

## **Economic Bulletin – Issue 71**

### **Gold as a Hedging and Alternative Investment Instrument: An Empirical Analysis Using Mean-Variance Optimization**

- The study evaluates whether gold is a suitable and effective portfolio asset for Indonesia, focusing on its roles as hedge, safe haven, and diversifier. It frames the question in an Indonesia-centric setting, so results translate into allocation policy and product design.
- A unified monthly dataset from CEIC and Bloomberg underpins the analysis. The study links drivers to returns with MIDAS and impulse responses, captures state dependence with dynamic correlations, and tests allocation with mean–variance portfolios.
- Rupiah depreciation and inflation provide the most reliable near-term support to IDR gold returns. Policy tightening strengthens gold with a lag, while crisis shocks produce short-lived safe-haven demand that fades as uncertainty is priced.
- Gold's correlation with Indonesian government bonds clusters near zero across regimes, indicating diversification rather than overlap. Its correlation with equities is weak on average and turns more negative in stress, consistent with defensive behavior.
- Adding gold shifts the efficient frontier outward in two-asset and three-asset cases. The combination of gold, equities, and sovereign bonds delivers higher risk-adjusted performance with lower volatility for a given expected return.
- Indonesia should institutionalize gold as a strategic, rules-based allocation while expanding investable channels such as bullion banking, digital-gold platforms, and gold-backed ETFs, so that long-standing household preference for physical bullion is converted into liquid, transparent exposures that improve portfolio efficiency, support insurance and pension resilience, and deepen integration with global capital markets.

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## Introduction

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Gold occupies a paradoxical position in modern finance: it is simultaneously a centuries-old store of value and a digitally tradable asset class embedded in global portfolios. A large literature documents its dual role as hedge in normal times and safe haven during stress, underpinned by asymmetric correlations with equities and bonds and by recurrent episodes of flight to quality. Yet most evidence and market practice are centered on advanced economies, where gold-backed ETFs and institutional mandates have matured into liquid, low-cost vehicles. Emerging markets, despite deep cultural affinity for physical bullion, have only recently begun to translate that affinity into portfolio constructs and investable products. This disconnect opens a substantive space for empirical inquiry and policy design.

Indonesia provides a particularly salient case. The domestic investment universe has expanded with growing participation in equities and government bonds, while macro-financial volatility, policy-rate cycles, and exchange-rate dynamics continue to shape household and institutional risk taking. Against this backdrop, understanding whether, and how, gold functions as hedge, safe-haven, and diversification anchor in an Indonesia-centric portfolio is both academically relevant and operationally consequential. Beyond investor welfare, it bears on the feasibility of developing bullion banking, gold-linked instruments, and market infrastructure that could integrate local savings into the global gold ecosystem.

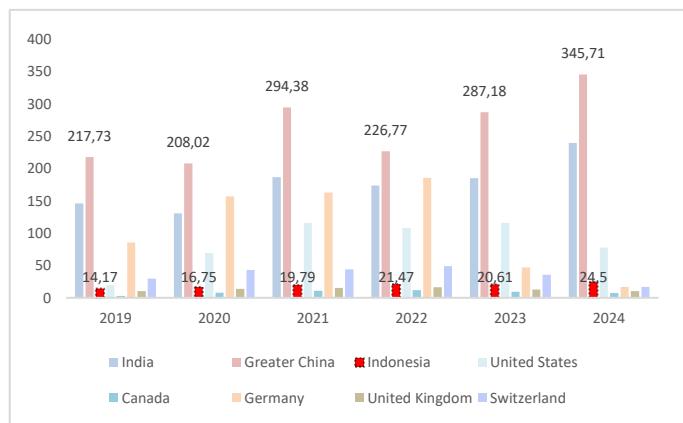
This study advances discussion in three ways. First, it centers the analysis on Indonesia's market context, evaluating the conditional relationship between gold and key macro-financial drivers through a time-series framework that prioritizes interpretability and diagnostics. Second, it couples econometric backbone with modern forecasting comparators from machine and deep learning to assess robustness and out-of-sample relevance, treating ML and DL as supportive benchmarks rather than substitutes for structural reasoning. Third, it connects return dynamics to portfolio construction by quantifying the implications for risk-adjusted performance, drawdown management, and allocation policy under alternative investment constraints.

## Global Gold Investment: Physical and ETF Holdings

This section introduces the role of gold in today's investment landscape and frames Indonesia's position within it. The Exhibits provide a starting point for understanding how different markets approach gold as an investable asset and what that might mean for portfolio design and market development in Indonesia. They set the context for the discussion that follows investor behavior, product choice, and the potential for deeper integration with the global gold ecosystem.

