# An Empirical Test of the Efficiency of the Asset Pricing Model for Cambodia Securities Exchange (CSX)

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**ABSTRACT**

*The capital asset pricing model (CAPM) is a model used to expect a return on risky assets. The model is a linear relationship between the expected return of risky assets to its market risk premium and the beta risk of the asset. This study examined the model's efficiency in the expected return of Phnom Penh Autonomous Port (PPAP) and Port Autonomous Sihanoukville (PAS) stock returns in Cambodia Securities Exchange (CSX). Daily and monthly stock prices of these two assets were collected from CSX's official website. The yearly return has been computed using the model to compare with the actual return of these assets to test the model's efficiency. As a result, the model was always undervaluationto apply to compute the return of PAP in five years from August 2017 to August 2022. For PPAP, applying CAPM to estimate asset return showed that there were undervaluation from 2017 to 2021, and over in 2016, and nine months in 2022. The study concluded that CAPM was inappropriate for CSX to estimate PPAP and PAP costs of capital (stock returns) since these two assets were not strongly related to the CSX index (coefficient of correlation was 0.582 for PPAP and 0.776 for PAP).*

**Keywords:** Cambodia Securities Exchange (CSX), Capital Asset Pricing Model (CAPM), Phnom Penh Autonomous Port (PPAP), Port Autonomous Sihanoukville (PAS)

## 1. Introduction

The Capital Asset Pricing Model is helpful to apply for companies' investment valuations and is a tool for appraising investment (Fabinu, Makinde & Folorunso, 2017). It has been widely considered by investors in the world's financial markets to estimate both the cost of equity and the weighted average cost of capital for firms (Nel, 2011; Rosi, 2016). The model can estimate the expected return on the market as a whole and individual security if the security beta is related to the market portfolio (Ross, Westerfild, Jaffe, & Jordan, 2016). It explains the tradeoff between risk and return of assets in financial markets. From an academic perspective, CAPM, developed by Sharp (1964) and Lintner (1965), is considered a powerful tool for measuring risk and return in financial markets (Berk & DeMarzo, 2020; Coffie, 2012; Rosi, 2016; Wang, 2016), even though it is subject to test for real business cycle effect of using it (Rossvoll, 2013). Those mentioned above indicate the crucial role of CAPM in academic and actual practice in financial markets. This model is essential for analyzing securities, portfolio risk, and return. To the efficiency of the CAPM, the moving average and weighted moving average are used to compare the model's accuracy.

Cambodia Securities Exchange, established in 2011 (CSX, 2022), has 17 listed companies, including nine equity and eight debt-listed companies (CSX, 2022). Trading is conducted every working day from 8:00 am to 3:00 pm. The stock price and volume of each securities trading fluctuated daily (CSX, 2022), leading to the production of the market's index. Some methods (models) are used to forecast future stock prices, and CAPM is one of them needed to make assumptions when using it (Benninga, 2008; Berk & DeMarzo, 2020; Ross, Westerfild, Jaffe, & Jordan, 2016). Rosi (2016) mentioned that there are some assumptions about using CAPM. However, it is still widely used for estimating the cost of capital for firms and evaluating the portfolios' performance. CAPM is a helpful tool for estimating the cost of capital for firms and the returns that investors require in investing in a company's assets.

On the other hand, Coffie (2012) has argued that substantial evidence of the benefits of volatility as an augmenting factor in CAPM is used to explain asset returns in Africa and other emerging markets with similar economic characteristics. It is because a pricing model that includes both market risk premium and volatility risk premium significantly captures patterns of returns. The other study by Zhao (2014) mentioned that the CAPM of Sharpe (1964) and Lintner (1965) presents a single-period simple linear relationship between the securities' expected return and its market risk. Nevertheless, much empirical evidence suggests that the traditional CAPM model has deficiencies. Since this model is still widely used by investors and in academic education, our study focuses on the efficiency of the Capital Asset Pricing Model in Cambodian Stock Markets. The paper examined two state-owned companies: Phnom Penh Autonomous Port (PPAP) and Port Autonomous Sihanoukville (PAS).

