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1 Introduction

Every person who is more or less familiar with a financial market or simply reads the news is aware of the dot-com bubble. The beginning of a third millennium, when it happened, was a time of internet-related start-ups and enormous valuations, and later their bankruptcies and closures. Nowadays, the tech companies are viewed much more positively by members of the public. Many people have them in their retirement portfolios, and companies' valuations are hiking.

However, not everyone shares that point of view. Wall Street market veteran J.Paulsen has recently stated that "The tech sector now is reminiscent of the 1990s dot-com bubble" [2]. In his interview he told CNBC that there are "similar warning signs in today's tech sector that led to the early 2000 bust". Moreover, Mr.Paulson supported an opinion that the stock market is heading towards the next crisis, in which one the biggest causes is going to be an overvaluation of technological companies.

Of course, it could be just an another conspiracy theory, which blames bad capitalism for a one more time. Moreover, Goldman Sachs strategists do believe that the technological companies' success is "explained by strong fundamentals, revenues and earnings rather than speculation about the future" [12].

However, there is a group of technological companies, which raises the biggest concern. These are so-called 'unicorns' or 'unicorn start-ups'. A 'unicorn' is a privately held start-up company valued at over $1 billion. The term was introduced in 2013 by venture capitalist Aileen Lee, who decided to choose the mythical animal to represent the statistical rarity of such successful ventures. That is an accurate term, since such companies are rare. However, Wired suggests that "they should be even rarer" [7].

In their recent highly-cited [1] paper W.Gornall and I.A.Strebulaev claim that "reported unicorn post-money valuations average 48% above fair value, with 13 being more than 100% above" [11]. This idea can be simply explained by looking at a unicorn's capital structure. An average unicorn has approximately eight classes (series) of stock for different types of investors (founders, employees, venture capitalists, mutual funds, and others). Due to that complicated structure, valuation is often based on the latest series' price, applied to all outstanding shares. However, that valuation does not take into account the special promises investors in that round were guaranteed. In some series, for example, investors are promised 1.5 to 2 times their money, in case of initial public offering failure [9]. "Common shares lack all such protections and are 56% overvalued. After adjusting for these valuation-inflating terms, almost one-half (65 out of 135) of unicorns lose their unicorn status" [11]. The researchers' point of view is supported by the former SEC chairman Mary Jo White, who said that "The concern is whether the prestige associated with reaching a sky-high valuation fast drives companies to try to appear more valuable than they actually are" [10].

Due to the concerns about the market fairness mentioned above, it was thought to be interesting to apply not the specifically-tailored model, but a standard valuation method, in order to estimate a 'true' market value of unicorn start-ups. In this research, main fundamental valuation methods (Free-Cash Flow to Equity, Discount Dividend Model and Relative Valuation) are used, in order to evaluate how a market

[1] Mentioned in Wall-Street Journal, Techcrunch and other magazines/newspapers

price of unicorns' common shares reflect their financial statements. This paper's approach also relies on the assumption that a market price higher than a price predicted by fundamentals means that a company is overvalued, while a market price lower than the price predicted by fundamentals means that a company is undervalued. More detailed description of the methods mentioned above can be found in the Section 2 ("Theoretical background").

In the Section 3 ("Empirical research") the sample of unicorns is evaluated and compared with samples of 'young' technological companies and 'mature' technological companies, to which the techniques mentioned above are also applied. This comparison allows to eliminate a possible bias caused by misestimation and computational errors.

Section 4 ("Discussion") contains comments, discussion of the results, possible limitations of the methods used and ideas for a further research on the theme.

2 Theoretical background

This section is aimed to provide a brief description of the fundamental valuation of stocks and thoroughly discuss its methods, which are later used in the empirical section.

Fundamental valuation is the name for a broad class of valuation approaches, based on the discounted cash-flow analysis [4]. Using a fundamental valuation techniques researcher estimates a stock's value that focuses on determinants such as earnings and dividends prospects, expectations for future interest rates, and risk evaluation of firms [5]. There are three main methods, which are used in this type of analysis. Their description can be found below.

2.1 Free Cash-Flow to Equity

Free Cash-Flow to Equity (FCFE) is widely used in a company value determination. It refers to a measure of how much cash is available to the equity shareholders of a company after all expenses, reinvestment and debt are paid. In other words, it is a measure of what a firm can afford to pay out as dividends.

