NOISY VALUATIONS

***Remarks on a study by Iván Bélyácz and Alexandra Posza*[1]**

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ABSTRACT

In this article, we examine the distribution of experts' firm valuations. As an individual homework assignment, 85 university students estimated the value of the majority share in the haulage firm Waberer's not traded on the stock exchange from the perspective of the seller, with a value date of 17 April 2018, using the comparative multiples approach. We measured the distribution using the so-called noise index proposed by *Kahneman* et al. (2016), the value of which (60%) – after excluding extreme and inconsistent answers – essentially corresponded to the values (46–62%) measured by the authors, typical of corporate experts with at least five years of practice. Interestingly, a sub-sample of 32 students who regarded themselves as eccentric proved the least "noisy" (with a noise index of 54%), with their answers significantly less dispersed around the sample average than those of the others. Based on the results, the level of noise in practice can be reduced by employing lower and upper bounds, filtering out inconsistent answers, and giving greater weight to boldly eccentric answers.[2]

JEL codes: G12, G14, G17

Keywords: fundamental analysis, estimation bias, dispersion of estimates

1. INTRODUCTION

On page 3 of their study on fundamental analysis, Bélyácz and Posza (2018) observe: "*Nevertheless, the problem with value-based investment is that it is difficult to estimate the intrinsic value of shares. Despite receiving exactly the same information, two investors may estimate different values for the company.*" Let alone the fact that untrained small investors price indiscriminately (*De Bondt*, 1998), it frequently occurs that even the views of highly trained experts lack any nodding acquaintance with each other. We can experience startling divergence not only in

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the valuation of companies, but in other areas of life as well, for example in medical diagnoses, judicial rulings or historical analyses. In this article, our intention is to comment on this narrow but not insignificant matter of detail.

In an ingenious series of experiments, *Hodgson* and *Cao* (2014) showed that wine-tasting experts disagree not only with other experts, but with themselves as well. During the experiment, highly experienced wine judges received the same wine for evaluation beneath a variety of labels, and not only failed to notice, but gave the most diverse set of ratings. Having carried out the same experiment over several years on a large sample, Hodgson and Cao (2014) essentially came to the conclusion that expert appraisals in this field contain no informative content whatsoever.

How much we can rely on the opinions of experts in the evaluation of companies is questionable. We cannot attempt to find out whether evaluators agree with themselves, since experts would surely notice if presented the same company for analysis on several occasions under different pseudonyms. Instead, we must concentrate on determining how much opinions are dispersed when several analysts evaluate the same stock or share of a business simultaneously.

A stock or company valuation is, therefore, an estimate or forecast which may be biased or noisy, or both at once. In the case of so-called rational expectations, which form the theoretical basis of fundamental analysis, forecasts are by definition unbiased, i.e. the forecast equals the expected value with the information available; however, noise can theoretically assume any size. Behavioural economics has focused on criticism of the rational expectations theory, and for this reason has dealt primarily with bias, so that before (Kahneman et al., 2016), relatively little attention was paid to noise, meaning the expected dispersion of outcomes. Daniel Kahneman, winner of the Nobel Prize in Economics and a defining figure in behavioural economics, has nevertheless now placed this hitherto wrongly neglected phenomenon at the centre of his research, and is currently working with his co-authors on a book to be titled "*Noise*", expected to appear in 2020.

The noise inherent in expert valuations is by no means devoid of interest either from the theoretical or practical perspective. The dispersion of recommendations by professional stock analysts, for example, can be regarded as a kind of measure of risk which can be related to stock returns, although empirical results in the latter regard are somewhat contradictory (see in detail Naffa, 2014).

Let us take a firm valuation expert, whom we ask to estimate the value of a business share we are thinking of purchasing in a given firm. The valuator performs a fundamental analysis from our point of view (*Juhász*, 2018), and let us assume that we can trust in their forecasts being truly unbiased. If, however, there is a lot of noise in the valuation, then we can expect a value that is too low or too high. In the former case we will miss a good business opportunity, while in the latter case we will end up paying too much. From this it follows that the errors will not be evened out even if we buy and sell shares in the business many times based on fundamental analysis, since the errors will persistently cause losses in both directions.

