Hochschule für
Wirtschaft und Recht Berlin
Berlin School of Economics and Law

The valuation of the four biggest tech stocks: Apple (APPL), Microsoft Corporation (MSFT), Amazon (AMZN) and Alphabet (GOOG). Are they overvalued?

HWR Berlin (Berlin School of Economics and Law)

Master of International Finance SS 2021

Supervisors:	Prof. Dr. Martin Uzik
	LL.M Sebastian Block
Submission:	26.08.2021
Author:	Thi Quynh Trang Nguyen

1. Introduction

2020 has been a pretty horrible, painful year in the human history. More than 1,7 million death caused by the Coronavirus, countless small businesses went bankrupt and millions of people lost their jobs and became unemployed because of the lockdown order. IFM projected that the global economy growth in 2020 would be -4,9%. United States- the biggest economy in the world might shrink 3,5% in 2020 with the highest record of unemployment rate ever since the financial crisis 2008.

By contrast, for stock investors, 2020 has gone with a swing, with the Dow Jones Industry Average and S&P 500 closing at all-time record levels and the best increase year of Nasdaq Composite in more than a decade.

After experiencing a market crash in March because of Covid-19, stock market rebounded strongly and hit a new record. Notably, the Big tech companies outperformed the entire market as the advantage of technology and virtual connection. Take Apple as an example, after going down 23,6% in March, its share price ends in 2020 with a growth of 73,5%, much higher than 14,3% of S&P 500 index.

The contradiction between bright expectation of stock investors and gloomy outlook of the economy results in a question of "fair value" of the four biggest tech stocks. Are the stock prices a good reflection of potential growth of the company in the future or just the irrational exuberance of investors like the bubble in early-2000?.

The purpose of the research is to use the valuation method to determine the value of the four biggest tech stocks and give an answer to the above question.

2. Literature review

In the need for a correct valuation of Internet stocks, Schwartz and Moon firstly introduced their model in Financial Analyst Journal In June 2000. In 2001, they expanded their initial model in the research "Rational Pricing of Internet companies revisited". The extension added one stochastic process of variable costs, taking into account of capital expenditures, depreciation and the future financing in bankruptcy conditions. There are a number of papers using the framework of Schwartz and Moon (2000) for the valuation of Internet companies. Baek et al. (2008) combine the methodology of Schwartz and Moon with Merton (1974)'s risky bond pricing technique to value six IT firms from the USA. Klobucnik and Sievers (2013) depict an easily applicable configuration of the Schwartz and Moon model, which is suited for the non-listed firms. In particular, the improved model of Klobucnik and Sievers shows its positive result on valuing especially small firms. Furthermore, Doffou (2015) uses the cross-sectional quarterly data to improve the pricing accuracy of the model released by Schwartz and

Moon (2000). The research tries to compare the stock price accuracy of five companies (Google, Amazon, eBay, Facebook, Yahoo) of improved model price, Doffou (2014) model price and Schwartz and Moon model price (2001). Recently, Schosser and Stroebele (2019) attempt to identify the critical valuation parameters and prove the superiority of Schwartz and Moon model in pricing future large -scale technology IPOs by evaluating Facebook at close date of IPO.

3. The Schwartz/Moon Valuation Model

In 2000, Moon and Schwartz first introduced their model, it was developed from the concept of real option theory and capital budgeting techniques and based on Monte Carlo simulation. To price an Internet company, Moon and Schwarz firstly formulated the model in continuous time, then form a discrete time approximation, estimate the parameters, solve the problem by Monte Carlo simulation and finally perform sensitivity analysis (Schwartz and Moon, 2000, p. 62).