Company value can be estimated as a discounted sum of all future FCFE:

$$V = \sum_{t=1}^{\infty} \frac{FCFE_t}{(1+K_e)^t}$$

Where, FCFE_t is a Free Cash-Flow to Equity for the year t, K_e is firm's cost of equity, formula for which is given below. Since one is not able to predict the FCFE up to infinity, the concept of terminal value has to be used. The company's value becomes:

$$V = \sum_{t=1}^{T} \frac{FCFE_t}{(1+K_e)^t} + \frac{TV}{(1+K_e)^T}$$

Where, TV is a terminal value, which is computed in a following way:

$$TV = \frac{FCFE_{T+1}}{K_e - g} = \frac{FCFE_T(1+g)}{K_e - g}$$

Where, g is a perpetuity growth rate, formula for which is given below.

FCFE for a single period is calculated using the following formula:

$$FCFE = After\text{-}tax\ Income + D\&A - CAPEX - \Delta Working\ Capital$$

Where, After-tax income is commonly referred to as a Net Income, and D&A is Depreciation and Amortization.

CAPEX stays for Capital Expenditures and is calculated in a following way [2]:

$$CAPEX_t = \Delta PPE + D\&A$$

Where, PPE refers to Property, Plant and Equipment.

[2] It was obtained in ready-made form from Quandl data

Working capital (WC) can be computed using the following formula[3]:

$$WC = Cash + Acc.Receivable + Inventories - Acc.Payable - ST.Borrowings - Accr.Liabilities$$

After the FCFE calculation for previous periods, it has to be forecasted for the next periods. The estimation was done using Exponential Smoothing State Space Model [4].

Company's cost of equity (K_e) is evaluated with the usage of Capital Asset Pricing Model (CAPM). According to it, K_e is equal to the required return (rr), which is calculated as:

$$rr = R_f + \beta(R_m - R_f)$$

Where, R_f is a risk-free rate [5] and R_m-R_f is equal to the country's equity risk premium [6]. β coefficient is obtained by fitting a regression:

$$R = \alpha + \beta R_m$$

Where, R is a daily return [7] of company's stock, and R_m refers to market return[8]. Estimation was done for the 1 year (β_1) and 3 years (β_3) time periods.

Then the β coefficient has to be unlevered. In other words, it has to be calculated without taking its debt into account, removing the effect of leverage, in order to represent only the cost of equity [3] [6]. Unlevering was done using the Hamada formula:

$$\beta_u = \frac{\beta_l}{1 + (1 - T_c) * \frac{D}{E}}$$

Where, β_u is unlevered beta, β_l is levered beta (from CAPM), T_c refers to a corporate tax rate [9], and $\frac{D}{E}$ is a debt to equity ratio [10]. The final β_u coefficient which was used to estimate the cost of equity is an arithmetic mean of unlevered β_1 and β_3.

$$K_e = R_f + \beta_u(R_m - R_f)P$$

Coefficient g (i.e. Perpetuity growth rate) is calculated using the following formula:

$$g = RR * ROE$$

Where, reinvestment rate (RR) refers to a fraction of a company's profit which is reinvested in business:

$$RR = \frac{CAPEX + \Delta WC - D\&A}{After\text{-}tax\ Income}$$

Return on Equity (ROE) equals to cost of capital (K_e), if market is in equilibrium Perpetuity growth rate used in the model was caculated as an arithmetic mean of growth rates for all years.

[3] It was obtained in ready-made form from Quandl data

[4] See Appendix 1 for a full description of a model and method for checking forecasts' validity

[5] Treasury yield was used as a proxy

[6] Both are obtained from Aswath Damodaran website [1]

[7] $R = ln(Price_t) - ln(Price_{t-1})$

[8] S&P500 index was used as a proxy

[9] 21% in the USA

[10] It was obtained in ready-made form from Quandl data

Finally, the price of a single share equals to the equity value divided by a number of shares outstanding:

$$P_{share} = \frac{V}{Number\ of\ shares\ outstanding}$$

2.2 Dividend discount model

Dividend discount model (DDM) assumes that the price of a stock is the present value of expected dividends discounted at the stock's expected return [5].

$$P_0 = \sum_{t=1}^{T} \frac{D_t}{(1+K_e)^t}$$

Where, D refers a dividend payed to a shareholder in a period t (starting from the next period), K_s is a cost of equity, calculated in a same way as in the FCFE method.

