CROSS-ASSET PORTFOLIO MODELING: A COMPARATIVE STUDY OF SYMMETRICAL AND ASYMMETRIC DYNAMIC METHODS

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Abstract

This study aims to develop a dynamic portfolio model based on asset class, precious metals, world oil, and dollar index. This study performs a comparative test between the Dynamics Conditional Correlation (DCC) and Asymmetric Dynamics Conditional Correlation (ADCC) to determine the best method in forming a dynamic portfolio. Four big cap companies on the Indonesian stock market (BBCA, BBRI, BMRI, and ASII) are examined in this study. The data used were daily returns for the period of January 2, 1998 – December 31, 2020, analyzed using Dynamics Conditional Correlation (DCC) and Asymmetric Dynamics Conditional Correlation (ADCC). The results of empirical testing suggest that including gold, world oil, and dollar index into the dynamic portfolio might increase the portfolio performance and minimize its risks. The stock-gold portfolios formed by utilizing the DCC and ADCC-GARCH methods outperform those composed of only stock. Gold could act as a financial system stabilizer by mitigating losses in the case of extreme negative market shocks. Stock-WTI portfolios formed by utilizing the DCC and ADCC-GARCH methods also outperform those composed of only stock.

Keywords: Portfolio; Precious Metals; Dollar Index; World Oil; Asset Class

JEL Classifications: G11; G15

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INTRODUCTION

Modern Portfolio Theory was originally introduced by Markowitz (1952). The theory assumes that stock return data is normally distributed (constant or static approach). The theory assumes that stock return data is normally distributed (constant or static approach). In this theory, and method employed with that, correlation become important measurement and input to form a portfolio. But this portfolio formulation still used constant correlation

instead of dynamic correlation, while market changing overtime.

Canedo and Cruz (2013); Chion, Veliz, and Carlos (2008); Ogata (2012); Robiyanto, Huruta, Frensidy, and Yuliana (2023); Yuliana and Robiyanto (2022) discovered the opposite. Also, portfolios should use a dynamic approach, because stock market conditions change fast from time to time. Chion et al. (2008); Robiyanto, Ernayani, and Ismail (2019); Robiyanto, Wahyudi, and Pangestuti (2017b) argued that forming a dynamic portfolio is a method for dealing with the data that cannot be normally distributed. The dynamic portfolios are also conisdered to have better performance. Therefore, Cappiello, Engle, and Sheppard (2006); Robiyanto, Nugroho, Huruta, Frensidy, and Suyanto (2021) claimed that different cross-asset instruments with negative or low correlation values could be used in forming a dynamic portfolio.

Several previous studies in Indonesia have employed the dynamic method, such as a study by Robiyanto, Ernayani, et al. (2019); Robiyanto et al. (2023) which formed a dynamic portfolio by combining stocks and fixed income instruments. Further, Putra, Robiyanto, and Andreas (2022); Susilo, Wahyudi, Pangestuti, Nugroho, and Robiyanto (2020) developed a dynamic portfolio by integrating crypto-currency asset instruments with stocks on the Indonesian even ASEAN stock markets. Many Indonesian researches also focus on the dynamic symmetrical method or Dynamics Conditional Correlation (DCC-GARCH). According to Cappiello et al. (2006), the ADCC-GARCH is more likely to have a leverage effect than the DCC-GARCH. Also DCC-GARCH has several limitations such as conditional correlation in DCC-GARCH does not take into account the dynamics of the asymmetric effect. Yuliana and Robiyanto (2022) stated that it is important to extend the DCC-GARCH analysis with the ADCC-GARCH analysis technique. Furthermore, they stated that it is better to measure the correlation with different asset classes by using the ADCC-GARCH. However, few research, particularly in Indonesia, have employed the ADCC-GARCH method to form the dynamic portfolios. So, the usage of ADCC-GARCH method in the Indonesian setting needs to be carried out.

Since the global financial crisis in 2008, precious metals – particularly gold – have been viewed as instruments capable of serving as a hedge for stock market investors (Akhtaruzzaman, Boubaker, Lucey, & Sensoy, 2021; Bahloul, Mroua, & Naifar, 2021; Baur & Lucey, 2010; Baur & McDermott, 2012; Ming, Zhang, Liu, & Yang, 2020; Robiyanto, Hadiyatno, Sudjinan, & Ernayani, 2019; Yuliana & Robiyanto, 2022). According to Ratner (2010) and Robiyanto et al. (2017b), integrating the gold in a stock portfolio can significantly improve the portfolio performance. McCauley and McGuire (2009) argued that the dollar index is also an asset that may serve as a safe haven or a hedge. International investors will often convert their portfolio sales into Dollars. Furthermore, Alqahtani, Lahiani, and Salem (2020); Robiyanto, Nugroho, Handriani, and Huruta (2020); Xu, Ma, Chen, and Zhang (2019); Iglesias and Rivera-Alonso (2022) found that the world oil might be utilized as a hedge for investing in developing-country stock markets. Besides, Chancharat and Sinlapates (2023) also found that the world oil could be used as an instrument for diversification and hedging on the stock market. For this reason, the purpose of this study is to develop a dynamic portfolio model based on the asset class, precious metals (gold), world oil (WTI), and the dollar index (DXY). This study also performs a comparative test between the Dynamics Conditional Correlation (DCC) and Asymmetric Dynamics Conditional Correlation (ADCC) to determine the best method in forming a dynamic portfolio.

LITERATURE REVIEW AND HYPOTESIS DEVELOPMENT

Stock-Gold Portfolio Formulation

Precious metals, including gold, have been seen as instruments capable of being a hedge for the stock market investors. Similar to the researches by Akhtaruzzaman et al. (2021); Baur and Lucey (2010); Yousaf, Hanif, Ali, and Moudud-Ul-Huq (2021); Yuliana and Robiyanto (2022) found that incorporating the gold in an investment portfolio might yield high returns and provide effective protection. Several previous studies – for example a study by Hoang, Lean, and Wong (2015); Robiyanto et al. (2017b) have also demonstrated that incorporating the gold in a stock portfolio may greatly increase its performance.

Many emerging markets have conducted researches on the dynamic portfolio formation using the stocks and gold. According to Mohamed El Hedi Arouri, Lahiani, and Nguyen (2015), the gold is a good diversification instrument in a portfolio and may be used as a hedge for the stocks. Robiyanto (2018a) discovered that there were two companies with a high Sharpe ratio and three stocks with a high Treynor ratio when paired with the gold to form a dynamic portfolio (a hedge portfolio). Raza, Ali, Shahzad, Rehman, and Salman (2019) mentioned that by using the ADCC-GARCH method, the gold can be an effective short and long-term hedge for real estate sector shares in the United States market. Besides, El Abed and Zardoub (2019) also found that the gold and financial markets exhibited asymmetry in conditional variances and a flexible modeling framework could be used to assess the connections between the two. The dynamic portfolio formation is projected to produce a risk-adjusted return from a hedged portfolio that outperforms the risk-adjusted return from an unhedged portfolio. Using both the DCC-GARCH and ADCC-GARCH methods to form a portfolio, hypotheses that can be proposed are as follow:

H1: Stock-gold portfolios outperform those composed of only stocks.