In theory, we could increase the number of valuators and average their results, thereby filtering out some of the noise and gaining a more reliable final result. It is no accident that decision-makers generally feel a strong compulsion to average expert opinions. However, in business valuation, analyses are expensive on the one hand, while on the other hand averaging may be contrary to professional standards (IVS, 2017, 105.10.6). Business valuation standards expressly oppose the averaging of valuations based on a variety of different assumptions, particularly if the methods applied also differ (DCF, multiples or asset-based approach, etc). According to the recommendations, the customer (or chief expert they employ) must be able to determine which valuation is the best in a given instance, and to rely exclusively on this.

Before we think about possible noise reduction techniques, let us examine the scale of the noise we may expect during a fundamental valuation; that is, how reliable such a valuation may be. In this article, based on Kahneman et al. (2016), we analyse the scale of dispersion of valuations if the same business share is evaluated by a whole year's intake of university students who have the same information at their disposal, and who have received the same training in advance. The sample of almost 100 provides the opportunity for analyses that are much richer than usual.

The article is structured as follows. In point 2, I summarise the results of the research by Kahneman et al. (2016) related to the dispersion of expert opinions, analysing in detail the characteristics of the so-called noise index they introduced. In point 3, I present the experiment carried out with the university students, before finally summarising the conclusions in point 4.

2. NOISE INDEX

Kahneman et al. (2016) developed a special consultancy service, known as a "noise audit," which helps to examine the dispersion of analysts' opinions within an organisation. During the noise audit, external consultants provide the methodological framework, but the organisation itself comes up with the analytical task for experts to carry out simultaneously, which is the best possible reflection of valuation tasks that arise on a regular basis (judgement of loan applications, client assessment, business valuation etc). They pay particular attention to ensuring that this task is not leaked ahead of time to colleagues participating in the experiment.

The subjects of the experiment are asked to carry out and document the valuation independently of each other. In order to avoid collusion, participating colleagues are unaware of the true goal of the inquiries, and know only that they are seeking possible ways to make processes more efficient (which, when all is said and done, is actually not so far from the truth).

The dispersion of valuation results can be measured using a variety of indicators, for example standard deviation, interquartile range, full range, average absolute deviation, average deviation from the median, etc. However, Kahneman et al. (2016) recommended a special indicator which they named the noise index. The essence of this is that we select two different analysts and compare the difference between their valuations to the arithmetic mean of their valuations, and then estimate the expected value of the indicator thus obtained with respect to all analysts; in other words, we calculate the arithmetic mean of the indicator taking into account all possible pairings. For example, if we have three analysts, A, B and C, who give respective values of 50, 100 and 150, then in the relation of A to B the indicator is (100–50)/75 = 67%, in the relation of B to C it is (150–100)/125 = 40%, and in the relation of A to C it is (150–50)/100 = 100%. Consequently, given that each pairing has an equal probability of 1/3, we calculate the arithmetic mean with equal weight, which is an unbiased estimate of the expected value: ((67% + 40% + 100%)/3 = 69%. In this nominal example, therefore, the noise index is 69%.

Although Kahneman et al. (2016) do not expand on this, it is worth considering the lower and upper bounds of the noise index under various assumptions. Let us consider the $a_i \in A$ non-negative valuations in non-descending order, where $i = 1,\ldots,N$ and N is the number of analysts. Here, the noise index Z is

$$Z(A) = \frac{\sum_{1 \le i < j \le N} \frac{a_j - a_i}{(a_j + a_i)/2}}{\binom{N}{2}} \tag{1}$$

It easily follows that every term in the sum falls between 0 and 2, and so the same also holds for their average:

$$0 \le Z(A) \le 2 \tag{2}$$

$Z(A) = 0$ precisely when every a_i is equal, and $Z(A) = 2$ when, if and only if, $N = 2$ and $a_i = 0$. It can also be seen that for any N, $Z(A)$ can be arbitrarily close to 2, if the $\frac{a_{i+1}}{a_i}$ ratios for every i are sufficiently large. If, on the other hand, the range of valuations has bounds, i.e. ($a_1 > 0$ and) $\frac{a_N}{a_1} \le K$, then we obtain

$$Z(A) \le 2 - \frac{4}{K+1} \tag{3}$$

So, by giving reasonable lower and upper bounds, the noise index can be significantly reduced, irrespective of the number of experts. To prove (3) for *i*<*j*, let

$$a_j = L_{i,j} a_i \tag{4}$$

Then

$$\frac{a_j - a_i}{(a_j + a_i)/2} = \frac{L_{i,j} a_i - a_i}{(L_{i,j} a_i + a_i)/2} = 2\frac{L_{i,j} - 1}{L_{i,j} + 1} = 2 - \frac{4}{L_{i,j} + 1} \leq 2 - \frac{4}{K + 1} \tag{5}$$