### Exhibit 1. Physical Gold and ETF Volume in Regions

Physical Gold (Annual Bar and Coin Investment by Region in volume (tonnes))



Physically backed gold ETF AuM by region in tonnes



Source: World Gold Council

Exhibit 1 compares two sides of the gold market. The left panel shows bar-and-coin purchases by region from 2019 to 2024. India and Greater China are consistently the largest buyers, with volumes that rise again after the pandemic dip. The United States and Europe are meaningful but smaller on the physical side.

The right panel shows assets in physically backed gold ETFs by region from Q1-2023 to Q4-2024. Here, North America and Europe dominate. Their ETF holdings are large and relatively stable through time, while Asia's ETF base is much smaller, even though it edges up toward the end of the period.

For Indonesia, the picture is clear. Physical buying remains modest at around 24.5 tonnes in 2024, far below India and China, and the ETF channel is still nascent. This suggests Indonesian participation is concentrated in physical bullion, with significant room to build financial products such as bullion banking and gold-linked funds to bring local investors into the global gold ecosystem.

Building on Exhibit 1, a wide body of work and market practice

explains why gold earns a place in portfolios. In calm periods it tends to move differently from equities and bonds, so it works as a hedge; in turbulent periods it often holds value when risky assets fall, so it can act as a safe-haven (Baur and Lucey, 2010; Baur and McDermott, 2010). These features help lower overall risk and can lift risk-adjusted returns, making gold a useful diversifier rather than a speculative add-on (Hillier, Draper, and Faff, 2006). Demand for gold also rises when inflation is high, when geopolitical tension escalates, or when financial conditions tighten, which reinforces its role as a global shelter asset held by households, institutions, and central banks alike (Erb and Harvey, 2013; World Gold Council, 2024; World Gold Council, 2025). Access has improved as well: physically backed ETFs turned gold from a mostly physical store of value into a liquid and regulated instrument that investors can add and remove with equity-like ease (Baur, 2013; Cheng, Chiu, and Jin, 2020). Taken together, these points offer a clear path for markets that still favor bars and coins. By developing bullion banking, digital gold, and ETF products, countries can convert long-standing trust in bullion into portfolio tools that connect investors to global capital flows and, in Indonesia's case, support a more diversified and resilient investment universe (Narayan, Narayan, and Zheng, 2010).

Against this backdrop, the paper asks a focused question: is gold a suitable and effective portfolio asset for Indonesian investors. We examine its roles as hedge in normal conditions, safe-haven during stress, and diversifier that can enhance risk-adjusted performance by lowering volatility and drawdowns. The inquiry is explicitly situated in Indonesia's market setting to yield practical guidance for allocation policy, product design, and market infrastructure, including the development of bullion banking, digital-gold solutions, and gold-backed ETFs that could translate long-standing trust in bullion into investable portfolio tools.

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## Data and Methodology

The study implements a two-track empirical design aligned with the slides. First, it models the determinants and shock transmission of gold using MIDAS regression and impulse-response analysis to capture mixed-frequency effects and the timing of monetary, currency, commodity, and crisis shocks. Second, it maps the resulting return properties into portfolio tests via Markowitz mean-variance optimization under explicit allocation constraints, supported by dynamic correlation estimates to characterize regime

dependence in co-movements with equities and bonds.

Table 1. Statistic Summary

## Data for MIDAS-Regression and IRF

	Obs	Min	Max	Median	Mean	Std	Skewness	Kurtosis
<b>RetailGold</b>	135	-15,14	21,73	0,48	1,02	3,75	0,83	8,87
<b>CPI</b>	148	-0,09	8,36	3,30	3,72	1,93	0,83	-0,09
<b>JISDOR</b>	147	-7,68	13,96	0,35	0,35	2,52	0,65	6,19
<b>BI7</b>	148	3,50	7,75	5,75	5,54	1,33	0,05	-1,08
<b>Coil</b>	147	-50,49	35,69	0,96	-0,27	10,89	-1,24	5,69
<b>RGDP</b>	49	-5,32	7,07	5,03	4,40	2,32	-3,13	9,43
<b>LiquidRatio</b>								
	146	11,22	21,67	16,25	16,27	2,30	-0,11	-0,21
<b>GoldReserve</b>								
	147	-12,90	10,31	0,38	0,62	4,18	-0,07	0,06
<b>CovidDummy</b>								
	148	0	1	0	0,07	0,25	3,48	10,25
<b>WarDummy</b>								
	148	0	1	0	0,07	0,26	3,28	8,87

