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Stock Prices and DCF valuation – Evidence from China

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ABSTRACT

The DCF model is a valuation model that we often use in our daily life. It is a common model for company valuation. Although the DCF model is the best choice of most companies' valuation models, there are still many inaccuracies in this valuation compared with the actual value. To verify the accuracy of the DCF model, this paper bases it on the real free cash flow, comparing and analysing the DCF valuation and stock prices. We found a) the results of the DCF model are not the same as the actual stock price at the end of 2005; b) the DCF valuation results are significantly higher than the actual stock price; c) the degree of deviation is different from various industries. The deviation may be caused by the reform of non-tradable shares in 2005.

Keywords: *Stock Prices, DCF valuation.*

1. INTRODUCTION

As the financial market's development, there is a rising demand of reasonably value a company for purchasing the equity or assets of a company and doing price initial public offerings (IPOs) of a company.[1] Discounted cash flow (DCF) model is a widely used method to value the company by forecasting its free cash flow (Efthimios G).[2] In this paper, the DCF model is adopted as an easier way to test the relationship between the value of a company and its free cash flow.

Our tests compare the valuation results of the companies by using the DCF model and its real value in the market in the same year. We contributed to the literature in a different way of evaluating the companies. The valuation results by using the DCF model can be easily changed through a small change in assumptions.[3] However, this paper chooses a reverse method to test the relationship between the free cash flow and the value of companies. Unlike normal order in making the DCF model, we choose historical cash flow data in the last 15 years as the "prediction" in the DCF model, which minimized the unreliable prediction and bias in the DCF model.[4]

Theoretically, companies' real market value should be the same as the results from the DCF model, which is adopted based on historical free cash flow data.[5]

In the research process of this article, we collected data of 2005 as a benchmark and adopted the data of listed companies in China from the first 15 years before 2019. We utilized these data to estimate the free cash flow (attributed to both creditors and shareholders[6]) of 2005 in the Chinese market to verify the accuracy of the DCF model. Then we compared the valuation data with the actual cash flow data in 2005 to test the accuracy of the DCF model in all aspects. We excluded data from listed financial companies to ensure that our data is more accurate and useful when selecting samples.[7]

This paper exams whether the estimated value per share of the DCF model is the same as the actual stock price in 2005. The first finding is the estimated value per share is not the same as the actual stock price. In this situation, the DCF model cannot reflect the real market.

Secondly, the systematic bias appeared: the DCF valuation is significantly higher than the stock price. Due to the free cash flow we used in the valuation is the historical data from the past 15 years, the higher estimated value per share means the stocks were undervalued largely in 2005.[8] In that year, China's government started implementing non-tradable shares, which caused panic in the market and lowered the investors' confidence.[9]

Lastly, the differences between industries' deviation show the degree of variation for each industry is divergent.[10] The most undervalued industry is wholesale and retail trade, and the industries with the smallest deviation are transportation and information transmissions.[11]

The remainder of our paper carries out as follows. In section 2, firstly, we introduced the selection of samples, mainly selecting most listed companies in the Chinese market from 2005 to 2019. Secondly, in this section, we also used the DCF model to estimate the cash flow data and used some ratios to evaluate the situation of the data. In section 3, we compared the estimated value with the actual value in 2005, analyzing the difference between estimated value and data of the actual value. We tried to explain the reason for the inaccuracy of the estimated data. In section 4, we summarized the results of our paper and provided our analysis and opinions on the reasons for the inaccuracy of the DCF model. In section 5, we presented the previous related papers about the accuracy of cash flow forecasting.

2. DATA AND SAMPLES

2.1. Data source

This paper selects the CSI 300 index in 2019 for research, and the target sample is determined at companies that went public before December 31, 2005. As of December 31, 2019, the data of all Chinese listed companies in the Cathay Pacific CSMAR database and Wind database.