In its logic, the noise index resembles the relative standard deviation $\left(\frac{\sigma}{m}\right)$, although it also differs in several respects. On the one hand, standard deviation only counts deviation from the average once, while the noise index does so twice. As an example, let us take a case where we have two analysts and their estimates are 50 and 150. Here the noise index is 100/100 = 100%, while the relative standard deviation is 50/100 = 50%. On the other hand, if we have several analysts, then because of the different base for comparison we obtain completely different values, even if we compare double the relative standard deviation to the noise index. Finally, another important difference is that relative standard deviation – contrary to the noise index – has no upper bound.

Kahneman et al. (2016) do not explain the justification for using the noise index over traditional measures of distribution. Perhaps this may be because it is relatively easy to understand, and it is easier to ask the manager, if we choose two analysts at the company at random, how much the two valuations will differ from each other as a percentage of the average. It is likely that managers would find it harder to answer the question of how much is the standard deviation or the relative standard deviation.

The main finding of the research by Kahneman et al. (2016) is that managers expected a much smaller noise index (around 5–10%) than what was measured in practice (34–70%). The managers' forecast was thus extraordinarily biased: they believed that the consensus among their colleagues was far greater than it was in reality. The authors attributed this to the tendency of people to overestimate the accuracy of their own valuations on the one hand, and the know-how and intelligence of their colleagues on the other. Perhaps an even more surprising finding, however, is that agreement among more experienced colleagues at the surveyed companies was no greater than among novices; although the value of the noise index fluctuated in a somewhat narrower range (46–62%).

The findings were very alarming because all managers agreed that noise, and particularly such significant noise, carries a great organizational cost. They therefore began to seek possible procedures to reduce noise. The complete automatization of valuation decisions (for example, using a regression model) would completely eliminate noise, since the same input parameters would always deliver the same result. The problem, however, is that a huge amount of data is required for perfection of the regression model, which is not always at hand in every situation, while important individual data and useful subjective valuations may be omitted from the analysis. Kahneman et al. (2016) came to the conclusion that one of the most effective tools for reducing noise is if we formulate a number of intuitive valuation criteria for analysts, ask them to score these individually, and then add up the scores with equal weight, while allowing them the freedom to correct the valuation if they deem it necessary.

I would note here that, based on the correlation (3), suitably defined lower and upper bounds can also be useful in reducing noise. This can also work if we assign the definition of the bounds to an external analyst or even a computer algorithm.

