STOCK VOLATILITY TESTS WITH THE CAPM AND FAMA–FRENCH THREE-FACTOR MODEL: PARTICULAR REFERENCE WORLD'S TOP 10 LARGEST COMPANIES

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Abstract

The primary purpose of this study is to show the return portfolio and stock volatility of the world's top 10 most prominent companies. The risks and return portfolio have been shown in this study by using the CAPM model using the Fama-French three-factor model implied different equity observations from stock prices. Besides, this study evaluates the relationship between systematic risk and the expected return of the selected companies' stocks. A comprehensive analysis has accomplished with the secondary data sources from world's largest stock market. The expected return structure has also explored by comparing the market competition. Moreover, using these combined models, the comparison of different forces of the stock market among the selected companies have addressed in this study.

Keywords: CAPM, Fama-French three-factor model, Apple, Microsoft, Alibaba

JEL Codes: G110, G120, G150

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1. Introduction

The Capital Assets Pricing Model with the Fama-French three-factor model is widely used in capital asset pricing and portfolio selection (Fama, 1998; Fama & French, 1996; Gaunt, 2004). There is sufficient empirical evidence that returns of the stocks are usually not normally distributed. According to Campbell et al. (1997), specifically taking fat-tails and asymmetry of stock data into account is relevant for asset pricing. In this sense, The Capital Asset Pricing Model (CAPM) has broader acceptance and very curious history (Maio, 2013; Murtazashvili & Vozlyublennaia, 2012). In the earlier time, this model was based on the previous revolutionary theory of Markowitz and on Tobin's Separation Theorem (Zhang et al., 2018). Another important model here is the Fama and French's (1993) seminal three-factor model has become widely experimented by researchers and assets pricing research for estimating cross-sectional equity returns. However, the model is motivated by two empirical regularities that CAPM leaves unexplained: the size premium (Banz, 1981; Keim, 1983) and the value premium (Stattman, 1980; Rosenberg et al., 1985). Whatever investors are rational and risk-averse, they can borrow and lend unlimited amounts when they find risk-free rate with homogeneous expectations and information about all assets returns. They always seek for the market efficiency for the right information specially the expected return information and the beta portfolio of the stock. The CAPM model with

the Fama-French three-factor model is one of the most familiar tools to get information regarding market efficiency. The three-factor model aims to capture these two well-known premiums by augmenting CAPM with additional factors to proxy size and value (Foye, 2018). That is why; we used this model in this study to estimate the beta coefficient of the stock of selected companies.

2. Research background with CAPM and Fama-French three-factor model

The literature on the CAPM with Fama-French three-factor model so far has investigated on stock price movement. Many researchers who are especially a stock market analyst such as Foye, J. (2018), Bao et al. (2017), Gaunt (2004) have emphasized on this stock analysis model. Whatever, after estimating the CAPM model on European stock market data, the results indicate that the generalized CAPM with IIAPD errors has desirable in stock prices (Bao et al., 2017). Moreover, another model, mean-variance capital asset pricing model (CAPM) postulates, developed by Sharpe (1964) & Lintner (1965) is also a linear tradeoff between expected return and beta of the stock. In the first test of the model, Douglas (1969) finds in his research that the estimated relationship between average excess return and beta is excessively flat in some cases. Another author Miller & Scholes (1972) settled that this model is primarily a consequence of measurement error in the beta of the stock. Grauer & Janmaat (2004) showed the data repackaged

postulates of CAPM, and When the CAPM is true and the data are repackaged, then simulation shows that the average values of the intercept and slope converge to their true values more rapidly and there are striking increases in R^2 as well as the power of the tests. Moreover, the empirical results are intensely diverse in datasets with and without the zero-weight portfolios. Besides, Buchner (2015) developed a novel Public Market Equivalent (PME) measure to evaluate the risk-adjusted performance of private equity investments using the standard CAPM and multi-factor extensions. One advantage of this method is that the calculation can easily be prolonged to integrate further risk factors, such as the Fama-French factors or traded liquidity factors. It deals with the certainty equivalent form of the CAPM.