The study's main objective was to examine CAPM's efficiency in the Cambodian Securities Exchange. To achieve the study's objective, we focus on

- Comparing the actual asset return with an expected return by using CAPM;
- Comparing the error of the model to errors of using moving average and weighed moving average with the same assets;
- Testing the accuracy of each asset;
- Comparing the errors of valuated assets in the study.

## 2. Literature Review

Stock markets were established centuries ago (Beattie, 2022; Hwang, 2021;; Zhou & Liu, 2018). The common objectives of investors are safety, income, and growth (Chen, 2022a; Reilly, Brown, Hedges & Chang, 2010). Chen (2022a) has mentioned that an investment in stock markets shows that safety, income, and growth objectives are mutually exclusive.

According to Reilly, Brown, and Leeds (2019), the Capital Asset Pricing Model was developed by Sharpe (1964), along with Lintner (1965) and Mossin (1966), and the model described the relationship between risk and expected return of risky assets (Bodie, Kane, & Marcus, 2021; Zhou & Liu, 2018). The model was developed after Markowitz's modern portfolio theory in the 1950s. In the 1960s, CAPM was developed during the foundation theory of decision-making in capital markets (Peroil, 2004).

According to Xiao et al. (2019), an empirical test of the effectiveness of CAPM. There are some assumptions to using CAPM, such as the following:

- First, investors are referred to as business entities. That is, under the same risk level, they choose securities with higher returns, while, at the same level of return, they choose securities with lower risk.

- Second, given the number of assets in the capital market, all assets can be completely subdivided, and assets are fully liquid, marketable, and decentralized.

- Third, the main factors affecting investment decisions are the expected rate of return and risk.

- Fourth, all investors have the same view on the probability of the distribution of securities returns, so there is only one efficiency boundary in the market.

- Fifth, all investors can get complete market information on time and free of charge. They have the same expected value for the expected rate of return, the standard deviation, and the covariance between securities.

- Sixth, there is no inflation, the discount rate remains unchanged, and there are no tax and transaction costs when buying and selling securities.

Berk et al. (2020) mentioned that the CAPM model is based on solid assumptions because some assumptions do not fully describe investors' behavior. The model is a content of risk-free rate, beta risk is the degree of volatility or systematic risk of a security or portfolio to the market as a whole (Kenton, 2022), and market premium and expected return is a linear relationship with its beta as the below formula, due to average market return has been higher than the average risk-free rate in the long run, is probably positive. Thus, the formula implies that the expected return on securities is positively related to its beta. The formula can be illustrated by assuming a few exceptional cases (Ross et al., 2016):

$$r_a = R_f + \beta_a(R_m - R_f)$$

***Equation 2.1 CAPM model***

The theoretical rate of return for an investment with no risk is known as the risk-free rate. It represents the interest an investor anticipates earnings over a specific period from a risk-free investment (Hayes, 2022). Theoretically, the risk-free rate is the minimum return that investors expect to earn on the investment because they will only accept the additional risk if the potential rate of return is greater than the risk-free rate. Determination of a proxy for the risk-free rate of return for a given situation must consider the investors' home market, while negative interest rates can complicate the issue (Hayes, 2022). In practice, the interest rate on a three-month government Treasury bill (T-bill) is often used as the risk-free rate for investors.

The market risk premium is an additional return to compensate investors for bearing a higher risk from holding risky assets instead of risk-free assets (CFA team, 2022). The market risk premium is part of the CAPM, which analysts and investors use to calculate the acceptable rate of return for an investment. Vineeth (2022) defined market risk premium as the difference between an expected rate of returns on a market portfolio and the rate which is considered risk-free. Investors are needed to offset risks and opportunity costs. The risk-free rate is a theoretical interest paid by an investment at zero risk. According to Chen (2022b), the market risk premium is obtained by the slope of the security market line (SML) (). The required rate of return on equity-linked investments is measured with the CAPM model. It is critical in the modern theory of portfolios. The real equity returns vary with the operational performance of underlying businesses. Hence, the pricing of the markets for such securities reflects it. The past rates of returns have varied as the economy ages and go through cycles, but traditional knowledge has typically calculated the long-term potential of around 8% annually. Investors ask for a premium on the investments in equity instruments as compared to lower-risk alternatives as their investment is more subject to uncertainty, which ultimately paves the way for the equity premium risk. The market risk premium explains the relationship between treasury bonds and equity market portfolios.