Using a terminal value:

$$P_{share} = \sum_{t=1}^{T} \frac{Dividend_t}{(1+K_e)^t} + \frac{TV}{(1+K_e)^T}$$

Terminal value (TV) is calculated in a following way:

$$TV_T = \frac{Div_{t+1}}{K_e - g} = \frac{Div_T(1+g)}{K_e - g}$$

Where g is Perpetuity Growth Rate, calculated in a same way as in FCFE method.

Next periods' dividends were forecasted with the Exponential Smoothing State Space Model (See Appendix 1).

2.3 Relative valuation

The Relative valuation (multiples) approach refers to a theory based on the idea that similar assets sell at similar prices. This assumes that a ratio comparing value to some firm-specific variable (operating margins, cash flow, etc.) is the same across similar firms.

Multiples used in the current research are EV/EBITDA and EV/EBIT. One can obtain the equity value (EV), multiplying EBIT or EBITDA by the relevant multiple for that industry [11].

The price of a single share equals to the equity value divided by a number of shares outstanding:

$$P_{share} = \frac{V}{Number\ of\ shares\ outstanding}$$

Finally, the price obtained by using this method is an arithmetic mean of prices for all multiples.

[11] Industry specific multiples were obtained from `http://valuationacademy.com/industry-specific-multiples/`

3 Empirical research

This section is devoted to the empirical implementation of the methods, discussed in the previous section, and evaluation of the companies value. At the beginning, the reader will find the description of data sources and sample of companies used. In the later part, there are the results of an estimation and their brief description. The thorough discussion can be found in the next section.

3.1 Data

It was decided to include not only unicorn companies sample, but also two reference groups, in order to check the quality of the valuation techniques used and avoid a possible bias which can occur due to misestimation and computational errors.

The companies used in this research are divided into three distinct subgroups: 'Unicorns', 'Young technological companies' and 'Mature technological companies'. Unicorns list was obtained from the CB Insights website [12]. However, it had to be reduced, due to the lack of financial data for privately-held or acquired companies. Only the unicorns which are based in the United States and have publicly traded shares were used (26 companies in total). Second and third groups are technological companies which IPO year is 2011 or later and 2000 or earlier respectively. A sample of 26 companies was randomly selected from the each group, using the NASDAQ Company List [13], which contains all companies listed on NASDAQ, NYSE and AMEX.

Data for all companies was obtained using 'Core US Fundamentals Data' database, published by Sharadar on Quandl [14]. Its publicly available version contains financial data for the US listed companies since 2011, which allowed to unify the starting point for all groups.

[12] https://www.cbinsights.com/research-unicorn-exits

[13] https://www.nasdaq.com/screening/company-list.aspx

[14] https://www.quandl.com/databases/SF1

3.2 Estimation results

This section presents results of companies' value estimation. The information is presented in the tabular form separately for each group. Each table's row includes the following data: company name, stock exchange ticker, 'real' price (average for the last three months), Free Cash Flow to Equity ('FCFE') price , Dividend discount model ('DDM') price, Relative valuation ('Multiples') price and arithmetic average of these three methods. If the predicted price is higher than the real one, the company's shares are said to be undervalued. If real price is higher, the stock is overvalued.

First estimated sample is 'Unicorns'. Its results can be found on the next page in the Table 1. One can be easily see that only three shares are undervalued according to FCFE method (BABA, RUN, GPRO). Meanwhile, 'DDM' price equals to zero for all companies, because none of them pays dividends. Just two companies are undervalued according to relative valuation method (RUN, BABA). Finally, the same two companies have average price which is higher than the real one. It means that other 24 companies are overvalued according to the model, with only four more 'average' prices higher than zero.

Second sample is 'Young technological companies', which results are presented in the Table 2. It might be said that this group has shown the better results than the previous one. Eight companies have 'FCFE' price which is higher than the 'real' one. However, all of the companies do not pay dividends and have 'DDM' prices equal to zero. Four of them are undervalued according to the multiples valuation technique. Four companies also have 'average' price higher than 'real' price (VNET, CRTO, MSDI, ZDGE). Ten 'average' prices are higher than zero.