3. Short Description of Selected Companies

In this study, top ten companies have been selected according to their market value from the world's TOP 100 industries from NasdaqGS, and the New York Stock Exchange. All of these companies are strong enough in their market capital. Their profit earnings ratio and earning per share (EPS) is also satisfactory. A brief description relating to the basic information, market value, PE ratio, EPS, and volume have been shown here in Table 1.

Table 1: Short Description of Selected Companies

Name and Ranking of	Country	Market Value (in	PE Ratio	EPS (TTM	Volume

the Companies		billion U.S. dollars)	(TTM)	)	
Apple	USA	926.9	13.12	11.91	42,291,424
Amazon.com	USA	777.8	82.81	17.85	8,828,950
Alphabet	USA	766.4	38.92	26.65	1,413,772
Microsoft	USA	750.6	41.35	2.43	38,169,312
Facebook	USA	541.5	20.08	6.64	22,627,569
Alibaba	China	499.4	39.77	3.50	11,955,273
Berkshire Hathaway	USA	491.9	8.04	25.12	5,420,780
JPMorgan Chase	USA	387.7	12.02	8.06	17,963,271
ExxonMobil	USA	344.1	12.54	5.44	19,710,603
Johnson & Johnson	USA	341.3	223.67	0.57	6,537,240

Source: Yahoo Finance, NasdaqGS, NYSE

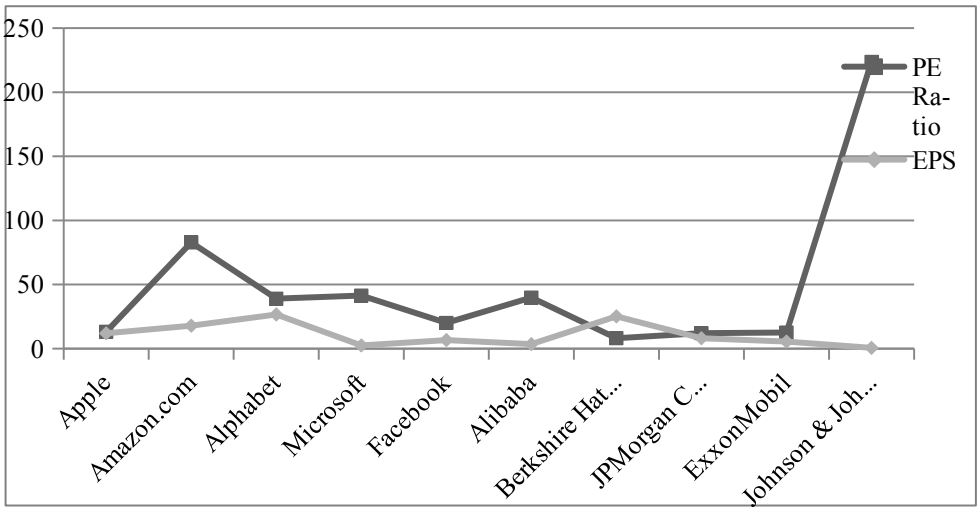

Figure 1: Comparison of EPS and PE Ratio
Source: Authors' explanation

Figure 1 presents the comparison of EPS and Profit Earning ratio of all the selected companies. Here, The PE ratio of Amazon and Johnson & Johnson is very high. Especially, the PE ratio of Johnson & Johnson is very high, almost 223.67. Also, the EPS of Apple, Amazon, Alphabet, and Berkshire Hathaway is high compared to others.

4. Data and Research Methods

In order to understand the stock exposures of selected world's TOP 10 companies from NasdaqGS and New York Stock Exchange, account for the estimated volatility of the

stock of these companies using a standard CAPM framework for pricing the securities are taken here. All the data was collected from secondary data sources. The regressions have used here to evaluate the outcome by using the CAPM model using the Fama-French three-factor model implied different equity observations from stock prices. Using this model is important for this study. We have selected top 10 companies from the 100 largest companies in the World by market value in 2018 (Top ten companies are selected for this study from the 100 largest companies in the world according to their market value in 2018). The selected companies are Apple, Amazon.com, Alphabet, Microsoft, Facebook, Alibaba, Berkshire Hathaway, JPMorgan Chase, ExxonMobil, and Johnson & Johnson. Whatever, mainly we used complete data from secondary data sources.

