

Market-based Stock Pricing Model

Alex Tham¹, William Lau²

¹City University of Hong Kong, Hong Kong

²The Chinese University of Hong Kong, Hong Kong

ABSTRACT

This paper has searched for an appropriate regression model to compare and predict the stock prices of three petroleum-related business enterprise listed in Hong Kong Stock Exchange Market but based in China, which are Sinopec Corp. (386), PetroChina Company Limited (857), CNOOC Limited (883). By figuring out the relevant independent factors such as Hang Seng Index, H-Share Index, etc., this paper formed a relevant regression model to evaluate the current price and to forecast the future price of these stocks.

Keywords

DDM, Crude Oil, Reliability, Statistical Tests.

1. INTRODUCTION

Under the Efficient Market Hypothesis, market price of a particular stock should reflect its fundamental value [5, 12]. However, there are always exceptional cases. For instance, the stock price of Petrochina (857) has remained at \$1.xx for more than a year, but its price has doubled within a few months just after Warren E. Buffett purchased it.

2. LITERATURE REVIEW

One of the most common stock valuation models is Discounted-Dividend Model (DDM). However, Marvin May [8] has criticized DDM had too many restrictive assumptions that it was often unable to be applied in real world, and he has proposed a new model that was more amenable to empirical testing.

$$V_0 = \frac{I_0 r_0}{k} + I_0 \left(\frac{r_1 - k}{k} \right) \left(\frac{g}{k - g} \right)$$

where

V_0 is value or price per share

I_0 is book value (equity) per share

R_0 is the rate of return on I_0

k is the rate of return investors require

r_1 is the rate of return the firm will earn on additional increments of equity

g is the rate of growth of equity

The first portion represents the gross capitalized value of present earnings from existing equity [7], while the latter represents the value attribute to the net capitalized value from earnings on future increments of invested equity.

Around ten years later, Richard O. Michaud and Paul L. Davis [9] also criticized that the DDM could be subject to significant misinterpretation and misuse. In particular, it was argued that DDM returns maybe on a different scale from actual expected returns. The implications of the scale mismatch problem were noted, particularly for interpreting parameters of the dividend discount market line and implementing the information adjustment procedure for portfolio optimization.

This study found that Marvin May's proposed model was also subject to the deficiency mentioned by Richard O. Michaud, and Paul L. Davis. Hence, instead of applying DDM or revising DDM, this research would like to build a new model

to evaluate the appropriate stock prices by using regression analysis.

In fact, W. Michael Keenan [11] has pointed out that a single-equation regression model for equity valuation would fail to meet reasonable statistical tests of reliability. Specifically, he found that [1] the estimated parameters of the models would not prove consistently significant, [2] the parameters would not exhibit reasonable stability in different cross-section samples, and [3] the parameters would not exhibit stability for the same sample over time. However, since the model aims only at comparing and evaluating a few stocks in a given period of time, W. Michael Keenan's criticism may not apply to this case.

K. V. Ramanathan and Alfred Rappaport [6] found that a company's reported earnings exercised a substantial influence on expected growth rate in corporate earnings. Alternative accounting reporting schemes might bring different expectation to the stockholders in evaluating the stock price. He also stated that the reporting scheme is particular important in the contest of a merger between firms. Since all the companies this study evaluated are following the same accounting system in China, this study would not take this factor in this model based on the principle of parsimony.

3. METHODOLOGY

This study ran three regression analyses in accordance with the three different petroleum-related business enterprises mentioned. This research have selected four factors, i) Hang Seng Index, ii) Hang Seng China Enterprises Index, iii) Nasdaq Composite, iv) Futures Price of Crude Oil, as the independent variables in this analysis. The reasons are as follows:

The increase in popularity of home computing and internet access has brought a whole new world to the fingertips of investors. This study believes that share prices can be affected by investors who use technical analysis to drive their investment techniques. Technical analysis, also known as Chartism, is simply the study of past share price movements and stock market [4, 10] index trends, which are then used to forecast how shares and stock markets will behave in future. Chartism tries to identify, for example, trends in a variety of stock market charts. They argue that if the charts show an upward trend, investors should continue buying. If, however, the charts show a downward trend, you should sell. They also look at moving averages, showing changes in the average share price over specific periods, say a month, and employ a range of other studies to predict future share price movements. Index of different exchange has been selected for this study:

3.1 Heng Seng Index

Hang Seng Index (HSI) was started on November 24, 1969, compiled and maintained by HSI Services Limited, which is a wholly-owned subsidiary of Hang Seng Bank, the second largest bank listed in Hong Kong in terms of market capitalization. HSI is a capitalization-weighted stock market index in the Hong Kong Stock Exchange. It is used to record

and monitor daily changes of the 33 largest companies of the Hong Kong stock market and as the main indicator of the overall market performance in Hong Kong. These companies represent about 70% of capitalization of the Hong Kong Stock Exchange.