## Data for Markowitz Mean-Variance Portfolio

	N (obs)	Mean (monthly)	Std (monthly)	Skewness	Kurtosis
<b>Gold</b>	188	0,006	0,05	1,58	8,79
<b>JCI</b>	188	0,007	0,04	-0,69	1,91
<b>GIDN10YR</b>	188	-0,000	0,004	0,48	1,13

Source: Bloomberg and CEIC

The study assembles a monthly macro-financial dataset from CEIC and Bloomberg. Core series include retail gold returns, consumer price inflation (CPI), the rupiah exchange rate (JISDOR), the BI 7-Day Reverse Repo Rate, and crude oil prices. Lower-frequency indicators such as real GDP and a banking liquidity ratio are aligned to the monthly grid using standard carry-forward procedures so that all estimations and impulse-response exercises run on a consistent monthly timeline. We also include policy and shock markers, namely official gold reserves, a COVID dummy, and a war-risk dummy.

For the Markowitz exercise, the study uses monthly total-return series for Gold, JCI equities, and the Indonesia 10-year government bond proxy, sourced from Bloomberg and CEIC. Descriptive statistics reported in Exhibit 2 summarize sample size, means, standard deviations, skewness, and kurtosis for each series, forming the basis for return modeling and portfolio optimization.

## Methodology

The study employs a streamlined framework to connect return drivers to portfolio outcomes. It estimates gold's sensitivity to macro shocks using MIDAS regression, traces the timing and persistence of those shocks with impulse-response analysis, and evaluates allocation implications through a Markowitz mean-variance portfolio. All models are implemented on a harmonized monthly dataset.

The study uses MIDAS regression to link monthly gold returns to macro variables that arrive at different frequencies.

$$Y_t = \alpha + \sum_{k=0}^K \beta_k X_{t-k/m} + \varepsilon_t$$

In this setup,  $Y_t$  is the retail gold returns at month  $t$ . The regressors  $X_{t-k/m}$  are macro drivers observed monthly or quarterly that are mapped to the monthly grid through a frequency ratio  $m$ . The coefficients  $\beta_k$  are lag weights that capture how past values of each driver affect current gold returns; they can be estimated freely or constrained by a smooth weighting function to keep the model parsimonious.  $\alpha$  is the interception and  $\varepsilon_t$  is the error term. By letting information from several past months or quarters enter with economically sensible decay, MIDAS recovers timing and persistence of shocks without overfitting and is well suited to the mixed-frequency dataset used in this paper.

Secondly, the study traces how a shock to a driver today affects gold returns over future months using impulse responses.

$$IRF_h = \frac{\partial Y_{t+h}}{\partial \varepsilon_t} = Z_h \text{ atau}$$

$$(for MIDAS): IRF_h = \beta \cdot w(h; 0)$$

An  $h$ -step IRF measures the partial effect on  $Y_{t+h}$  of a one-standard-deviation innovation in the driver at  $t$ . In the MIDAS setting, the IRF at horizon  $h$  can be obtained from the estimated base coefficient  $\beta$  combined with the lag-weight function  $w(h; \theta)$ , which maps how the impact decays or builds over time. The sequence  $\{Z_h\}_{h=0}^H$  summarizes timing and persistence:  $Z_0$  is the contemporaneous effect, peaks indicate strongest transmission, and the return to zero signals dissipation. The study reports point estimates with confidence bands from bootstrap standard errors and, were informative, cumulative responses to quantify total impact over the horizon.

Thirdly, the study evaluates allocation using the standard mean-variance framework. Let  $w$  be the vector of asset weights. Given the vector of expected returns  $\mu$  and the return covariance matrix  $\Sigma$ , the baseline problem minimizes portfolio variance  $\frac{1}{2}w'\Sigma w$  subject to a target return  $w'\mu = \mu_p$  and full investment  $\sum_i w_i = 1$ . The Lagrangian yields the efficient frontier, a set of portfolios that deliver the lowest variance for each feasible expected return. When a risk-free rate  $r_f$  is available, the tangency portfolio that maximizes the Sharpe ratio has closed-form weights

$$w^* = \frac{\Sigma^{-1}(\mu - r_f \mathbf{1})}{\mathbf{1}'\Sigma^{-1}(\mu - r_f \mathbf{1})}.$$

Inputs  $\mu$  and  $\Sigma$  are estimated from monthly returns of Gold, JCI, and the Indonesia 10-year bond proxy. The study reports result under clear constraints, such as no short selling or limited weights, and evaluates outcomes with volatility, drawdown, and risk-adjusted performance.