3.1. The continuous time model

The model proposes that the value of the firm is obtained by discounting the cash flow at time T under the risk-neutral measure with the risk-free rate. The firm value has two main components, cash balance outstanding (which is the X(T)) and the value of the business as going concern (which is calculated as EBITDA = R(T) – Cost(T) times a multiple M) (Klobucnik and Sievers, 2013, p.948).

$$V(0) = E^Q\left[e^{-rT}\left\{X(T) + M \cdot \left(R(T) - Cost(T)\right)\right\}\right] \quad (1)$$

where r is the risk-free rate, M is a market multiplier, R(T) is the firm's revenues at time T, Cost(T) is the firm's total costs at time T and X(T) is the firm's cash position at time T.

Obviously, the market value of the firm represented in the equation (1) neglected the debt level of the firm. To simplify the analysis, the effects of debt financing, including tax shield, the direct and indirect of debt capital, are approximately offset each other (Klobucnik and Sievers, 2013, p.956 and further references).

The valuation of a company is built from the main three stochastic processes including: the revenue process, the expected rate of growth in revenues process and the variable cost process.

3.1.1 The revenue process

The model considers an Internet company at the time T with the simultaneous rate of revenues given *R(T).* The stochastic model emphasizes the dynamics of the revenues by the stochastic differential equation:

$$\frac{dR(t)}{R(t)} = \mu(t)dt + \sigma(t)dz_1(t) \quad (2)$$

where dz_1 is the Brownian motion

μ(t), the drift, is the expected rate of growth in revenues and is assumed to follow a mean reverting process with a long-term average drift $\bar{\mu}$.

The expected rate of growth in revenues is assumed to be the second stochastic process:

$$d\mu(t) = \kappa_\mu\big(\bar{\mu} - \mu(t)\big)dt + \eta(t)dz_2(t), \qquad \mu(0) = \mu_0 \quad (3)$$

where the mean-reversion coefficient κ is the influence of the rate at which the growth rate is expected to converge to its long-term average. The interpretation of $\frac{\ln(2)}{\kappa}$ is the "half-life" of the deviations in that any growth rate μ is expected to be halved in this time period. The η represents the volatility of the expected growth rate and dz_2 the Brownian motion.

The volatility of the rate of revenue growth *σ(t)* and the volatility of the growth rate η are assumed to converge to a normal level:

$$\frac{d\sigma(t)}{dt} = \kappa_\sigma\big(\bar{\sigma} - \sigma(t)\big), \qquad \sigma(0) = \sigma_0 \quad (4)$$

$$d\eta(t) = -\kappa_\eta \eta(t)dt \quad (5)$$

3.1.2 The cost process

The total cost is determined by two components: the fixed and variable costs:

$$C(t) = \gamma(t)R(t) + F \quad (6)$$

The variable costs are defined as a fraction of the revenues. The variable parameter, *γ(t),* follows the stochastic differential equation:

$$d\gamma(t) = \kappa_\gamma\big(\bar{\gamma} - \gamma(t)\big)dt + \varphi(t)dz_3(t) \quad (7)$$

where $\kappa_3$is the rate at which the variable costs are expected to converge the long-term average φ denotes as the unanticipated changes in variable costs are assumed to converge to a normal level:

$$d\varphi(t) = \kappa_\varphi\big(\bar{\varphi} - \varphi(t)\big)dt, \qquad \varphi(0) = \varphi_0 \quad (8)$$

The unanticipated changes in the growth rate of revenues, expected rate of growth in revenues and the variable costs are correlated:

$$dz_1(t)dz_2(t) = \rho_{12}dt \quad (9)$$

$$dz_1(t)dz_3(t) = \rho_{13}dt$$

$$dz_2(t)dz_3(t) = \rho_{23}dt$$

The net income after tax rate of the firm, Y(t), is given by:

$$Y(t) = \big(R(t) - Cost\ (t) - Dep(t)\big)(1 - \tau_c)\ (10)$$

The corporate tax rate of the firm is taken into consideration if there is no loss-carry-forward and the net income is positive. The dynamics of the loss-carry-forward are calculated by:

$$dL(t) = -Y(t)dt \quad if\ L(t) > 0 \ \ (11)$$

$$dL(t) = Max[-Y(t)dt, 0] \quad if\ L(t) = 0$$

The accumulated Property, Plant and Equipment at time t, P(t), is assumed to be calculated based on the rate of capital expenditures for that period, Capx(t), and the rate of depreciation, Dep(t) as below:

$$pPPE(t) = [Capx(t) - Dep(t)]dt\ (12)$$

The periodic depreciation Dep(t) is assumed to equal to a fraction DR (depreciation rate) of the accumulated property, plant and equipment PPE(t):

$$Dep(t) = DR.PPE(t)\ (13)$$

At the initial period, the planned capital expenditure is represented CX(t), after that Capx(t) is modeled as a fraction capital ratio (CR) of revenues:

$$Capx = CX(t) \quad for\ t \leq \bar{t}\ (14)$$

$$Capx(t) = CR.R(t) \ \ for\ t > \bar{t}$$

3.1.3 The cash reserve

The below equation gives the amount of cash available to the firm X, assuming that no dividends are paid out and reinvested to earn the risk free rate of interest. The cash available is calculated in every simulation, and discounted the cash flow at the horizon T.

$$dX(t) = \{rX(t) + Y(t) + Dep(t) - Capx(t)\}dt \ \ (15)$$

In the initial publish of Schwartz and Moon, the firm would go bankrupt when its reserved cash falls below a predetermined threshold X*, which equals 0. In the revisited model, the future equity and debt financing are taken into account and allow the cash reserved to be negative.

3.2. The risk adjustment of stochastic processes

The Schwartz and Moon model indicates that there are three sources of uncertainty: uncertainty about the changes in revenues, the expected rate of growth in revenues and the variable costs. Only the first uncertainty has a risk premium associated with it, the market price of risk of revenue process λ_R is related to the “beta” of the stock. Keiber at al. (2002, p741) and Schosser and Stroebele (2019, p. 273) suggested that all three sources of uncertainty should be adjusted. Therefore, the market price of risk of the revenue process (λ_R), the market price of risk of the expected growth rate in revenues (λ_μ) and the market price of risk for the variable costs (λ_γ) are added in the drift-adjusted processes as follow:

$$\frac{dR(t)}{R(t)} = [\mu(t)dt - \lambda_R.\sigma(t)]dt + \sigma(t)dz_1 \text{ (16)}$$

$$d\mu(t) = \kappa_\mu.\left(\bar{\mu} - \mu(t) - \lambda_\mu.\eta(t)\right)dt + \eta(t)dz_2(t) \text{ (17)}$$

$$d\gamma(t) = \left(\kappa_\gamma.\left(\bar{\gamma} - \gamma(t)\right) - \lambda_\gamma.\varphi(t)\right)dt + \varphi(t)dz_3(t) \text{ (18)}$$

3.3. The discrete-time approximation of the model

The described model is path dependencies when it comes to the available cash, the loss carry-forward and the depreciation. These dependencies can be easily implemented the Monte Carlo Simulation for the valuation of the company. By contrast, the stochastic processes in equation (2), (3) and (7) need to be discretized before performing the simulation:

$$R(t+\Delta t) = R(t).e^{\left\{\left[\mu(t)-\lambda\sigma(t)-\frac{\sigma^2}{2}\right]\Delta t+\sigma(t)\sqrt{\Delta t}dz_1\right\}} \text{ (19)}$$

$$\mu(t+\Delta t) = e^{-\kappa_\mu \Delta t}.\mu(t) + (1 - e^{-\kappa_\mu \Delta t}).(\bar{\mu} - \frac{\lambda_\mu.\eta(t)}{\kappa_\mu}) + \sqrt{\frac{1-e^{-2\kappa_\mu \Delta t}}{2\kappa_\mu}}\eta(t)dz_2 \text{ (20)}$$

$$\gamma(t+\Delta t) = e^{-\kappa_\gamma \Delta t}.\gamma(t) + (1 - e^{-\kappa_\gamma \Delta t}).(\bar{\gamma} - \frac{\lambda_\gamma.\varphi(t)}{\kappa_\gamma}) + \sqrt{\frac{1-e^{-2\kappa_\gamma \Delta t}}{2\kappa_\gamma}}\varphi(t)dz_3 \text{ (21)}$$