The last group is 'Mature technological companies'. Its estimation results can be found in the Table 3. More than a half of companies (14 out of 26) are overvalued according to FCFE method. Seven companies pay dividends, but they are so small, that 'DDM' price can be assumed to be zero. The same number of companies are undervalued according to the relative valuation method. Finally, ten companies has the 'average' price higher than 'real' one. Moreover, 75% of all companies has 'average' price higher than 0

Company	Ticker	IPO year	Real	FCFE	DDM	Multiples	Average
Facebook, Inc.	FB	2012	176.46	98.06	0.00	111.09	69.72
Snap Inc.	SNAP	2017	14.61	-228.23	0.00	-41.25	-89.83
Zynga Inc.	ZNGA	2011	4.00	2.32	0.00	0.90	1.08
Twitter, Inc.	TWTR	2013	24.01	-23.74	0.00	4.46	-6.43
Groupon, Inc.	GRPN	2011	5.10	3.66	0.00	2.54	2.07
Nutanix, Inc.	NTNX	2016	21.25	-122.63	0.00	-41.35	-54.66
Sunrun Inc.	RUN	2015	5.90	105.41	0.00	41.06	48.82
FireEye, Inc.	FEYE	2013	14.20	-312.57	0.00	-15.10	-109.23
Okta, Inc.	OKTA	2017	29.45	-50.17	0.00	-15.77	-21.98
Coupa Software Incorporated	COUP	2016	38.23	-146.11	0.00	-10.01	-52.04
Alibaba Group Holding Limited	BABA	2014	107.83	1419.44	0.00	398.60	606.01
Atlassian Corporation Plc	TEAM	2015	35.18	-1.29	0.00	-1.72	-1.00
Pure Storage, Inc.	PSTG	2015	20.14	-59.66	0.00	-9.34	-23.00
GoPro, Inc.	GPRO	2014	7.57	13.99	0.00	-13.89	0.03
Shopify Inc.	SHOP	2015	101.00	-92.20	0.00	-4.39	-32.20
Square, Inc.	SQ	2015	34.67	-10.07	0.00	-1.26	-3.77
Cloudera, Inc.	CLDR	2017	18.72	-102.21	0.00	-38.71	-46.97
Box, Inc.	BOX	2015	22.24	-122.30	0.00	-13.96	-45.42
Blue Apron Holdings, Inc.	APRN	2017	4.03	-38.79	0.00	-14.41	-17.73
Wayfair Inc.	W	2014	80.27	14.90	0.00	-30.82	-5.31
Workday, Inc.	WDAY	2012	119.97	-80.28	0.00	-16.52	-32.27
MuleSoft, Inc.	MULE	2017	23.26	-56.48	0.00	-8.50	-21.66
Vonage Holdings Corp.	VG	2006	10.17	-13.65	0.00	6.38	-2.42
Twilio Inc.	TWLO	2016	23.60	-244.85	0.00	-8.21	-84.35
Quotient Technology Inc.	QUOT	2014	11.75	-8.16	0.00	-0.68	-2.95
New Relic, Inc.	NEWR	2014	74.12	-19.61	0.00	-8.23	-9.28

