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# Applying Markowitz PortfolioTheoryon Cambodia Securities Exchange

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## ABSTRACT

*This research bestows one of the most famous portfolio selection theories known as the Markowitz Portfolio Theory on Cambodia Securities Exchange. The result of the study indicates that in the case that short-selling is not prohibited, an optimal portfolio investment with the required rate of return of 20 percent per year is constructed through the long-position of FX and all of the securities listed in the CSX, such as stocks and bonds and the short-selling position of commodity goods, gold and crude oil. Long-position is applied only to all stocks and generates positive average annual return, while the assets, FX, gold, crude oil, and bond generates negative average annual return are not recommended to invest, in the case that short -selling is prohibited. The result of the survey on the undergraduate students majoring in accounting and finance reveals that the qualification of undergraduate students related to financial markets and financial instruments has a statistically significant relationship with the extent that lecturers or professors teach students how to apply financial theory in practice.*

***Keywords: Markowitz Port olio Theory, Cambodia Securities Exchange, Survey***

## INTRODUCTION

Cash is the most liquid asset; however, an opportunity cost arises as a result of holding too much cash in hand since reinvestment in other assets such as real estate, gold, crude oil, stock, bond, etc., could yield more return in the forms of interest and capital gain. Indeed, asset with no risk is nonexistent. Risk and return are closely link together and as generally stated, high risk leads to high return and low risk leads to low return. Investing in a single asset has high risk, specifically, a default risk. This risk could be diversified or reduced through portfolio investment meaning don't put all eggs in one basket.

Markowitz Portfolio Theory (MPT) is the most popular theory in portfolio investment through an optimization process by minimizing portfolio risk regarding to required rate of return. Optimal weight is derived by solving a minimization problem which have one portfolio risk function considering as an objective function and two constraint functions, in case short-selling is not prohibited. The first constraint function is that the sum of optimal weight has to be lower or equal to one or one-hundred percent and the second constraint function is the portfolio return equals to required rate of return. In a case where short-selling is prohibited, only three constraints are imposed. The first and second constraints are as stated above and the third constraint is each optimal weight has to be larger or equals to zero.

The primary goal of this research study is to apply Markowitz Portfolio Theory on Cambodia Securities Exchange (CSX) by creating a portfolio investment that includes all CSX listed stocks and bond. Moreover, Foreign Exchange (FX) and commodities such as gold and crude oil investments are also included in this portfolio investments. This study is also focusing on level of understanding of undergraduate students about financial sector via surveys at universities in Phnom Penh

## LITERATURE REVIEW

The aspiration of the investment is to optimize the return and minimize the risk. The portfolio optimization, therefore, plays a vital role in guiding the investment behaviors. The portfolio return, however, changes based on the desirable portfolio risk which the investors have to balance the contradiction between risk and return. Determined by the investor's risk and return, the optimal portfolio, presumably, is required to have more than one option in order to satisfy all the investors.

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The study of theory of financial market, like other area of economics, involves a long history of development. Harry Markowitz (1952), an American financial economist, developed the modern theory of portfolio selection in the article "Portfolio Selection" which explicit recognition was given to risk and its quantification in term of variance. The model may have been extended and developed by later researchers, the model is still exceptionally popular. Marc (2001), for example, employed the model to apply on the single-period and multiple-period variants to analyze the tradeoff between profit and risk. The result of the study suggested that the single-period and multiple-period mean-variance behave similarly and the over-performance is possible to avoid by allowing the removal of the capital. The small rate of return, in addition, can be achieved at zero risk.

Maria and Lilko (2017) applied the model to the Bulgarian Stock Exchange between January 2013 to December 2016. Given that the Markowitz diversification seriously takes into consideration the covariance and correlation between assets. The result shows that the portfolio created by Markowitz model out performed any other individual domestic security. By investing in the portfolio efficient frontier, therefore, the investors will be able to gain maximum rate of return with the respect to a certain level of risk. Knowing about its application, additionally, will probably help to improve the performance of the Bulgarian investors. Martin and Lukas (2015), likewise, used the model to build the optimal portfolio for the US stocks market by comparing five examined portfolios which consists of the portfolio made using Capital Asset Pricing Model, low-beta security, high-beta securities and random portfolio. The result of the study suggested that the portfolio consists of low-beta securities outperformed the portfolio consists high-beta securities by a large margin of the rate of return while the risk of the former was still considerably lower. Eugene and Kenneth, similarly, argue that higher return may not be guaranteed by the higher risk measured by the beta coefficient which is contradict to the traditional form of capital asset pricing model.

The review of the existing literatures has provided comprehensive insight which strongly supports that Markowitz portfolio theory is applicable to help the investors to improve the investment performance if applied properly. Given the model seriously takes into account the covariance and correlation between assets.

## METHODOLOGY

### 3.1. DATA AND MARKOWITZ PORTFOLIO PROBLEM FORMULATION

To incorporate Markowitz Portfolio Theory (MPT) into practice, a portfolio which consist of foreign exchange (FX), commodities, bond, and stocks is established. FX is the exchange rate between Khmer Riel (KHR) and US dollar (USD). Two types of commodity are also included in this portfolio which are gold and crude oil. A corporate bond, Hattha Kaksekar Limited (HKL), which is firstly issued and traded in CSX, is also selected in creating this portfolio investment. Beside HKL bond, all stocks which are listed in CSX are also taken into account. The detail information regarding to the invested assets is presented in Table I below.

**Table I. Portfolio: Type of Assets**

| Type | Symbol | Name | Measurement |
|---|---|---|---|
| FX | FX | Foreign Exchange | KHR per USD |
| Commodity | XAU | Gold | USD per Troy Ounce |
| Commodity | CO | Crude Oil | USD per Barrel |
| Corporate Bond | HKL21A | Hattha Kaksekar Limited (HKL) | KHR per share |
| Stock | PWSA | Phnom Penh Water Supply Authority | KHR per share |
| Stock | PPAP | Phnom Penh Autonomous Port | KHR per share |
| Stock | PPSP | Phnom Penh SEZ Plc. | KHR per share |
| Stock | PAS | Sihanouk Autonomous Port | KHR per share |
| Stock | GTI | Grand Twin International | KHR per share |

Daily data is employed in this study from January 2, 2018 to January 22, 2019 and the position date of this portfolio investment is on January 22, 2019. Daily parallel exchange rate is collected from National Bank of Cambodia (NBC), while gold and crude oil prices are collected from Bloomberg. The information related to bond as well as daily stock prices are extracted from Cambodia Securities Exchange (CSX).

