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Random Matrix Theory Approach to Indonesia Energy Portfolio Analysis

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Abstract. In a few years, Indonesia experienced difficulties in maintaining energy security, the problem is the decline in oil production from 1.6 million barrels per day to 861 thousand barrels per day in 2012. However, there is a difference condition in 2015 until the third week in 2016, world oil prices actually fell at the lowest price level since last 12 years. The decline in oil prices due to oversupply of oil by oil-producing countries of the world due to the instability of the world economy. Wave of layoffs in Indonesia is a response to the decline in oil prices, this led to the energy and mines portfolios Indonesia feared would not be more advantageous than the portfolio in other countries. In this research, portfolio analysis will be done on energy and mining in Indonesia by using stock price data of energy and mines in the period 26 November 2010 until April 1, 2016. It was found that the results have a wide effect of the market potential is high in the determination of the return on the portfolio energy and mines. Later, it was found that there are eight of the thirty stocks in the energy and mining portfolio of Indonesia which have a high probability of return relative to the average return of stocks in a portfolio of energy and mines.

1. Introduction

1.1. Background

According on local news, a lot of layoff happened on mining and energy employees both national and multinational companies. Domestically, PT Chevron Pacific Indonesia has sent a layoff letter of 1,200 employees plan to the Special Unit of Upstream Oil and Gas (SKK Migas). In the coal mining sector, more than 125 companies in East Kalimantan is not operating and causing thousands of people affected by layoffs. A wave of layoffs has potential to continue to happen given the price of energy commodities is still deteriorating. One of the companies is INPEX Indonesia, which decided to downsize personnel to 40% of the total personnel in Indonesia, downsizing personnel triggered mining companies and global oil and gas in the country to consider moving the portfolio from Indonesia. In other countries, the wave of layoffs hit the global enterprise. Heillong Longmay Mining, Schlumberger, Halliburton and Chevron each had to lay off 100,000 people, 34,000 people, 20,000 people, and 1,500 people.

Executive Director of the Indonesian Coal Mining Association (ICMA) stated, mining, oil and gas sector companies in global scale, began reviewing its business portfolio in Indonesia. If possible, they will focus on the mining sites in other countries which more profitable. Portfolio review has done

considering the condition of the mining, oil and gas industry are worrying. The company's portfolio review also performed to ensure the company remains efficient, under employment and declining investment confidence. What can be done is to improve efficiency, control the cost of production, and optimization.

Imelda Adhisaputra (Director of Corporate Affairs BHP Billiton) said that the global mining industry is in poor condition, especially the coal mine. Therefore, it is only natural that as an international business entity, BHP Billiton is considering reviewing and reviewing back the economic value of their projects worldwide.

From the point of view mentioned before, we know that Indonesia energy portfolio need to be reviewed, then every mining, oil, and gas company portfolio can be optimized. Through this paper, we will try to analyze Indonesia energy portfolio using random matrix theory and then calculate the mean and variance of the portfolio to create Efficient Frontier graph then we can analyze the optimum return value of the portfolio.

1.2. Random Matrix Theory

Random matrix theory (RMT) was developed by Wigner, Dyson, Mehta, and others in order to explain the statistics of energy levels of complex quantum systems. RMT methods to analyze the properties of Correlation matrices (C), showed that 98% of the eigenvalues of C agree with RMT predictions, suggesting a considerable degree of randomness in the measured cross correlations. It is also found that there are deviations from RMT predictions for 2% of the largest eigenvalues. We find that the largest eigenvalue of C represents the influence of the entire market that is common to all stocks. Our analysis of the contents of the remaining eigenvalues that deviate from RMT shows the existence of cross correlations between stocks of the same type of industry, stocks having large market capitalization, and stocks of firms having business in certain geographical areas [1-3]. As stated above, our aim is to extract information about cross correlations from C. So, we compare the properties of C with those of a random cross-correlation matrix [4]. In matrix notation, the correlation matrix can be expressed as

$$C = \frac{1}{L} GG^T \tag{1}$$

where G is an $N \times L$ matrix with elements $\{g_{im} \equiv g_i(m\Delta t); i = 1, \cdots, N; m = 0, \cdots, L-1\}$ and G^T denotes the transpose of G. Therefore, we consider a random correlation matrix