We followed the Capital Assets Pricing Model (CAPM) model (Capital Assets Pricing Model (CAPM) had been followed to accomplish this study). Simply the formula for calculating the expected return of a stock is as following in equation 1:

$$R_i = R_f + \beta_i (R_m - R_f) \quad (1)$$

In the above equation, R_i is the expected return of investment; R_f is the risk-free rate, β_i is volatility of the investment, R_m is expected return of the market, (R_m-R_f) is market risk premium.

Moreover, the combination of The CAPM model with Fama-French three-factor model has been used in this study. The model has been explored below equation 2, 3, and 4. In

equation form, for *n* portfolio or asset returns and *m* factors, in the first step the factor exposure β_s are obtained by calculating *n* regressions, each one on m factors (each equation in the following represents a regression):

$$R_{1;t} = \alpha_1 + \beta_{1;F1}F_{1;t} + \beta_{1;F2}F_{2;t} + \ldots\ldots\ldots\ldots + \beta_{1;Fm}F_{m;t} + \$_{1;t} \quad (2)$$

$$R_{2;t} = \alpha_2 + \beta_{2;F1}F_{1;t} + \beta_{2;F2}F_{2;t} + \ldots\ldots\ldots\ldots + \beta_{2;Fm}F_{m;t} + \$_{2;t} \quad (3)$$

$$R_{10;t} = \alpha_{10} + \beta_{10;F1}F_{1;t} + \beta_{10;F2}F_{2;t} + \ldots\ldots\ldots\ldots + \beta_{10;Fm}F_{m;t} + \$_{10;t}\ ; \quad (4)$$

Where, $R_{i;t}$ is the return of portfolio or asset *i* (n total) at time t, $F_{j;t}$ is the factor j (m total) at time t, Fm are the factor exposures, or loadings, that describe how returns are exposed to the factors, and *t* goes from 1 through T. Notice that each F_1 regression uses the same factors F, because the purpose is to determine the exposure of each portfolio's return to a given set of factors.

5. Findings and Analysis

The experimental methodology has been applied to a research-quality investment flow data set at the level of the world biggest company’s investments with the related comparison of the portfolio companies. In the following part, we have described the nature of the data, and the outline of the sample distribution. The estimation results are presented thereafter.

The relation between both dependent variables and independent variables are positive and significant for all the companies. The value of *Multiple* ***R*** is positive for each company share. Specifically, the relation between the excess market return and excess return of Microsoft, Berkshire Hathaway, JPMorgan Chas, Apple, Exxon Mobil, and Facebook is very high compared to others. In this sense, the relation between the excess market return and excess return of Alibaba and Amazon are not so high but positive regarding significance.

The *R Square* value here is also important to predict the stock position of the company. It refers that influence of the excess market return to the excess return of stock prices. In this sense, the excess market return of the stock of Apple, Microsoft, Berkshire Hathaway, and JPMorgan has a moderate influence on the dependent variable excess return. Their *R Square* value is almost .50 or above this. This is the valuation by comparative judgment among the company's stock variables.

The significance of the regression is also an important factor in considering the expected return analysis. Regression of all the company should be significant with the model and variables. The significance has also been explored here with the *F-statistics*, which is simply a ratio of two variances. Here, the larger values represent greater dispersion. In this sense, almost the significance of the regression is positive here except Alibaba. Their *F statistics* significance is almost 0.00 (2 decimal). Only the F statistics significance of Alibaba is very high. That means in most cases, the correlation between excess market return and

excess return is not consistent. The dispersion between excess market return and excess return is very high compared to other companies. Another important force is the beta coefficients of the companies. The beta coefficients are analyzed in the below table 4.