Where:

$$\sigma(t) = \sigma_{0.}e^{-\kappa_\sigma t} + \bar{\sigma}.(1 - e^{-\kappa_\sigma t}) \text{ (22a)}$$

$$\eta(t) = \eta_{0.}e^{-\kappa_\eta t} \text{ (22b)}$$

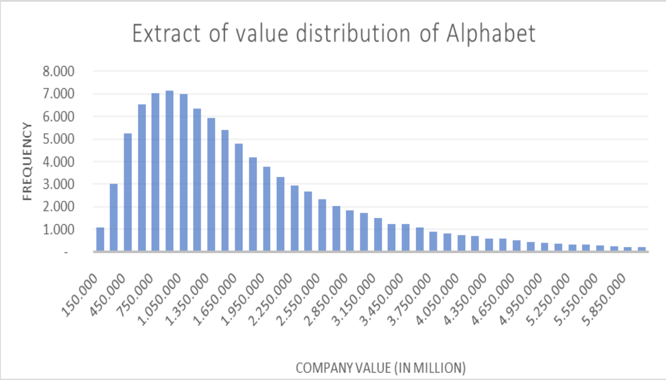
$$\varphi(t) = \varphi_0.e^{-\kappa_\varphi t} + \bar{\varphi}.(1 - e^{-\kappa_\varphi t}) \text{ (22c)}$$

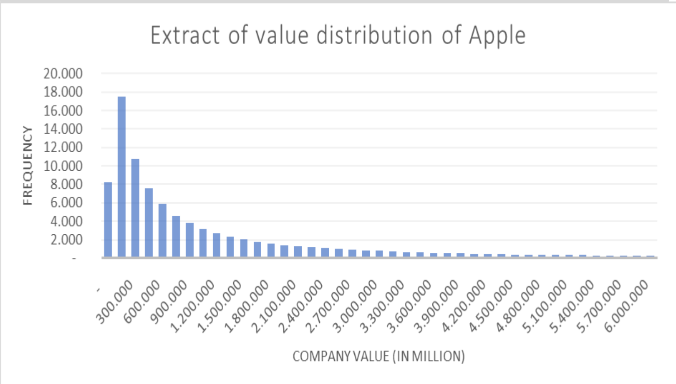
4. Parameter estimation

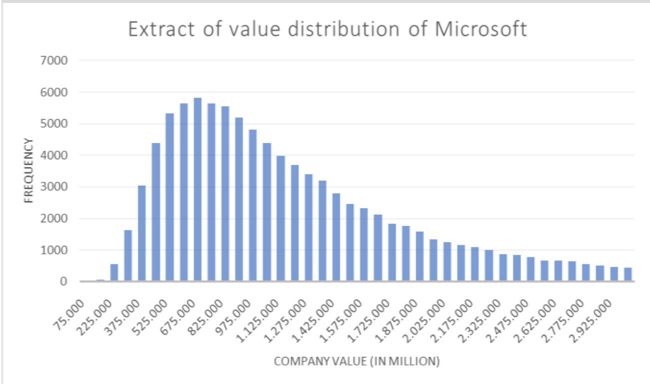
Table 1: Overview of estimated input parameter