Hatha Kaksekar's bond is the first corporate bond which has been issued in Cambodia in November 14, 2018 and the bond is firstly traded in the Cambodia Securities Exchange in December 5, 2018. The detail information related to this bond is provided in Table II below.

| Table II. Corporate Bond, Hatha Kaksekar Limited | |
|---|---|
| Issuer name | Hattha Kaksekar Limited (HKL) |
| Symbol | HKL21A |
| Short Code | B0000718B |
| Standard Code | KH20000718B4 |
| Underwriter | SBI Royal Securities Plc. |
| Bondholder's Representative | Acleda Securities |
| Face value | KHR100,000 |
| Coupon rate | 8.50% |
| Payment frequency | Semiannually |
| Payment date | May 14th and November 14th |
| Credit rating | BBB+ |
| Credit Rating Agency (CRA) | TRIS Rating Thailand |
| Issuing date | November 14, 2018 |
| Maturity date | November 14, 2021 |

Source: CSX.

The face value of the bond is KHR100,000 and the coupon rate is 8.50 percent per year. The coupon payment is conducted semiannually in May 14th and November 14th of each year. Since the maturity of the bond is three years, cash flow series has been allocated to be six period of time as indicated in Table III.

| Table III. Cash Flow (CF), HKL21A | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bond | Cash Flow | CF1 | CF2 | CF3 | CF4 | CF5 | CF6 |
| HK-L21A | Date | 14-May-19 | 14-Nov-19 | 14-May-20 | 14-Nov-20 | 14-May-21 | 14-Nov-21 |
| | Payment | KHR 4,250 | KHR 4,250 | KHR 4,250 | KHR 4,250 | KHR 4,250 | KHR 104,250 |

The daily bond price is determined discount future cash flow by zero-coupon yields (Z), corresponding the time to maturity. Bond price (BP) is calculated using the following formula.

$$BP = \sum_{t=1}^{T} \left[ \frac{CF_t}{\left(1 + \frac{Z}{100}\right)^t} \right]$$

Since the zero-coupon yields are not available yet in CSX, to determine daily bond price, this study uses zero-coupon yields which are extracted from Thai Bond Market Association (ThaiBMA) through Bloomberg from January 2, 2018 to January 22, 2019. The extracted zero- coupon yields are three months (Z3M), six months (Z6M), one year (Z1Y), two years (Z2Y) and three years (Z3Y).

| Cash Flow in KHR | 4,250 | 4,250 | 4,250 | 4,250 | 4,250 | 104,250 |
|---|---|---|---|---|---|---|
| TTM | 0.3068 | 0.8110 | 1.3096 | 1.8137 | 2.3096 | 2.8137 |

| Zero-Coupon Yield | Z3M | Z6M | Z1Y | Z2Y | Z3Y |
|---|---|---|---|---|---|
| TTM | 0.2493 | 0.4986 | 1 | 2 | 3 |

**Table IV. Cash Flow, Time to Maturity (TTM) in Year of HKL21A and Zero-Coupon Yield (Z), Month (M) and Year (Y) Position date: January 22, 2019**

As indicated in Table IV, the given zero-coupon yields could not be used to discount expected future cash flows back to the present value in order to determine daily bond price since the time to maturity between cash flows and zero-coupon yields are different. To obtain zero-coupon yields that match up with time to maturities of each cash flow of the bond, the interpolated zero-coupon yields are conducted as below.

$$Z_{0.3068} = Z_{0.2493} + \frac{(t_{0.3068} - t_{0.2493})(Z_{0.4986} - Z_{0.2493})}{(t_{0.4986} - t_{0.2493})}$$

$$Z_{0.8110} = Z_{0.4986} + \frac{(t_{0.8110} - t_{0.4986})(Z_1 - Z_{0.4986})}{(t_1 - t_{0.4986})}$$

$$Z_{1.3096} = Z_1 + \frac{(t_{1.3096} - t_1)(Z_2 - Z_1)}{(t_2 - t_1)}$$

$$Z_{1.8137} = Z_1 + \frac{(t_{1.8137} - t_1)(Z_2 - Z_1)}{(t_2 - t_1)}$$

$$Z_{2.3096} = Z_2 + \frac{(t_{2.3096} - t_2)(Z_3 - Z_2)}{(t_3 - t_2)}$$

$$Z_{2.8137} = Z_2 + \frac{(t_{2.8137} - t_2)(Z_3 - Z_2)}{(t_3 - t_2)}$$

The daily return of each asset is calculated as below.

**Rt = LN (St / St-1)**

where

R : Return of individual asset at time, t,

S : Price of individual asset at time, t or t-1,

LN : Natural logarithm.

After determine daily return of each asset, the variance-covariance matrix (VCM) is established and denoted as Ω. To apply the Markowitz Portfolio Theory, the portfolio variance, $\sigma p^2$, is contracted using the established variance-covariance matrix and the weight vector of assets. This function is classified as the objection. In addition, two constraints are imposed. Thus, the minimization problem is written as follow.

Objective function:

$$\boldsymbol{Minimize}\ \frac{1}{2}\boldsymbol{W^T \Omega W}$$

Subject to:

$$\boldsymbol{1^T W} = 1$$

$$\boldsymbol{R_i^T W} = R_q$$

where

Ri : Column vector of the assets' return, ri ;

W : Column vector of the weight in the portfolio,

Ω : Variance-covariance matrix of assets' returns,

1 : Column vector whose all entries are 1

Rq : Required return of portfolio.

The objective variables of this minimization problem are weights (Ws). To solve for the optimal weights, the Lagrange method is employed and the Lagrange function is written as below.