3. AN EXPERIMENT INVOLVING UNIVERSITY STUDENTS

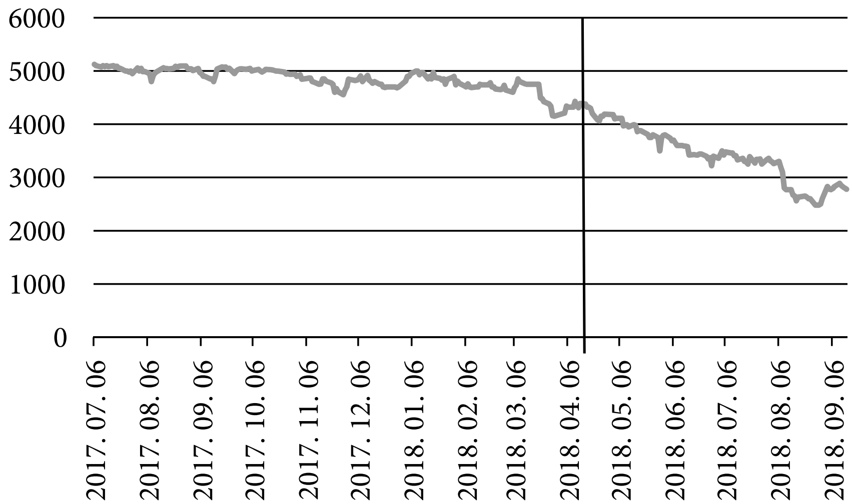
An excellent context for the examination of the distribution of valuations was provided by the homework assignment and related voluntary task given to third-year undergraduate students of Finance and Accounting at Corvinus University of Budapest, as part of the Financial Case Studies course (compulsory in the Finance, and optional in the Accounting specialisation). The deadline for submission was midnight on 6 May 2018. The task was to estimate the value of the 72% business share in haulage firm Waberer's not traded on the stock exchange, using the multiples approach and with a value date of 17 April 2018, from the perspective of the seller. The method of valuation using multiples had been taught in detail some weeks earlier as part of the Business Valuation course, besides which students also had the opportunity to attend a 90-minute lecture from the Waberer's investor relations manager, where they could also ask questions. The homework assignment was worth 10 points (of the total 100 points obtainable in the course), so that successful performance of the assignment potentially represented one grade's difference in the student's final result.

As a starting point, students had to find out the price of bourse-listed Waberer's shares as they were traded on the Budapest Stock Exchange on the day of valuation, embodying a 28% share of the company. The closing price on that day was HUF 4,320, which, if simply applied in proportion to the 72% share of the business, gives us a figure of about HUF 55 billion. This is of course only a raw figure, from which the actual value of the business share may differ considerably, since we must certainly take into account that the stock market price is also influenced by the prevailing mood; furthermore, that the 72% majority share in ownership is not listed on the bourse, and we must therefore reckon with an illiquidity discount; and finally, that a majority share ensures significant controlling rights, so that some size of control premium must be applied. We may thus regard the value of HUF 55 billion merely as a kind of base for comparison, from which we can – indeed, must – deviate during the valuation.

To get a sense of the stock market mood, it is worth glancing at *Figure 1*, which shows the evolution of the price of ordinary shares in Waberer's (with the vertical line indicating the date of valuation, 17 April 2018).

Figure 1

Price of Waberer's ordinary shares on the Budapest Stock Exchange (in HUF)



Source: portfolio.hu (2018)

Note: The issue price on 6 July 2017 was HUF 5,100; on the valuation date of 17 April 2018, the closing price of the share was HUF 4,320; while the latest price, on 14 September 2018, was HUF 2,780.

As we can see, the share price had been on a downward trajectory for some time as of the date of the valuation. In this regard, the investor relations manager said during his lecture that the timing of the share issue was unfortunate because of the plunge on stock markets in developing countries, as well as the failure of the private sale of the 72% portion of the company at that time, which was probably not communicated properly. The manager noted that a combination of these unfortunate circumstances contributed to the significant drop in price, while pointing at the same time to detailed data showing the fundamentals to be essentially in order and asserting that, in their view, the outlook was decidedly positive at that time. In Figure 1, however, we can see that unfortunately the decline in price has continued ever since. (Most recently, the closing price on 14 September 2018 was only HUF 2,780, so that the raw value of the business share calculated at the stock market price is around HUF 36 billion.)

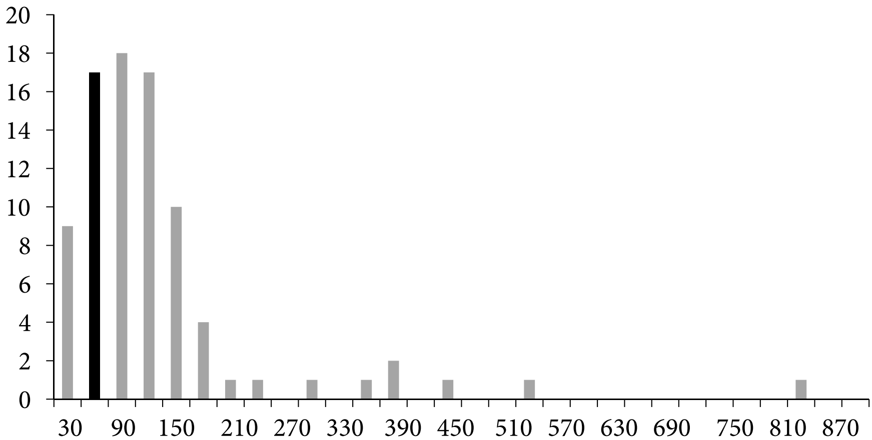
In conducting a valuation using multiples, the students needed to determine the value of the majority share package in Waberer's in comparison to European competitors. As instructions in the description of the task, they were told to specify the chosen multiple and the justification for using it, the peer group of companies featured in the comparison, the working of their calculations, the discounts and premiums applied, and the justification for using them. We emphasised that they should take into account the asset-heavy business model of Waberer's in the valuation, as the firm owns its pool of trucks and trailers, unlike its rivals, which only rent assets.

