EMR") significantly influence pricing of shares or earnings forecasts. Despite proposals and testing of numerous models of EMR, there has been very little inquiry into the meaning of those models in corporate and valuation terms in the academic literature. Therefore, we see such an inquiry as highly desirable. The aim of this paper is to critically review the models of transitory earnings (vice versa EMR), their methodology, practical applicability of their results, and their limitations stemming from the characteristics of earnings data. We find that most of the recent models of transitory earnings (EMR) are misspecified in terms of target earnings or reasons of EMR. We also find that EMR is partly caused by cycles in relevant industry or economy, and partly by company-specific processes and accruals. Also, elimination of survivorship bias and use of margins or lower-level profitability like ROI and ROC instead of ROE is worth testing in EMR models.

Keywords: *Transitory Earnings, Profit, Persistence, Mean Reversion*

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1. INTRODUCTION

Abnormal earnings are mostly transitory. Already Bliss (1923) suggested that the industry average should be target for most of company's financial ratios (Peles and Schneller, 1989). The support for this hypothesis was weak at first, as many studies considered earnings to follow submartingale process. In 1982 Freeman, Ohlson and Penman wrote: '*Over the years, there has developed a fairly substantial body of research on the time series of earnings. As a whole, this literature concludes that changes in (annual) accounting earnings are unpredictable, that is, earnings follow a random walk.*' Later, the support for hypothesis that there is regularity in earnings behaviour has grown due to many empirical studies.

La Porta (1996) found that analysts and financial markets do not fully reflect the earnings persistence (or conversely mean reversion, hereinafter MR). Horváth and Trapani (2019) came to similar conclusions. One of the possible explanations of the inadequate estimates is that most of the earnings MR research is not particularly well understood by the practice or does not provide the theory and evidence needed by practice. We did not find an English-written review of earnings MR literature, which would include a critical review, which would enable understanding of EMR models and their eventual improvement or re-formulation. The purpose of this paper is to provide such a review by answering the following questions:

1) which models have been used and tested for EMR,
2) what do the existing EMR models tell us and what is their practical applicability,
3) how does earnings MR translate into share prices and earnings forecasts,
4) what causes earnings to revert,
5) which way the future research in this area could go.

Without answers to those questions, research on EMR could happen to look into practically unimportant processes or provide irrelevant explanations of EMR due to methodologically incorrect formulation of the EMR models.

We do not want to provide a classical review (meta study), in which the models would be categorized, their results summarized and point estimate or interval estimate provided. The reason is that it is the existing EMR models examine reversion to absolutely different targets, mixing together different factors. Even EMR models based on similar processes or assumptions (autocorrelation models, adaptive expectation models, etc.) differ in explanatory variables in a way, that makes many of them incomparable in terms of numeric results.

Therefore, this paper is a critical review in order to show the troublesome, frequently tacit, assumptions of the reviewed research and to show possibilities of

future research in the area. Thus, it concentrates on methodologically significant recent EMR literature.

This nature of the paper makes it naturally impossible to formulate one or more hypotheses, which would be tested. However, we believe that it is sometimes necessary to critically sum up the recent knowledge.

The academic literature did not link the EMR (resp. vice versa earnings persistence) models to share prices. Therefore, we provide review of literature concerning the relation between publicly traded shares and earnings in the first section. The purpose is of the first section is to find if there is a relation between earnings persistence and share prices. We will provide a short review of ways of estimation of future earnings persistence in the second section of this paper. As we will see below, the first and second section provide justification for critical inquiry into practical applicability and understandability of EMR models. Third and fourth section of this paper contain critical review of most frequently used EMR models and their results. Finally, we discuss the properties of data, which can be used for EMR measurement. We sum up the findings in conclusions.

2. EARNINGS MEAN REVERSION AND SHARE PRICES

Papers, which examine MR of P/E or P/BV ratios or which deal with relationship between expected growth of earnings or profitability and share prices are too numerous to be cited all. However, those papers, which explicitly examine the relation between share prices and earnings MR, for a narrower sample. Yet, we have to pick.

Fairfield (1994) forms portfolios based on P/BV and P/E. She finds steady EPS growth and moderate ROE at portfolios with both P/E and P/BV low or both high. However, high-P/E and low-P/BV portfolios exhibit initial low ROE and sharp increase of EPS. Initial high ROE at low P/E and high P/BV portfolio is outweigh by low EPS growth. Evidently, shares exhibit converging profitability as (P/BV)/(P/E) = ROE and markets incorporate MRE in share pricing as P/E and P/BV seem to go the opposite ways at portfolios with high or low EPS growth. Moreover, Fairfield (1994) finds that the poorly profitable companies still tend to be underdogs, although their performance increases significantly (ibid).