The risk premium shows the required returns, the expected returns, and the historical returns.

Historical market risk is the same for all investors, while the required and expected returns vary across investors, depending on the investing styles and risk tolerance.

A security or portfolio's beta (β) is essential to measure an investor's risk tolerance (Investopedia, 2021). Risk-averse investors should invest their money in low-beta assets such as Utility and Treasury securities. Investors willing to take on more risk may want to invest in stocks with a higher beta. For individual security, beta is measured by analyzing a stock's past performance to evaluate how its price might move in relation to the overall market. Calculating the beta coefficient of a particular stock can help determine how its returns respond to market fluctuations. For portfolios, beta also allows investors to recognize which investments match their risk tolerance level and which do not. Risk-averse investors tend to put their money into assets with low beta coefficients, such as Treasury bills and utility stocks. Investors who can tolerate a higher degree of risk tend to invest in stocks with higher beta coefficients.

$$\beta_i = \frac{Cov\ (R_i, R_m)}{Var.\ (R_m)}$$

***Equation 2.2 Beta formula***

There are two ways that a stock's beta coefficient can be calculated in practice.

- First, given our conceptual discussion of the CAPM, the above formula can calculate a beta coefficient for securities.

- Secondly, security betas can also be estimated as the slope coefficient in a regression equation between the returns to the securities ($R_{it}$) over time and the returns ($R_{mt}$) to the market portfolio. This regression-based method is often preferred because it is a formal estimation process.

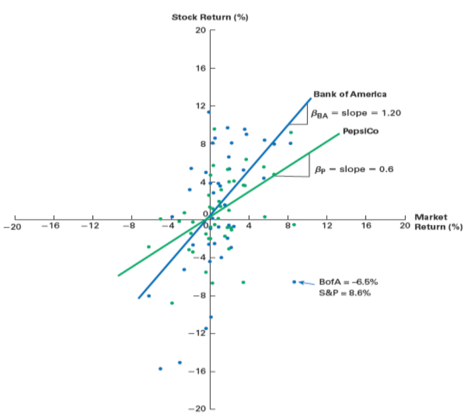


Figure 2.1 The relationship between Betas for Bank of America and Pepsi

Estimating Betas for Bank of America and Pepsi: The blue line is Bank of America's characteristic line. Each blue dot represents the return on Bank of America and the S&P 500 in a specific month.

This line's slope, which is Bank of America's beta (1.2), shows how well that stock responds to changes in market returns. The green dots are monthly returns on Pepsi and the S&P 500; the green line is Pepsi's characteristic. Pepsi's beta is 0.6 (Smart & Zutter, 2020).

CAPM is the first asset pricing model that helps investors and financial managers evaluate stocks and select efficient portfolios (Pham, 2017). This asset pricing model was ideally studied by American economists such as John Lintner, Jack Treanor, and Jesse Morson; later on, in the 1970s and 1980s, there were some empirical tests by scholars, and there were questions on the validity of the beta (Xiao et al., 2019). Benninga (2008) mentioned that the experiment by plotting the security market line did not work out well. There is not much evidence in favor of the SML; neither the R2 of the regression nor the t-statistics give much evidence that there is a relation between expected return and the portfolio. According to Xiao et al. (2019), the CAPM describes the formation of market equilibrium when investors adopt Markowitz's theory for investment management and considers that there is a positive correlation between the expected return rate of an asset and the β-coefficient, which is a yardstick to measure the risk of the asset. Benninga (2014) has considered that there are several reasons why these disappointing results of CAPM, and there may be some reasons as follows:

- One reason is that the CAPM itself does not hold. There are several possible explanations for this:

+ Short sales of assets may be restricted in the market. Our derivation of the CAPM assumes that there are no short-sale restrictions. This is an unrealistic assumption. In this case, however, there is no simple relationship between the returns of assets and their beta. The SML is especially unlikely to continue if short sales are restricted.