$$R = \frac{1}{L} AA^T \tag{2}$$

where A is an $N \times L$ matrix containing N time series of L random elements $a_{im}$with zero mean and unit variance, that are mutually uncorrelated. Statistical properties of random matrices such as R are known [5,6]. Particularly, in the limit $N \to \infty, L \to \infty$ such that $Q = \frac{L}{N}\ (> 1)$ is fixed, it was shown analytically [6] that the probability density function of eigenvalues of the random correlation matrix R is given by

$$P_{rm}(\lambda) = \frac{Q}{2\pi} \frac{\sqrt{(\lambda_+ - \lambda)(\lambda - \lambda_-)}}{\lambda} \tag{3}$$

for λ within the bounds $\lambda_- < \lambda_i < \lambda_+$, where λ_- and λ_+ are the minimum and maximum eigenvalues of R, respectively given by

$$\lambda_{\pm} = 1 + \frac{1}{Q} \pm 2\sqrt{\frac{1}{Q}} \tag{4}$$

2. Methods

We constructed an Indonesia energy portfolio consists of 32 companies in energy, mining, oil, and gas sectors. We analyzed in the period of 11-26-2010 until 01-04-2016 (approximately 1378 rows of prices data from each companies). Then analyzed the probability density function (PDF) of the eigenvalues. From the result of analyzing the PDF, then we used the filtered eigenvalues to compare correlation before and after the RMT processed. After we've done the analysis of the correlation, we analyzed the eigenvector which represent each companies expected return, then we analyzed the efficient frontier of our energy portfolio. From the graphic of efficient frontier, we'll know the optimum expected return and risk value of our energy portfolio.

3. Results

As we can see at figure 1 that the contents of our C matrix mostly agree with the PDF from the random matrix and that only a few (largest) eigenvalues that deviate from the random PDF, these eigenvalues will be used to generate eigenvectors. From PDF analysis we've got $\lambda_+ = 2$ and $\lambda_- = 0.7224$.

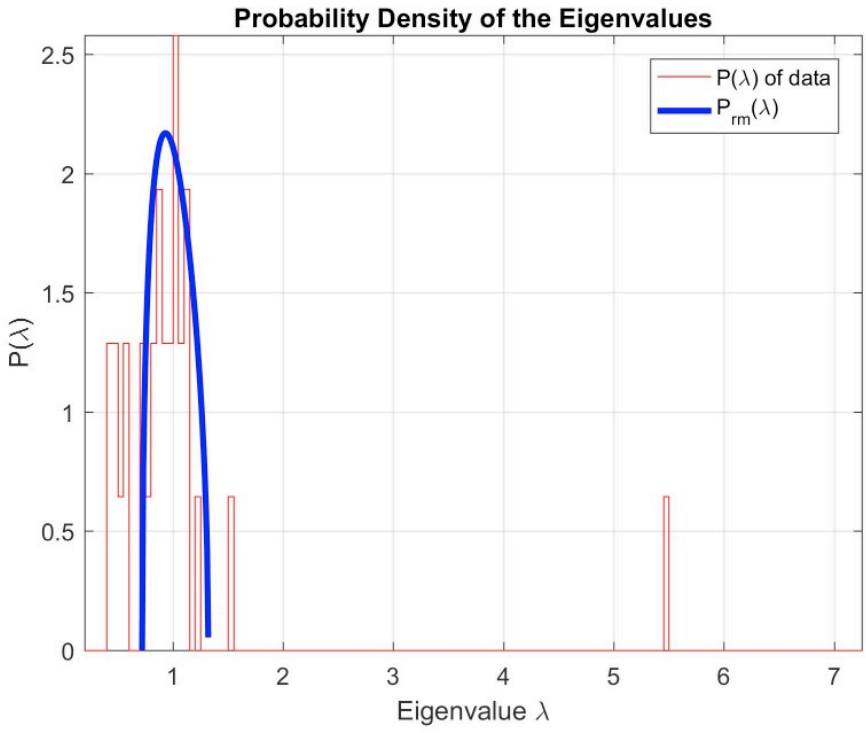

Figure 1. Probability Density Function (PDF)

Figure 2 and figure 3 shows the correlation between stocks at our energy portfolio before and after the RMT filtering. We've got that after the RMT filtering, the correlation between stocks are weaker than before we did the RMT filtering.