## Result

The results are organized in three parts. First, the study reports MIDAS estimates together with impulse-response functions (IRFs) that trace the timing and magnitude of macro shocks to monthly gold returns. Second, it summarizes conditional co-movements with equities and government bonds using dynamic correlations. Third, it maps these return patterns into mean-variance allocations for Indonesia, comparing constrained and unconstrained portfolios and evaluating volatility, drawdowns, and risk-adjusted performance

### MIDAS Regression

The MIDAS estimates indicate three dominant channels. First, the currency channel is immediate: a rupiah depreciation (higher JISDOR) is associated with a contemporaneous increase in IDR gold returns (coefficient = 0.35,  $p \approx 0.01$ ). Second, balance-sheet support matters: larger official gold reserves correlate with higher gold returns on impact (coefficient = 0.41,  $p < 0.001$ ), while several longer lags carry negative signs, which is consistent with mean reversion after inventory adjustments. Third, crisis markers are economically large and statistically precise. The COVID dummy has positive effects at short lags ( $p < 0.02$ ) and the war-risk dummy turns significant at medium horizons, confirming safe-haven

demand during stress.

**Table 2. MIDAS Regression Results**

**MIDAS-Regression without Polynomial Weight**

	<b>Coefficient</b>	<b>StdErr</b>	<b>t-Stat</b>	<b>P&gt; t </b>
CPI_L4	-3,36	1,66	-2,03	0,05
BI7_L7	-7,22	3,98	-1,81	0,08
Coil_L5	-0,20	0,09	-2,06	0,05
Coil_L7	-0,24	0,08	-3,03	0,005
GoldReserve_L0	0,53	0,14	3,83	0,000
GoldReserve_L2	-0,35	0,16	-2,13	0,04
GoldReserve_L5	-0,37	0,17	-2,21	0,03
GoldReserve_L6	-0,39	0,22	-1,74	0,09
GoldReserve_L9	-0,58	0,18	-3,16	0,003
GoldReserve_L10	-0,30	0,16	-1,82	0,08
CovidDummy_L1	20,87	8,44	2,47	0,02
CovidDummy_L5	30,44	13,60	2,24	0,03
WarDummy_L6	15,13	6,94	2,18	0,04
RGDP_L1	2,68	1,49	1,80	0,08
LiquidRatio_L0	-2,58	1,11	-2,32	0,03

**MIDAS-Regression with Polynomial Weight**

<b>Variable</b>	<b>Coef</b>	<b>StdErr</b>	<b>t-Stat</b>	<b>P&gt; t </b>
JISDOR_L0	0,35	0,13	2,58	0,01
GoldReserve_L0	0,41	0,08	4,84	0,000
CovidDummy_L1	7,50	2,77	2,71	0,007

*Source: Analyzed by using Phyton*

Price-level and policy variables play a secondary role. A 4-month lag of CPI is marginally negative ( $p = 0.05$ ) and a 7-month lag of the policy rate is weakly negative ( $p = 0.08$ ), in line with tighter domestic financial conditions weighing on local gold returns with a delay. Oil prices show significant negative coefficients at 5-7month lags, suggesting a delayed transmission from global energy shocks to the Indonesian gold market. Real activity and banking liquidity provide additional nuance: RGDP growth is weakly positive at short lags, while a higher liquidity ratio coincides with lower gold returns contemporaneously, consistent with a shift toward risk assets when domestic funding is ample.