+ Individuals may not have homogeneous probability estimates or have exact expectations about value returns, variances, and covariances.

- Perhaps the CAPM holds only for portfolios and not for single assets.

- Perhaps our set of assets is not large enough: After all, the CAPM talks about all risky assets, whereas we have chosen to test a minimal subset of these assets for illustrative purposes. In the CAPM testing, tests involving bonds, real estate, and even non-diversifiable assets like human capital have been added to the list of risky assets.

- Perhaps the "market portfolio" is not efficient. The mathematics of efficient portfolios suggests this possibility.

- Perhaps the CAPM holds only in the event of positive market returns (they were, on average, negative over the surveyed period).

Some critical literature reviews revealed some advantages and disadvantages of CAPM. This study used CAPM to evaluate asset pricing in CSX.

## 3. Methodology

This study tests CAPM's efficiency in the Cambodia Securities Exchange. The official website of CSX, " http://csx.com.kh," is the primary source for data collection of daily stock prices in the study. There are nine equities listed companies on CSX until the present, incuding three state-owned companies and six other private companies. They have different market capitalizations and are also traded daily in different amounts. The study chose two state-owned companies, Phnom Penh Autonomous Port (PPAP) and Sihanoukville Autonomous Port (PAS), to test their efficiency on the market index by using CAPM.

Daily data prices were collected, and both companies' monthly and yearly rates of return were computed. The collected data recorded daily prices since the companies were listed on CSX (PPAP was listed on 22 September 2015, and PAS was listed on 8 June 2017). The CSX market index was also collected for the same periods as PPAP and PAS data to compute their correlation coefficients and betas. According to Benninga (2014), the stock return was computed as follows:

$$r_t = l_n(\frac{Pt+1}{Pt}) \text{ (When data were continued or time series data) or}$$

$$r_t = l_n(\frac{Pt+1}{Pt})\text{-1, (When data were discrete)}$$

***Equation 3.1 Stock return formula***

Where:

$r_t$– Return of investment in time t
$P_{t+1}$ – Asset price in time t+1
$P_t$ – Asset price in time t, and
$l_n$ – natural logarithm

This study collected all time series data since the stock market was traded daily, so $r_t = l_n\,(\frac{Pt+1}{Pt})$ was applied to compute the daily return for the study. The monthly return for each asset and market index was computed as an average daily return multiplied by the number of trading days (Benninga, 2014). The daily traded price of PPAP was collected from September 2015 to September 2022 and PAS from June 2017 to September 2022, and the market index was collected accordingly. According to Benninga (2014), the return data for the 60 months represents the distribution of the returns for the coming month; thus, this study assumed that historical data could help us predict how returns would behave in the future. This assumption allows us to assume that the average of the historical data represents the expected monthly return on each stock. Each asset's coefficient of correlation and beta were computed as follows (Lind, Marchal, & Wathen, 2021; Doane & Seward, 2016):

$$r = \frac{\sum_{i=1}^{n}(x-\bar{x})(y-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y-\bar{y})^2}}$$

***Equation 3.2 Correlation Coefficient formula***

$$b_i = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2}$$

***Equation 3.3 Beta formula***

$$b_0 = \bar{y} - b_i\bar{x}$$

***Equation 3.4 Alpha formula***

To test the efficiency of the CAPM model, the study also compared the model results with forecasting results by using a single moving average and weighted moving average. To forecast the expected return of each asset, we use the CAPM model as per the below formula:

$R_a = R_f + \beta_a(R_m - R_f)$ (Smart & Zutter, 2020)
Where:

- $R_a$ is the expected return on the asset
- $R_f$ is a risk-free rate
- $R_m$ is the market index return
- $\beta_a$ is the coefficient or index of non-diversifiable risk for investment

According to Render et al. (2018), the forecast values are compared with the actual or observed values to see how well one model works or to compare that model with others. The forecast error (or deviation) is defined as follows:

Forecast error = Actual value - Forecast value

***Equation 3.5 Forecast Error formula***

The mean absolute deviation (MAD) is needed to compute to measure the model's accuracy. This is computed by taking the sum of the absolute values of the individual forecast errors and dividing by the number of errors (n):

$$\text{MAD} = \frac{\sum[Forecast\ Error]}{n}$$

***Equation 3.6 Mean Absolute Deviation formula***

The small MAD is a better model than the large MAD.

## 4. Results

*Compute daily return*

The market prices of the two assets were collected from the official website of CSX, "http://csx.com.kh," and then the daily return was computed using $r_t = l_n(\frac{Pt+1}{Pt})$, respectively, since the data are time-series. In this case, to compute the return on 29 September 2022 of PAS, the follwing formala was used:

$$r_t = l_n(\frac{Pt+1}{Pt}) = l_n(13{,}000/13{,}000) = 0$$

To compute return on 28 September 2022, we used:

$$r_t = l_n(\frac{Pt+1}{Pt}) = l_n(13{,}000/12{,}960) = 0.00308 \text{ or } 0.308\%$$

Table 4.1 The daily return of PAS stock price

| Date | Price | Daily Return |
|---|---|---|
| 30/09/2022 | 13,000 | |
| 29/09/2022 | 13,000 | 0.000% |
| 28/09/2022 | 12,960 | 0.308% |
| 27/09/2022 | 13,000 | -0.308% |
| 23/09/2022 | 13,020 | -0.154% |
| 22/09/2022 | 12,980 | 0.308% |
| 21/09/2022 | 12,820 | 1.240% |
| 20/09/2022 | 12,800 | 0.156% |
| 19/09/2022 | 13,200 | -3.077% |
| 16/09/2022 | 13,160 | 0.303% |
| 15/09/2022 | 13,180 | -0.152% |
| 14/09/2022 | 13,240 | -0.454% |
| 13/09/2022 | 13,220 | 0.151% |

We followed the same procedure for PAS from 1 August 2017 until 29 September 2022.

To compute the daily return of PPAP from 9 December 2015 to 29 September 2022, the computation is as follows:

To compute return on 29 September 2022 of PPAP:

$$r_t = l_n(\frac{Pt+1}{Pt}) = l_n(14{,}400/14{,}380) = 0.00139 \text{ or } 0.139\%$$

To compute return on 28 September 2022:

$$r_t = l_n(\frac{Pt+1}{Pt}) = l_n(14{,}380/14{,}380) = 0 \text{ or } 0\%$$

Table 4.2 The daily return of PPAP stock price

| Date | Price | Daily Return |
|---|---|---|
| 30/09/2022 | 14,400 | |
| 29/09/2022 | 14,380 | 0.139% |
| 28/09/2022 | 14,380 | 0.000% |
| 27/09/2022 | 14,460 | -0.555% |
| 23/09/2022 | 14,440 | 0.138% |
| 22/09/2022 | 14,420 | 0.139% |
| 21/09/2022 | 14,400 | 0.139% |
| 20/09/2022 | 14,400 | 0.000% |
| 19/09/2022 | 14,400 | 0.000% |
| 16/09/2022 | 14,420 | -0.139% |
| 15/09/2022 | 14,280 | 0.976% |
| 14/09/2022 | 14,500 | -1.529% |
| 13/09/2022 | 14,600 | -0.687% |

We used the same procedure for PPAP and PAS in accordance with the market index to calculate daily returns.