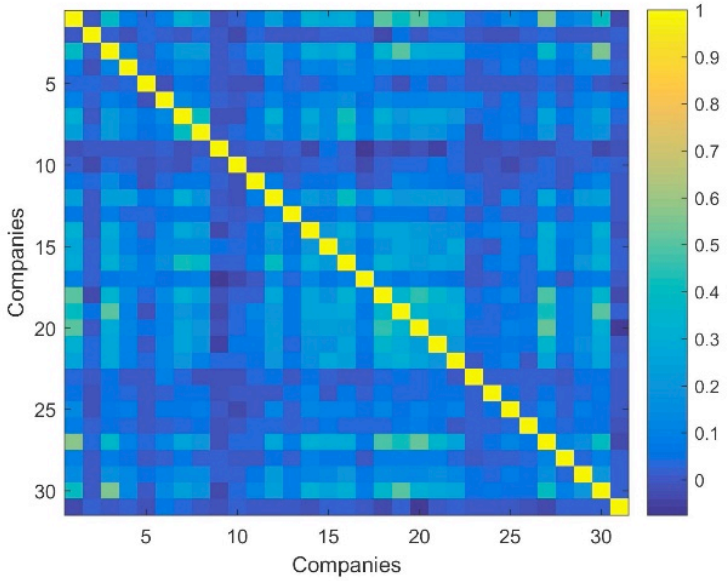

Figure 2. Correlation before RMT processed

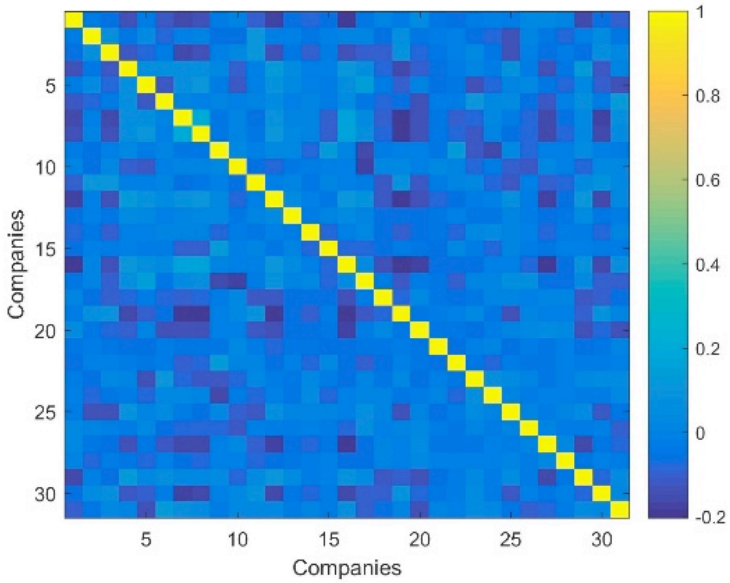

Figure 3. Correlation after RMT processed

After the RMT processed, we did a decomposition on our filtered C matrix, from the decomposition, we know that the market wide effect had a big enough potential to affect the return value of our portfolio (see figure 4).