H_{1a}: Stock-gold portfolios formed using the DCC-GARCH method outperform those composed of only stocks.

H_{1b}: Stock-gold portfolios formed using the ADCC-GARCH method outperform those composed of only stocks.

Stock-WTI Portfolio Formulation

Hersugondo, Robiyanto, Wahyudi, and Muharam (2015) explained that commodity market is a highly developed market and its price fluctuations can impact the stock market fluctuation in the capital market. Investments made by the investors in various asset classes also create relationships between the commodity market and capital market (Morales, 2009). Lin, Wesseh, and Appiah (2014) argued that the most significant commodity in the global financial market is the world oil. When the world oil market and financial market are both experiencing extreme volatility, it is highly possible to form a portfolio that includes both markets. According to, the consumer goods and WTI had a negative correlation. Similarly, Hersugondo et al. (2015) confirmed that the JCI had a negative correlation with the WTI. The greater the rate of change in the WTI oil prices, the lower the JCI return, and vice versa. The risk-adjusted return from a hedged portfolio will outperform the one from the unhedged portfolio in the dynamic portfolio formation. Considering that this study builds a portfolio by utilizing the DCC-GARCH and ADCC-GARCH methods, hypotheses that can be proposed are as follow:

H2: Stock-WTI portfolios outperform those composed of only stocks.

H_2: Stock-WTI portfolios formed using the DCC-GARCH method outperform those composed of only stocks.

H_{2b}: Stock-WTI portfolios formed using the ADCC-GARCH method

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outperform those composed of only stocks.

Stock-DXY Portfolio Formulation

The US Dollar Index (DXY) is one of the most liquid instruments. Its liquidity stems from the over-the-counter forex market, which according to a survey by Bank International Settlements (BIS) had a turnover of more than 2.8 trillion in 2011. Agyei-Ampomah, Gounopoulos, and Mzaouz (2013) found that when the financial market was volatile, the investors sought for the safest asset (flight for safety). McCauley and McGuire (2009) later shown that during the global financial crisis, the US dollar was sought after by the investors as a safe haven as well as a hedge by non-institutional investors.

Furthermore, the investors and investment managers must use both passive and active methods to make decisions that affect portfolio composition when allocating portfolio assets. The active method seeks to improve the value of a portfolio over time, whereas the passive method seeks to decrease portfolio volatility (Robiyanto, 2017). The formation of dynamic portfolio is expected to provide a risk-adjusted return from the hedged portfolio that outperforms the risk-adjusted return from the unhedged portfolio. By implementing both the DCC-GARCH and ADCC-GARCH methods in forming the dynamic portfolio, hypotheses that can be proposed are as follow:

H3: Stock-DXY portfolios outperform those composed of only stocks.

H_{3a}: Stock-DXY portfolios formed using the DCC-GARCH method outperform those composed of only stocks.

H_{3b}: Stock-DXY portfolios formed using the ADCC-GARCH method outperform those composed of only stocks.

Portfolio Formulation using the ADCC-GARCH Method

The ADCC-GARCH analysis method examines present volatility and then differentiates the impacts of future positive and negative shocks that cause the investors to evaluate risks in order to protect the asset values (Jin, Han, Wu, & Zeng, 2020). A study by Cui and Feng (2020) confirmed that the ADCC-GARCH method is the best method for single hedges and time-varying conditional correlations, and it gives evidence of continuous changes in the correlations throughout periods. This method allows asymmetrical effects in conditional variances and conditional correations that increase over time, as well as limited diversification under volatile situations. Raza et al. (2019) showed that alternative gold assets can provide diversification and a higher rate of return than the DCC-GARCH method. Based on previous theoretical and empirical studies, this study compares the performance of portfolios constructed using the ADCC-GARCH and DCC-GARCH methods. Therefore, the hypothesis that can be proposed is as follows:

H4: Portfolios formed using the ADCC-GARCH method outperform those formed using the DCC-GARCH method.

METHOD

Research Sample

This study used a data of daily closing prices for stocks listed on the Indonesia Stock Exchange (IDX) and prices for precious metals, world oil, and the DXY on the international market during the period of January 2, 1998 – December 31, 2020. The sample was collected using a judgement sampling method. There were several sample criteria, including 1) the companies must be one of the five companies with the highest market capitalization on the IDX; and 2) the companies never engage in corporate acts that alter the nominal value of shares, such as stock splits and reverse stock splits. Based on these criteria, there were 4 big companies included in this study (see Table 1).

Table 1. Research Sample

Issuer	Market Capitalization Value	Stock Split and Reverse Stock Split	Date of IPO	Conclusion
BBCA	IDR 761.84 trillion	NO	May 11, 2000	Acceptable
BBRI	IDR 485.98 trillion	NO	November 10, 2003	Acceptable
TLKM	IDR 412.10 trillion	YES	November 14, 1995	Not Acceptable
BMRI	IDR 304.50 trillion	NO	July 14, 2003	Acceptable
ASII	IDR 259.09 trillion	NO	April 4, 1990	Acceptable

Source: IDX, processed.

Return of Cross-Aset Instruments

This study employed the cross-asset portfolio modeling. The cross-asset instrument return, consisting of stocks, precious metals (gold), WTI, and the DXY, can be calculated using the following formula:

$$R_t = \frac{I_t - I_{t-1}}{I_{t-1}} \quad (1)$$

Notes:
R_t : Instrument return on day t
I_t : Instrument price on day t
I_{t-1} : Instrument price on day t-1

The DCC-GARCH Method

The DCC model introduced by Engle (2002) is as follows:

$r_t | = {}_{t-1} \sim N(0, D_t R_t D_t)$ (2)
$D_t^2 = \text{diag}\ \{\omega_i\} + diag\ \{\omega_i\}^0\ r_{t-1}\ r'_{t-1} + \text{diag}\ \{\lambda_i\} \circ D_{t-1}^2$,
$\varepsilon_t = D_t^{-1} r_t$,
$Q_t = S^o (\iota\, \iota' - A - B) + A^o\ \varepsilon'_{t-1} + B^o Q_{t-1}$,
$R_t = \text{diag}\ \{Q_i\}^{-1} Q_t\, \text{diag}\ \{Q_i\}^{-1}$.