Table 2: Regression Statistics

Statistics	**Apl**	**Azn**	**Alpbt**	**Msoft**	**FB**	**Baba**	**Berk**	**JPM**	**Exn**	**J&J**
Multiple R	0.69	0.29	0.43	0.85	0.55	0.02	0.79	0.74	0.62	0.43
R Square	0.47	0.08	0.18	0.73	0.30	0.00	0.62	0.55	0.39	0.18
Adjusted R Square	0.47	0.08	0.18	0.72	0.30	0.00	0.62	0.54	0.39	0.18
Standard Error	1.11	1.41	0.94	0.87	1.96	2.22	0.81	0.91	1.01	0.94
Observations	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00
Note: Apl = Apple, Azn = Amazon, Alpbt = Alphabet, Msoft = Microsoft, FB = Facebook, Baba = Alibaba, Berk = Berkshire, Hath = Hathaway, JPM = JPMorgan Chase, Exn = Exxon Mobil, J&J = Johnson & Johnson										

Source: Author's Explanation

Table 3: ANOVA results

Name of the Company	**Factors**	**df**	**SS**	**MS**	**F**	**Significance F**
Apple	Regression	1.00	232.46	232.46	187.23	0.00
	Residual	208.00	258.24	1.24		
Amazon	Regression	1.00	37.22	37.22	18.60	0.00
	Residual	208.00	416.14	2.00		
Alphabet	Regression	1.00	41.88	41.88	47.06	0.00
	Residual	208.00	185.08	0.89		

Microsoft	Regression	1.00	414.33	414.33	548.51	0.00
	Residual	208.00	157.12	0.76		
Facebook	Regression	1.00	343.35	343.35	89.76	0.00
	Residual	208.00	795.65	3.83		
Alibaba	Regression	1.00	0.39	0.39	0.08	0.78
	Residual	208.00	1021.74	4.91		
Berkshire Hathaway	Regression	1.00	224.90	224.90	341.44	0.00
	Residual	208.00	137.00	0.66		
JPMorgan Chase	Regression	1.00	208.29	208.29	251.33	0.00
	Residual	208.00	172.38	0.83		
ExxonMobil	Regression	1.00	135.17	135.17	132.41	0.00
	Residual	208.00	212.33	1.02		
Johnson & Johnson	Regression	1.00	113.15	113.15	122.45	0.00
	Residual	208.00	192.21	0.92		

Source: Author’s Explanation

Table 4: Analysis of Beta

Name of the	**Factors**	**Coefficients**	**Std Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**

Companies									
Apple	Intercept	0.12	0.08	1.52	0.13	-0.03	0.27	-0.03	0.27
	X Variable	1.09	0.08	13.68	0.00	0.94	1.25	0.94	1.25
Amazon	Intercept	0.15	0.10	1.54	0.13	-0.04	0.34	-0.04	0.34
	X Variable	0.44	0.10	4.31	0.00	0.24	0.64	0.24	0.64
Alphabet	Intercept	0.01	0.07	0.14	0.89	-0.12	0.14	-0.12	0.14
	X Variable	0.46	0.07	6.86	0.00	0.33	0.60	0.33	0.60
Microsoft	Intercept	0.11	0.06	1.77	0.08	-0.01	0.22	-0.01	0.22
	X Variable	1.46	0.06	23.42	0.00	1.34	1.58	1.34	1.58
Facebook	Intercept	-0.07	0.13	-0.54	0.59	-0.34	0.19	-0.34	0.19
	X Variable	1.33	0.14	9.47	0.00	1.05	1.61	1.05	1.61
Alibaba	Intercept	-0.11	0.15	-0.70	0.48	-0.41	0.19	-0.41	0.19
	X Variable	-0.06	0.23	-0.28	0.78	-0.51	0.38	-0.51	0.38
Berkshire Hathaway	Intercept	0.01	0.06	0.23	0.82	-0.10	0.12	-0.10	0.12
	X Variable	1.08	0.06	18.48	0.00	0.96	1.19	0.96	1.19
JPMorgan	Intercept	0.01	0.06	0.17	0.87	-0.11	0.13	-0.11	0.13
	X Variable	1.04	0.07	15.85	0.00	0.91	1.17	0.91	1.17
ExxonMob	Intercept	-0.02	0.07	-0.30	0.77	-0.16	0.12	-0.16	0.12

il	X Variable	0.83	0.07	11.51	0.00	0.69	0.98	0.69	0.98
Johnson & Johnson	Intercept	0.01	0.07	0.11	0.91	-0.12	0.14	-0.12	0.14
	X Variable	0.76	0.07	11.07	0.00	0.63	0.90	0.63	0.90