Lagrange function

$$\boldsymbol{L} = \frac{1}{2}(\boldsymbol{W^T \Omega W}) + \boldsymbol{\lambda_1}(1 - \boldsymbol{1^T W}) + \boldsymbol{\lambda_2}(R_q - \boldsymbol{R_i^T W})$$

First Order Necessary Condition (FOC):

$$\boldsymbol{\nabla_W L}: \boldsymbol{\Omega W} + \boldsymbol{\lambda_1}(\boldsymbol{-1}) + \boldsymbol{\lambda_2}(\boldsymbol{-R_i}) = \boldsymbol{0} \qquad (1)$$

$$\boldsymbol{\nabla_{\lambda_1} L}: 1 - \boldsymbol{1^T W} = \boldsymbol{0}$$

$$\boldsymbol{1^T W} = 1 \qquad (2)$$

$$\boldsymbol{\nabla_{\lambda_2} L}: R_q - \boldsymbol{R_i^T W} = \boldsymbol{0}$$

$$\boldsymbol{R_i^T W} = R_q \qquad (3)$$

After solving for FOC, n equations with n unknowns are generated. Hence, with n equations and n unknowns, column vector of the weight in the portfolio, W, can be determined by solving linear equation which is written in matrix form as below.

$$\begin{bmatrix} \boldsymbol{\Omega} & \boldsymbol{1} & \boldsymbol{R_i} \\ \boldsymbol{1^T} & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{R_i^T} & \boldsymbol{0} & \boldsymbol{0} \end{bmatrix} \begin{bmatrix} \boldsymbol{W} \\ \boldsymbol{-\lambda_1} \\ \boldsymbol{-\lambda_2} \end{bmatrix} = \begin{bmatrix} \boldsymbol{0} \\ 1 \\ R_q \end{bmatrix}$$

Where $\boldsymbol{\lambda_1}$ and $\boldsymbol{\lambda_2}$ are vector of Lagrange Multiplier or so-called Shadow Prices.

### 3.2. RESEARCH DESIGN

Beside applying Markowitz Portfolio Theory on Cambodia Securities Exchange, this research also conducts a survey over undergraduate students at universities majoring in accounting and finance in order to observe the qualification of the students regarding to financial market and financial instruments. Questionnaire which is applied in this survey is classified into eighteen items (see Appendix) and the objective of each item is explained in Table V below.

**Table V. Objective of each Item of Questionnaire**

| Item | Objective |
|---|---|
| Item 1 to Item 4 | Demography of students |
| Item 5 to Item 10 | Qualification of students in finance |
| Item 11 to Item 13 | Applying finance theory in practice by students |
| Item 14 to Item 17 | Teaching students to apply finance theory in practice by Lecturers or Professors |
| Item 18 | Participation in Portfolio Investment workshop using Excel and VBA |

Three universities are selected and the sample size in each university is one hundred students, thus, the total sample size is three hundred students (see Table VI). The target respondents are the third and fourth-year students majoring in accounting and finance.

**Table VI. Sample Size**

| University | Sample size |
|---|---|
| CamEd Business School (CamEd) | 100 |
| Pannasastra University of Cambodia (PUC) | 100 |
| University of Economics and Finance (UEF) | 100 |

The link or QR code to the developed questionnaire is distributed to the students through emails, social medias, Google classrooms and in classes.

## RESEARCH RESULT

The research result is separated into two main parts. The first part will present the result of optimization of portfolio investment using the Markowitz Portfolio Theory. The second part will show the result of survey from the students from the three different universities as explain in the previous section.

**Table VII. Summary Statistics of Return of Each Individual Asset**

| | FX | Gold | CO | Bond | PWSA | GTI | PPAP | PPSP | PAS |
|---|---|---|---|---|---|---|---|---|---|
| No. of observation | 246 | 246 | 246 | 246 | 246 | 246 | 246 | 246 | 246 |
| Average daily return | -0.002% | -0.011% | -0.024% | -0.002% | 0.076% | 0.102% | 0.317% | 0.043% | 0.386% |
| Annual return | -0.61% | -2.77% | -6.09% | -0.60% | 19.05% | 25.49% | 79.15% | 10.71% | 96.41% |
| Standard deviation | 0.08% | 0.63% | 1.97% | 0.03% | 1.61% | 3.07% | 2.09% | 1.78% | 2.16% |
| CV or RSD | -33.63 | -56.97 | -80.82 | -13.08 | 21.07 | 30.11 | 6.60 | 41.57 | 5.59 |
| VaR (99%CL, 30ds) | 0.0104 | 0.0805 | 0.2507 | 0.0040 | 0.2046 | 0.3912 | 0.2662 | 0.2269 | 0.2746 |
| VaR (as %) | 1.04% | 8.05% | 25.07% | 0.40% | 20.46% | 39.12% | 26.62% | 22.69% | 27.46% |

Regarding to Table VII, the total number (No.) of observation in this study is 246. The average daily return of each individual asset as well as risk which is represented by daily standard deviation are also shown in table above. However, annual return of each individual asset is determined by the multiplication of average daily return by 250 days. The coefficient of variation (CV) which is so-called relative standard deviation (RSD) is the ratio of standard deviation (SD)

to average or mean of daily return. The lower the CV or RSD, the better risk and return trade off.

In addition to CV, this study also provides the calculation of Value at Risk (VaR) of each asset with confident level (CL) of 99 percent and the holding period is 30 days. The lowest VaR as percentage (VaR (as %)) is bond, 0.4 percent, which is described that there would be 99 percent chance to lose not more than 0.4 percent on the next 30 days of holding this bond investment.

Regarding to daily return matrix of all assets in the portfolio, the variance and covariance matrix and inverse variance and covariance matrix are contructed as indicated in Table VIII and Table IX, respectively