The estimator logarithm or log likelihood is as follows:

$$Lr_t = {}_{t-1} \sim N(0, H_t) \quad (3)$$

$$L = -\frac{1}{2}\sum_{t=1}^{T} (n\, log(2\pi) + log|H_t| + r_t' H_t^{-1} r_t)$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n\, log(2\pi) + log\,|D_t R_t D_t| + r_t' D_t^{-1} R_t^{-1} D_t^{-1} r_t)$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n\, log(2\pi) + 2log\,|D_t| + Log|R_t| + \mathcal{E}_t' R_t^{-1} \varepsilon_t)$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n\, log(2\pi) + 2log\,|D_t| + r_t' D_t^{-1} R_t^{-1} D_t^{-1} r_t - \mathcal{E}_t' R_t^{-1} \varepsilon_t + log|R_t| + \mathcal{E}_t' R_t^{-1} \varepsilon_t)$$

The tern volatility is as follows:

$$Lv(\emptyset) = \frac{1}{2}\sum_t (n\, log(2\pi) + log\,|D_t|^2 + r_t' D \quad (4)$$

The correlation component is as follows:

$$Lc(\emptyset) = \frac{1}{2}\sum_t (log|R_t| + \mathcal{E}_t' R_t^{-1} \varepsilon_t - \varepsilon_t' \varepsilon_t) \quad (5)$$

Partial volatility is the sum of the individual likelihoods, which is as follows:

$$Lc\ (\theta, \emptyset) = -\frac{1}{2}\sum_t \sum_{i=1}^{n} (log(2\pi) + log(h_{i,t}) + \frac{r_{i,t}^2}{h_{i,t}}) \quad (6)$$

These equations could be combined and maximized by optimizing each term. Both of the likelihoods were performed to estimate the correlation parameters. Considering that the squared residuals were unrelated to the parameters, they could not participate in the first oder condition and must be ignored. The resulting estimator was then called DCC LL INT, since it used an integrated model. A two-stage approach to maximize the likelihoods was employed to produce:

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$$L\hat{\theta} = arg\,max\ (L_v(\theta)) \quad (7)$$

Then, the value was integrated into the second stage as follows:

$$\max_{\emptyset} \{L_c(\hat{\theta}, \emptyset)\} \quad (8)$$

The ADCC-GARCH Method

Cappiello et al. (2006) formulated the ADCC-GARCH method into the following equation:

$$Q_t = (S^o - A'^{Q}A - B'^{Q}B - G'NG) + A'^{zt-1z}{}_{t-1} \quad A+B'^{Qt-1}B + G'n_{t-1}n'_{t-1}G \quad (9)$$

Whereas A, B and G refer to the diagonal parameter, and nt = I [zt <0] ozt (o is an indicator variable).

The Eviews software was used to calculate the DCC-GARCH and ADCC-GARCH. The hedging effectiveness (HE) was calculated using the following formula developed by Ku et al. (2007):

$$\text{HE} = \frac{Variance_{unhedged} \quad - Varian}{Variance_{unhedged}} \quad (10)$$

The optimal hedge ratio used the following formula:

$$\beta_t^{is} = \frac{h_t^{si}}{h_t^{i}} \quad (11)$$

Notes:
β_t^{is} is an optimal hedge ratio
h_t^{si} and h_t^{i} is the conditional volatility of hedged asset return conditinal covariance between the hedged asset return and stock market return in period t.

RESULTS AND DISCUSSIONS

Descriptive Statistics of Research Variables

The minimum value of BBCA shares is -7.89, suggesting that the highest floating loss for BBCA stock was -7.89% on December 4, 2012. On March 26, 2020, the maximum value or largest day return was 20.49. The BBCA's average daily return is 0.160, with a standard deviation value that is less than the average of 0.028. Considering that the standard deviation value is less than the average, the BBCA stock return data is considered homogenous or has minimal volatility (see Table 2).

The minimum value of BBRI shares is -13.11. On September 22, 2011, it experienced the greatest day loss of -13.11%. On May 26, 2020, its maximum value (highest return) was 20.49. Its daily return is 0.162% on average, with a standard deviation value of 0.028. The standard deviation value of less than the average indicated that the BBRI stock was less volatile. Furthermore, the minimum value of BMRI stock is -12.99. Its worst daily loss was -12.99% on March 9, 2020. On May 26, 2020, its maximum value (highest return) was 15.80. It has an average daily return of 0.168 and a standard deviation value of 0.037 (less than the average), indicating that the BMRI shares was less volatile. In addition, ASII shares has a -11.45 minimum value. Its worst daily loss was -11.45% on March 9, 2020. On May 27, 2020, its maximum value (highest return) was 12.71. It has an average daily return of 0.07 and a standard deviation value of 0.034 – which is less than the average, indicating that the ASII shares was less volatile. In addition, the minimal value of the gold asset is -9.340. On April 15, 2013, it experienced a 9.340% floating loss. On September 28, 1999, it had the highest daily return of 9.23%. Its average daily return is 0.039, while the standard deviation value is 1.114. Considering that its standard deviation value is bigger than the average value, its data variance was relatively substantial, or, in other words, the gold was extremely volatile. Meanwhile, the minimum value or maximum floating loss for the world oil (WTI) was -33.281% on April 21, 2020, while the highest return was 49.711% on September 17, 2020. From January 2, 1998 to December 30, 2020, its average daily

return was 0.06% with a standard deviation value of 2.60. The results show that its standard deviation value is higher than the mean value, indicating that the data distribution was widely diverse and confirming that the WTI was highly volatile.

Portfolios Formed using the DCC-GARCH Method

Table 3 shows the results of forming individual stock dynamic portfolios with gold, WTI, and DXY using the DCC-GARCH method.

The stock-gold dynamic portfolios using the DCC-GARCH method have a minimum value in the range of -0.501 to 0.289, while the maximum value is between 0.001 and 0.987. The BBCA-Gold portfolio has the lowest average return of 0.128, while the BBRI-Gold portfolio has the best average return of 0.153. Further, the minimal value range for the stock-WTI dynamic portfolios is in the range of -0.937 to -0.036. The maximum value or return range is 0.234 to 0.532. The BBRI-WTI portfolio has the lowest average return, with a value of 0.146. Meanwhile, with a value of 0.002, the average portfolio that delivers the best return is the BMRI-WTI combination. The stock-DXY dynamic portfolio has a minimum value range of -0.937 to -0.036. The maximum value or return range is 0.107 to 0.987. The BBRI-DXY portfolio has the lowest average return, with a value of 0.128. Meanwhile, with a value of 0.032, the average stock-DXY portfolio that delivers the best return is the BMRI-DXY combination.