2.2. Criteria and process of sample screening

The sample selection was based on the CSI 300 index in 2019. Considering the completeness of the data, we selected companies that went public after 2005 and deleted companies with negative average cash flow and missing data. Due to the high industry leverage ratios in the financial and real estate industries, we deleted companies in these two industries when selecting.[12] In addition, although Youngor Company is a real estate company, its main business industry is the garment industry.[13] When we deleted the company in the real estate industry, the Youngor Company was not deleted.

Screening through the above process, finally, we have 68 companies as samples.

2.3. Discovery of the calculation process

When calculating free cash flow, we found some obvious conclusions

1) Because most companies' business fluctuates greatly, some industries are cyclical industries, and cash flow increases at a certain period, so the calculation of free cash flow may not be a positive number.[14] When we screened and checked the samples, we found that there were only four companies with positive free cash flow every year, accounting for 5.88% of all samples.

2) When calculating the fluctuations of free cash flow, we found that the free cash flow fluctuations of the consumer goods industries are relatively low. In contrast, the high-tech industries have high fluctuations. This is in line with our perception that the consumer goods industry has a stable development, such as the food industry, and the development of high-tech industry have greater changes.[15]

3) When calculating the free cash flow and WACC of the samples, we found that the free cash flow fluctuation and WACC positively correlate. The greater the volatility of free cash flow, the greater the WACC of the company.[16]

3. EMPIRICAL RESULTS

3.1. DCF model

DCF model is a classical valuation model which is dominantly used in the financial area (Efthimios G).[17] We choose the free cash flow for 15 years as the "project out free cash flows" in the DCF model. The empirical analysis thought is to use the WACC formula to calculate the discount rate of each company and then use the DCF model to calculate the valuation of the company in 2005, divide it by the total number of shares in 2005, to get the theoretical stock price, and compare it with the actual stock price.

3.1.1. Calculation of the discount rate

First, WACC calculates the discount rate. The formula is as follows:

$$WACC = Re \times \frac{E}{V} + R\,d(1 - Tc) \times \frac{D}{V} \quad (1)$$

$$Re = Rf + \beta(Rm - Rf) \quad (2)$$

Where

D/V=target level of debt to value using market-based values

E/V=target level of equity to value using market-based values

Rd=cost of debt

Re=Rm-Rf=cost of equity

Tc=company's marginal tax rate on income

The nominal tax rate used in this article is 25%.[18]

3.1.2. Market yield and risk-free interest rate

Market yield with Shanghai index yield and Shenzhen index yield average to calculate. The Treasury yield represents the risk-free rate.

Table 1. Market yield and risk-free interest rate

year	Shanghai index yield	Shenzhen Index Yield	Risk-free rate	Market yield
2005	-8.33	-11.74	2.82	-10.03
2006	130.43	97.53	2.53	113.98
2007	96.66	162.81	3.37	129.74
2008	-65.39	-61.76	0.86	-63.58
2009	79.98	117.12	1.76	98.55
2010	-14.31	7.45	3.26	-3.43
2011	-21.68	-32.86	2.71	-27.27
2012	3.17	1.67	2.89	2.42
2013	-6.75	20.03	4.18	6.64
2014	52.87	33.80	3.26	43.34
2015	9.41	63.15	2.37	36.28
2016	-12.31	-14.72	2.69	-13.51
2017	6.56	-3.54	3.80	1.51
2018	-24.59	-33.25	2.64	-28.92
2019	22.30	35.89	2.36	29.10

Due to the excessive fluctuation of the market return rate from 2005 to 2009 due to the reform of non-tradable shares[4], we substituted the average market return rate from 2010 to 2019 for RM, which was 4.62%.

3.1.3. Cost of debt

The loan interest rate fluctuates little from 2006 to 2009. The nominal tax rate adopted in this paper is 25%. The arithmetic average of the weighted loan interest rate from 2006 to 2019 is 6.33%, which is RD. The specific data are listed and calculated in detail in Figure 2.