*Compute Asset Beta*

To compute the beta of each asset, at least 60 monthly returns on each asset and the market index are needed. The monthly return for each asset and market index was computed as an average daily return multiplied by the number of trading days (Benninga, 2014). Using the monthly return of asset data on the Y-axis and market index monthly data on the X-axis, the beta of assets was computed using the statistical formula as follows:

The average monthly return of PPAP during the study period is:

$$\bar{y} = \frac{6.77\% - 0.73\% + \ldots - 2.61\%}{82} = 1.25\%$$

The average monthly return of the market index during the study period is:

$$\bar{x} = \frac{3.39\% - 3.95\% + \ldots - 0.23\%}{82} = 0.18\%$$

The beta of PPAP during the period of study is:

$$\beta = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sum(x - \bar{x})^2}$$

$$\beta_{PPAP} = \frac{(3.39\% - 0.18\%)(6.77\% - 1.25\%) + \ldots + (-0.23\% - 0.18\%)(-2.61\% - 1.25\%)}{(3.39\% - 0.18)^2 + \ldots + (-0.23\% - 0.18\%)^2} = 0.47$$

Table 4.3 Comparing between PPAP and Index monthly return

| Item | Date | PPAP monthly return | INDEX monthly return |
|---|---|---|---|
| 1 | 01/12/2015 | 6.770% | 3.388% |
| 2 | 01/01/2016 | -0.730% | -3.947% |
| 3 | 01/02/2016 | 0.000% | 0.630% |
| 4 | 01/03/2016 | -0.367% | -1.014% |
| 5 | 01/04/2016 | -0.738% | -2.507% |
| 70 | 01/09/2021 | -0.535% | -1.142% |
| 71 | 01/10/2021 | -0.673% | -1.837% |
| 72 | 01/11/2021 | -1.361% | -1.684% |
| 73 | 01/12/2021 | 2.034% | -2.782% |
| 74 | 01/01/2022 | 0.000% | -0.017% |
| 75 | 01/02/2022 | 0.000% | 19.582% |
| 76 | 01/03/2022 | 4.591% | -1.442% |
| 77 | 01/04/2022 | -0.514% | -5.849% |
| 78 | 01/05/2022 | -0.776% | -4.153% |
| 79 | 01/06/2022 | -0.651% | -3.297% |
| 80 | 01/07/2022 | -2.649% | -3.106% |
| 81 | 01/08/2022 | -0.809% | -1.444% |
| 82 | 01/09/2022 | -2.605% | -0.231% |

The average monthly return of PAS during the study period is:

$$\bar{y} = \frac{0.398\% + 0\% + \ldots - 1.98\%}{62} = 1.54\%$$

The average monthly return of the market index during the study period is:

$$\bar{x} = \frac{0.24\% + 0.56\% + \ldots - 0.23\%}{62} = 0.55\%$$

Beta of PAS during the period of study is:

$$\beta = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sum(x - \bar{x})^2}$$

$$\beta_{PAS} = \frac{(0.24\% - 0.55\%)(0.40\% - 1.54\%) + \ldots + (-0.23\% - 0.55\%)(1.98\% - 1.55\%)}{(0.24\% - 0.55)^2 + \ldots + (-0.24\% - 0.55\%)^2} = 0.94$$

Table 4.4 Comparing between PAS and Index monthly return

| Item | Date | PAS monthly return | INDEX monthly return |
|---|---|---|---|
| 1 | Aug-17 | 0.398% | 0.237% |
| 2 | Sep-17 | 0.000% | 0.560% |
| 3 | Oct-17 | -2.410% | 2.352% |
| 4 | Nov-17 | 0.406% | -3.578% |
| 5 | Dec-17 | 0.806% | 2.802% |
| 50 | Sep-21 | -0.147% | -1.142% |
| 51 | Oct-21 | -1.783% | -1.837% |
| 52 | Nov-21 | 0.449% | -1.684% |
| 53 | Dec-21 | -0.299% | -2.782% |
| 54 | Jan-22 | -0.150% | -0.017% |
| 55 | Feb-22 | 3.100% | 19.582% |
| 56 | Mar-22 | 1.729% | -1.442% |
| 57 | Apr-22 | -0.861% | -5.849% |
| 58 | May-22 | 3.539% | -4.153% |
| 59 | Jun-22 | -4.117% | -3.297% |
| 60 | Jul-22 | -0.873% | -3.106% |
| 61 | Aug-22 | -3.118% | -1.444% |
| 62 | Sep-22 | -1.980% | -0.231% |