Parameter	*Symbol*	*Alphabet*	*Amazon*	*Apple*	*Microsoft*
Initial cash available	X_0	135.104	73.270	69.834	125.407
Negative amount of cash available	X^*	-	-	-	-
Initial loss carry forward	L_0	0	0	0	0
Initial property, plant and equipment	PPE(0)	87.606	121.461	37.815	54.945
Initial revenues	R(0)	55.314	108.518	89.584	41.706
Initial expected rate of growth in revenues	μ_0	5,749%	8,10%	6,162%	4,24%
Initial volatility of revenues	σ_0	8,839%	9,304%	11,957%	8,348%
Initial volatility of expected rates of growth in revenues	η_0	2,194%	2,162%	2,608%	2,404%
Long term expected rate of growth in revenues	$\bar{\mu}$	0,750%	0,750%	0,750%	0,750%
Long-term volatility of the rate of growth in revenues	$\bar{\sigma}$	5,000%	5,000%	5,000%	5,000%
Fixed cost	F	6.871	5.330	6.643	4.559
Initial variable costs as a fraction of revenue	γ_0	54,295%	80,000%	60,899%	41,221%
Long term variable costs as a fraction of revenues	$\bar{\gamma}$	60%	85%	65%	46%
Initial volatility of variable costs	φ_0	11,418%	20,017%	30,236%	11,894%
Long term volatility of variable cost	$\bar{\varphi}$	1,5%	1,5%	1,5%	1,5%
Depreciation ratio	DR	4,079%	7,171%	7,658%	7,476%
Capital Ratio	CR	13,88%	6,742%	3,733%	11,126%
Corporate tax rate	τ_c	21%	21%	21%	21%
EBITDA-multiple for the terminal value component	M	10	10	10	10
Market price of risk of revenue process	λ_R	0,032	0,025	0,012	0,023
Market price of risk for the process of expected growth rate	λ_μ	0,025	-0,007	0,007	0,013
Market price of risk for the process of variable cost	λ_γ	0,023	0,025	0,023	0,006
Risk free rate	r_0	1,19%	1,19%	1,19%	1,19%
Mean-reversion coefficient for the expected rate of growth in revenues	κ_μ	0,077	0,104	0,038	0,072
Mean-reversion coefficient for the volatility in revenues	κ_σ	0,077	0,104	0,038	0,072
Mean-reversion coefficient for the volatility of expected rate of growth in revenues	κ_η	0,077	0,104	0,038	0,072
Mean-reversion coefficient for the variable costs	κ_γ	0,077	0,104	0,038	0,072
Mean-reversion coefficient for the volatility of variable costs	κ_φ	0,077	0,104	0,038	0,072
Horizon for the estimation	T	100	100	100	100
Time increment for the discrete version of the model	Δt	1	1	1	1

5. Simulation Results and valuation analysis







The number of outstanding shares at the end of March 2021 is 671,094 thousand and the figure for restricted stock is 24,573,482 units with the average exercise price is $1,427.6. Calculating from the mean of distribution and the total share number, the stock price of Alphabet equals:

$$P = \frac{1{,}835{,}863{,}710{,}424.5}{695{,}667{,}482} = \$\ 2{,}638.99\ per\ share$$

At the valuing date June 30, 2021, the close price of Alphabet stock (GOOG) is $2,506.32 per share. The model price is nearly 5.3 percent higher than the actual market price.

From the above information, the share price of Amazon can be estimated as:

$$P = \frac{736{,}603{,}914{,}302.818}{533{,}500{,}000} = \$1{,}380.7\ per\ share$$

The market price of Amazon stock (AMZN) on the last day of June 2021 closed at $3,440.16 per share. Compared to the model price, it is obviously seen that the market price is about 2.5 times higher than the model result.

According to quarter report for period ended March 2021, the company has 16,929,157 thousand outstanding shares and 308 million restricted stock units. Therefore, the price of Apple stock is obtained as follow:

$$P = \frac{3{,}036{,}209{,}655{,}143.400}{17{,}237{,}790{,}000} = \$176.14\ per\ share$$

Deriving the close price of Apple stock (APPL) from the historical data on June 30 2021, it was $136.96 per share, approximately 30 percent below the model price.