**Table VIII. Variance and Covariance Matrix (VCM), Ω**

| VCM | FX | Gold | CO | Bond | PWSA | GTI | PPAP | PPSP | PAS |
|---|---|---|---|---|---|---|---|---|---|
| FX | 7E-07 | 8E-08 | 6E-07 | -4E-08 | -8E-07 | -1E-06 | -2E-06 | -4E-07 | -4E-07 |
| Gold | 8E-08 | 4E-05 | 8E-06 | 1E-07 | 1E-06 | -2E-05 | 3E-06 | -1E-05 | -7E-06 |
| CO | 6E-07 | 8E-06 | 4E-04 | -7E-07 | 6E-05 | 1E-04 | 2E-05 | -3E-06 | -1E-05 |
| Bond | -4E-08 | 1E-07 | -7E-07 | 1E-07 | 3E-07 | -1E-07 | 4E-07 | 2E-07 | 2E-07 |
| PWSA | -8E-07 | 1E-06 | 6E-05 | 3E-07 | 3E-04 | 5E-05 | 6E-05 | 3E-05 | 4E-05 |
| GTI | -1E-06 | -2E-05 | 1E-04 | -1E-07 | 5E-05 | 9E-04 | 3E-05 | 2E-05 | 7E-05 |
| PPAP | -2E-06 | 3E-06 | 2E-05 | 4E-07 | 6E-05 | 3E-05 | 4E-04 | 1E-05 | 1E-04 |
| PPSP | -4E-07 | -1E-05 | -3E-06 | 2E-07 | 3E-05 | 2E-05 | 1E-05 | 3E-04 | 4E-06 |
| PAS | -4E-07 | -7E-06 | -1E-05 | 2E-07 | 4E-05 | 7E-05 | 1E-04 | 4E-06 | 5E-04 |

**Table IX. Inverse Variance and Covariance Matrix (VCM-1), Ω$^{1}$**

| VCM$^{-1}$ | FX | Gold | CO | Bond | PWSA | GTI | PPAP | PPSP | PAS |
|---|---|---|---|---|---|---|---|---|---|
| FX | 1569225 | -4635 | -2367 | 632045 | 3766 | 1591 | 4716 | 441 | -854 |
| Gold | -4635 | 25933 | -673 | -41027 | -162 | 447 | -286 | 1034 | 414 |
| CO | -2367 | -673 | 2825 | 20404 | -634 | -300 | -98 | 67 | 166 |
| Bond | 632045 | -41027 | 20404 | 10749886 | -10319 | 3 | -6999 | -7269 | -1724 |
| PWSA | 3766 | -162 | -634 | -10319 | 4256 | -103 | -456 | -413 | -207 |
| GTI | 1591 | 447 | -300 | 3 | -103 | 1120 | -15 | -33 | -151 |
| PPAP | 4716 | -286 | -98 | -6999 | -456 | -15 | 2541 | -61 | -584 |
| PPSP | 441 | 1034 | 67 | -7269 | -413 | -33 | -61 | 3248 | 48 |
| PAS | -854 | 414 | 166 | -1724 | -207 | -151 | -584 | 48 | 2344 |

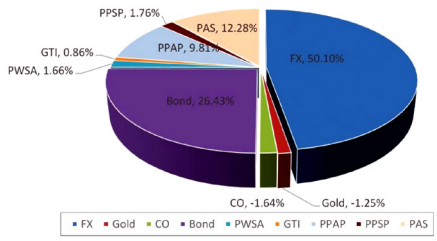
The portfolio required rate of return (Rq) the developed portfolio investment is set to be 20 percent per year. In case that short-selling is not prohibited, the optimal weight which is determined by applying Markowitz Portfolio Theory (MPT) is indicated in Table X below.

**Table X. Optimal Weight Based on MPT**

| Asset | FX | Gold | CO | Bond | PWSA | GTI | PPAP | PPSP | PAS |
|---|---|---|---|---|---|---|---|---|---|
| Annual return | -0.61% | -2.77% | -6.09% | -0.60% | 19.05% | 25.49% | 79.15% | 10.71% | 96.41% |
| Weight (W) | **50.10%** | **-1.25%** | **-1.64%** | **26.43%** | **1.66%** | **0.86%** | **9.81%** | **1.76%** | **12.28%** |
| Posi-tion | **Long** | **Short** | **Short** | **Long** | **Long** | **Long** | **Long** | **Long** | **Long** |

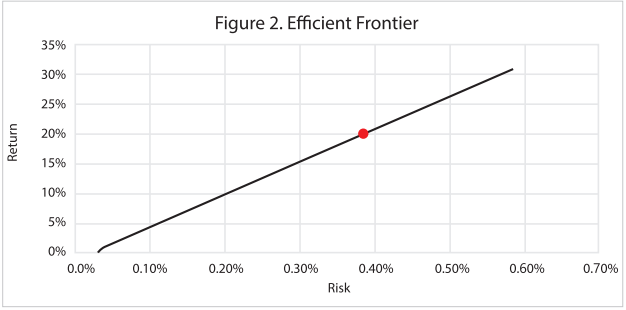
In case that short-selling is not prohibited, to get a portfolio required of return, Rq, of 20 percent per year and minimize portfolio risk, σp, as suggested by MPT, short-selling position is conducted to two different kind of assets, gold and crude oil, while the long position is applied to FX, bond and all stocks which are listed in the Cambodia Securities Exchange. The optimal weight of each individual asset is presented in Table X.

Figure 1. Optimal Weight Based on MPT




With the given optimal weight and the annually portfolio required rate of return, the efficient frontier can be constructed as indicated in Figure 2. The efficient frontier represents about the optimal combination set between portfolio risk in the horizontal axis and portfolio return in the vertical axis. An investment sentence which is always been quoted that "high risk, high return" is derived from this portfolio investment theory. Under this research, since the portfolio required return is 20 percent per year, thus the portfolio risk is 0.39 percent, and the optimal combination between risk and return of this portfolio investment is presented in a red circle over the efficient frontier in Figure 2 below.

Figure 2. Efficient Frontier



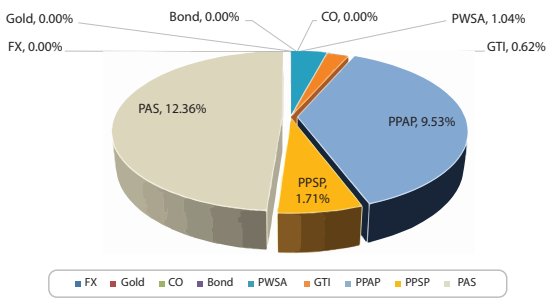

In case that short-selling is prohibited, the third constraint is imposed which is the optimal weight has to be greater or equal to zero. With portfolio required rate of return, Rq, 20 percent per year, the optimal investment weight is shown in Table XI below.