Table 2. MIACR

year	6 months	6 months -1 year	1-3 year	3-5 year	Over 5 years	MIACR
2005	5.58	5.76	5.85	6.12	11.39	6.94
2006	6.12	6.3	6.48	6.84	12.72	7.69
2007	7.47	7.56	7.74	7.83	14.23	8.97
2008	5.31	5.4	5.76	5.94	9.65	6.41
2009	5.31	5.4	5.76	5.94	9.40	6.36
2010	5.81	5.85	6.22	6.4	10.64	6.98
2011	6.56	6.65	6.9	7.05	9.55	7.34
2012	6	6.15	6.4	6.55	7.86	6.59
2013	6	6.15	6.4	6.55	7.77	6.57
2014	5.6	6	6	6.15	7.43	6.24
2015	4.35	4.75	4.75	4.9	7.04	5.16
2016	4.35	4.75	4.75	4.9	6.85	5.12
2017	4.35	4.75	4.75	4.9	6.95	5.14
2018	4.35	4.75	4.75	4.9	6.75	5.10
2019	4.35	4.75	4.75	4.9	6.00	4.95

3.1.4. The calculation of WACC

Through formula (1) and formula (2), we obtained the WACC values of 68 sample enterprises.

Table 3 shows the descriptive statistics of WACC calculation results and related data. In Table 3, assets and liabilities are in units of a hundred million yuan. Among them, the mean value of WACC is 0.0324, and the range of maximum and minimum values is 0.0282, with a large relative variation range. Still, the standard deviation is only 0.0668, and the degree of dispersion is low.

Table 3. Descriptive statistics for WACC

	beta	asset	debt	RE	WACC
count	68	68	68	68	68
mean	0.96	2075.02	1080.84	0.0207	0.0324
std	0.32	6725.80	3554.41	0.0059	0.0068
min	0.41	37.92	8.56	0.0104	0.0164
25%	0.72	145.03	62.24	0.0162	0.0285
50%	0.92	425.00	184.70	0.0199	0.0334
75%	1.13	1106.50	437.73	0.0238	0.0378
max	2.00	52060.00	27560.00	0.0401	0.0446

3.1.5. Estimation of investment value

We use the WACC calculated above to discount the cash flows of each year from 2006 to 2019.

Where

CF=Corporate free cash flow in year i

r=discounted rate, WACC

By Formula (3), we calculated the discount of enterprise free cash flow from 2006 to 2019, and the discount rate was the corresponding WACC value of each enterprise in Table 3. The theoretical market value of 68 enterprises in 2005 was obtained. The theoretical stock price of the enterprise was obtained by dividing the market value by the total number of shares at the end of 2005. Finally, the ratio of the difference between the theoretical stock price and the actual stock price at the end of 2005 to the actual stock price is used to measure the deviation of the DCF model. The specific calculation results are shown in Table 4:

Table 4. Estimation of investment value

code	Theoretical stock price	Share price at the end of 2005	Deviation (%)
000063.SZ	3.14	27.78	-88.71
000157.SZ	11.79	6.41	84.01
000423.SZ	10.18	5.41	88.14
000568.SZ	15.09	4.34	247.79
000596.SZ	4.64	4.10	13.13
000625.SZ	8.08	3.64	122.02
000630.SZ	1.54	4.08	-62.26
000651.SZ	95.73	10.37	823.19
000661.SZ	1.50	3.03	-50.48
000709.SZ	18.62	2.41	672.74
000723.SZ	34.03	3.42	894.91
000786.SZ	5.55	4.84	14.58
000858.SZ	8.74	7.26	20.42
000876.SZ	58.04	7.05	723.26
000895.SZ	46.92	12.79	266.88
000898.SZ	8.17	3.94	107.29
000963.SZ	12.58	4.34	189.84
002007.SZ	15.82	10.56	49.82
002008.SZ	0.89	10.49	-91.51
002024.SZ	10.20	20.00	-49.02
002027.SZ	34.60	6.26	452.69
002032.SZ	19.72	6.37	209.51
002044.SZ	8.08	4.25	90.12
600004.SH	5.32	6.76	-21.30
600009.SH	6.49	14.42	-55.02
600011.SH	6.38	5.74	11.23
600019.SH	5.60	4.12	35.84
600027.SH	1.84	2.79	-33.92
600028.SH	4.16	4.66	-10.65
600029.SH	6.88	2.65	159.68
600031.SH	31.46	6.64	373.77
600050.SH	4.20	2.80	49.93
600066.SH	24.31	7.25	235.26
600085.SH	2.10	13.91	-84.89
600100.SH	7.33	9.56	-23.36
600104.SH	56.47	3.31	1606.08
600111.SH	7.65	4.57	67.49
600176.SH	3.91	4.68	-16.51
600177.SH	17.27	3.41	406.60
600183.SH	2.27	7.12	-68.08