Table 2. Descriptive Statistics

Type of Asset	Asset	N	Minimum %	Maximum %	Mean %	Standard Deviation
Shares	BBCA	5.042	-7.891	20.490	0.160	0.028
Shares	BBRI	4.188	-13.11	20.491	0.162	0.028
Shares	BMRI	4.276	-12.992	15.801	0.168	0.037
Shares	ASII	6.209	-11.453	12.710	0.071	0.034
Commodity	Gold	6.209	-9.340	9.230	0.039	1.114
Commodity	World Oil	6.209	-33.281	49.711	0.061	2.601
Currency Index	Dollar Index	6.209	-3.020	2.580	0.0005	0.005

Source: IDX and Bloomberg, processed.

Table 3. Results of DCC-GARCH Portfolios

Portfolio			DCC-GARCH		
			Minimum	Maximum	Mean
BBCA	-	Gold	-0.417	0.081	0.128
BBRI	-	Gold	-0.501	0.532	0.153
BMRI	-	Gold	-0.298	0.001	0.113
ASII	-	Gold	0.289	0.987	0.068
BBCA	-	WTI	-0.881	0.234	0.130
BBRI	-	WTI	-0.036	0.532	0.146
BMRI	-	WTI	-0.937	0.491	0.012
ASII	-	WTI	-0.958	0.048	0.016
BBCA	-	DXY	-0.571	0.987	0.068
BBRI	-	DXY	-0.500	0.107	0.128
BMRI	-	DXY	-0.298	0.724	0.032
ASII	-	DXY	-0.257	0.523	0.028

Source: IDX and Bloomberg, processed.

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Portfolios Formed using the ADCC-GARCH Method

Table 4 shows the results of forming individual stock dynamic portfolios with gold, WTI, and DXY using the ADCC-GARCH method.

The stock-gold dynamic portfolios using the ADCC-GARCH method have a minimum value range of -0.005 to -0.207, while the maximum value is between 0.241 and 0.532. The BBRI-Gold portfolio has the lowest average return of 0.018, while the ASII-Gold portfolio has the best average return of 0.083. Meanwhile, the stock-WTI dynamic portfolios has a minimum value range of -0.005 to -0.207, while the maximum value is between 0.241 and 0.532. The BBRI-Gold portfolio has the lowest average return of 0.018, while the ASII-Gold portfolio has the best average return of 0.083. In addition, the stock-DXY dynamic portfolios have a minimum value range of -0.005 to -0.207, and the maximum value is between 0.241 and 0.532. The BBRI-Gold portfolio has the lowest average return of 0.018, while the ASII-Gold portfolio has the highest average return of 0.083.

Summary of Optimal Hedge Ratio and Stock-Gold Hedging Effectiveness

The results of optimal hedge ratio and hedging effectiveness for individual stocks with gold during the observation period can be seen in the following Table 5.

In the BBRI-Gold portfolio, the optimal hedge value is -32.161. This indicated that the BBRI stock purchases must be accompanied with gold purchases. In contrast, every IDR 1 in the BBCA stock must be linked with the purchase of IDR 0.321 in the gold. Meanwhile, in the BMRI-Gold portfolio, the optimal hedging ratio value is -12.112. As a result, investors who purchased the BMRI stock must also purchase the gold in order to secure their portfolios. When an investor purchased IDR 1 of the ASII stock, he/she must purchase the gold for IDR 0.121. In addition, the BBRI-Gold portfolio has the lowest optimum hedge value of -21.241 when calculated using the ADCC-GARCH approach. While the highest optimal hedging value achieved from the ASII-Gold portfolio is -12.349. This implied that investors who possessed the BBRI and ASII stock should pair them with gold. In contrast, every IDR 1 of the BBRI stock must be paired with a IDR 0.212 gold transaction. Meanwhile, each IDR 1 of the ASII stock must be purchased in conjunction with IDR 0.123 of gold.

On the other hand, the BBCA-Gold portfolio has the lowest value of hedging effectiveness between the stock and gold using the DCC-GARCH approach, which is 72.256. Adding the gold to the portfolio could lower risk by 72.256%. Meanwhile, the BBRI-Gold portfolio has the greatest hedging effectiveness value of 81.236. Adding gold to the portfolio could reduce risk by 81.23%. The results of calculations utilizing the ADCC-GARCH method suggest that the BMRI-Gold has the lowest hedging effectiveness value of 74.387. As a result, adding the gold to the portfolio could reduce the risks by 74.38%. Meanwhile, the BBCA-Gold portfolio has the greatest hedging effectiveness value of 75.721, implying that adding the gold to the portfolio would reduce risk by 75.72%.

Summary of Optimal Hedge Ratio and Stock-WTI Hedging Effectiveness

The results of optimal hedge ratio and hedging effectiveness for individual stocks with the WTI during the observation period can be seen in the following Table 6.

The DCC-GARCH method yields the lowest optimal hedge value of -12.011 for the BBRI-WTI portfolio. Adding the WTI to the portfolio would increase its performance. Each IDR 1 of the BBRI stock must be mixed with IDR 0.120 of the WTI. Meanwhile, the ASII-WTI portfolio earns the highest optimal hedge value using the DCC-GARCH method of -2.721. The investors must purchase the WTI to

hedge their portfolios, but when IDR 1 of the ASII stock increased, they must purchase IDR 0.027 of the WTI. The optimal hedge value calculated using the ADCC-GARCH approach yields the lowest value of -13.721 for the BBRI-WTI portfolio and the maximum optimal hedge of 7.832 for the ASII-WTI portfolio. As a result, investors who purchased the BBRI stock must additionally purchase the WTI worth IDR 0.137 for every IDR 1 of the BBRI stock purchased. For each IDR 1 of the BMRI stock, the investors must purchase the WTI worth IDR 0.098.