Table 1: Unicorns valuation

21Vianet Group, Inc.	VNET	2011	7.98	35.12	0.00	6.60	13.91
Acacia Communications, Inc.	ACIA	2016	36.23	74.48	0.00	16.09	30.19
Criteo S.A.	CRTO	2013	26.03	221.05	0.00	29.09	83.38
Exa Corporation	EXA	2012	37.75	8.98	0.00	13.60	7.53
GDS Holdings Limited	GDS	2016	22.53 -	56.52	0.00	5.49	-17.01
Gridsum Holding Inc.	GSUM	2016	10.19	-514.77	0.00	-11.91	-175.56
Inovalon Holdings, Inc.	INOV	2015	15.00	12.89	0.00	6.67	6.52
Inspired Entertainment, Inc.	INSE	2014	13.25	-345.04	0.00	-0.59	-115.21
JMU Limited	JMU	2015	1.02	-2.65	0.00	-1.61	-1.42
Monster Digital, Inc.	MSDI	2016	2.41	12.08	0.00	20.35	10.81
Presidio, Inc.	PSDO	2017	14.31	20.28	0.00	19.41	13.23
Qualys, Inc.	QLYS	2012	59.35	-80.34	0.00	-18.38	-32.91
Resonant Inc.	RESN	2014	7.47	-6.76	0.00	-2.91	-3.22
TrueCar, Inc.	TRUE	2014	11.20	-8.53	0.00	-57.64	-22.06
Veritone, Inc.	VERI	2017	23.20	-4.70	0.00	-0.41	-1.70
Zedge, Inc.	ZDGE	2016	2.07	180.79	0.00	86.27	89.02
58.com Inc.	WUBA	2013	71.57	-32.93	0.00	-3.28	-12.07
A10 Networks, Inc.	ATEN	2014	8.31	-35.65	0.00	-5.43	-13.69
Aerohive Networks, Inc.	HIVE	2014	5.83	-1681.62	0.00	-7.02	-562.88
New Relic, Inc.	NEWR	2014	74.12	-19.61	0.00	-8.23	-9.28
NQ Mobile Inc.	NQ	2011	29.98	-8.71	0.00	3.25	-1.82
Ooma, Inc.	OOMA	2015	10.25	-128.01	0.00	-9.52	-45.84
Sequans Communications S.A.	SQNS	2011	1.91	-46.53	0.00	-3.50	-16.68
Shutterstock, Inc.	SSTK	2012	43.03	67.49	0.00	20.77	29.42
Telaria, Inc.	TLRA	2013	4.03	6.10	0.00	1.82	2.64
YuMe Inc	YUME	2013	15.39	-10.24	0.00	-1.50	-3.91

Table 2: Young technological companies

Adobe Systems Incorporated	ADBE	1986	179.52	210.95	0.00	70.36	93.77
Bottomline Technologies, Inc.	EPAY	1999	25.69	-14.05	0.00	1.05	-4.33
Brocade Communications Systems, Inc.	BRCD	1999	30.36	50.94	0.00	18.85	23.26
Cerner Corporation	CERN	1986	67.39	219.40	0.00	56.16	91.86
CSP Inc.	CSPI	1982	11.05	83.33	0.00	14.99	32.77
DSP Group, Inc.	DSPG	1994	12.50	-27.93	0.00	-0.76	-9.56
eGain Corporation	EGAN	1999	1.65	-27.29	0.00	-1.07	-9.45
Harmonic Inc.	HLIT	1995	4.20	1109.62	0.00	-10.83	366.26
Intuit Inc.	INTU	1993	137.21	424.45	0.00	86.49	170.31
j2 Global, Inc.	JCOM	1999	75.03	-415.81	0.00	106.98	-102.94
Key Tronic Corporation	KTCC	1983	7.09	55.26	0.00	18.24	24.50
Logitech International S.A.	LOGI	1997	36.73	92.07	0.00	23.30	38.45
Maxim Integrated Products, Inc.	MXIM	1988	45.92	-401.37	0.00	39.53	-120.61
Mitcham Industries, Inc.	MIND	1994	3.76	-217.812	0.00	-13.23	-77.01
NVIDIA Corporation	NVDA	1999	243.33	101.23	0.00	80.56	60.60
Pegasystems Inc.	PEGA	1996	47.15	-5.07462	0.00	9.45	1.46
Power Integrations, Inc.	POWI	1997	73.55	111.42	0.00	36.01	49.14
Quality Systems, Inc.	QSII	1982	13.65	14.69	0.00	5.74	6.81
Rambus, Inc.	RMBS	1997	14.22	34.72	0.00	11.25	15.32
SigmaTron International, Inc.	SGMA	1994	5.41	120.823	0.00	22.52	47.78
Stratasys, Ltd.	SSYS	1994	19.96	-506.95	0.00	1.38	-168.52
Syntel, Inc.	SYNT	1997	22.99	511.42	0.00	43.04	184.82
Take-Two Interactive Software, Inc.	TTWO	1997	97.78	55.09	0.00	19.44	24.84
Tower Semiconductor Ltd.	TSEM	1994	34.08	238.23	0.00	50.05	96.09
Veeco Instruments Inc.	VECO	1994	14.85	-270.35	0.00	-10.15	-93.50
Zebra Technologies Corporation	ZBRA	1991	103.80	47.31	0.00	125.43	57.58

Table 3: Mature technological companies

4 Discussion

Tables which were presented in the previous section contain all the relevant information, but it has to be aggregated more for the purposes of between-group comparison. Therefore, an arithmetic mean of each column [15] was computed and can be found in the Table 4.