600196.SH	19.11	4.74	303.18
600271.SH	22.16	18.02	22.96
600276.SH	7.72	14.75	-47.64
600297.SH	85.48	5.63	1418.26
600309.SH	27.81	14.05	97.94
600362.SH	4.35	5.08	-14.32
600398.SH	22.01	4.32	409.51
600436.SH	3.95	16.91	-76.64
600489.SH	14.64	7.57	93.43
600516.SH	11.60	3.28	253.66
600519.SH	125.03	45.62	174.06
600535.SH	10.14	9.86	2.84
600547.SH	88.13	12.12	627.10
600566.SH	10.63	4.42	140.50
600570.SH	23.04	5.19	343.92
600585.SH	20.46	9.58	113.59
600588.SH	22.69	18.80	20.67
600637.SH	0.28	3.97	-92.88
600660.SH	6.78	5.27	28.71
600674.SH	54.12	3.67	1374.58
600690.SH	40.30	4.10	882.95
600741.SH	35.67	3.40	949.12
600795.SH	7.93	6.23	27.34
600809.SH	11.85	8.03	47.58
600867.SH	4.56	3.47	31.44
600886.SH	9.37	5.55	68.83
600887.SH	28.37	14.74	92.45
600900.SH	25.04	6.92	261.85

3.2. Baseline Results

（1） Descriptive statistics for Theoretical stock price

Table 5 is the descriptive statistics of the calculation results. The average value of the deviation is 219.35%, indicating that the theoretical stock prices of most companies are significantly higher than the actual stock prices. The standard deviation is 372.00%, and the sample has a large degree of dispersion.

Table 5. Descriptive statistics for Theoretical price

	WACC	Theoretical stock price	Share price at the end of 2005	Deviation (%)
count	68	68	68	68
mean	0.0324	20.15	7.98	219.35
std	0.0068	24.29	6.81	372.00
min	0.0164	0.28	2.41	-92.88
25%	0.0285	5.58	4.10	-0.53
50%	0.0334	10.41	5.59	86.08

75%	0.0378	23.36	9.65	263.10
max	0.0446	125.03	45.62	1606.08

（2）The results substantially deviate from the null hypothesis.

Comparing the results from the DCF model and the actual stock price at the end of 2005, we found the estimated price per share at the end of 2005 is different from the actual stock price for each sample. If the null hypothesis is true, the actual stock price should be as same as the estimated price by valuation through the DCF model. Hence, as the above chart shows, the spots in the chart should be placed on a straight line at an angle of 45° from the horizontal axis, which has been shown in Figure 1.

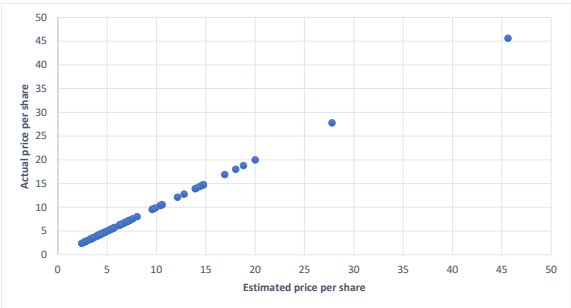

Figure 1. Null hypothesis: Stock price ended 2005

However, the real results from the calculation are heavily different from the null hypothesis. As figure 2 below shows, the spots distributed irregularly, therefore we rejected the null hypothesis.