Table 4. Results of ADCC-GARCH Portfolios

Portfolio			ADCC-GARCH		
			Minimum	Maximum	Mean
BBCA	-	Gold	-0.097	0.435	0.029
BBRI	-	Gold	-0.031	0.241	0.030
BMRI	-	Gold	-0.207	0.811	0.018
ASII	-	Gold	-0.005	0.532	0.083
BBCA	-	WTI	-0.126	0.491	0.014
BBRI	-	WTI	-0.175	0.342	0.226
BMRI	-	WTI	-0.189	0.744	0.172
ASII	-	WTI	-0.207	0.532	0.168
BBCA	-	DXY	-0.135	0.249	0.074
BBRI	-	DXY	-0.118	0.342	0.120
BMRI	-	DXY	-0.082	0.430	0.991
ASII	-	DXY	-0.130	0.248	0.112

Source: IDX and Bloomberg, processed

Table 5. Summary of Optimal Hedge Ratio and Stock-Gold Hedging Effectiveness

Portfolio			DCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	Gold	-13.464	72.256	0.128	0.015
BBRI	-	Gold	-32.161	81.236	0.153	0.017
BMRI	-	Gold	-12.112	73.475	0.113	0.009
ASII	-	Gold	-13.080	74.392	0.068	0.028
Portfolio			ADCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	Gold	-18.264	75.721	0.029	0.005
BBRI	-	Gold	-21.241	77.374	0.030	0.008
BMRI	-	Gold	-13.283	74.387	0.018	0.009
ASII	-	Gold	-12.349	74.721	0.083	0.008

Source: IDX and Bloomberg, processed.

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Meanwhile, the BBCA-WTI portfolio has the lowest hedging effectiveness utilizing the DCC-GARCH method of 69.501, while the BBRI-WTI portfolio has the best hedging effectiveness of 84.812. Adding the WTI to a BBCA-based portfolio would reduce risks by 69.5% and 84.8% in a BBRI-based portfolio. The lowest hedging effectiveness value utilizing the ADCC-GARCH method is 70.262. Adding the WTI to a portfolio of BMRI stock could lower the risks by 70.2%. In addition, the highest value of ADCC-GARCH hedging effectiveness is 74.961. This indicated that eliminating the ASII stock from the portfolio could lower the risks by 74.9%.

Summary of Optimal Hedge Ratio and Stock-DXY Hedging Effectiveness

The following Table 7 presents the results of optimal hedge ratio and hedging effectiveness for individual stocks with the DXY during the observation period.

The maximum optimal hedge value generated from the BBRI-DXY portfolio using the DCC-GARCH method is -9.211. Adding the DXY to the portfolio would increase its performance. Every IDR 1 of the BBRI stock must be multiplied by IDR 0.092 of the DXY. The lowest optimal hedge value achieved by the ASII-DXY portfolio using the DCC-GARCH method is -12.721. Adding the DXY to the portfolio would boost its performance. Every IDR 1 of the ASII stock must be multiplied by IDR 0.127 of the DXY. The optimal hedge value calculated using the ADCC-GARCH method results in the lowest value of -11.231 for the BMRI-DXY portfolio and the maximum optimal hedge of -8.931 for the BBRI-DXY portfolio. Therefore, investors who purchased the BBRI stock must also purchase the DXY worth IDR 0.089 for every IDR 1 of the BBRI share purchased. Meanwhile, the BBCA-DXY portfolio has the lowest hedging effectiveness utilizing the DCC-GARCH approach of 72.256, while the BBRI-DXY had the highest hedging effectiveness value of 81.234. Adding the DXY to a portfolio that included the BBCA would reduce the risks by 72.2% and 81.2% in a portfolio that included the BBRI stock. The lowest hedging effectiveness value utilizing the ADCC-GARCH method is 70.721. Adding the DXY to a portfolio of BBCA stock could lower the risks by 70.72%. The maximum hedging effectiveness value with the ADCC-GARCH method is 82.387. By including the DXY into the BMRI portfolio, it could reduce the risks by 82.3%.

Stock-Gold Portfolio Performance Assessment

The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios were used to evaluate the performance of stock-gold portfolios. The following Table 8 displays the results.

When the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios were used to calculate the performance of stock portfolios without the gold hedge, the average values are -0.052, -0.091, 0.0005, -0.001, and 0.858. Meanwhile, when they were calculated using the DCC-GARCH method, the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios have an average value of 0.0035, 0.008, 0.001, 0.009, and 0.456. The portfolios utilizing the ADCC-GARCH method have an average Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios of 0.0068, 0.0068, 0.0012, 0.0004, and 1.028. In conclusion, the stock-gold portfolios utilizing the DCC-GARCH and ADCC-GARCH method outperform those composed of only stock.

Table 6. Summary of Optimal Hedge Ratio and Stock-WTI Hedging Effectiveness

Portfolio			DCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	WTI	-7.322	69.501	0.130	0.006
BBRI	-	WTI	-12.011	84.812	0.146	0.006
BMRI	-	WTI	-5.770	71.212	0.012	0.005
ASII	-	WTI	-2.721	66.321	0.016	0.008
Portfolio			ADCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	WTI	-11.192	74.392	0.014	0.006
BBRI	-	WTI	-13.721	72.256	0.226	0.018
BMRI	-	WTI	-7.832	70.262	0.172	0.009
ASII	-	WTI	-9.831	74.961	0.168	0.015

Source: IDX and Bloomberg, processed.

Table 7. Summary of Optimal Hedge Ratio and Stock-DXY Hedging Effectiveness

Portfolio			DCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	DXY	-11.001	72.256	0.068	0.015
BBRI	-	DXY	-9.210	81.236	0.128	0.017
BMRI	-	DXY	-12.112	73.475	0.032	0.009
ASII	-	DXY	-12.720	74.392	0.028	0.028
Portfolio			ADCC-GARCH			
			Optimal Hedge	Hedging Effectiveness	Mean	Standard Deviation
BBCA			-	-	0.160	0.028
BBRI			-	-	0.162	0.028
BMRI			-	-	0.168	0.037
ASII			-	-	0.071	0.034
BBCA	-	DXY	-9.290	70.721	0.074	0.005
BBRI	-	DXY	-8.930	79.374	0.120	0.008
BMRI	-	DXY	-11.230	82.387	0.991	0.009
ASII	-	DXY	-7.321	71.721	0.112	0.008

Source: IDX and Bloomberg, processed.

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Stock-WTI Portfolio Performance Assessment

The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios were used to evaluate the performance of stock-WTI portfolios. Table 9 displays the results.

The calculation the stock portfolio performance without hedging using the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios shows an average value of -0.052, -0.091, 0.0005, -0.001, and 0.858. Meanwhile, when calculated using the DCC-GARCH method, the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios have an average value of 0.035, 0.008, 0.001, 0.009, and 0.456. The portfolios utilizing the ADCC-GARCH method have an average Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios of 0.068, 0.0068, 0.012, 0.004, and 1.028. In short, the stock-WTI portfolios utilizing the DCC-GARCH and ADCC-GARCH methods outperform those composed of only stock.