Is the underperformance determined by industry-pertinence or other factors? The answer to this question is immensely important to the practice because significant part of pricing on the securities markets is done via comparison to peers (Demirakos et al., 2004). The analysis of P/E and P/BV stability (Tab. 4, ibid) also

shows that just a small share of companies remain in the same portfolio after few years. Either investors' estimates are subject to substantial pricing errors or share prices fluctuate so wildly or the MR of earnings (or BV) shifts the ratios elsewhere. However, Fairfield (1994) does not examine the accuracy of investors' estimates.

Also, Penman (1996) shows that the deflated EPS growth rates converge in few years to approximately the same level for each of the 20 portfolios, which he sorted on E/P. However, residual income deflated by book value converged at slower pace at portfolios sorted on P/BV. From his findings we can draw similar conclusions as from Fairfield's ones. However, Penman (1996) explicitly notes that the P/E– P/BV relationship gives picture about current and expected earnings.

Paper written by Chung and Kim (2002) is methodologically important in our review, for it examines departures from industry-average earnings (ROE) and P/E and finds them unpredictable. Are the earnings management, accounting rules or competition reasons of the unpredictability? Due to the strong influence of accruals on the P/E and EV/EBIT ratios (Sloan, 1996, or Desai et al., 2004), the use of cash flow from operations (OCF) instead of EBIT and EAT (earnings after taxes, net income) or complementary use of abnormal accruals could increase the predictive power of profitability with respect to share pricing (Cheng and Thomas, 2006). Nevertheless, Chung and Kim (2002) state that share prices are better explained by earnings than cash flows or dividends and Dechow et al. (2008) do not find accrual anomaly to be result of accruals, but rather result of investors inability to reflect diminishing returns on investment and companies' temptation to accumulate excessive positive cash flows.

We can conclude that the reaction of share prices to earnings MR seems to be ambiguous, or is at least ambiguously explained in the recent literature. Mean reversion of earnings seems to be assumed by financial markets, but the extent of incorporation of EMR in share prices seems to be inadequate. In order to get more insight into earnings forecasting by financial markets, let us review findings about the analysts' estimates of earnings.

3. EARNINGS MEAN REVERSION EXPECTATIONS

One cannot say much about the expectations about earnings MR unless he uses the indirect evidence presented in previous section of this paper or examines forecasts published by analysts. Regarding expectations, researchers relied almost exclusively on analysts' estimates, compare e.g. Dechow and Sloan (1997), Givoly (1985), Billings and Morton (2001), Doukas et al. (2002), or Bradshaw (2004).

Dechow and Sloan (1997), who use data till 1993 and compare the pricing of securities to analyst forecasts. They find that analysts' forecasts of corporate earnings can be regarded a proxy for investors' expectations.

But is it possible to trust analysts' reports? La Porta (1996) shows that analysts are too pessimistic about poorly performing companies and too optimistic about well performing ones, which is firmly linked with market overshooting. Several other research papers support this evidence. Ali et al. (1992) analyse in more detail conclusions of Bernard and Thomas (1990) and Freeman and Tse (1989) about the way market uses information about past earnings and find that analysts do not fully utilize the properties of time series of earnings.

Easterwood and Nutt (1999) examine why some papers report analyst overreaction to news and other report underreaction. They find that analysts tend to overreact to positive information and underreact to the negative one. Findings of Jegadeesh et al. (2004) have similar implications. Dechow et al. (2000) find just a tiny difference between pricing errors achieved using BV and the ones achieved with use of additional information from analyst forecasts (see Tab. 5, ibid). The superiority of BV pricing could be caused by the fact that most of listed companies are holding headquarters, therefore most of assets and liabilities of subsidiaries in their consolidated financial statements are revalued to fair (market) values in line with the significant standards of accounting resp. financial reporting (IAS/IFRS, US GAAP).

It could seem from the previous paragraphs that analysts' recommendations are inferior to other publicly available information about target companies. However, the evidence is not so straightforward. Womack (1996) finds that not only is there significant price change in the direction of analyst recommendation at the time of its publication, but that there is also significant post-announcement drift in the same direction. It is possible to find some other studies, which state the analysts' recommendation superiority compared to other sources of information, e.g. meta-study by Ramnath et al. (2008). Nevertheless, the complaint about possibly better utilization of EMR information remains, as also Dichev and Tang (2009) mention with respect to past earnings variance.

Analysts concentrate their attention on fundamental factors of share pricing (Bauman, 1996) and seem not to fully reflect EMR. Indeed, there is one big misunderstanding between researchers and the financial markets. Whereas researchers concentrate on the statistical characteristics of earnings generating process, almost every valuation textbook emphasises the top-down analysis, starting with macroeconomic environment, continuing with industry analysis and ending with company-specific factors of expected corporate financial performance. Most analyst reports compare the evaluated company to peers (Demirakos et al., 2004).