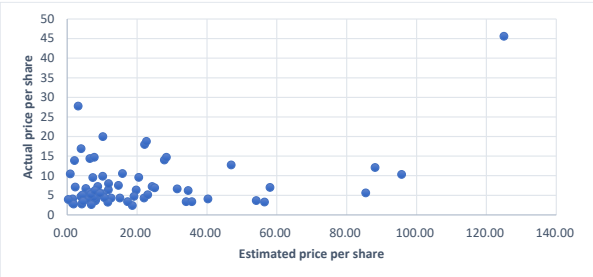

Figure 2. The stock price ended 2005

（3）DCF valuation is significantly higher than the stock price.

According to the observation above, we concluded that the estimated price per share from DCF is massively higher than the actual price per share in 2005. Hence, we have two possibilities to explain this result: (a) if the estimated price should be the true value of the stock price, it means the stock market undervalued most companies in 2005. (b) if the actual price reflects the companies' value properly, then the calculation's process may cause mistakes or errors.

If hypothesis (a) is true, there is a systematic bias. The drop in stock price reveals that the investors were pessimistic in 2005.[19] According to Reuters, the China Securities Regulatory Commission (CSRC) announces proposals in April 2005 that allowing companies to compensate the public for the sale of state-owned stock under a reform program to tackle the overhang of government shareholdings.[20]

However, this revolution caused a panic in China's stock market, the fears that too many shares will flood the market led to a sharp decrease in Shanghai Composite Index. This change is shown in Figure 3, and it is obvious that there has been a significant stock price decline in the middle of 2005-2006.[21]

The panic swept through the market. Many investors did not believe in the future of China's stock market. During that time, a lot of companies were extremely undervalued. This could be one possible explanation of considerably high standard deviation from our calculation results.

Figure 3. The volatility of China's stock prices from 2005 to 2006[22]

3.3. Cross-sectional variation

The deviation measures how far the industry is from the actual stock price in 2005. Based on the DCF model, the estimated share price should be the same as the actual stock price that ended in 2005. Therefore, the deviation is calculated by the formula below:

Thus, the higher the deviation is, the higher the estimated share price is, so the company is more undervalued.[23]

Table 6. The mean of the deviations in different industries

Industry classification	Average of Deviation	Count of Deviation
Transportation, storage, and postal service	27.79%	3
Information transmission, software, and information technology service	80.41%	4

Manufacturing	208.31%	46
Health and social work	90.12%	1
Property	406.60%	1
Wholesale and retail trade	519.70%	3
Production and supply of electricity, heat, gas, and water	284.98%	6
Leasing and business service	452.69%	1
Mining industry	236.63%	3
Grand Total	**219.35%**	**68**

According to Table 6 above, the manufacturing companies account for the majority. Other industries reveal two directions despite the minority industries (health and social work, property, and leasing and business services). The market undervalues the manufacturing, mining industry, and production and supply of electricity, heat, gas, and water companies, but they are close to the average deviation. On the one hand, wholesale and retail trade companies are significantly undervalued by the market, especially for China Grand Auto, which drives the average deviation up so much. On the other hand, transportation, storage, and postal service, and information technology service companies are more on the verge of estimated value from the DCF model. The driving companies involve Shanghai Airport and Shanghai Oriental Pearl Media which the market overvalues both.

4. CONCLUSION

This paper examines the accuracy of DCF model valuation by comparing the estimated value per share and the actual stock price. To minimize the bias from assumptions, we used the data from the past 15 years so that all FCF is true data, which reflects the stock's intrinsic value in the long-term. However, the findings do not reflect the hypothesis of the DCF model. The main reason is the reform of non-tradable shares in 2005. The whole market started to recover after 2006. China's financial market's reform is based on systematic reform but not technical reform. Also, the theory and the result present an obvious conflict because of the free cash flow, which is attributed to both creditors and shareholders.

Therefore, the changes in policies will impact the whole market substantially. The systematic reform brings the differences of the results. Secondly, the investors in China's financial market are not very mature. They may have the wrong concept of valuation of stocks. Therefore, the problem could be the market value but not the DCF model. In conclusion, to a certain extent, the DCF model cannot work effectively in the Chinese market with relative accuracy.

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