Source: Author's Analysis

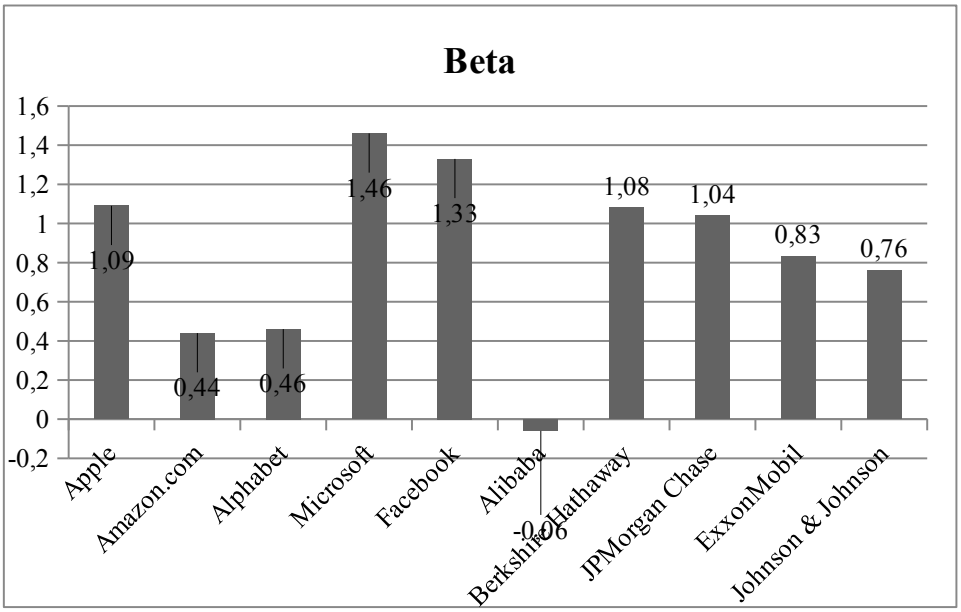

Figure 2: Volatility of Stock Price
Source: Author's Explanation

The beta measure risk by comparing the returns of an individual security or portfolio to the returns of the overall market and identify the proportion of risk that can be attributed to the market. Usually, the CAPM estimates stock's *Beta* based on a single factor excess market return. The cost of equity derived by the CAPM reflects a reality in which most investors have diversified portfolios from which unsystematic risk has been successfully diversified away. Whatever the beta of the stock refers to the risk level of the individual security relative to the broader market. A beta value of 1, indicates the stock moves in tandem with the market. If the Nasdaq gains 5 percent, so does the individual security. A higher beta indicates a more volatile stock, and a lower beta reflects greater stability. Whatever, According to Table 4 & Figure 2, the average beta of the ten company's stock is 0.843. Comparing the beta of the selected company's stock, Apple, Microsoft, Facebook, Berkshire Hathaway, JPMorgan Chase, and Exxon Mobil is very high. That means their stock portfolio is comparatively more

volatile than others are. Especially the beta of Microsoft and Facebook are very high, 1.46 and 1.33 respectively.

On the other hand, the stock volatility of Amazon, Alphabet, and Alibaba are lower than the others. The stock of these three companies is reflecting greater stability. There is a high possibility of a positive return. The beta coefficient of Johnson & Johnson is moderate (0.76), almost near to the mean beta value.