4. REVIEW OF TRANSITORY EARNINGS MODELS

The previous two sections suggest how analysts both at the financial markets and in corporations form their forecasts of corporate earnings and what is the information they need and from academia to properly value shares, traded either publicly or privately. Evidently, they need to estimate the persistence of earnings, which are abnormal compared to peers of the evaluated company or to required rate of return, among other things.

To address that problem, this section will indicate what information can the markets and corporations obtain from models of transitory earnings examined in academic literature. As this is a critical review, we will demonstrate the advantages and drawbacks of basic models and then discuss some properties of their extensions, in order to keep the analysis readable.

Transitory Earnings Models and Measurement Methods

Numerous models, which have been employed to describe abnormal earnings, can be split into two main categories:

1) autoregressive (AR) models
2) partial adjustment (PA) models.

Simple Autoregression (AR) and Autocorrelation (AC) Models of EMR

One of the first papers, which statistically examine MR models, is Beaver's (1970) analysis of earnings time series. In the first part of his paper he shows how AC function value is influenced by data generating processes: white noise, random walk and moving average. Let us denote earnings (profitability, margin) $x_{j,t}$, where t is ordinal number of time period. The relations analysed by Beaver (ibid) can be formulated as follows, due to equality between standard deviations of stationary data $\sigma\left(x_t\right)=\sigma\left(x_{t-1}\right)$:

$$x_t - x_{t-1} = \beta\left(x_{t-1} - x_{t-2}\right) + \varepsilon_t x_t, \tag{1}$$

$$x_t = \beta x_{t-1} + \varepsilon_t x_t, \tag{2}$$

where Beaver (ibid) looks for β, and $\varepsilon_{j,t}$ is an error term. Then he examines AC of earnings, returns and prices and their first differences. Beaver (1970) finds that earnings yield, undeflated earnings, and ratio of earnings per share (EPS) to net worth per share (i.e. book value, BV), show the properties of moving average, contrary to total return on share, which he finds random. That was surprising given the preceding studies finding submartingale, resp. random walk as the earnings generating process (e.g. Ball and Watts (1972), Little (1962), Ball and Brown (1969) or Watts and Leftwich (1977)). However, Brooks and Buckmaster (1976) also conclude that there is *"tendency of income to revert to previous levels"* despite they similarly to Ball and Watts (1972) stratify deflated (or normalized) first differences and estimate the best smoothing constant for each stratum. Salamon and Smith (1977) suggest that the inability of Ball and Watts (1972) to find regularity in earnings behaviour is caused by different nature of earnings generating processes in different companies.

Some of the last contributions to the AC/AR models of EMR have recently added Frankel and Litov (2009) and Dichev and Tang (2009), who have derived equation (3) from equation (2) and rearranged it by the knowledge of $\sigma(x_t) = \sigma(x_{t-1})$ into (4)

$$\sigma^2(x_t) = \beta^2\sigma^2(x_{t-1}) + \sigma^2(\varepsilon_t), \tag{3}$$

$$\beta = \sqrt{1 - \sigma^2(x_t)/\sigma^2(\varepsilon_t)}. \tag{4}$$

From the equation (4) and the positivity of σ^2 we can see that

1) if at least half of the variability is caused by error term, then earnings converge or fluctuate around a target,
2) EMR is the faster, the higher is share of error term variance in the time series variance.

Let us note that AC/AR models have several drawbacks. Among the most serious is that they assume the MR target, the "true" earnings (x_t) as company-specific and generally unobservable to the researcher (see equation (1) and/or (3)). That renders them practically almost inapplicable, since analysts need to reason their estimates by fundamentals and not by abstract unknown targets. Also, raw AC/AR models mix company-specific randomness and industry-wide regularities in one estimate (Garbar, 2016), which prevents from utilization of these industry-wide regularities.

Recent extensions and numeric results of AR and AC models of EMR

Dechow et al. (1999) and Beaver (1970) applied models based on equation (2) on different data sets. They both examined inter alia MR of earnings and report similar results of ACF(1) of net income per share (38 % by Dechow et al. (1999) compared to Beaver's 32 %). Due to the property of AR coefficient in simple OLS $\beta_{t,t-1} = ACF(1)\sigma_t / \sigma_{t-1}$ we see that earnings revert to mean, but do not converge ($\sigma(x_t) = \sigma(x_{t-1})$). That tendency is most visible when the above researchers formed deciles of companies by difference of earnings from the central tendency. The average profitability in extreme deciles converged, but new extreme deciles emerged due to variance at previously "average" companies. Thus, even in the empirical examination, AC/AR models let us know too little about individual companies.