Table 8. Stock-Gold Portfolio Performance

Portfolio			DCC-GARCH				
			Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA			-0.038	-0.069	0.0009	-0.0001	0.886
BBRI			-0.046	-0.085	0.0009	-0.0001	0.873
BMRI			-0.061	-0.100	0.0004	-0.0001	0.843
ASII			-0.066	-0.107	0.0000	-0.0002	0.833
BBCA	-	Gold	0.034	0.066	0.0005	0.0027	0.302
BBRI	-	Gold	0.004	0.008	0.0005	0.0006	0.192
BMRI	-	Gold	-0.010	-0.018	0.0007	0.0012	0.972
ASII	-	Gold	-0.014	-0.023	0.0004	0.0005	0.963
Portfolio			ADCC-GARCH				
			Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA			-0.038	-0.069	0.0009	-0.0001	0.886
BBRI			-0.046	-0.085	0.0009	-0.0001	0.873
BMRI			-0.061	-0.100	0.0004	-0.0001	0.843
ASII			-0.066	-0.107	0.0000	-0.0002	0.833
BBCA	-	Gold	0.029	0.057	0.0007	0.0004	1.093
BBRI	-	Gold	0.017	0.003	0.009	0.0013	1.049
BMRI	-	Gold	-0.009	-0.016	0.0012	0.0010	0.973
ASII	-	Gold	-0.010	-0.017	0.0008	0.0008	0.972

Source: Processed secondary data (2022)

Table 9. Stock-WTI Portfolio Performance

Portfolio			DCC-GARCH				
			Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA			-0.038	-0.069	0.0009	-0.0001	0.886
BBRI			-0.046	-0.085	0.0009	-0.0001	0.873
BMRI			-0.061	-0.100	0.0004	-0.0001	0.843
ASII			-0.066	-0.107	0.0000	-0.0002	0.833
BBCA	-	WTI	0.034	0.066	0.0008	0.0012	-0.302
BBRI	-	WTI	0.004	0.008	0.0009	0.0002	0.192
BMRI	-	WTI	-0.010	-0.018	0.0009	0.0002	0.972
ASII	-	WTI	-0.014	-0.023	0.0001	0.0005	0.963

Table 9. Continue

Portfolio	ADCC-GARCH				
	Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA	-0.038	-0.069	0.0009	-0.0001	0.886
BBRI	-0.046	-0.085	0.0009	-0.0001	0.873
BMRI	-0.061	-0.100	0.0004	-0.0001	0.843
ASII	-0.066	-0.107	0.0000	-0.0002	0.833
BBCA - WTI	0.029	0.057	0.0013	0.0011	1.093
BBRI - WTI	0.017	0.003	0.0010	0.0004	1.049
BMRI - WTI	-0.009	- 0.016	0.0008	-0.0003	0.973
ASII - WTI	-0.010	- 0.017	0.0008	-0.0003	0.972

Source: IDX and Bloomberg, processed.

Stock-DXY Portfolio Performance Assessment

The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios were used to evaluate the performance of stock-DXY portfolios. The results could be seen in the following Table 10.

The calculation of the performance of the stock portfolios without hedging when measured using the Sharpe, Sortino, Jensen Alpha, Treynor and Omega ratios has an average value of -0.042, -0.071, -0.035, -0.001, and 0.830. When using the DCC-GARCH method, the Sharpe, Sortino, Jensen Alpha, Treynor and Omega ratios have an average value of 0.046, 0.023, 0.004, 0.002 and 0.982. The portfolios formed using the ADCC-GARCH method when measured by the Sharpe, Sortino, Jensen Alpha, Treynor and Omega ratios have an average value of 0.0642, 0.041, 0.003, 0.002 and 1.108. Therefore, the stock-DXY portfolios formed using the DCC-GARCH and ADCC-GARCH methods outperform those composed of only stock.

Comparison of Unhedged Dynamic Portfolio – Using Gold as the Hedge

The portfolios were constructed using two models: ADCC-GARCH and ADCC-GARCH. The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios were used to assess the performance of unhedged and gold-hedged portfolios. The independent sample t-test was performed with a significance level of 5% to determine the difference in the average portfolio return. The following Table 11 displays the test results

The results of the independent sample t-test of several tests comparing the portfolios without and with gold hedging reveal that the average returns of the DCC-GARCH and ADCC-GARCH method differ. This is evidenced by the significance value of each test < Alpha of 0.05. This suggested that having gold in a portfolio could improve the portfolio performance when compared to those composed of only stock..

Table 10. Stock-DXY Portfolio Performance

Portfolio	DCC-GARCH				
	Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA	-0.038	-0.069	0.0009	-0.0001	0.886
BBRI	-0.046	-0.085	0.0009	-0.0001	0.873
BMRI	-0.061	-0.100	0.0004	-0.0001	0.843
ASII	-0.066	-0.107	0.0000	-0.0002	0.833
BBCA - DXY	0.079	0.057	0.006	0.001	1.093
BBRI - DXY	0.037	0.003	0.003	0.001	1.049
BMRI - DXY	0.029	0.016	0.001	0.003	0.883
ASII - DXY	0.040	0.017	0.009	0.003	0.901

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Table 10. Continue

Portfolio	ADCC-GARCH				
	Sharpe	Sortino	Jensen Alpha	Treynor	Omega
BBCA	-0.038	-0.069	0.0009	-0.0001	0.886
BBRI	-0.046	-0.085	0.0009	-0.0001	0.873
BMRI	-0.061	-0.100	0.0004	-0.0001	0.843
ASII	-0.066	-0.107	0.0000	-0.0002	0.833
BBCA - DXY	0.059	0.047	0.0015	0.0021	1.093
BBRI - DXY	0.067	0.013	0.0002	0.0015	1.049
BMRI - DXY	0.039	0.036	0.0021	0.0013	0.991
ASII - DXY	0.092	0.027	0.0009	0.0013	1.201

Source: IDX and Bloomberg, processed.

Table 11. Results of Independent Sample t-Test of Portfolios without or with a Gold Hedge

DCC-GARCH

No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe without a hedge	-	with a gold hedge	0.056	-2.132	0.004	Different
2	Sortino without a hedge	-	with a gold hedge	0.098	-1.902	0.000	Different
3	Jensen without a hedge	-	with a gold hedge	0.051	-1.993	0.019	Different
4	Treynor without a hedge	-	with a gold hedge	0.062	-2.772	0.006	Different
5	Omega without a hedge	-	with a gold hedge	0.403	2.473	0.000	Different

ADCC-GARCH

No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe without a hedge	-	with a gold hedge	0.060	2.232	0.002	Different
2	Sortino without a hedge	-	with a gold hedge	0.097	-2.072	0.000	Different
3	Jensen without a hedge	-	with a gold hedge	0.071	-1.903	0.001	Different
4	Treynor without a hedge	-	with a gold hedge	0.062	-1.921	0.000	Different
5	Omega without a hedge	-	with a gold hedge	0.163	2.384	0.000	Different

Source: IDX and Bloomberg, processed.