According to *Keynes* (1936, p. 100), it is not the long-term thinkers and rational fundamental analysts who are the most successful on the stock markets, but rather those who can "*guess better than the crowd how the crowd will behave*." With this in mind, we also set a voluntary assignment, to guess the average, minimum, and maximum of the estimates submitted by all students. An extra 5 points for the voluntary assignment were awarded to students who both completed the homework and gave the most accurate guess of at least one of the average, minimum, and maximum of the full set of estimates. If several students guessed with equal accuracy, then the extra points would be split equally. By handing in the voluntary assignment, students consented to using their answers anonymously in the research.

To summarise, students were motivated in carrying out the extra assignment, the homework was adequately prepared, all important information was at the students' disposal, and they had sufficient time to complete their work. Graduating university students constitute a suitably homogeneous group, so we could expect comparatively little noise in their valuations.

Contrary to this expectation, however, we experienced a wide dispersion of estimates. A total of 99 students submitted the homework, but of these only 85 completed the voluntary assignment, so that in the following I analyse the responses of only this narrower group of 85 students. *Figure 2* depicts a histogram of students' estimates of the value of the majority share in Waberer's.

Figure 2
Students' estimates of the value of the majority share in Waberer's (17 April 2018, HUF billion)



Source: compiled by author

In Figure 2, the HUF 30–60 billion range is in a darker shade, because it contains the raw value (HUF 55 billion), calculated at the actual stock price, serving as benchmark. It can be seen that most students estimated a higher value.

Of the 85 valuations, seven were unrealistic outliers: six estimates were less than HUF 1 billion, while one student – even more startlingly – estimated the value of the business share at exactly (!) HUF 216,139,647,231,919, equivalent to approximately six times Hungary's annual GDP (this value is missing from Figure 2). Applying the EV/EBITDA multiple, this latter student determined the size of the multiple's numerator and denominator accurately, obtaining a realistic value of around HUF 54 billion in the first step. However, the student then corrected this in an untraceable sequence of discounts and premiums, thus reaching the above figure (with predictions of a similar order of magnitude for the average, minimum, and maximum of all estimates). I omitted these seven outliers from the analysis, thus obtaining a working sample of 78 elements.

Of these 78 students, 14 gave an obviously false minimum-maximum range not containing their own estimate. Two additional students predicted the population average outside the minimum-maximum range. These 16 students probably misunderstood the task, or were insufficiently motivated to think the questions through properly. We can regard the remaining 62 students' responses as consistent. These were also split into two groups, depending on how much they saw their own estimates as different from those of the other students. A total of 32 students believed the average of all students' valuations would fall outside of the range of

+/-10% of their own valuation. These students felt that their thinking significantly differed from the others, thus qualifying themselves as "eccentric." Interestingly, these 32 students were more or less equally split between 18 who felt they had overestimated the value of the share compared to the others, and 14 who felt they had underestimated it. Tables 1a–1d reveal the key characteristics of the sub-samples of 85, 78, 62 and 32 students (always referring only to the given sub-sample).