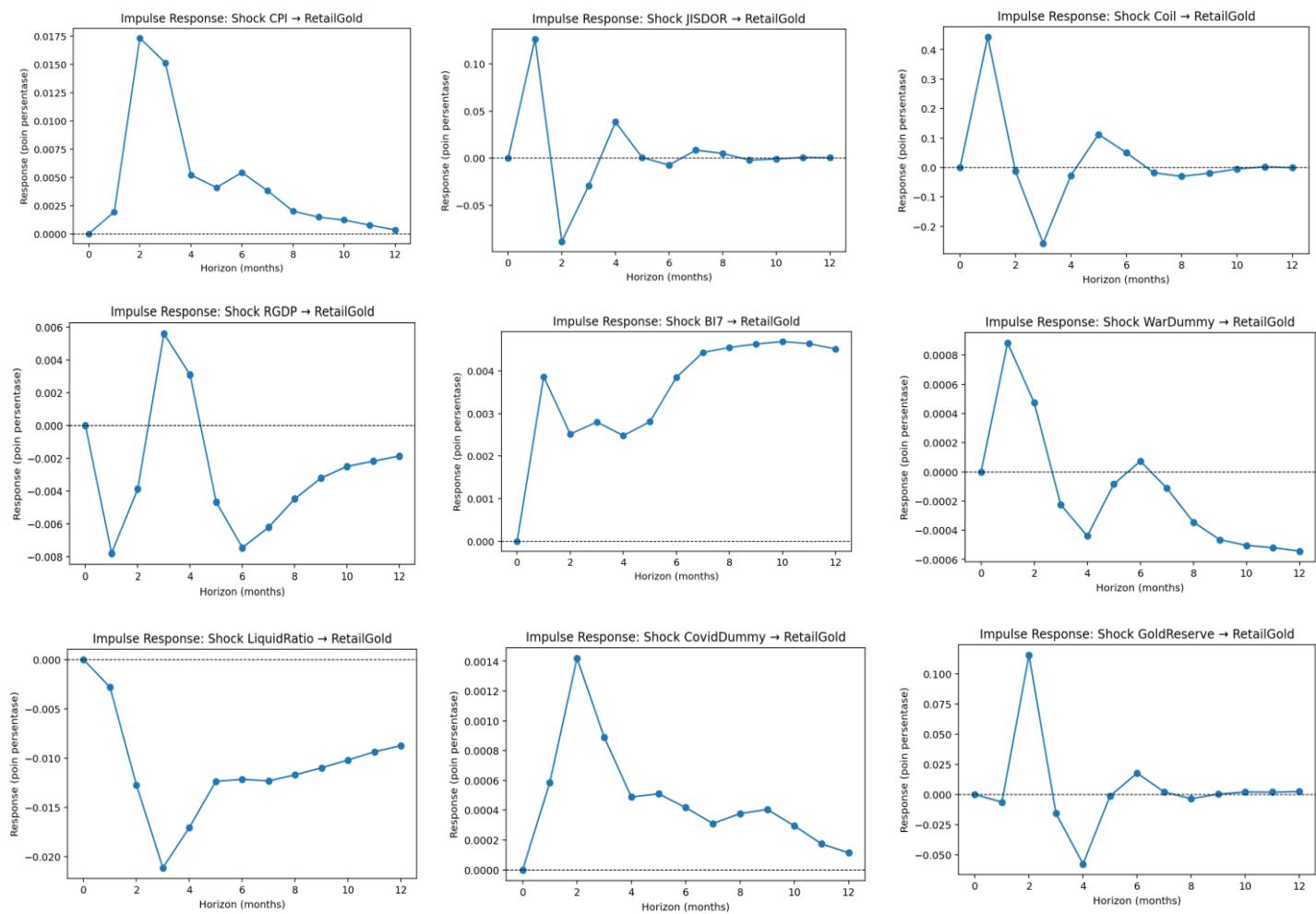
For market participants, the exchange rate is the primary near-term driver of IDR gold performance, with reserve management and crisis conditions amplifying moves. For policy, credible macro stabilization and transparent reserve operations are central to dampening volatility. For portfolios, these estimates justify treating gold as a tactical hedge against currency weakness and market stress in Indonesia, while recognizing that macro and commodity shocks transmit with identifiable delays that can be monitored through the lag structure reported in the regression.

### **Impulse Response Function**

This subsection examines how macroeconomic and crisis shocks propagate to Indonesia's monthly retail gold returns using impulse-response functions. The approach traces the sign, timing, and persistence of each shock over a 0–12 months horizon, allowing the study to distinguish immediate pass-through effects from slower, expectation-driven adjustments.

The results indicate that inflation surprises lift gold returns quickly, peaking around the second month before fading by mid-horizon, consistent with a shift into inflation hedges as real cash and bond yields fall. Rupiah depreciation raises IDR gold on impact and remains mildly supportive for several months because local prices reference USD benchmarks and precautionary buying amplify the pass-through. Monetary tightening shows a delayed positive effect that builds through months four to eight as tighter financial conditions curb risk appetite and increase demand for defensive assets. Oil shocks generate an initial rise followed by a temporary dip, reflecting the offset between cost-push inflation and growth or USD dynamics. Reserve accumulation triggers a short-run positive impulse that later mean reverts, consistent with inventory adjustment once flows are absorbed. Real-activity shocks are small and oscillating as currency and risk-sentiment channels offset each other, while easier domestic liquidity coincides with weaker near-term demand for gold that normalizes over time. Crisis markers for COVID and war risk deliver brief safe-haven spikes that dissipate as uncertainty is priced, or policy backstops arrive. Overall, currency and inflation shocks provide the most reliable near-term support for IDR gold, with policy and crisis effects material but shorter lived.