Class	Real	FCFE	DDM	Multiples	Average
Unicorns	39.528	-2.893	0.00	10.419	2.509
Young technological companies	21.32	-90.12	0.00	3.749	-28.793
Mature technological companies	51.110	61.320	0.00	30.953	30.758

Table 4: Average real and predicted prices.

Then a price for each method was transformed as a difference with real price, in order to see the degree of over-/undervaluation [16]. However, since average price estimated by Discount Dividend Model is 0, it represents average price of single share and is not very relevant for purposes of the analysis. These computed differences are presented in form of a bar-chart below (Figure 1).

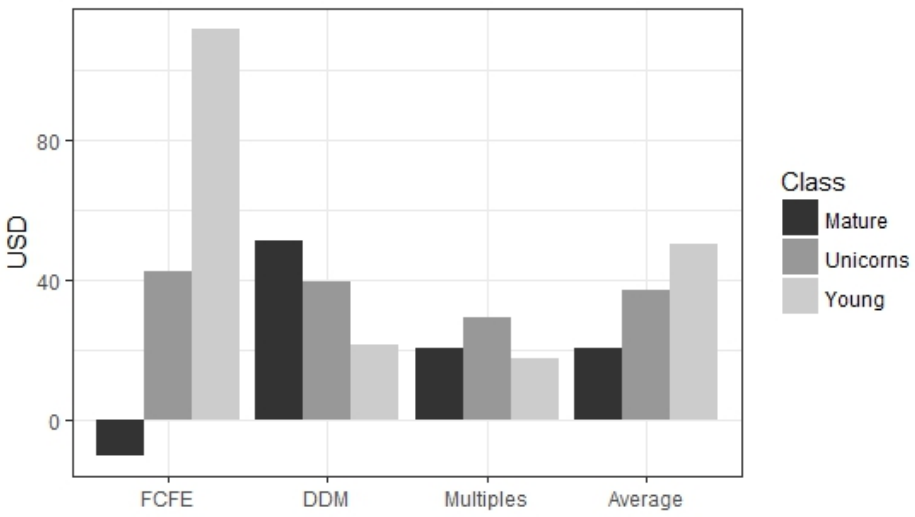

Figure 1: Difference between an average real price and an average predicted price

It can be clearly seen that young technological companies are, in general, the most overvalued ones among the sample groups, having the biggest 'FCFE' and 'Average' differences. However, Unicorns are the most overvalued ones, if the relative valuation method is used. Mature technological companies have, on average, the fairest valuation among the peer groups. These companies are even, generally, undervalued, if Free Cash-Flow to Equity method is used.

[15] Real, FCFE, DDM, Multiples and Average

[16] Difference = Real Price - Predicted price. Hence, the further a difference is from zero (to a positive side), the more overvalued company is.

However, these bar-chart can be misrepresenting, since the data contains several outliers. Company which has predicted price per share less than -1000 or greater than 1000 might be seen as one of those [17]. This tremendous over-/undervaluation could be just a result of a computational mistake or biased data. If those companies are excluded from the sample, results start to look in a following way:

Class	Real	FCFE	DDM	Multiples	Average
Unicorns	36.796	-59.786	0.00	-5.108	-21.631
Young technological companies	21.943	-26.468	0.00	4.180	-7.429
Mature technological companies	52.987	19.388	0.00	32.624	17.338

Table 5: Average real and predicted prices (Excluding outliers).

Since the results have changed, the differences do also alter.