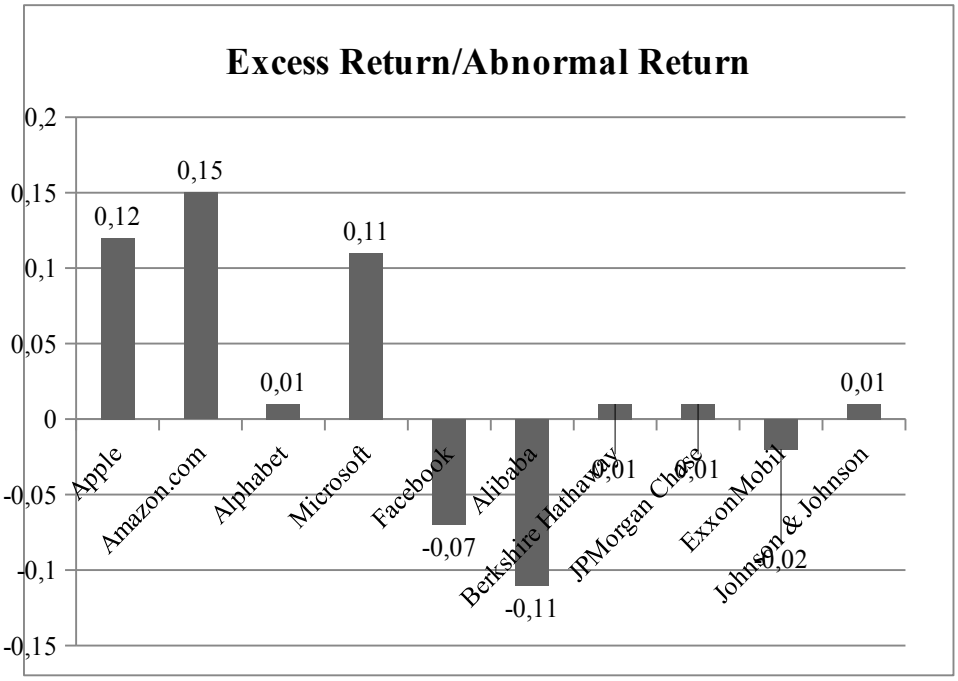

Figure 3: Excess Return or Abnormal return
Source: Author's Explanation

Another important factor is the excess return or abnormal return coefficient of the stock return. The excess returns are investment returns from security or portfolio that exceed the riskless rate on security generally perceived to be risk-free, such as a certificate of deposit or a government-issued bond. Additionally, the concept of excess returns may also be applied to returns that exceed a particular benchmark, or index with a similar level of risk.

Excess returns can be either positive or negative depending on the result of the equation. Positive excess returns demonstrate the investment outperformed the riskless rate or benchmark, while negative excess returns occur when an investment underperforms in comparison to the riskless rate or benchmark. According to these criteria and the result of CAPM model regression analysis of this study, Apple, Amazon, Microsoft's stock excess return is very high comparing to Alphabet, Berkshire Hathaway, JPMorgan, Johnson & Johnson's stock excess return. However, the excess return of Facebook, Alibaba, and Exxon Mobile's stock is negative that means investment in these company's stocks underperforms in comparison to the riskless rate or benchmark.

6. Conclusion

An empirical study has tested by following the CAPM model with the three-factor model in a wide range of developed and emerging markets. This study extends the stock volatility as the sample of emerging markets. Those companies are the market leader of the world biggest stock market; NasdaqGS and NYSE. Almost every company's stock present expected estimated return. As we have analyzed the stock volatility with the last 2 years data (1 January, 2018 to 31 December, 2019. We think it will be giving more assumption of those stocks with a very long period analysis. But if an investor wants to invest with a short period decision then the result of this study will be effective as well as help for the investors.

References:

Foye, J. (2018). A comprehensive test of the Fama-French five-factor model in emerging markets. *Emerging Markets Review*, https://doi.org/10.1016/j.ememar.2018.09.002

Banz, R.W., 1981. The relationship between return and market value of common stocks. Journal of financial economics, 9(1), pp.3-18.