**Table XI. Optimal Weight Short-Selling are Prohibited**

| Asset | FX | Gold | CO | Bond | PWSA | GTI | PPAP | PPSP | PAS |
|---|---|---|---|---|---|---|---|---|---|
| Annual return | -0.61% | -2.77% | -6.09% | -0.60% | 19.05% | 25.49% | 79.15% | 10.71% | 96.41% |
| Weight (W) | 0.00% | 0.00% | 0.00% | 0.00% | 1.04% | 0.62% | 9.53% | 1.71% | 12.36% |
| Position | Not Invest | Not Invest | Not Invest | Not Invest | Long | Long | Long | Long | Long |

As indicated in Table XI, the optimal portfolio investment is allocated to the investment only on securities which generated annual positive average return such as PWSA (1.04%), GTI (0.62%), PPAP (9.53%), PPSP (1.71%) and PAS (12.36%). Regarding to this allocation, the portfolio return is 20 percent and the portfolio risk is 0.38 percent

Figure 3. Optimal Weight, Short-Selling are Prohibited




As mention earlier, this research also conducts a survey to investigate the qualification of students related to finance. The surveying process was participated by 300 students from three universities, CamEd, PUC, and UEF. The questionnaires had been filled out by a hundred students from each university who were third and fourth-year students studying in accounting and finance. 64 percent of the total participants were female and 36 percent of which were male.

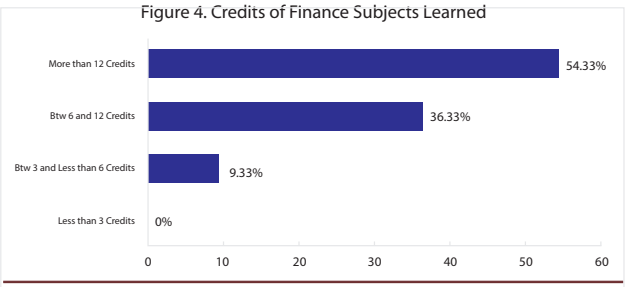
**Table XII. Demography of Students**

| Gender | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| Male | 108 | 36 | 36 |
| Female | 192 | 64 | 100 |
| **Total** | **300** | **100** | |

| Year | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| Third Year | 66 | 22 | 22 |
| Fourth Year | 234 | 78 | 100 |
| **Total** | **300** | **100** | |

Also, 78 percent were fourth-year students and 22 percent were third-year students. Since most students are in the fourth year, 36 percent of the students had studied from 6 to 12 credits and about 54 percent had more than 12 credits of financial courses.

Figure 4. Credits of Finance Subjects Learned




Even though, most of the accounting and finance students are in the fourth year and had studied many credits of financial courses, the financial knowledge of the students was still limited. Between 40 percent to 50 percent of the students did not have a clear understanding of securities and commodity goods specifically, risk-free and risky assets. In addition, only 30 to 44 percent of students understood the methodology in assessing risk and return of stocks investment though 79.7 percent of the students had studied investment management or portfolio investment.

This research study has shown that practical financial theories taught by instructors are still low, especially the teaching of statistical tools used in analyzing financial risks. Approximately 82 percent of instruction used Excel as tool in analyzing financial risk and 61.7 percent of data used during instruction was taken from textbooks while only 19.3 percent was taken from CSX, 6.7 percent from Bloomberg, 4.3 percent from Datastream, and 8 percent from other sources. Moreover, the result of this study has indicated that students' knowledge in finance is correlated to the extent of practical financial theories taught in the classroom.

**Table XIII. Non-Parametric Test**

| Relationship | Inde-pendent Variable | Pearson Chi-Square | df | P-Value | Phi | P-Value | CF6 |
|---|---|---|---|---|---|---|---|
| Item 5 and Item 14 | Item 14 | 36.440 | 12 | 0.0000 | 0.349 | 0.0000 | 14-Nov-21 |
| Item 6 and Item 14 | Item 14 | 48.842 | 12 | 0.0000 | 0.403 | 0.0000 | |
| Item 7 and Item 14 | Item 14 | 11.112 | 4 | 0.0250 | 0.192 | 0.0250 | |
| Item 8 and Item 14 | Item 14 | 23.061 | 12 | 0.0270 | 0.277 | 0.0270 | |
| Item 9 and Item 14 | Item 14 | 44.108 | 12 | 0.0000 | 0.383 | 0.0000 | |
| Item 10 and Item 14 | Item 14 | 49.507 | 12 | 0.0000 | 0.406 | 0.0000 | |

From the fifth to the tenth item of the questionnaire (see Appendix) are developed to observe the qualification of the students regarding to securities, commodity goods and how to measure risk and return of an investment, while the fourteen item is established to observe the extent that lecturers or professors teach the students to apply financial theory in practice.

As indicated in Table XIII, from the fifth to the tenth item, each has a statistically significant at 5 percent level of association with the fourteen item regarding to the calculated Chi-Square and the P-Value. The level of association between qualification of students

in finance to the extent that lecturers or professors teach the students to apply financial theory in practice is ranged from low, 0.192, to moderate, 0.406, as revealed by the value of Phi, especially, each level of association is statistically significant at 5 percent level (see Table XIII).

As revealed by the students, if a workshop in Financial Analysis using Excel and VBA (Visual Basic for Applications) is arranged, about 94 percent of the students are willing to participate in this workshop.

Figure 5. Sources of Data used

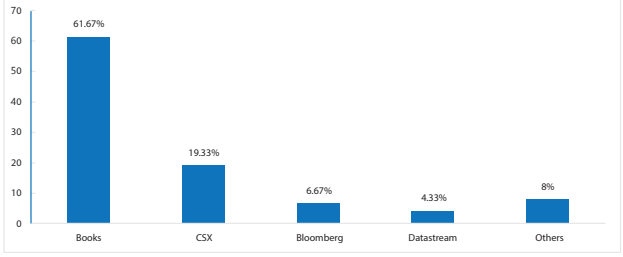
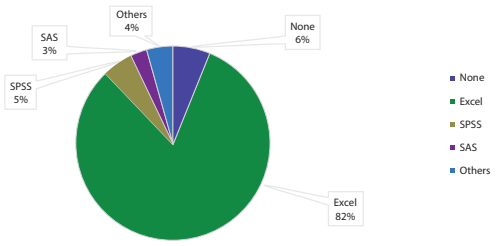