## Exhibit 2. Impulse Response Function (IRF) Graphics



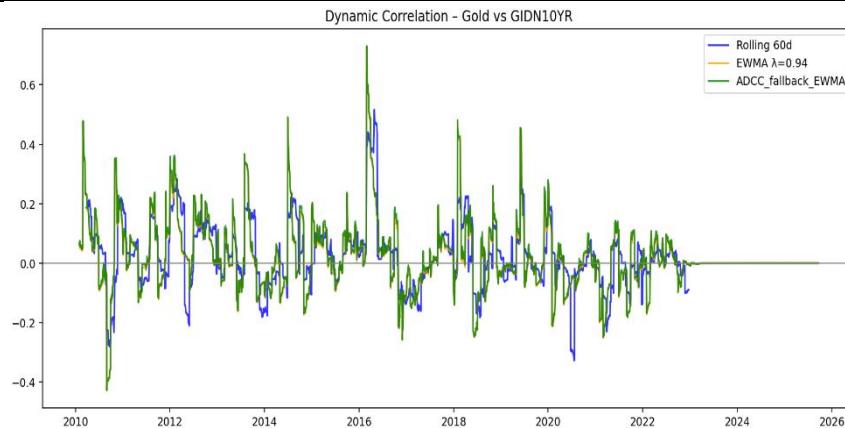
Source: Analyzed by using Python

### Dynamic Correlation

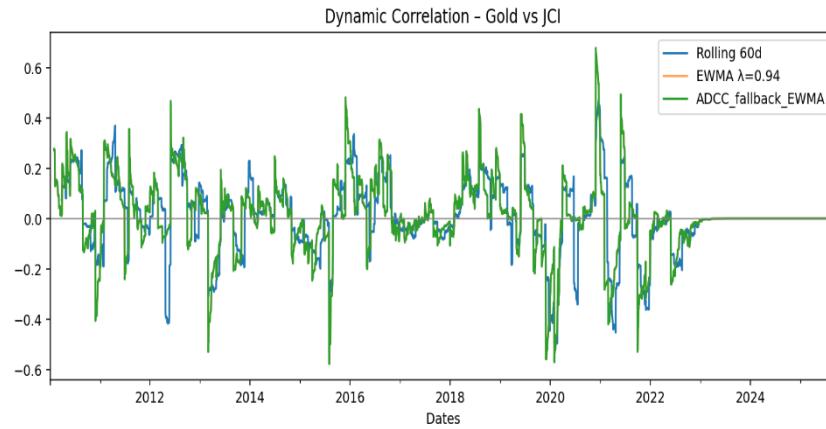
This subsection introduces the time-varying co-movement between gold, Indonesian equities, and government bonds. Using rolling and EWMA correlations, the study tracks how relationships evolve across macro and market regimes and whether gold behaves as a diversifier or safe haven when equity or duration risk dominates. The Exhibits provide the context for interpreting state dependence, highlighting episodes when correlations approach zero or turn negative and the implications for portfolio construction in Indonesia.

### Exhibit 3. Dynamic Correlation

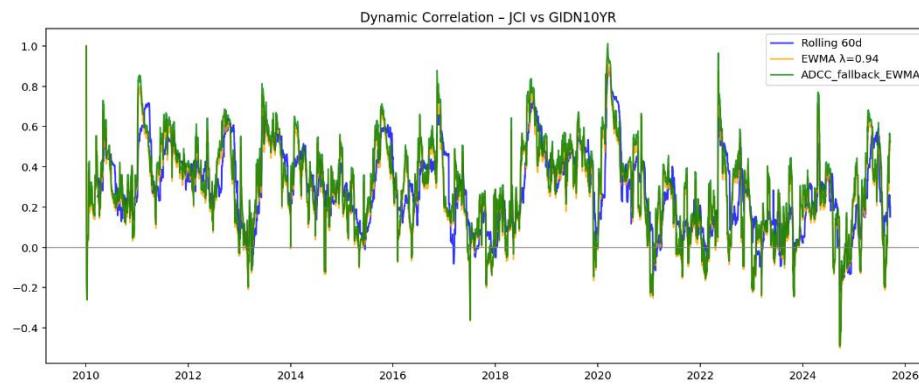
#### Gold vs Government Bond 10 Years



#### GOLD vs JCI



#### JCI vs Government Bond 10 Years



Source: Analyzed with Python

The dynamic correlation estimates show three clear patterns. First, gold's correlation with Indonesia's 10-year government bond stays low and clustered around zero throughout the sample, with brief negative episodes. This supports gold's role as a diversifier for duration risk and at times a hedge when yields move abruptly.

Second, gold's correlation with JCI is weak on average and turns distinctly negative during stress windows, notably around the 2020 to 2022 period, which is consistent with safe-haven behavior when equity volatility rises. Third, JCI's correlation with the 10-year bond is visibly higher and state dependent. It is elevated during easing or risk-on phases and falls toward zero, or briefly negative, when inflation or currency pressures dominate. Together, these results imply that a modest allocation to gold can enhance portfolio efficiency in Indonesia without displacing sovereign bonds, with the benefits strongest when equity risk is elevated or macro conditions tighten.