Baginski et al., (1999) and Lipe and Kormendi (1994) find *"rich higher-order autocorrelation patterns"* in time series of earnings, contrary to many other papers, including those with more sophisticated methods. Their portfolio approach shows that there is probably some common central tendency around which profits oscillate in long term or at least that there is group of central tendencies (e.g. for each industry one), which unsurprisingly have variance lower than the variance of profits of individual companies.

Freeman et al. (1982) are among those, who test AR (of ROE), but use logit framework in order to determine predictive power of profitability, which is more robust to the assumption about statistical distribution of residuals. They find that only the large deviations from average profitability (again average is computed per each firm in their sample as the application of simple AR/AC models implies) perform better than simple trend model. In other words, we cannot say much about the future direction of profits slightly below or above normal, but we are quite sure about mean reversion in the extreme cases.

Goddard et al. (2005) use similar model to the Beavers' (1970) one, based on AR of ROA and on other endogenous variables and estimates wide range of earnings persistence rates (AR(1) mostly between 0.2 and 0.5) for different industries and different countries in Europe using generalized method of moments.

Baber et al. (1999) examine first differences of EPS enriched by some differences of forecasts.

Ewing and Thompson (2007) measure the asymmetry of profit MR at the economy as whole, using MTAR methodology, thus regressing changes in detrended logarithms of aggregate corporate profits against their separated positive and negative lags. Ewing and Thompson (ibid) interestingly find that negative devia-

tions from trend persist longer. They estimate MR rate (MR%) at ~18 % p.a. for the positive deviations and ~6 % for the negative ones.

Fairfield et al. (2009) explain book value of equity (BV), sales, ROA and ROE and their growth rates by AR models. Their goal is however not another estimate of mean reversion rates, but comparison of these estimates for economy-wide and industry-wide groups. Parameter estimates in their equations are thus economy-wide in one equation and industry-specific in other. Their review of literature provides evidence that the profitability levels could be industry-specific, as well as some mean reversion rates (as also some of the above cited papers do). However, they find that the industry-specific models provide marginal forecast improvements of growth rates, but not for ROE, ROA, sales and BV themselves. That is quite expectable, since their AR models use company-specific average profitability as a target, whereas changes in industry take quite long time (their data sample spans just over 15 years) and company-specific factors can account for most of the variability of profits. From that stems an objection that they mix apples and oranges by putting in one coefficient industry-specific and company-specific factors.

Amir et al. (2012) estimate the industry-wide earnings persistence and company-level one and also filter out (or rather estimate the influence) of irregularities in companies' profits. They do the latter by separating the 4-year average component of profit and the rest. Their results based on pooled OLS estimates of AR models, augmented by some other explaining variables, show that there is long-term and short-term cycle, or let us say EMR. Contrary to what could be expected from their separation of core and non-core component of earnings, the non-core component possesses still quite high persistence (from 30 % in case of net income to 70 % for gross margin), which means approx. 70 % to 30 % EMR. Their result, that gross profit is significantly more persistent than EBIT and much more persistent than net income, is expectable and can partly explain why lower-level ratios are so popular for analysts for earnings forecasts.

Partial summary of findings about AR/AC models of EMR

The most serious drawback of AC/AR models is that they assume the MR target, the "true" earnings (x_t) as company-specific and generally unobservable to the researcher. That renders them practically almost inapplicable, since analysts need to reason their estimates by fundamentals and not by abstract unknown targets. Also, raw AC/AR models mix company-specific randomness and industry-wide regularities in one estimate, which prevents from utilization of these industry-wide regularities.

Results of the empirical application of AC/AR models of EMR vary significantly among different papers with data and methodology, resp. extensions of the models being the primary source of that variation. Some papers report EMR rates as low as 8 % to 16 % (Ewing and Thompson, 2007), other up to 70 % (Amir et al, 2012) with the latter ones being estimated on deviations 4-year average. Pure AR of earnings is mostly estimated between 30 % and 50 % (Goddard et al., 2005; Beaver, 1970 or Dechow et al., 1999).

Partial adjustment (PA) models of EMR

Many papers examine EMR using PA models, among which also the exponential smoothing models can be included. Little (1962), Ball and Brown (1969), Lev (1969), Ball and Watts (1972), Brooks and Buckmaster (1976), Frecka and Lee (1983), Fama and French (2000), Allen and Salim (2005) or Jiang and Kattuman (2010) apply the PA models while analyzing the time series properties of corporations' profits. Let us denote y_t the target, usually peer-group average, which is a central tendency of x_t. However, in (Brooks and Buckmaster, 1976) the target can be estimate of x_t (denoted $\hat{x}_t$) too.