Bao, T., Diks, C., & Li, H. (2017). A generalized CAPM model with asymmetric power distributed errors with an application to portfolio construction. *Economic Modelling*, (November 2016), 1–11. https://doi.org/10.1016/j.econmod.2017.03.035

Mahmud, A., Ding, D., Kiani, A., & Hasan, M. M. (2020). Corporate Social Responsibility Programs and Community Perceptions of Societal Progress in Bangladesh: A Multimethod Approach. *SAGE Open*, *10*(2). https://doi.org/10.1177/2158244020924046

Buchner, A. (2015). Risk-adjusting the returns of private equity using the CAPM and multi-factor extensions. *Finance Research Letters*, *000*, 1–8. https://doi.org/10.1016/j.frl.2015.10.023

Hasan, M. M., Yajuan, L., & Mahmud, A. (2020). Regional Development of China's Inclusive Finance Through Financial Technology. *SAGE Open*, *10*(1), 215824401990125. https://doi.org/10.1177/2158244019901252

Campbell, J.Y., Lo, A.W., MacKinlay, A.C., 1997. Econometrics of Financial Markets. Princeton University Press, Princeton, NJ.

Douglas, G.W., 1969. Risk in the equity markets: an empirical appraisal of market efficiency. Yale Economic Essays 9, 3–45.

Fama, E. F. (1998). Market efficiency, long-term returns, and behavioral finance1. *Journal of financial economics*, *49*(3), 283-306.

Fama, E. F., & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *The journal of finance*, *51*(1), 55-84.

Fama, E.F. and French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of financial economics, 33(1), pp.3-56.

Fama, E.F. and French, K.R., 1998. Value versus growth: The international evidence. The journal of finance, 53(6), pp.1975-1999.

Hasan, M. M., Popp, J., & Oláh, J. (2020). Current landscape and influence of big data on finance. *Journal of Big Data*, *7*(1), 21. https://doi.org/10.1186/s40537-020-00291-z

Gaunt, C. (2004). Size and book to market effects and the Fama French three factor asset pricing model: evidence from the Australian stockmarket. *Accounting & Finance*, *44*(1), 27-44.
Grauer, R.R., Janmaat, J.A., 2004. The unintended consequences of grouping in tests of asset pricing models. Journal of Banking and Finance 28, 2889– 2914.
Keim, D.B., 1983. Size-related anomalies and stock return seasonality: Further empirical evidence. Journal of financial economics, 12(1), pp.13-32.
Kutan, A. M., & Murado, Y. G. (2016). Financial and real sector returns, IMF-related news , and the Asian crisis. *Finance Research Letters*, *16*, 28–37. https://doi.org/10.1016/j.frl.2015.10.016
Lintner, J., 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. Review of Economics and Statistics 47, 13–47.
Hasan, M. M., Nekmahmud, M., Yajuan, L., & Patwary, M. A. (2019). Green business value chain: A systematic review. *Sustainable Production and Consumption*, *20*, 326–339. https://doi.org/10.1016/J.SPC.2019.08.003
Maio, P. (2013). Return decomposition and the Intertemporal CAPM. Journal of Banking & Finance, 37(12), 4958–4972. doi:10.1016/j.jbankfin.2013.08.021
Miller, M., Scholes, M., 1972. Rates of return in relation to risk: a re-examination of some recent findings. In: Jensen, M.C. (Ed.), Studies in the Theory of Capital Markets. Praeger Publishers, New York.
Murtazashvili, I., & Vozlyublennaia, N. (2012). The performance of cross-sectional regression tests of the CAPM with non-zero pricing errors. Journal of Banking & Finance, 36(4), 1057–1066. doi:10.1016/j.jbankfin.2011.10.018
Rosenberg, B., Reid, K. and Lanstein, R., 1985. Persuasive evidence of market inefficiency. The Journal of Portfolio Management, 11(3), pp.9-16.
Sharpe, W.F., 1964. Capital asset prices: a theory of market equilibrium under conditions of risk. Journal of Finance 19, 425–442.
Stattman, D., 1980. Book values and stock returns. The Chicago MBA: A journal of selected papers, 4(1), pp.25-45.
Zhang, Y., Jiang, J., Xiang, Y., Zhu, Y., Wan, L., & Xie, X. (2018). Cloud-assisted privacy-conscious large-scale Markowitz portfolio. Information Sciences. doi:10.1016/j.ins.2018.12.055

Hasan, M. M., Yajuan, L., & Khan, S. (2020). Promoting China's Inclusive Finance Through Digital Financial Services. *Global Business Review*, 097215091989534. https://doi.org/10.1177/0972150919895348