Comparison of Unhedged Dynamic Portfolio – Using WTI as the Hedge

In this study, the portfolios were constructed using two models: ADCC-GARCH and ADCC-GARCH. The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega performance evaluation ratios were used to compare the portfolios with and without a WTI hedge. The independent sample t-test was conducted with a significance level of 5% to determine the difference in the average portfolio return. Table 12 displays the test results as follows.

Based on the findings of the independent sample t-test for the portfolio modeling using the DCC-GARCH method, there is a difference in the average return as measured by the Sharpe and Sortino ratios when compared to the portfolios without the WTI hedging. Meanwhile, based on the Jensen, Treynor, and Omega ratios, there is no substantial variation in the average return. The findings of modeling using the ADCC-GARCH method, as evaluated by the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios, reveal that there is no difference in the average return when compared to the WTI-unhedged portfolios. In comparison to the portfolios composed of only stock, incorporating the WTI in the

portfolios did not guarantee a rise in the portfolio performance.

Comparison of Unhedged Dynamic Portfolio – Using DXY as the Hedge

The portfolios were constructed using two models of ADCC-GARCH and ADCC-GARCH. The Sharpe, Sortino, Jensen Alpha, Treynor, and Omega performance evaluation ratios were used to compare the portfolios with and without a DXY hedge. The independent sample t-test was performed with a significance level of 5% to determine the difference in the average portfolio return. The following Table 13 displays the test results.

When the Jensen and Treynor ratios were compared, there is no significant difference in the average returns between the DXY-hedged portfolio and the one that is not DXY-hedged. Meanwhile, based on the Sharpe, Sortino, and Omega ratios, there is a difference in the average return of portfolios that incorporate the DXY and those that do not. When employing the ADCC-GARCH method and without using the DXY as a hedge, the portfolio modeling as assessed by the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios has a different average return. This demonstrated that having the DXY in a stock portfolio could boost its performance.

Comparison of the DCC-GARCH and ADCC-GARCH Portfolios with Gold, WTI, and DXY as the Hedges

The portfolios were constructed using two models: ADCC-GARCH and ADCC-GARCH. The independent sample t-test was used with a significance level of 5% to determine the difference in the average portfolio return. Table 14 displays the test results as follows.

The results of the independent sample t-test of multiple tests between the portfolios formed by the DCC-GARCH and ADCC-GARCH methods demonstrate that there is a significant difference in the average portfolio performance between the DCC-GARCH and ADCC-GARCH methods. It is demonstrated by the sig. value of < Alpha of 0.05. This also implied that the portfolio modeling utilizing the ADCC method was effective, as seen by the results of portfolio performance evaluation.

Table 12. Results of Independent Sample t-Test of Portfolios without or with a WTI Hedge

DCC-GARCH							
No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe without a hedge	-	with a WTI hedge	0.025	-4,018	0.000	Different
2	Sortino without a hedge	-	with a WTI hedge	0.049	-3.704	0.001	Different
3	Jensen without a hedge	-	with a WTI hedge	0.001	-1.265	0.222	Similar
4	Treynor without a hedge	-	with a WTI hedge	0.006	-0.987	0.332	Similar
5	Omega without a hedge	-	with a WTI hedge	0.082	6.090	0.031	Different
ADCC-GARCH							
No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe without a hedge	-	with a WTI hedge	0.046	-7.618	0.013	Different
2	Sortino without a hedge	-	with a WTI hedge	0.082	-12.504	0.002	Different
3	Jensen without a hedge	-	with a WTI hedge	0.004	-0.265	0.112	Similar
4	Treynor without a hedge	-	with a WTI hedge	0.006	-1.667	0.103	Similar
5	Omega without a hedge	-	with a WTI hedge	0.130	-12.390	0.000	Different

Source: IDX and Bloomberg, processed.

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Table 13. Results of Independent Sample t-Test of Portfolios without or with a DXY Hedge

DCC-GARCH							
No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe wihout a hedge	-	with a DXY hedge	0.025	-3.111	0.000	Different
2	Sortino wihout a hedge	-	with a DXY hedge	0.049	-2.704	0.001	Different
3	Jensen wihout a hedge	-	with a DXY hedge	0.001	-0.265	0.531	Similar
4	Treynor wihout a hedge	-	with a DXY hedge	0.006	-0.987	0.032	Similar
5	Omega wihout a hedge	-	with a DXY hedge	0.082	-3.890	0.000	Different
ADCC-GARCH							
No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe without a hedge	-	with a DXY hedge	0.046	-3.618	0.000	Different
2	Sortino wihout a hedge	-	with a DXY hedge	0.082	-4.504	0.001	Different
3	Jensen wihout a hedge	-	with a DXY hedge	0.004	-2.265	0.012	Different
4	Treynor wihout a hedge	-	with a DXY hedge	0.006	-3.667	0.006	Different
5	Omega wihout a hedge	-	with a DXY hedge	0.130	-5.390	0.001	Different

Source: IDX and Bloomberg, processed.

Table 14. Results of Independent Sample t-Test of Portfolios of Stock, Gold, WTI and DXY with the DCC and ADCC Methods

Stock – Gold Portfolio							
No.	Comparison			Mean Difference	t	Sig.	Conclusion
1	Sharpe DCC	-	ADCC	-0.057	-20.132	0.003	Different
2	Sortino DCC	-	ADCC	-0.067	-19.082	0.001	Different
3	Jensen DCC	-	ADCC	-0.017	-5.293	0.001	Different
4	Treynor DCC	-	ADCC	-0.087	-7.662	0.000	Different
5	Omega DCC	-	ADCC	-0.083	-8.473	0.000	Different

Source: IDX and Bloomberg, processed.

Stock-Gold Portfolio Formulation

The results of this study reveal that the stock-gold dynamic portfolios outperform those composed of only stock. This is evident from the calculation results of optimal hedge value which is negative. The negative optimal hedge value, according to Yuliana and Robiyanto (2022), implied that every purchase of major assets must be matched with the acquisition of hedge assets. In this case, the stock was the primary asset and the gold was the hedge. As a result, the investors must purchase gold in order to preserve their investments. In conclusion, incorporating the gold into a portfolio could boost its performance. In terms of hedging effectiveness, adding the gold to a portfolio would also lower the risks. This study finds that the portfolio risks could be reduced by 72% to 81% by combining the stock and gold. Alkhazali and Zoubi (2020) supported the findings of this study by stating that combining the stock and gold could lower the risks. Similarly, Basher and Sadorsky (2016) added that the gold was the most efficient hedging asset in protecting the stock values in developing economies. Robiyanto, Wahyudi, and Pangestuti (2017a) discovered that

integrating the gold in an investment portfolio might result to high profits while also providing the effective protection. According to Baur and Lucey (2010), the gold was such a safe haven and a powerful hedge for most markets during the peak of crisis.