Lev (1969) started his model design with the PA model, where the target y_t is actually known or expected normal level (see equation (6)), which is reformulation of weighted average (5). In addition to Lev's (1969) specification, PA models include error terms (see Waud, 1968):

$$x_t = \beta y_t + (1-\beta) x_{t-1} + \varepsilon_t \tag{5}$$

$$x_t - x_{t-1} = \beta (y_t - x_{t-1}) + \varepsilon_t. \tag{6}$$

Then, Lev (1969) set target equal to industry mean in (t – 1), which leads to (7) and (8)

$$x_t = \beta y_{t-1} + (1-\beta) x_{t-1} + \varepsilon_t x_t - x_{t-1} = \beta (y_{t-1} - x_{t-1}) + \varepsilon_{j,t} \tag{7}$$

$$x_t - x_{t-1} = \beta + \varepsilon_t x_t - x_{t-1} = \beta y_{t-1} + (1-\beta) x_{t-1} + \varepsilon_{j,t} \tag{8}$$

The adjustment of earnings towards central tendency would have to be intentional in order to satisfy (7) and (8). However, individual profits x_t fluctuate around the industry mean unknown at the time of estimation (y_t), due to the properties of mean. Thus, the nature of processes generating earnings and their means would

imply unintentional (random) adjustment of earnings, contrary to specification of (7) or (8). Use of the last known industry average in (7) and (8) as a target instead of the nearest expected one is controversial. It removes from the model uncertainty about the unknown target (by which ε_t would incorrectly mix company-specific and industry-wide error terms). It causes the target to be biased downwards in times of industry-wide profit growth and to be biased upwards when profits in general sink. Moreover, it would illogically mean that companies intentionally adjust the profits towards industry level, instead of maximizing them.

Even with y_t as a target in (5) and (6), trouble is far from over, as either the target would have to be incorrectly assumed known or the error term ε_t ambiguously mixes company-specific and industry-wide estimate errors (Garbar, 2016). More importantly, one has to be very cautious about interpreting the β in equation (7) or equation (5) as EMR. Common part of x_t and y_t, e.g. economic cycle or trend, suffices for equations (5) and (7) to exhibit significant positive β even with difference $y_{t-1} - x_{t-1}$ being purely random (Buus, 2013), i.e. with no mean reversion, regardless if intentional or not.

Recent extensions and numeric results of partial adjustment (PA) models of EMR

Fama and French (2000), Allen and Salim (2005), or Jiang and Kattuman (2010) use Lev's (1969) PA model with unknown target y_t. This rearrangement avoids the implicit objection that y_{t-1} is not a valid target for x_t. However, they tend to estimate y_t using variables like market-book ratio, dividend payment, capital intensity, gearing, etc. This way, they introduce expectations of future earnings into their PA-based models. Market capitalization, as well as dividend payment or corporate debt rating are a function of expected earnings. If y_t is function of expected earnings, then y_t and x_t have to converge, because either expectations of earnings adapt towards reality or actual earnings (partially) adjust towards target, if it is known, except for permanently mispriced securities.

By using a reformulation of Waud's (1968: 206) PA model, where target is unknown, Fama and French (2000) and their successors put both adaptation of earnings expectations and partial adjustment of earnings in one estimate. Not only is such an estimate scientifically ambiguous, it is also practically inapplicable for practice needs to estimate the future earnings, not mutual convergence of expectations and earnings. Moreover, Fama and French (2000) and their successors could have introduced collinearity in their models by estimating the target from variables, which could have been formed with use of adaptive expectations and expect-

ed partial adjustment in the same way they formulate in their model (cp. changes of coefficient estimates with changes of model specification at p. 166, 167, 172). To test dependence of adjustment speed on the deviation from target, they also use squares of these variables (similarly to Ramsey's (1969) RESET test) and separate negative and positive deviations (or changes) so that positive and negative changes have their own regression coefficient estimates, similarly to the MTAR methodology (cp. Ewing and Thompson, 2007). That can cause a collinearity too (ibid). Due to missing correlation matrix in all three papers, that suspicion cannot be ruled out. Despite "exogenous" variables that incorporate expectations, both Fama and French (2000) and Allen and Salim (2005), reach quite low R^2 up to 25 % in y_t forecasting regressions (and much lower at MR regressions).

Nordal and Naes (2009), who enrich the MR literature by examination of earnings of Norwegian non-listed companies, employ approximately the same methodology as Fama and French (2000), thus the above complaints relate to their paper too. Due to the above objections, estimated mean reversion rates are difficult to interpret and cannot be considered as EMR rates, although similar to previous papers (38 % Fama and French, 55 % Jiang and Kattuman, 25 % Allen and Salim, 44 % Nordal and Naes).

Abnormal (residual) earnings as a solution to flaws of AC/AR and PA models

As we have mentioned, application of AC/AR models on earnings without adjustment for common part (e.g. industry-average profitability) renders the company-specific target unknown. At PA models that approach implies incorrect assumptions about intentional adjustment towards last known or even unknown target.