Table 1a
Average, median, standard deviation, minimum and maximum of estimates (HUF billion)

Sample	No. elements	Average	Median	Standard deviation	Minimum	Maximum
All	85	2655	89	23432	0	216140
Minus outliers	78	123	91	122	14	822
Consistent	62	107	89	79	14	441
Eccentric	32	103	90	64	31	375

Table 1b
Dispersion of estimates

Sample	No. elements	Relative standard deviation	Noise index
All	85	883%	88%
Minus outliers	78	99%	74%
Consistent	62	74%	60%
Eccentric	32	62%	54%

Table 1c
Average guesses (HUF billion)

Sample	No. elements	Average guess for average	Average guess for minimum	Average guess for maximum
All	85	2531	1232	3642
Minus outliers	78	113	59	203
Consistent	62	111	50	205
Eccentric	32	112	41	234

Table 1d
Maximum noise

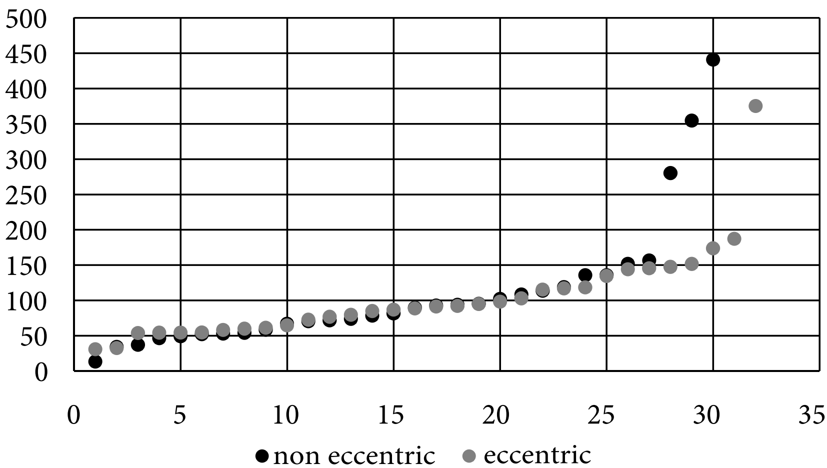
Sample	No. elements	Guess	Reality
All	85	1.14	2.00
Minus outliers	78	1.12	1.94
Consistent	62	1.13	1.88
Eccentric	32	1.30	1.69

Source: compiled by author

From Table 1a, it is apparent that the omission of the outliers – particularly the one strikingly high value – reduced the average, standard deviation, and minimum-maximum range the most spectacularly, while the elimination of inconsistent answers also had a perceptible effect in this direction. Interestingly, if we look at only the eccentric valuations among the consistent ones, then the standard deviation and the minimum-maximum range do not increase, but are even further reduced. We should note that the decrease in the average is significant only in the first step ($t = -2.35$). It is also worth remarking that the median is nearly the same (around HUF 90 billion) in all sub-samples.

It is interesting that students describing themselves as eccentric deviated far less from the sample average than those who identified their own estimates as close to the common opinion. *Figure 3* compares the distribution of eccentric and non-eccentric estimates.

Figure 3
Distribution of eccentric and non-eccentric estimates (HUF billion)



Source: compiled by author

Figure 3 reveals that students who saw themselves as eccentric were actually not eccentric in the final analysis, since the values of their estimates were typically neither unusually low nor unusually high. If we calculate the standard deviation of eccentric and non-eccentric estimates, then we obtain values of HUF 63 billion and HUF 92 billion, respectively, which is a significant difference using an F test ($p = 1.96\%$).

It seems, therefore, that the sub-sample of eccentrics is the least noisy. The explanation may be that these students were the ones who put the greatest effort into solving the task and who gave the most thorough consideration to their answers; otherwise, they would likely not have dared deviate from what they assumed was the common opinion.

Table 1b reinforces this, containing two indicators of dispersion: the relative standard deviation and the noise index (grey column) proposed by Kahneman et al. (2016). The two indicators differ in order of magnitude, but both decrease strictly monotonically as the sample is narrowed, with the sub-sample of eccentrics assuming its minimum. It is worth noting that once the extreme and inconsistent estimates are removed, the noise index calculated from the student estimates (60%) essentially corresponds to the values (34–70%) measured by Kahneman et al. (2016); moreover, it also falls within the range of values (46–62%) of "professionals" with at least five years' experience.

Table 1c shows the averages of guesses given in the voluntary assignment with respect to the average, minimum, and maximum of the given sample. Once the extremes are removed, further narrowing of the sample no longer has a significant impact on the average guesses, though the eccentrics give a somewhat wider minimum-maximum range than the others.