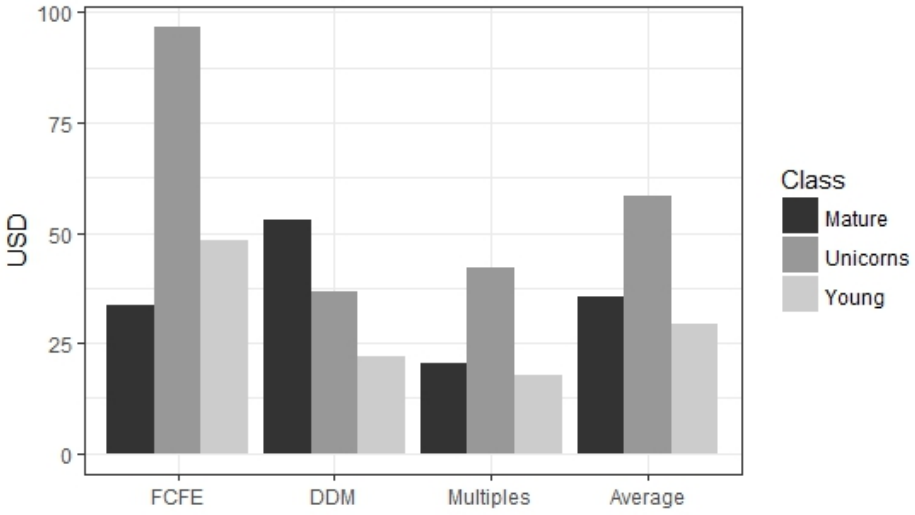

Figure 2: Difference between an average real price and an average predicted price (Excluding outliers)

It might be seen now, that the 'Unicorns' group contains companies which are, on average, the most overvalued. Other technological companies are, in general, also overvalued, but to a much smaller degree. Moreover, this effect is disappearing along with the growing company's maturity. In other words, mature technological companies are less likely to be overvalued, than young technological companies.

There are several possible explanations for findings mentioned above. At first, current market overvaluation could indicate the expectations of a higher fundamental valuation in the later periods. Let us suppose, for example, that a unicorn is working on a break-through technology, which could potentially bring billions in profits. However, on the current stage of development the firm experiences losses due to high research and development costs or something similar. On the one hand, it seems like a possible explanation. Both venture capitalists and common shareholders expect future profits, which mean high dividends and increase

[17]BABA in the Unicorns group, HIVE in 'Young technological companies' group and HLIT in 'Mature technological companies' have 'FCFE' prices equal to $1420, $-1681.616 and $1109.617 respectively

in share value. On the other hand, it sounds too similar to the dot-com rise. New technologies, enormous expected profits. The history shows that they might never happen. Moreover, a fair valuation should include potential risk, which means that the future revenues must be even bigger. Secondly, the current situation might be just a part of a bullish cycle and speculative behaviour which potentially lead to another bubble burst, as it was mentioned in the introduction. According to the findings of this paper, technological companies tend to become less overvalued as maturity increases. Therefore, a valid questions arise: "How much money will funds and ordinary people lose, when the valuation drop happens? Will it cause domino effect?".

In further research, I think it would be also worthwhile to estimate the valuations of privately hold unicorns using the methods of fundamental analysis. However, it might be a harder task, since those companies are not obliged to publish their financial results regularly.

5 Appendices

5.1 Exponential Smoothing State Space Model

Exponential smoothing is an econometric technique for smoothing time series. Exponential functions allows the researcher to use all the available data, assigning exponentially decreasing weights over time.

Let one have data on y from time period 1 to t. Then the forecast equation looks in a following way: [8]

$$\hat{y}_{t+h|t} = \alpha y + \alpha(1-\alpha)y_{t-1} + \alpha(1-\alpha)^2 y_{t-2}...$$

Where $\alpha \in [0,1]$ and $\hat{y}_{t+h|t}$ = point forecast of $y_{t+h|t}$ given data $y_1, ..., y_t$.

It might be also written as:

$$\hat{y}_{t+h|t} = l_t = \alpha y_t + (1-\alpha)l_{t-1}$$

Where l_t is the level (i.e. smoothed value) of time-series at time t. Both α and l_0 are chosen by minimizing the SSE.

Various types of this model exist: the ones that include trend, the ones that include seasonality and many others. However, all of them might be written in terms of a State Space Model with three possible trends: None, Additive, Damped, three possible seasonal components: None, Additive, Multiplicative, and two possible error types: Additive, Multiplicative. Hence, there are 18 possible State Space Models. *ets* function in R was used, a framework, which provides an automatic way of selecting the best method, minimizing the corrected Acaike's Information Criteria (AIC_c).

The validity of forecast was checked using the trend analysis method [**?**]. A dummy variable was created, which equals to one for the forecasted periods and zero for original data. Then, the following regression model was estimated:

$$FCFE_t = \beta_0 + \beta_1 Trend_t + \beta_2 Shift_t + \epsilon_t$$

Where FCFE_t is estimated Free Cash-Flow to equity in period t, Trend is equal to t and Shift is the dummy variable mentioned above. Then, the significance of Shift variable was checked. If Shift is significant (t-test's P-value > 0.05), then there is a structural change and forecasts should not be used. Otherwise, one may proceed and use forecasted data.

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