These issues can be addressed by using those models on abnormal (resp. residual) earnings (resp. profitability) instead of unadjusted ones. Central tendency of abnormal earnings is by nature known and is 0. Moreover, use of abnormal earnings removes the common tendency of target and earnings from the model, thus avoiding false causality.

Geroski and Jacquemin (1986), as well as Goddard and Wilson (1996) apply AR models on abnormal profitability from Europe (UK, France, Germany). Both papers estimate the abnormal profitability as differences from economy-wide average profitability. Geroski and Jacquemin (1986) concentrate on comparison of persistence of profits in different countries and industries, whereas Goddard and

Wilson (1996) provide interval estimates of profit persistence rates. They both find the average persistence of approximately 40 – 50 %. However, the latter paper shows that the point estimates are significantly dispersed, therefore point estimates can be intriguing.

5. TROUBLE WITH DATA

Deflated or undeflated, EPS, earnings, EBIT or EBITDA?

Most of the above cited papers analyse deflated earnings. The deflating variables are mostly assets or BV so that the ratio turns out to be ROA with earnings after or before tax (e.g. Lev (1969), Wu and Ho (1997), Fama and French (2000)), although some others analysed net income/assets, e.g. Frecka and Lee (1983) or return on investment (ROI), e.g. Konings and Roodhooft (1997). Because most of the variables in financial statements are proportional to the company size, there is cointegration between ratio variables (Whittington and Tippet, 1999 or O'Hanlon, 1999), thus financial ratios are stationary in long term. Variance of any ratio, where profit is numerator, can be higher or lower than variance of profit, depending mostly on the variance and mean of both the divisor and numerator (cp. Frishman, 1975).

The drawback of ratios, which is their instability, can be avoided by use of lower-level inputs, i.e. of those, which contain as much of stable parts as possible. ROA is usually more stable than ROE. Assets are relatively more stable than BV of equity. The possibility of negative (or close to zero) BV makes ROE instable and subject to possible inflation by low BV.

Are margins the choice then, which are generally a ratio of earnings (EBIT, EBT, EAT, EBITDA) to sales? Margins show only part of the picture. Compared to ROE, ROA, ROC and ROIC, margins do not reflect the degree of assets utilization (turnover). However, revenues are much more stable and much less influenced by accounting policies (especially by depreciation) than BV, although profitability is closely correlated to sales (Horrigan, 1965). Moreover, margins are also difficult to manipulate (especially the gross margin), even compared to assets, as assets can be inflated by goodwill or unadjusted non-performing assets. Unfortunately, the MR literature does not pay attention to margins.

However, the consistence of denominator and numerator of such ratios is important for the usability of MR research results in valuation models.

Therefore, EMR research needs to concentrate on consistent and relatively stable measure of profitability. The measure satisfying both requirements – stabil-

ity and consistency– is return on invested capital (ROIC) or more simply return on capital (ROC), which were analysed in none of the above papers. Other choices include gross margin, EBITDA margin or EBIT margin. As we can see, all of those choices are double-edged as one advantage (e.g. lack of influence of depreciation policies at EBITDA) comes at cost (EBITDA does not show the entire picture).

Moreover, the best choice depends even on the purpose. For example, shareholders do not have to be interested about profitability. EPS are the most important for them, if share price is function of (expected) earnings (cp. Chung and Kim, 2002). However, with EPS it would get back to the problem of false causality and inflation: Berkshire Heathway A-class share costs about 270,000 USD and provides about 13,000 USD EPS by September 2017, but it had about 1,000 USD EPS and 56,000 USD share price by the end of 1999. Dell share is at 74 USD and has minus 4 USD EPS by the September 2017, but was at 50 USD by the end of 1999 with EPS 0.58 (fiscal year ending 31 Jan 1999). Evidently, it is necessary to deal with the inflation in this case as most of the profit observations come from inflationary environment. Undeflated earnings have lower mean reversion rates, i.e. higher AC than is AC coefficient of ratio of earnings to net worth in Beaver's (1970) results. By analysing AC of earnings, one examines not only the MR, but also the stability of the size of the company.

Nevertheless, in our opinion the practice still would be interested in mean reversion of EBITDA and EBIT margins, more than in mean reversion of earnings, ROE, net income margin (Welc, 2012) or EPS. The reason is that in practice, an analyst can quite easily estimate financing structure and interest cost for particular company if the analyst knows the expected EBITDA, investment and dividend policy. Higher-level variables and ratios like ROE, earnings or EPS are commonly estimated in practice from EBIT or EBITDA, whereas the opposite direction of estimate is very rare. Analysts usually start from forecast of revenues and margins. We can conclude that significant part of the EMR (or vice versa earnings persistence) research concentrates on practically inadequate variables.