Figure 6. Software used for Financial Analysis




## CONCLUSION

In the case that short-selling is not prohibited, the optimal weight of portfolio investment, as suggested by the Markowitz Portfolio Theory, the short-selling position is conducted on two kinds of assets, gold and crude oil, which generated negative average annual return. The short- selling, however, is not applied to FX and Bond, although, the average annual return of both assets is negative. The long-position, on the other hand, is applied to all of the stocks listed in the Cambodia Securities Exchange, PWSA, GTI, PPAP, PPSP and PSA, and generates positive average annual return. From the constructed portfolio investment and the average annual required return of the portfolio, Rq, of 20 percent, the optimal portfolio risk, is 0.39 percent. In the case that short-selling is prohibited and the average required return of the portfolio remains 20 percent per year, the same as the case that short-selling is not prohibited, the optimal portfolio investment is established by conducting a long-position to all stocks listed in the Cambodia Securities Exchange only, since each individual stock generated positive average annual return, while the assets which generated negative average annual return are not recommended to invest. The optimal portfolio risk from the constructed portfolio is 0.38 percent which is slightly lower than the case that short-selling is not prohibited.

The qualification of undergraduate students related to financial markets and financial instruments has a statistical significant relationship with the extent that lecturers or professors teach students how to apply financial theory in practice. To improve the undergraduate students' qualification in finance as well as to improve lecturers or professors teaching methods, besides teaching students about financial theories in class, lecturers or professors should instruct students more on how to apply the lectured financial theories in practice as well. Workshop s using Excel spreadsheets and other computer programs should be provided by finance instructors to finance students more often in class, especially, using different sources of data from famous links such as CSX, Bloomberg and Datastream. These kinds of workshops are not only to give a chance to the students to apply financial theory in practice, but would also increase the level of understanding of the students in the financial field and make the students to become more professional. The universities, at the same time, should provide a free-access link to Bloomberg as well as Datastream which would provide a pivotal channel to lecturers and students to access to more financial data which facilitates financial analysis and study.

To increase the level of understanding of Cambodian students and the public about the financial market and financial assets or instruments, the Securities and Exchange Commission of Cambodia (SECC) and the Cambodia Securities Exchange (CSX) should arrange seminars about the role of SECC, CSX and the securities, which are traded in CSX, more often and open to the public to attend freely.

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## APPENDIX 1

Questionnaire

1. Gender

☐ Male ☐ Female

2. Which university do you study?

☐ CamEd Business School

☐ Pannasastra University of Cambodia

☐ University of Economics and Finance

3. Which year of your bachelor do you currently study?

☐ Third year

☐ Fourth year

4. How many credits of finance subjects have you studied at your university?

☐ Less than 3 Credits

☐ Between 3 and Less than 6 Credits

☐ Between 6 and 12 Credits

☐ More than 12 Credits

5. Which financial instrument below do you think most likely regarded as securities?

☐ Gold

☐ Oil

☐ Bond

☐ Foods

6. Which goods below do you think most likely regarded as commodity goods?

☐ Treasury bill

☐ Stock

☐ Call option

☐ Silver

7. If you were asking to invest in a risk free asset, between corporate bond and government bond, which one would you choose?

☐ Corporate bond ☐ Government bond

8. Corporate XXX stock is trading today in the stock market at 11,000 Riel per share, while it was trading at 10,000 Riel per share yesterday. How many percent of return of XXX stock between today and yesterday?

☐ 10

☐ 100

☐ 1,000

☐ None of all above

9. If you were asking to measure the level of risk of your investment on an asset, let assume stock, by using a Statistical tool, which tool would you use?

☐ Mean of asset price

☐ Mean of return of asset

☐ Standard deviation of asset price

☐ Standard deviation of return of asset

10. If you were asking to choose one among two stocks, what is your fundamental decision in selecting between the two stocks?

☐ Average return of the stocks

☐ Standard deviation of return of the stocks

☐ Variance of return of the stocks

☐ Coefficient of variation of the stocks

11. Have you ever learned about Portfolio Investment or Investment Management?

☐ Yes ☐ No

12. Most of the finance theory which you had ever learned at your university, how often that your lecturers asked you to apply this theory in practice (such as assignments or workshop using Excel or other software)?

☐ Never ☐ Occasionally ☐ Sometime ☐ Often

13. In Cambodia's financial market, CSX represents of what? (You could choose only one answer).

☐ Cambodia Stock Exchange

☐ Cambodia Safety Exchange

☐ Cambodia Securities Exchange

☐ Cambodia SWIF Exchange

14. When you were studying Finance subject, to what extend did your professor applies financial theory in practice?

☐ To a small extent

☐ To some extent

☐ To a moderate extent

☐ To a great extent

☐ To a very great extent

15. When you were studying Finance subject, to what extent did your professor instruct you how to use statistics in financial analysis?

☐ To a small extent

☐ To some extent

☐ To a moderate extent

☐ To a great extent

☐ To a very great extent

16. When your professor teaches you how to conduct financial analysis, where did the most source of financial data cited from?

☐ Books ☐ CSX ☐ Bloomberg

☐ Datastream ☐ Others

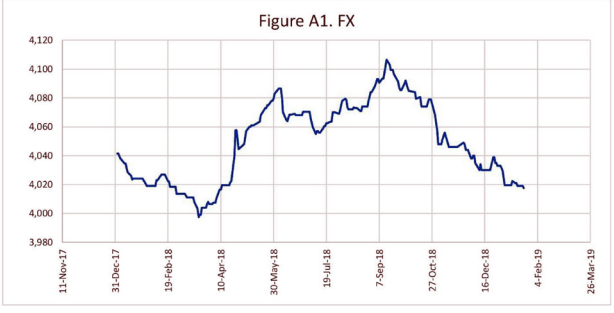
17. Which software was the most likely used by your professor to teach you how to conduct financial analysis?