3.2 Hang Seng China Enterprises Index

The Index, introduced in August 1995, tracks the overall performance of 50 China's state-owned enterprises listed on the Hong Kong Stock Exchange. Full market capitalization of the H-share portion of each of the constituting company is adopted for the index calculation.

3.3 NASDAQ Composite Index

NASDAQ Composite Index measures all NASDAQ domestic and international based common type stocks listed on The

NASDAQ Stock Market. Today the NASDAQ Composite includes over 3,000 companies, more than most other stock market indices. Because it is so broad-based, the Composite is one of the most widely followed and quoted major market indices.

3.4 Futures Price of Crude Oil

The price of oil fluctuates quite widely in response to crises or recessions in major economies, because any economic downturn reduces the demand for oil. On the supply side the OPEC cartel uses its influence to stabilize or raise oil prices. Since the main business is oil refinery, the public do expect the changing price of crude oil should have some influence on the share price of the companies.

Table 1: Model Summary^e

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.995 ^a	0.989	0.989	0.08279	0.178
2	0.995 ^b	0.991	0.991	0.07720	
3	0.995 ^c	0.991	0.991	0.07650	
4	0.996 ^d	0.992	0.991	0.07405	

a. Predictors: (Constant), CHINA INDEX

b. Predictors: (Constant), CHINA INDEX, Crude Oil

c. Predictors: (Constant), CHINA INDEX, Crude Oil, HANG SENG INDEX

d. Predictors: (Constant), CHINA INDEX, Crude Oil, HANG SENG INDEX, NASDAQ INDEX

e. Dependent Variable: SINOPEC

Table 2: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	-5.539E-02	0.007		-7.814	0.000		
CHINA INDEX	6.785E-04	0.000	0.995	302.967	0.000	1.000	1.000
2 (Constant)	-.155	0.011		-14.772	0.000		
CHINA INDEX	6.436E-04	0.000	0.943	181.771	0.000	0.348	2.875
Crude Oil	6.375E-03	0.001	0.063	12.221	0.000	0.348	2.875
3 (Constant)	-7.247E-02	0.022		-3.357	0.001		
CHINA INDEX	6.523E-04	0.000	0.956	161.648	0.000	0.263	3.803
Crude Oil	6.178E-03	0.001	0.061	11.906	0.000	0.345	2.897
HANG SENG INDEX	-8.905E-06	0.000	-0.017	-4.373	0.000	0.581	1.720
4 (Constant)	-0.108	0.021		-5.079	0.000		
CHINA INDEX	6.410E-04	0.000	0.940	154.788	0.000	0.234	4.275
Crude Oil	8.311E-03	0.001	0.083	14.693	0.000	0.272	3.674
HANG SENG INDEX	-3.400E-05	0.000	-0.066	-9.339	0.000	0.170	5.866
NASDAQ INDEX	1.624E-04	0.000	0.056	8.198	0.000	0.182	5.492

Dependent Variable: SINOPEC

4. RESULTS

This research gathered the 5 years data for this regression analysis. This study adopts Stepwise Regression. There are totally 989 values, which is large enough to avoid the over-fitted problem as there are only four independent variables. This study analyzes each of the petroleum-related business enterprises as follows:

4.1 Sinopec Corp. (386)

The p-values of the F-test is 0.00, which means that at least one of the independent variables is significant. However, autocorrelation (the computed values of Durbin-Watson statistic of all four models [by running regression four times]

are less than D_L , which means positive autocorrelation) and multi co-linearity problems (VIF of some variables are as larger than 5 in model 4) do exist and note that Adjusted R^2 has neither increased from model 2 to model 3, nor from model 3 to model 4. Hence, by the parsimony principle, this study would choose model 2 for this prediction purpose. VIF in model 2 has decreased to 2.875.

$$Y = -0.155 + 0.0006436X_1 + 0.006375X_2$$

Where Y is the stock price of Sinopec Corp. (386)

X_1 is the value of Hang Seng China Enterprises Index

X_2 is the Futures Price of Crude Oil

4.2 PetroChina Company Limited (857)

Table 3: Model Summary^d

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.990 ^a	0.981	0.981	0.15091	0.077
2	0.994 ^b	0.987	0.987	0.12186	
3	0.994 ^c	0.988	0.988	0.12073	

- a. Predictors: (Constant), CHINA INDEX
 b. Predictors: (Constant), CHINA INDEX, Crude Oil
 c. Predictors: (Constant), CHINA INDEX, Crude Oil, NASDAQ INDEX
 d. Dependent Variable: PETROCHINA