Ending the first quarter of 2021, the company reported 7,531,574,551 outstanding shares and 63 million of stock awards. From this, the model price is calculated as:

$$P = \frac{1{,}323{,}685{,}505{,}301.43}{7{,}594{,}574{,}551} = \$174.29\ per\ share$$

On the last day of June 2021, the Microsoft stock (MSFT) is trading at the price $270.9 per share, 1.5 times higher than the calculated price from Schwartz and Moon model.

6. Discussion and Conclusion

The model using within the context of the thesis is based on the valuation model of Schwartz and Moon (2001) and focuses on the process of evaluating the stock price of the four biggest technology companies by capitalization in US stock market. Compared to the original model, the thesis has optimized and improved the accuracy in several ways. Instead of using the beta of the stock to derive the market price of risk of the revenue process, the thesis calculates the market price from the correlation between the market portfolio and the return of the asset and the volatility of the return of the market portfolio. Besides, there are two market prices added for the stochastic processes of expected growth rates and variable costs. Due to the limitation of access, the forecast of analysts is not used for estimating parameter, the thesis take advantage of existing accounting data of previous quarters to obtain the critical input including expected rate of growth in revenues and the mean reversion parameters.

Valuation results vary among the four companies. As of the date of valuation, the model prices of Amazon and Microsoft are smaller than the market prices of that two stocks. The model price for Amazon is only $1,380.7 per share, below the trading price per share by 60 percent. This situation happens the same to stocks of Microsoft. In the term of Schwartz and Moon model, the stocks of Amazon and Microsoft are overpriced by the market participants. In the research of Tokic, he stated that the inflation of tech stock price might primarily come from the factor of broad environment factors including the great lockdown, the government big stimulus package. On the other hand, the model price of Alphabet and Apple is larger than its stock price. There is a slight discrepancy between the stock price and the model price of Alphabet, while the model price is 30 percent above the market price. The model also required the evaluators to have to profound knowledge and understanding of the company and its industry to make the valid assumption and achieve reliable outcomes.

7. Literature

Baek, C., Dupoyet, B.V. and Prakash, A.J. (2008): Fundamental capital valuation for IT companies: a real options approach. *Frontiers in Finance and Economics*, Vol. 5 No. 1, pp. 1-26

Cheng, E. (18 January 2021): China says its economy grew 2.3% in 2020, but consumer spending fell. *CNBC*. Available at: https://www.cnbc.com/2021/01/18/china-economy-release-of-fourth-quarter-full-year-2020-gdp.html (date of access: 29.07.2021).

Cox, J (28 January 2021): U.S. economy closes out 2020 with lower than expected 4% gain. *CNBC*. Available at: https://www.cnbc.com/2021/01/28/fourth-quarter-gdp-increased-4point0percent-vs-4point3percent-estimate.html (date of access: 29.07.2021).

Damodaran, A. (2009): The Dark Side of Valuation. Valuing Young, Distressed, and Complex Businesses. *Pearson, Upper Saddle River*.

Doffou, A. (2014): The valuation of Internet companies. *The Journal of Applies Financial Research*, Vol. 1.

Doffou, A. (2015): An improved valuation model for technology companies. *International Journal of Financial Studies*, Vol. 3 No. 2, pp. 162-176.

Dubreuille, S., Lleo, S. and Mchawrab, S. (2011): Schwartz and Moon valuation model: evidence from IT companies. *Working Paper, Reims Management School*.

Klobucnik, J. and Sievers, S. (2013): Valuing high technology growth firms. *Journal of Business Economics*, Vol. 83 No. 9, pp. 947-984.

Schosser, J., Stroebele, H. (2019): What is the value of Facebook? Evidence from the Schwartz/Moon model. *The Journal of Risk Finance*, Vol. 20 No. 3 pp. 267-190.

Schwartz, E.S. and Moon, M. (2000): Rational pricing of internet companies. *Financial Analysts Journal*, Vol. 65 No. 3, pp. 62-75.

Schwartz, E.S. and Moon, M. (2001): Rational pricing of internet companies revisited. *The Financial Review*, Vol. 36 No. 4, pp. 7-26.