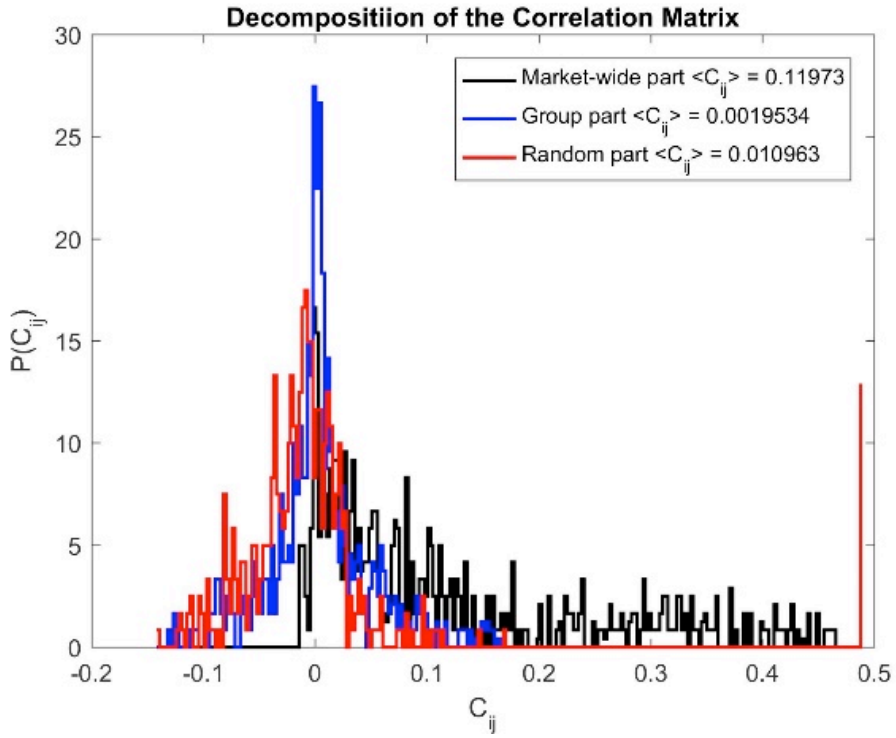

Figure 4. Decomposition of the correlation matrix

Below (figure 5) is the efficient frontier graphic, which show us about the return and risk value of our portfolio, this graph could help us to decide the risk we would take if we build the portfolio.

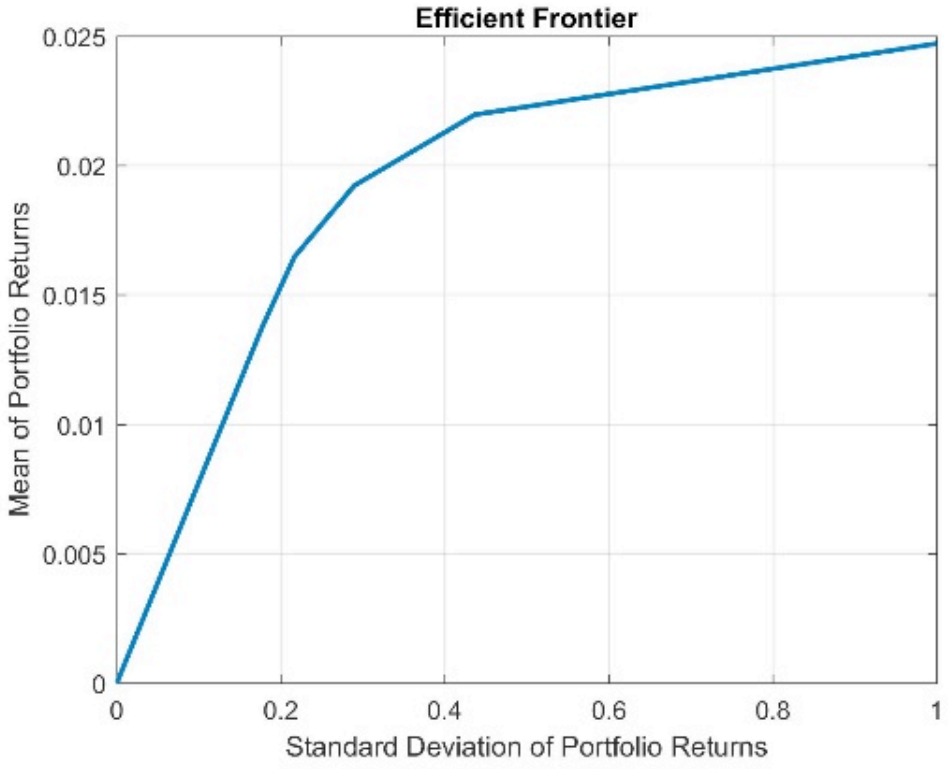

Figure 5 Efficient frontier graphic

4. Conclusions

According to our results, we can conclude that:

1. There are 8 out of 31 oil and mine stocks company that have higher return relative to the average of another stocks on the portfolio energy of Indonesia,
2. Portfolio energy of Indonesia have an optimum return approximately at 2.1 percent,
3. Portfolio energy of Indonesia will be more stable if there are just a few of another country intervention on Indonesia energy portfolio cause the 8 companies that have higher return value, the major owner of them are Indonesia.

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