Table 4: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	-0.275	0.013		-21.296	0.000		
CHINA INDEX	9.153E-04	0.000	0.990	224.202	0.000	1.000	1.000
2 (Constant)	-0.571	0.017		-34.450	0.000		
CHINA INDEX	8.116E-04	0.000	0.878	145.205	0.000	0.348	2.875
Crude Oil	1.892E-02	0.001	0.139	22.975	0.000	0.348	2.875
4 (Constant)	-0.699	0.033		-21.000	0.000		
CHINA INDEX	7.945E-04	0.000	0.860	117.712	0.000	0.234	4.272
Crude Oil	2.020E-02	0.001	0.148	23.334	0.000	0.309	3.237
NASDAQ INDEX	7.737E-05	0.000	0.020	4.424	0.000	0.621	1.610

- a. Dependent Variable: PETROCHINA

Hang Seng Index is being excluded by the Stepwise Regression analysis. The p-values of F-test is 0.00, which means that at least one of the independent variables is significant. However, autocorrelation and multi co-linearity problems exist. By the parsimony principle, model 2 has been chosen in this study.

$$Y = -0.571 + 0.0008116X_1 + 0.01892X_2$$

where

Y is the stock price of PetroChina Company Limited (857)

X₁ is the value of Hang Seng China Enterprises Index

X₂ is the Futures Price of Crude Oil

iii) CNOOC Limited (883)

Table 5: Model Summary^d

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.934 ^a	0.872	0.872	0.3105	0.077
2	0.963 ^b	0.928	0.928	0.2337	
3	0.971 ^c	0.942	0.942	0.2090	

- a. Predictors: (Constant), CHINA INDEX
 b. Predictors: (Constant), CHINA INDEX, Crude Oil
 c. Predictors: (Constant), CHINA INDEX, Crude Oil, NASDAQ INDEX
 d. Dependent Variable: CNOOC

Table 6: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	0.439	0.027		16.505	0.000		
CHINA INDEX	6.902E-04	0.000	0.934	82.172	0.000	1.000	1.000
2 (Constant)	-0.241	0.032		-7.590	0.000		
CHINA INDEX	4.521E-04	0.000	0.612	42.183	0.000	0.348	2.875
Crude Oil	4.345E-02	0.002	0.399	27.515	0.000	0.348	2.875
4 (Constant)	0.548	0.058		9.508	0.000		
CHINA INDEX	5.573E-04	0.000	0.754	47.698	0.000	0.234	4.272
Crude Oil	3.556E-02	0.001	0.327	23.730	0.000	0.309	3.237
NASDAQ INDEX	4.766E-04	0.000	-0.153	-15.743	0.000	0.621	1.610

- a. Dependent Variable: CNOOC

Hang Seng Index is being excluded by the Stepwise Regression analysis. The p-values of F-test is 0.00. However, autocorrelation and multicollinearity problems exist. This study chooses model 3 for it has the highest Adjusted R². Since this regression model aims at prediction only, so even though individual regression parameters maybe poorly estimated when multicollinearity exists, the overall prediction is still accurate provided this study predicts Y-value within the range of X-values in this model:

$$Y = 0.548 + 0.0005573X_1 + 0.03556X_2 + 0.000476X_3$$

where

Y is the stock price of CNOOC Limited (993)

X₁ is the value of Hang Seng China Enterprises Index

X₂ is the Futures Price of Crude Oil

X₃ is the value of NASDAQ Composite Index

5. DISCUSSIONS & CONCLUSIONS

This research found that Hang Seng China Enterprises Index and Futures Price of Crude Oil are both significant variables in all three prediction model. R² are very high in all three models (0.991 for Sinopec Corp., 0.994 for PetroChina Company Limited, 0.971 for CNOOC Limited), meaning that the models have very high prediction power. This study can therefore compare the market price and the predicted price as a reference for this stock purchase. Ranges of values of the variables in this regression model are as follows:

Stock Price of Sinopec Corp.: HK\$1.00 – HK\$3.75

Stock Price of PetroChina Company Limited: HK\$1.29 – HK\$4.85

Stock Price of CNOOC Limited: HK\$1.23 – HK\$4.525

Futures Price of Crude Oil: US\$17.45 – US\$55.17

Value of Hang Seng China Enterprises Index: 1560.55 – 5391.28

Value of NASDAQ Composite Index: 1114.11 – 2313.85

Let's illustrate how to predict the stock price of Sinopec Corp. by fitting the values of the independent variables on 8 March in this sample:

$$Y = -0.155 + 0.0006436(5082.47) + 0.006375(54.59) = 3.464$$

Hence, the stock price of PetroChina should be \$3.46, and the market price on that day is \$3.45, which is nearly the same. If the predicted price is much larger than the market price, then

this study helps to decide to purchase it. In future, people can use this model to predict the price and can save their money.

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