Table 1d shows that the students on average expected the noise index for the minimum and maximum estimates would be much lower (between 1.12 and 1.30, depending on the sample), while in reality much higher noise values were typical (between 1.69 and 2.00, depending on the sample). This confirmed the finding of Kahneman et al. (2016) that participants overestimate the consensus of experts.

For the sake of completeness, we mention that the minimum was guessed most accurately by a consistent eccentric, the average by an inconsistent, and the maximum by the student with the extremely high valuation, so these students were awarded the extra points for the voluntary assignment.

4. CONCLUSIONS

In the practice of fundamental analysis, it is generally not possible to carry out a great number of parallel valuations because the cost of such valuations is very high. In the Central European region, even the most liquid listed stocks are usually valuated by only 4–5 professional analysts. In this article, we analysed the homework and related voluntary assignment given to 85 university students, aimed at performing a comparative multiples-based valuation of the 72% majority share in Waberer's, which created an excellent opportunity to examine the dispersion, or "noise," inherent in fundamental analyses, thanks to the large size of the sample, and also to the well-prepared and standardised nature of the experiment.

First, we omitted from the 85-strong sample students whose estimates of the value of the business share were either extremely low (less than HUF 1 billion) or extremely high (HUF 216,000 billion). Even the remaining 78 elements showed a significant dispersion, with a lowest value of HUF 14 billion, and a highest value of HUF 822 billion. We then removed the answers of a further 16 students from the analysis due to their inconsistency, leaving us with a sub-sample of only 62 elements. The average and median valuations in this sub-sample were HUF 107 billion and HUF 89 billion, respectively, almost double the raw value calculated at the stock price (HUF 55 billion). From this, we can conclude that most participating students believed the stock to be underpriced on the Budapest Stock Exchange compared to its European competitors on the date of valuation (17 April 2018), since other corrective factors (liquidity discount, control premium) cannot in themselves explain such a large discrepancy. This demonstrates that the optimistic lecture delivered by the investor relations manager had ultimately convinced the students.

The noise index (60%) of the 62 consistent students corresponds to the noise index (34–70%) of corporate experts measured by Kahneman et al. (2016); moreover, it also falls within the range (46–62%) typical of experts with at least five years' experience. From this, we may draw the conclusion that the valuations of university students contain approximately the same degree of noise as those of corporate experts, but only after eliminating the extreme and inconsistent answers.

Interestingly, the estimates of students who regarded themselves as eccentric (a sub-sample of 32), who initially expected their own valuations to deviate significantly from the others, proved the least noisy. Probably these students were the most careful to think over their valuations and invested the greatest energy into their answers. The eccentrics were otherwise divided almost symmetrically between those who believed they had undervalued or overvalued the stock compared to the others. Students who saw themselves as eccentric were thus in reality nothing of the sort; indeed, their estimates were dispersed significantly less around the sample average than those of the other students.

In the voluntary assignment, we also asked students to guess the minimum-maximum range in which all the estimates would fall. In this way, we were able to compare the students' expectations of the dispersion to the reality. Here, too, we obtained similar results to Kahneman et al. (2016): students expected a much narrower dispersion than existed in reality.

A great many methods can be applied in practice to reduce noise, from artificial intelligence, through regression models, to simpler decision support tools. Kahneman et al. (2016) argue that even simple decision support systems can prove very effective. For example, the discrepancy can be considerably reduced if we elaborate a number of clear-cut criteria for the analysts, each of which they must evaluate on separate scales, and average the scores thus obtained with equal weight.

It is not clear how simplifying methods of this kind could be applied in business valuation. What certainly emerges from the above experiment with students is the great importance of filtering out extreme and inconsistent answers. It might prove effective, for example, to ask analysts to give lower and upper bounds – no matter how trivial, but justified. Or – if the sample is sufficiently large – we can use the median instead of the average. This might help us exclude extreme valuations, and thus at least keep the size of the estimates within reasonable bounds. On the other hand, when weighing expert opinions, we need to pay close attention to even the smallest signs of inconsistency, since these can greatly reduce the reliability of the evaluation. At the same time, we should appreciate those who think differently, the eccentrics who openly hold opinions that deviate from the majority.

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