### Markowitz mean–variance portfolio

This subsection evaluates how gold alters portfolio trade-offs in Indonesia using a mean–variance framework. The study compares efficient frontiers for two asset mixes that pair gold with equities and bonds, and for a three-asset mix that holds all three. The Exhibits position the minimum-variance and tangency portfolios to show how small changes in weights shift expected return and volatility, providing a clear basis for judging gold's contribution to diversification and risk control.

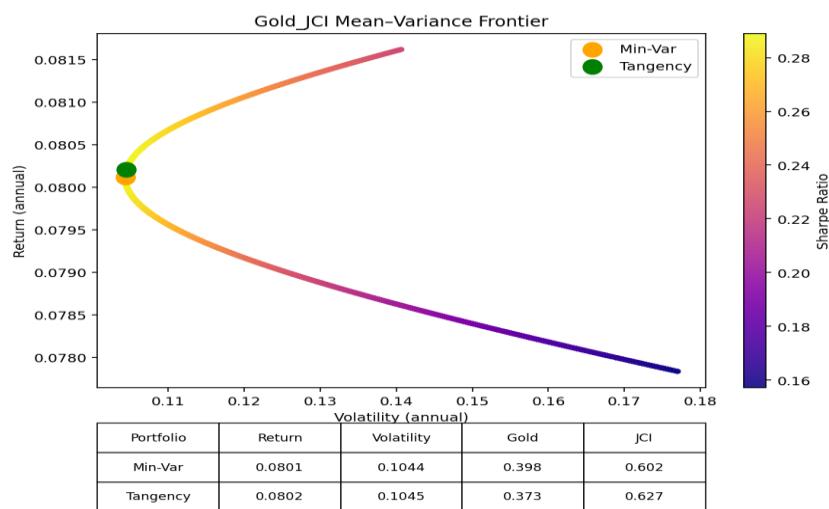
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#### Exhibit 4. Efficient Frontier and Portfolio Diversification

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##### Gold and JCI

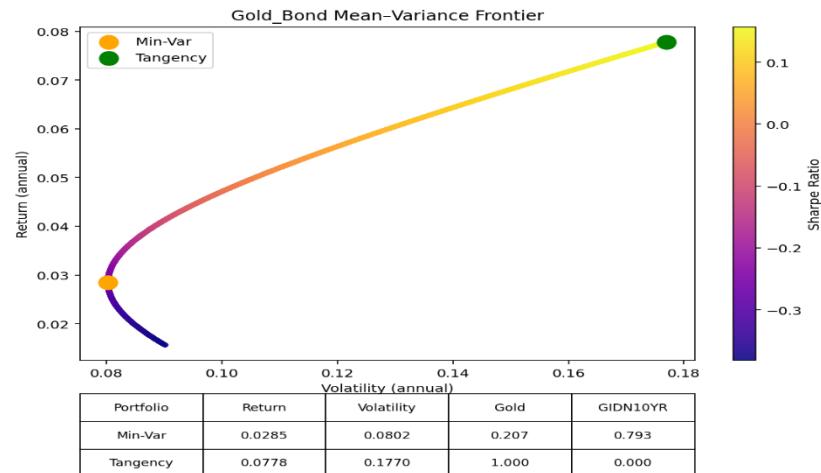
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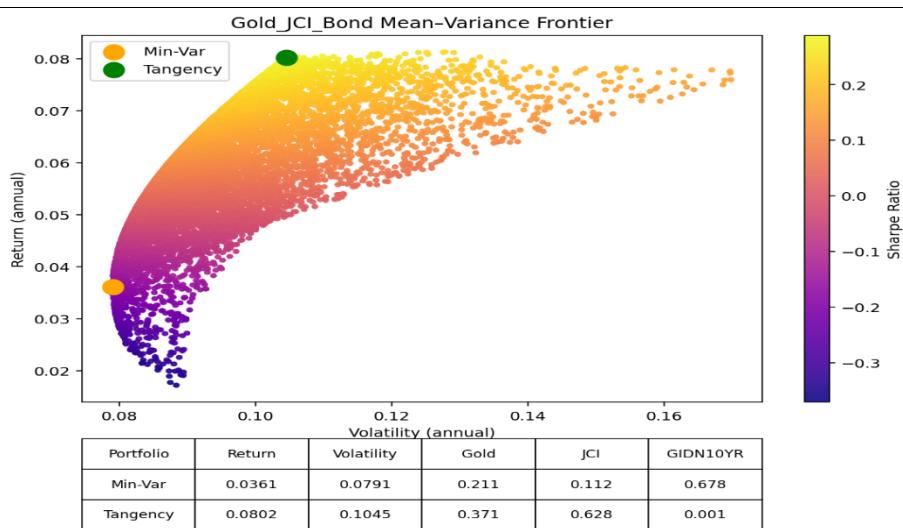