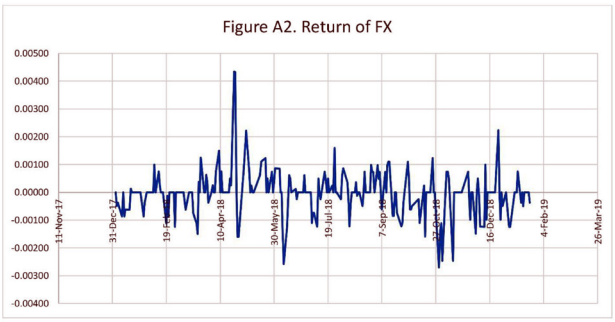
☐ None ☐ Excel ☐ SPSS ☐ SAS ☐ Others

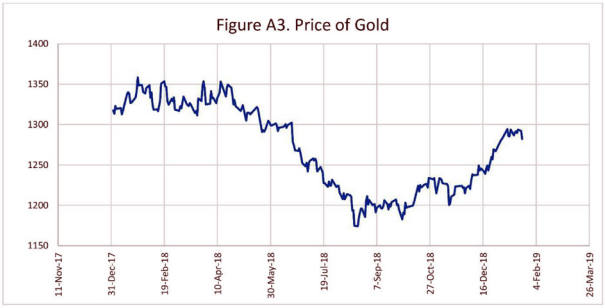
18. If there is workshop in Financial Analysis using Excel and VBA (Visual Basic for Applications), do you want to participate?