Statistical properties of financial ratios

Above the problems with meaning, deflation and consistency of the examined variable one should also expect the problems with proper transformation (or proper ratio) in order to satisfy the residuals normality required by least squares (LS) regression methods, which are almost exclusively employed at earnings MR papers as correlation is part of regression coefficient. For the AR coefficient like in Dechow et al. (1999) or a little bit extensively even for the ACF (1) in Beaver (1970)

to be consistent estimate it is needed the residuals to be normally, independently and identically distributed.

Normal distribution is not so frequent in social sciences, as it would seem at the first sight. Limpert et al. (2001) provide some examples of lognormal distribution for several scientific areas, including economics. Ezzamel et al. (1987) conclude that finding the proper distribution, which would fit financial ratio, is uneasy task and that fat tails are not uncommon at distribution of financial ratios. However, they found that in some of the industries the hypothesis that the ratio of net income/assets has normal distribution cannot be rejected. Both Ezzamel et al. (ibid), and McLeay (1986) find that Cauchy- or lower-order t-distributions, both skewed, could fit profitabilities and earnings. Literature on distribution of financial ratios states in general that most of the financial ratios do not have normal distribution due to skewness or fat tails (Trigueiros, 1995). Regarding the profit transformations or profitability ratios, Trigueiros (1995) shows that the one, which has almost normal distribution, is EBIT/Assets, or EBIT/Sales (EBIT margin) contrary to EBIT/Net worth, which is much more skewed and spikier than would correspond to normal distribution.

Bougen and Drury (1980) conduct visual inspection of ratio histograms and conclude approximately the same as previous authors did on the base of parametric tests results: That there is positive skewness of margins and ROIC, although the observed distribution is very close to the normal one in the neighbourhood of mean. They also review the up-to-date studies in this area conducted on U.S. data and summarize again the findings of asymmetry in financial ratios distributions. For the purposes of finding of statistically favourable distribution, ratios can be split into three main groups according to their nature: Σ / Σ (e.g. leverage) having usually lognormal distribution, Δ / Σ (e.g. ROE), which tends to have t-distribution and Δ / Δ (e.g. EBIT margin) with Cauchy distribution according to Barnes's (1987) citation of (McLeay, 1986).

Frecka and Hopwood (1983) however note that gamma distribution is suitable for most financial ratios as it is a two-parameter family of continuous distributions and that deletion of outliers and proper transformation shift the distribution towards the normal one.

Suitable statistical methods of EMR rate estimation

Because many financial ratios need lognormal or square root transformation (Deakin, 1976) and because of such plethora of opinions on financial ratios' distri-

butions, it is necessary to use estimation methods robust to non-normality, or proper transformation methods while estimating EMR (earnings persistence). The matter is complicated by the fact that EMR data are usually two-dimensional (panel).

For measuring EMR rate on panel data there are generally two options. One is to use panel regression methods, mostly pooled OLS to estimate MR% of earnings, requiring i.i.d. and normally distributed residuals. Earnings management distorts the earnings probability density function, compared to normal distribution, as Burgstahler and Dichev (1997) show. Lack of normality would imply use of methods more robust to the assumptions about the distribution, for example least absolute value (LAV), resp. least absolute deviation (LAD). Nevertheless, panel LAD has not been used in the above-mentioned papers.

Dielman (2005, p. 268) cites large number of papers, which prove weak consistency of least absolute value (in other words least absolute deviation, or LAV, resp. LAD) estimator for unspecified distribution under the condition of independent disturbances. LAD models are less sensitive to outliers compared to LS, cp. Dielman (2005) or Cade and Richards (1996), although Ellis (1998) disputes that. LAV models are also more robust to changes in model specification and to data changes, than LS models. The use of LAV models in case of stock markets has already quite long history, cp. Sharpe (1971). It should be also considered the possibility of non-i.i.d. residuals, e.g. their heteroskedasticity. Nevertheless, there is, as always, trade-off. Panel weighted LS would be helpful in case of heteroskedastic residuals of LAV, cp. Beck and Katz (1995), or Wooldridge (2003), but then one needs complete set of observations for every period and every subject (company).

6. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Persistence of earnings (or vice versa their mean reversion) is a phenomenon, which significantly influences forecasts of corporate profits and prices of shares. The recent literature shows that share prices incorporate expectations of earnings mean reversion.

The contemporary academic knowledge of earnings mean reversion (EMR) is ample. However, practice does not seem to fully utilize them. Review of literature shows that stock market analysts seldom rely on formal models of earnings persistence. Naturally, a question emerges, whether that lack of practical use of results of scientific research is a result of its inadequate publicity or a result of its inadequacy for practice.