Stock-WTI Portfolio Formulation

This study finds that compared to a stock portfolio that does not include the WTI as the hedge, the stock-WTI dynamic portfolios perform better. The calculation results of optimal hedge value are negative. This demonstrated that the WTI might be used as a hedge for the Indonesian stock market. These findings also suggested that stockholders should acquire the world oil commodities in order to boost their portfolio performance and decrease its risk. The results of hedging effectiveness underline that including the WTI in the stock portfolio could lower the risk, by 69% to 84%. This finding supports previous studies which revealed that the world oil was the best asset for protecting the stock values in emerging economies. To protect the developing market share prices with the oil, VIX, or bonds, the ADCC model's hedging ratio was chosen as it was proven to be the most successful model (Basher & Sadorsky, 2016). M. E. H. Arouri, Lahiani, and Nguyen (2011) employed the VAR-GARCH method to investigate the level of volatility transmission between the world oil and stock markets in Europe and the United States. They found that there was significant spillover volatility between the oil and sector stock returns. This implied that the world oil might bring gains even when the financial markets in Europe and America were highly volatile. Hersugondo et al. (2015) claimed that they also found a negative connection between the Hersugondo et al. (2015) Indonesian stock market and the WTI, suggesting that the WTI could be used as a stock portfolio hedge.

Stock-DXY Portfolio Formulation

This study finds that compared to a stock portfolio without the DXY as the hedge, the stock-DXY dynamic portfolios produce higher results. The calculation results of optimal hedge value are negative. This demonstrated that the DXY might be used as a hedge for the Indonesian stock market. The existing shareholders should acquire the DXY in order to boost their portfolio performance and decrease its risks. According to Agyei-Ampomah et al. (2013), the United States Dollar was the most valuable asset when the financial market turmoil occurred, and thus it would be in demand by the investors as a safe haven or hedge. When it came to the hedging effectiveness, putting the currency index into the stock portfolio might improve the performance while also lowering the risks. As a result, combining the stock and DXY could lower the portfolio risk by 70% to 82%. The calculation results of dynamic portfolio performance with and without the DXY as a hedge reveal that there is a difference in the resultant performance. The average performance of stock-DXY dynamic portfolios outperforms the performance of a stock portfolio that does not include the DXY as the hedge. This finding implied that the DXY could serve as a hedge or safe haven for the Indonesian stock market. The DXY was found to have a negative correlation with equities, allowing it to take advantage of diversification likelihoods while reducing the portfolio risk. Furthermore, Syahri and Robiyanto (2020) supported this claim by demonstrating a negative dynamic association between the JCI and the exchange rate during the COVID-19 pandemic. Similarly, McCauley and McGuire (2009) argued that throughout the global financial crisis, the US Dollar was sought after by the investors as a safe haven as well as a hedge by non-institutional investors. These findings are consistent with the findings by Agyei-Ampomah et al. (2013) which discovered

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that when the financial market was volatile, the investors sought for the safest asset (flight for safety). When there was financial instability, the investors seeking secure assets would sell a portion of their investment holdings in dollar denominations. They would often convert the profits from the portfolio sales into US currency. The three best safe haven currencies, according to Todorova (2020), were the US Dollar (USD), Japanese Yen (JPY), and Swiss Franc (CHF). In the short to medium term, the US Dollar would continue to be the finest safe haven asset.

Comparison of Symmetric and Asymmetric Dynamic Portfolio Methods

The above Table 14 presents the results of various tests of the two portfolio formation methods, namely the DCC-GARCH and ADCC-GARCH. This study confirms that there are differences in the average performance as evaluated by the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios. This could happen as a result of changing financial market conditions, and the inclusion of gold, WTI, and DXY could modify the performance of the two methods. The results also show the average value of portfolio performance using the Sharpe, Sortino, Jensen Alpha, Treynor, and Omega ratios which demonstrate that the ADCC method has a higher average ratio than the DCC method. These findings implied that the ADCC-GARCH method outperform the DCC-GARCH analysis method. According to Basher and Sadorsky (2016), the ADCC model's hedging ratio was superior (more effective) for protecting the stock values in the developing countries by adding the oil, VIX, or bonds. Jin et al. (2020) added that the ADCC model worked well during crisis moments, whereas the DCC model did not function as well over a longer period of time. However, both the ADCC and DCC methods outperformed the static methods. In addition, Cui and Feng (2020) also discovered that the ADCC method performed better than other comparatively basic models.

CONCLUSION

The stock-gold portfolios formed by utilizing the DCC and ADCC-GARCH methods outperform those composed of only stock. Including the gold in the portfolio could lower the risks by 72% to 81%. Furthermore, the gold could act as a financial system stabilizer by mitigating losses in the case of extreme negative market shocks. Meanwhile, the stock-WTI portfolios formed by utilizing the DCC and ADCC-GARCH methods also outperform those composed of only stock. Combining the stock and WTI could lower the risks by 69% to 84%. Similarly, the stock-DXY portfolios formed by using the DCC and ADCC-GARCH methods also outperform those composed of only stock. Combining the stock and DXY could minimize the risks by 70% to 82%. The DXY was one of the most liquid assets and had a negative connection with the Indonesian stock market. Therefore, when there was an economic crisis, the DXY would become a priority for the investors to serve as a financial risk reduction asset. Furthermore, this study also finds that compared to the DCC-GARCH method, the portfolios formed by using the ADCC-GARCH method perform well. The ADCC-GARCH method might overcome the heteros-cedasticity and capture asymmetric poten-tials by calculating present volatility and distinguishing the impacts of positive and negative shocks. As a result, it was more preferable to utilize it to assess the association with various asset classes.

This study has faced several limitations. First, the research sample has limited variations; three of the four selected samples were banking companies, making their characteristics in capturing micro and macroeconomic shocks were not significantly different; thus, the results of this study may differ when applied to other non-banking sectors. Second, considering that several samples of this study went

public after 1998, the observation period for each portfolio model was varied, and so not all portfolio models in this study were able to capture all of the crisis turbulence that happened. Finally, the daily stock price data was only available 5 days a week and on national holidays, but other assets were available 7 days a week, resulting in an imbalance in the data. As a result, a large quantity of data on the gold, world oil, and dollar index was excluded in order for the data utilized to be the same amount. Future studies are suggested to employ stocks coming from different sectors and adding more period if possible.

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