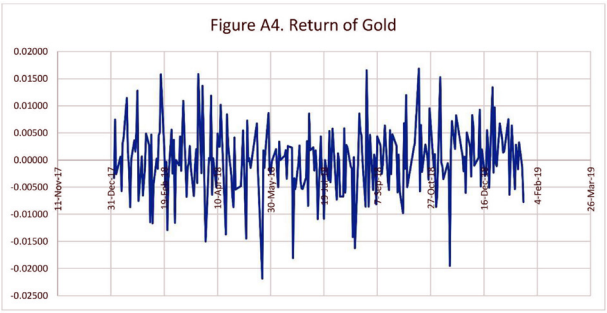
☐ Yes ☐ No

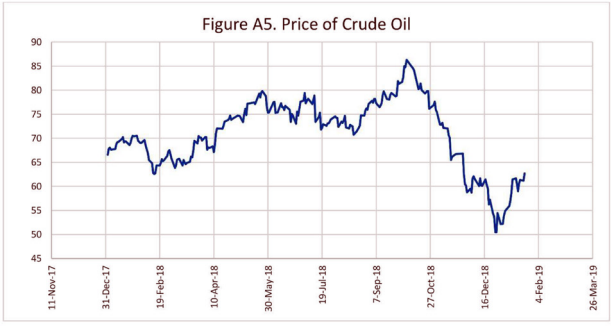
## APPENDIX 2



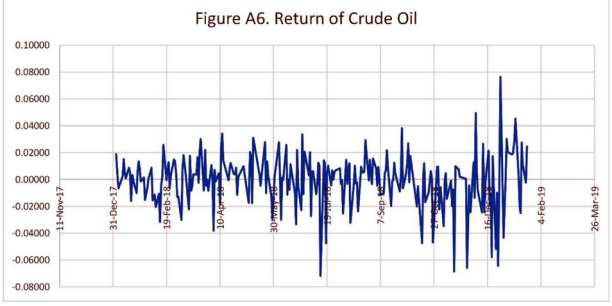



Figure A7. Price of Bond

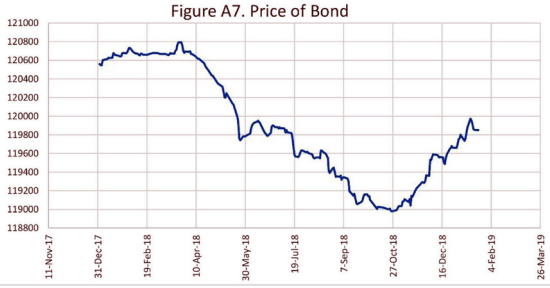



Figure A8. Return of Bond

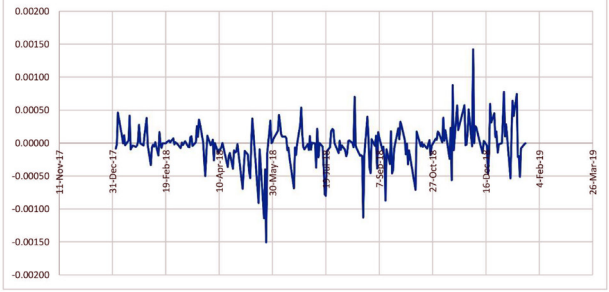



Figure A9. Price of PWSA

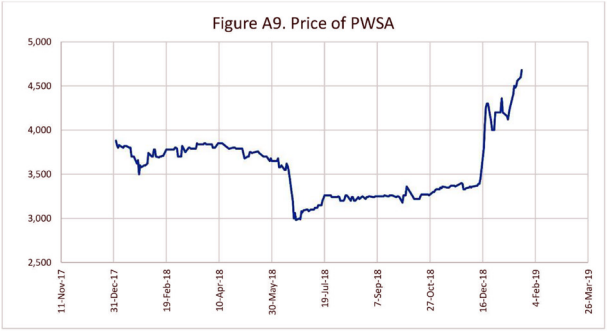



Figure A10. Return of PWSA

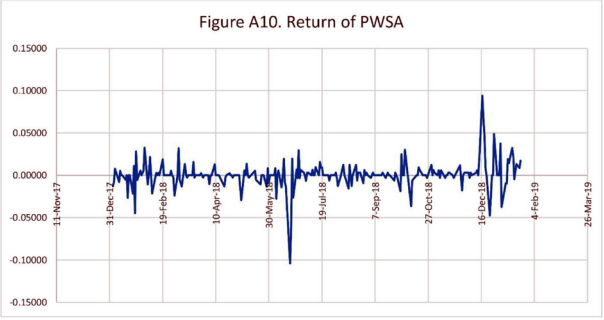



Figure A11. Price of GTI

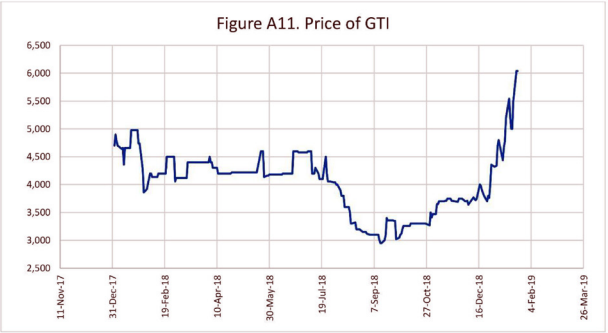



Figure A12. Return of GTI

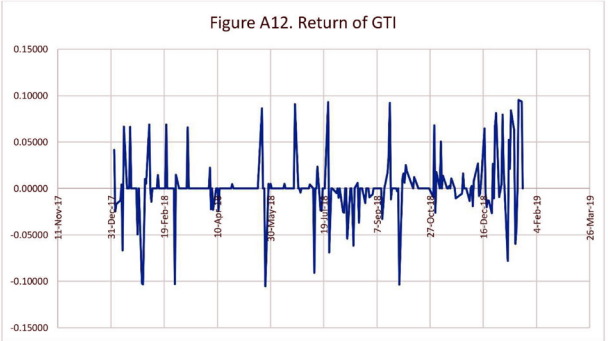



Figure A17. Price of PAS

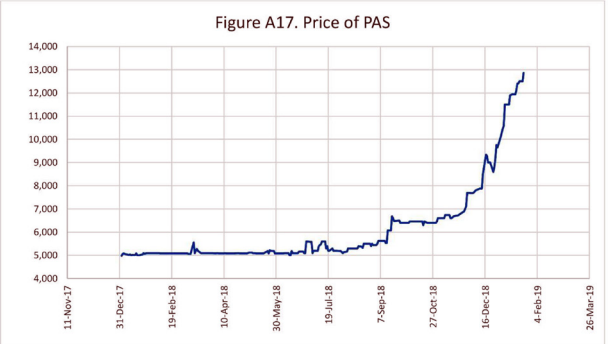
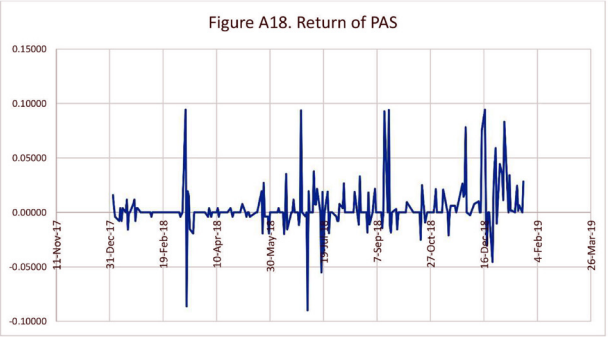



Figure A18. Return of PAS



## APPENDIX 3

### VBA Codes*

### VBA Code I: Interpolated Zero Coupon Yield

```
Function Get_interpolatedvalue_i (Term As Double, Beginning Term As Double, Beginning_Value As Double, Ending_Term As Double, Ending Value As Double) As Double
Dim v As Double
Dim x As Double
x = ((Term - Beginning_Term) * (Ending_Value - Beginning_Value) / (Ending_Term- Beginning_Term))
v = Beginning_Value + x
Get_interpolatedvalue_i = v
End Function
```

### VBA Code II: Variance and Covariance Matrix

```
Function x Covariance (matrix) As Variant
Dim T As Integer
Dim d As Integer
Dim i As Integer
Dim j As Integer
Dim M As Integer

Dim C() As Double
Dim S() As Double
Dim SS() As Double
Dim xT As Double

T = matrix.Rows.Count
xT = T
M = matrix.Columns.Count
ReDim C (1 To M, 1 To M)
ReDim SS (1 To M, 1 To M)
ReDim S (1 To M)
For i = 1 To M Step 1
   S(i) = 0#
   For j = 1 To M Step 1
   SS(i, j) = 0#
   Next j
Next i
For d = 1 To T Step 1
   For i = 1 To M Step 1
   S(i) = S(i) + matrix.Cells(d, i)
   For j = i To M Step 1
   SS(i, j) = SS(i, j) + matrix.Cells(d, i) * matrix.Cells(d, j) Next j
   Next i
Next d
For i = 1 To M Step 1
   For j = i To M Step 1
   'C(i, j) = SS(i, j) / (xT- 1)- (S(i) * S(j)) / (xT * (xT- 1))
    C(i, j) = SS(i, j) / (xT- 1)- (S(i) * S(j)) / (xT * (xT- 1))
    C(j, i) = C(i, j)
Next
Next
xCovariance = C()
End Function
```

### VBA Code III: Optimal Weight

```
Function x Weight (matrix, mVec, mBar) As Variant
Dim M As Integer
Dim N As Integer
Dim i As Integer
Dim j As Integer
Dim xM() As Double
Dim xU() As Double
Dim xW() As Double
Dim xA As Double
Dim xB As Double
Dim xC As Double
Dim xD As Double
Dim xZ As Double
Dim errstr As String
'On Error GoTo ErrorX:
M = matrix.Columns.Count
```

* The author would like to express his sincerely thank to Prof. Jirapol Pobukadee for VBA codes instruction, MIF10.

```
N = mVec.Rows.Count
ReDim x M (1 To M, 1 To 1)
ReDim x U (1 To M, 1 To 1)
ReDim x W (1 To M, 1 To 1)

For i = 1 To M Step 1 x M (i, 1) = 0#
   X U (i, 1) = 0#
   xA = 0#
   xB = 0#
   xC = 0#
   xD = 0#
‘  errstr = “1”
   For j = 1 To N Step 1
   xM(i, 1) = xM(i, 1) + matrix.Cells(i, j) * mVec.Cells(j)
   xU(i, 1) = xU(i, 1) + matrix.Cells(i, j)
   ‘  errstr = “2” Next j
   ‘  errstr = “3”
Next i
For i = 1 To M Step 1
   ‘xZ = xM(i, 1)
   ‘MsgBox “xZ=U(i)= “ and x Z
   xA = xA + xU(i, 1)
   xB = xB + xM(i, 1)
   xC = xC + xM(i, 1) * mVec.Cells(i) Next i
xD = (xA * xC)- (xB * xB)
‘MsgBox “A= “ and xA and “ B=” and xB and “ C= “ and
xC and “ D=” and xD
‘errstr = “4”
For i = 1 To M Step 1
   xW(i, 1) = ((xA * mBar- xB) * xM(i, 1) + (xC- xB *
              mBar) * xU(i, 1)) / xD
   ‘  errstr = “5”
Next i
xWeight = xW()
‘errstr = “6”

‘Exit Function
‘ErrorX:
‘  MsgBox errstr and “ > “ and Err.Description and “ :
“ and Err.Number
End Function
```