To use CAPM, a risk-free rate is needed. According to Xinhuanet (2022), an article dated 7 September 2022 mentioned that the Cambodian government bond has a fixed interest rate of 2 percent per annum. Since it is an auctioned rate, so in this study, we used a risk-free rate of 2%.

Using computed betas and the risk-free rate above, we can forecast the expected return of PPAP and PAS as follows (Smart & Zutter, 2020):

$$R_a = R_f + \beta_a (R_m - R_f)$$

Where:

- $R_a$ is the expected return on the asset
- $R_f$ is a risk-free rate
- $R_m$ is the market index return
- $\beta_a$ is the coefficient or index of non-diversifiable risk for investment

We computed the expected return of PPAP by using CAPM:

Table 4.5 Expected return of PPAP by using CAPM

| Year | Actual return | Market return | Beta of PPAP | Expected return by CAPM | Estimation Error | Absolute Deviation |
|---|---|---|---|---|---|---|
| 2016 | -5.61% | -11.63% | 0.465 | -4.34% | -1.27% | 1.27% |
| 2017 | -1.98% | -8.68% | 0.465 | -2.97% | 0.99% | 0.99% |
| 2018 | 39.63% | 36.35% | 0.465 | 17.97% | 21.66% | 21.66% |
| 2019 | 49.23% | 44.25% | 0.465 | 21.65% | 27.59% | 27.59% |
| 2020 | -6.61% | -17.31% | 0.465 | -6.98% | 0.36% | 0.36% |
| 2021 | 24.18% | -31.66% | 0.465 | -13.65% | 37.83% | 37.83% |
| 2022 | -3.41% | 0.04% | 0.465 | 0.82% | -4.24% | 4.24% |

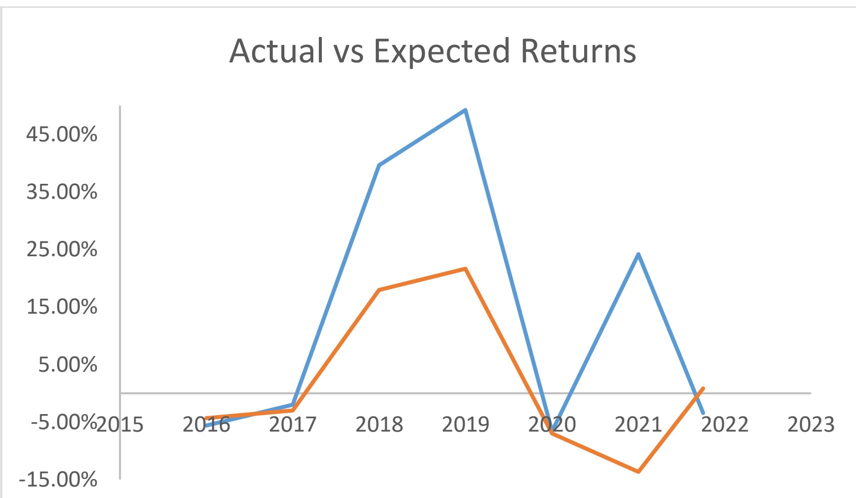


Figure 4.2 Comparing between Expected and Actual return of PPAP

We also computed the expected return of PAS by using CAPM:

Table 4.6 Expected return of PAS by using CAPM:

| Year | Actual return | Market return | Beta of PPAP | Expected return by CAPM | Estimation Error | Absolute Deviation |
|---|---|---|---|---|---|---|
| Aug. 2017 to Jul. 2018 | 2.36% | -2.59% | 0.943 | -2.33% | 4.69% | 4.69% |
| Aug. 2018 to Jul. 2019 | 100.91% | 66.47% | 0.943 | 62.79% | 38.12% | 38.12% |
| Aug. 2019 to Jul. 2020 | 5.92% | 6.32% | 0.943 | 6.07% | -0.15% | 0.15% |
| Aug. 2020 to Jul. 2021 | -9.53% | -22.03% | 0.943 | -20.66% | 11.12% | 11.12% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Aug. 2021 to Jul. 2022 | 0.59% | -12.44% | 0.943 | -11.62% | 12.21% | 12.21% |

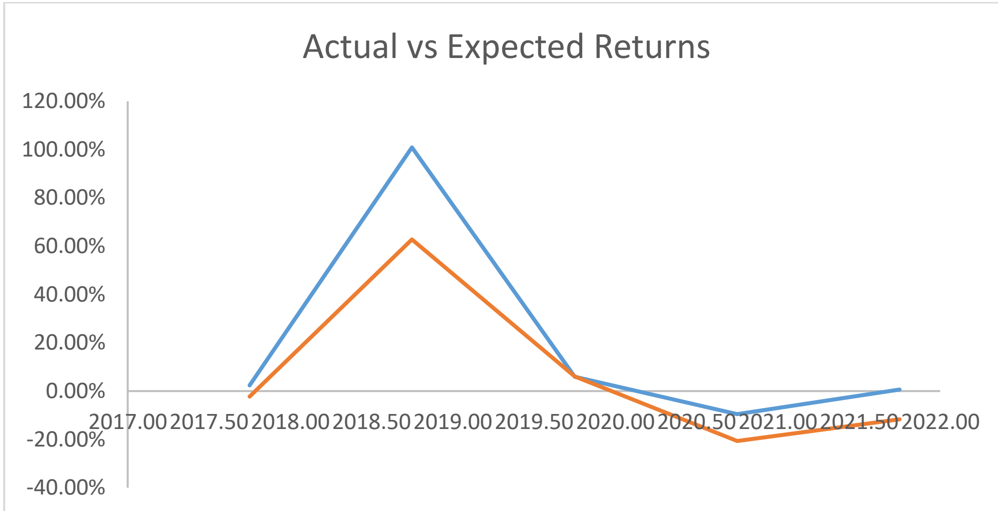


Figure 4.2 Comparing between Expected and Actual return of PAS

The graphics above showed the errors of expected returns compared to actual returns. The errors can be computed as average (Render et al.,2018).

$$\text{MAD of PPAP} = \frac{1.27\%+0.99\%+\ldots+4.24\%}{7} = 13.42\%$$

$$\text{MAD of PAS} = \frac{4.69\%+38.12\%+\ldots+12.21\%}{5} = 13.26\%$$

The graphics show that there are almost undervaluation by using CAPM to forecast stock returns (PPAP & PAS). Despite different beta values, the mean absolute deviations were almost the same (around 13%).

To compute the forecast error, there is a need to compare the actual and forecast returns (Render et al., 2018); Forecast error = Actual value - Forecast value. Forecast errors of PPAP and PAS were shown in the tables 4.5 and 4.6 mean forecast errors are computed as follows:

$$\text{Forecast error of PPAP} = \frac{-1.27\%+0.99\%+\ldots-4.24\%}{7} = 11.85\%$$

$$\text{Forecast error of PAS} = \frac{4.69\%+38.12\%+\ldots+12.21\%}{5} = 13.20\%$$

Both stocks were undervaluation by using the CAPM model to estimate return. PPAP was 11.85% undervalued, and PAS was 13.20% undervalued.

## 5. Conclusion

According to the above results, there are better tools than the CAPM model to estimate the PPAP and PAS in CSX. As a result of the analysis, it is revealed that the return from investment was unevaluated. For further research, the CAPM was inappropriate for forecasting PPAP and PAS stock prices. We recommend using other methods rather than CAPM because these two stock prices were unrelated to the CSX index.

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