To address this issue, we critically review available literature with emphasis on basic EMR models: partial adjustment (PA) and autocorrelation, resp. autoregressive (AC, resp. AR) models. We review their results and extensions then.

In the papers, which describe earnings generating process as AR or AC, the EMR target is company's long-term earnings (profitability) average. However, the the MR target, the "true" earnings (x_t), is company-specific and generally unobservable to the researcher in AC/AR models. That renders them practically almost inapplicable, since analysts need to reason their estimates by fundamentals and not by abstract unknown targets. Also, raw AC/AR models mix company-specific randomness and industry-wide regularities in one estimate, which prevents from utilization of these industry-wide regularities.

Partial adjustment (PA) models suffer from other pitfalls. One of them is that they implicitly assume intentional adjustments towards last known target (usually industry-average earnings) or the nearest one, which is unknown. However, companies try to maximize profit in practice, and the processes, which drive earnings towards central tendency, are rather beyond control of individual company. There is also a plethora of extensions of PA models, which try to derive the EMR targets from market variables, which depend on earnings expectations. That renders their results inapplicable again as they mix expectations and the real earnings persistence.

The other pitfalls of the hitherto EMR research come from the measured variables. Earnings can provide falsely strong results, because by autoregressing them it not only measures the MR, but also persistence of the size of company. A popular ROE is subject to the problem with inflationary or inverse effects of low or negative equity. ROA, also frequently used, embodies inconsistence between numerator (EBIT) and denominator (equity). The need to deflate the mean reverting variable together with the above-mentioned issues, lead to either ROIC (return on invested capital), ROC, or margins: EBIT, resp. EBITDA margin. They are feasible choices, basic building blocks of most business valuations, but unfortunately infrequent in earnings MR literature. These ratios also have distributions close to normal, contrary to e.g. ROE. Besides that, margins are widely used for income valuation of businesses (not to say shares).

Finally, survivorship bias is a special theme. We found no study on earnings persistence, which would deal with troubled companies.

The above objections could be the reasons why financial markets and analysts seem to miss out the benefits of earnings MR literature. Although stock market prices are mean reverting and somehow incorporate the earnings MR beyond any doubt, they exhibit too much optimism in good times and too much pessimism in the bad times, as well as the analysts' reports do.

There is large body of articles on accruals and their influence on pricing and earnings forecasting as the growing importance of accruals creates new challenge. Despite the accrual reversals have been studied in the last decade (Allen et al., 2013), earnings persistence literature has not fully utilized these findings yet. And financial markets give too much weight to accruals while pricing shares. The reason for omission simply irrational or too slowly adaptive behaviour of investors (Beshears et al., 2013) can be both lack of detailed information on accruals in financial statements and annexes or the increased variance of accruals, apparently for sake of increased prudence.

There are two suggestions for the future research. Firstly, practice needs EMR (resp. earnings persistence) research, which would distinguish income statement accruals, industry-wide, and company-specific part of earnings. Modelling of abnormal (residual) earnings instead of unadjusted ones could avoid several drawbacks of AC/AR and PA models. Secondly, despite numerous papers on relation between earnings and share prices and other on analyst expectations, direct estimates of EMR expectations have not been examined as far as we know.

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KRITIČKI PREGLED STABILNIH MODELA ZARADE

Sažetak

Hipoteza da se zarada vraća na svoju srednja vrijednost predložena je prije 90 godina i od tada je opsežno testirana. Očekivanja povrata zarade srednjoj vrijednosti (u daljnjem tekstu "EMR") značajno utječu na cijene dionica ili prognoze zarade. Unatoč prijedlozima i testiranju brojnih modela EMR-a, bilo je vrlo malo istraživanja o značenju tih modela u korporativnom i vrijednosnom smislu u akademskoj literaturi. Stoga takvo istraživanje smatramo vrlo poželjnim. Cilj ovog rada je kritički osvrnuti se na modele privremenih zarada (obrnuto EMR), njihovu metodologiju, praktičnu primjenjivost njihovih rezultata i njihova ograničenja koja proizlaze iz karakteristika podataka o zaradi. Ustanovljeno je da je većina nedavnih modela privremene zarade (EMR) pogrešno specificirana u smislu ciljane zarade ili razloga EMR-a. Također, potvrđujemo da je EMR dijelom uzrokovan ciklusima u relevantnoj industriji ili gospodarstvu, a dijelom zbog specifičnih procesa u poduzećima i obračuna. Također, eliminiranje pristranosti preživljavanja i korištenje marži ili profitabilnosti na nižoj razini, kao što su ROI i ROC umjesto ROE, vrijedno je testiranja u modelima EMR.

Ključne riječi: privremena zarada, dobit, perzistentnost, povratak na srednju vrijednost