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##### GOLD and Indonesia's Government Bond 10 Years

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### GOLD, JCI, and Indonesia's Government Bond 10 Years



Source: Analyzed with Phyton

The mean–variance tests show that adding gold improves portfolio efficiency across all combinations. In the Gold–JCI set, allocations that include gold deliver lower volatility for a given return and the tangency portfolio assigns a meaningful share to gold. In the Gold–Bond set, bonds anchor risk in calm rate environments while gold lifts expected return, and the minimum variance mix remains bond heavy. The three-asset case provides the strongest overall result: portfolios that hold gold, equities, and sovereign bonds achieve higher expected returns at moderate risk, confirming that gold operates as a stabilizer that complements duration risk and equity exposure in Indonesia.

## Conclusion

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The study evaluates gold's role as a portfolio asset in Indonesia using a consistent monthly dataset and a methods stack that links return drivers to allocation outcomes. Evidence from MIDAS estimates and impulse responses shows that currency and inflation shocks are the most reliable supports for IDR gold in the near term. Monetary tightening strengthens gold with a lag through tighter financial conditions and weaker risk appetite. Crisis indicators such as COVID and war risk produce short bursts of safe-haven demand that fade as uncertainty is priced. These results affirm that gold functions as a hedge in calm periods and as a safe haven in stress.

Dynamic correlations confirm low and state-dependent co-movements. Gold's correlation with the 10-year government bond clusters around zero, while its correlation with equities turns more negative in global risk episodes. The interaction implies that gold complements duration exposure rather than replacing it. Mean-variance tests translate these properties into allocations that improve efficiency across two-asset and three-asset mixes. Portfolios that include gold achieve lower volatility for a given return, with the strongest improvement in the three-asset case that holds gold, equities, and sovereign bonds.

For investors and product designers in Indonesia, the findings support a strategic role for gold with room for tactical tilts around currency and inflation risk. For policymakers and market infrastructure, the results point to practical avenues to deepen participation. Development of bullion banking, digital-gold solutions, and gold-backed ETFs can convert long-standing trust in physical bullion into investable instruments that offer liquidity, transparency, and integration with global markets.

The analysis has boundaries that suggest next steps. Future work can expand the asset set beyond the three-asset core, incorporate transaction costs and rebalancing rules, and test nonlinear or regime-switching specifications. High-frequency identification of shocks and richer measures of risk sentiment could refine the timing of responses. Even with these limits, the central message is clear. In Indonesia's market setting, gold improves portfolio resilience and provides a credible hedge against depreciation, inflation, and episodic market stress.

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### Indonesia Financial Group (IFG)

Indonesia Financial Group (IFG) adalah BUMN Holding Perasuransian dan Penjaminan yang beranggotakan PT Asuransi Kerugian Jasa Raharja, PT Jaminan Kredit Indonesia (Jamkrindo), PT Asuransi Kredit Indonesia (Askrindo), PT Jasa Asuransi Indonesia (Jasindo), PT Bahana Sekuritas, PT Bahana TCW Investment Management, PT Bahana Artha Ventura, PT Bahana Kapital Investa, PT Graha Niaga Tata Utama, dan PT Asuransi Jiwa IFG. IFG merupakan holding yang dibentuk untuk berperan dalam pembangunan nasional melalui pengembangan industri keuangan lengkap dan inovatif melalui layanan investasi, perasuransian dan penjaminan. IFG berkomitmen menghadirkan perubahan di bidang keuangan khususnya asuransi, investasi, dan penjaminan yang akuntabel, prudent, dan transparan dengan tata kelola perusahaan yang baik dan penuh integritas. Semangat kolaboratif dengan tata kelola perusahaan yang transparan menjadi landasan IFG dalam bergerak untuk menjadi penyedia jasa asuransi, penjaminan, investasi yang terdepan, terpercaya, dan terintegrasi. IFG adalah masa depan industri keuangan di Indonesia. Saatnya maju bersama IFG sebagai motor penggerak ekosistem yang inklusif dan berkelanjutan.

### Indonesia Financial Group (IFG) Progress

The Indonesia Financial Group (IFG) Progress adalah sebuah *Think Tank* terkemuka yang didirikan oleh Indonesia Financial Group sebagai sumber penghasil pemikiran-pemikiran progresif untuk pemangku kebijakan, akademisi, maupun pelaku industri dalam memajukan industri jasa keuangan