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Gold as an alternative payment and save haven against inflation

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Abstract
Physical gold has a long history as a store of value. It dates back to ancient times and still has high importance today. Technological advancements in distributed ledger technology eliminate the downsides of physical gold we were exposed to in the past. In this article, we analyze the relationship between the gold price and inflation and ask whether gold is suitable as an alternative means of payment. Regarding the mentioned tokenization possibility, gold fulfils all the functions to become a means of payment. We tested the value storage capability of gold. This was tested by relating gold as a protection against inflation to HICP in regression analyses and mean comparisons. A total of six hypotheses were tested, of which three could be rejected. The existing literature mainly focuses on testing the correlation between gold and other assets to verify its safe haven property. A part of this paper tests the regression relationship in which the dependent variable is represented by gold, and the independent variable is represented by inflation. Under this methodology, we demonstrated that a stable, statistically significant positive relationship exists when using log gold prices and log HICP values.

Keywords
Finance, Inflation, Gold, Gold as a safe haven, means of payment, distributed ledger technology, digitalization.

Introduction

The recent difficulties of Credit Suisse and the bailout of UBS as well as the Swiss government, confirm the crisis that has been ongoing since 2008. In economically unstable times, when inflation is rising and confidence in the conventional banking system is falling, people are looking for alternative ways to protect their assets and settle their transactions (Dimitriou et al., 2020; Setiawa, 2022; Hafner, 2020). "Means of payment is a generally accepted institutional arrangement or method that facilitates delivery of money from one to another" (Yang, 2007). One option often discussed in this context is the use of gold as an alternative means of payment. Gold has a long history as a store of value (Jones & Podolsky, 2015; Přívara, 2019a, 2019b) and is considered by many to be a safe investment. Gold has been used as a form of money for thousands of years. The history of gold as a means of payment dates back to ancient times, and it still holds an essential place in the global economy today (Sedgwick, 1936; Eichengreen & Flandreau, 2008; O'Connor et al., 2015). There are many advantages of using gold as a means of payment. One of the main advantages of gold is that there is a limited amount of it on Earth. This means that it does not become inflationary as quickly as paper money. Gold also has the advantage of being a store of value. Unlike paper money, gold cannot simply be printed by the government to pay debts. This means that gold is a safe investment option (Eichengreen & Flandreau, 2008; Skrodzka, 2021; Vorobeva & Dana, 2021; Jaffe, 1989). The use of gold as a means of payment has a significant advantage from an economic point of view, which the limited quantity on Earth can explain. This makes it difficult for a gold currency to be used in an inflationary manner.

Gold has served as a stable means of payment in the past, especially during the period of the gold standard. During that time, currencies were pegged to the price of gold, which meant that they could be exchanged for gold. However, this approach was abandoned when governments had difficulty holding enough gold to back their currencies (Eichengreen & Flandreau, 2008; Přívara et al., 2018). At the same time, two main disadvantages of gold as a means of payment are prevalent. First, it is difficult to transport. Unlike paper money, which can be easily carried in a wallet or pocket, gold is heavy and must be stored securely. This can make owning gold a security risk. Second, it cannot be shared as easily as paper money. This is not possible with gold because it must be sold or purchased as a whole in standardized sizes.

However, technological developments in the field of distributed ledger technologies eliminate these two disadvantages, which means that gold in tokenized form can be shared on the blockchain as desired (eight to sixteen decimal places) and can be easily transported as a token in a digital wallet on a smartphone (the explanations on tokenization essentially refer to Schmitz & Užík (2023). In this context, a token represents an abstract value or serves to store information and is referred to as a "colored coin" or "custom token" (Garcia-Teruel & Moreno. 2021, p. 1). However, the literature has not yet conclusively delineated a precise definition.

The technological developments have also caused increases in the importance of online payments (Hassan & Lee, 2021) and in the usage of cryptocurrencies (Obeng, 2021), which are the outcomes of financial innovation (Obeng & Attor, 2022) and innovative technologies affecting business performance as well (Rigelsky et al., 2022; Civelek et al., 2021; Ključnikov et al., 2021). Most of the literature believes that a coin symbolizes a cryptocurrency with its native blockchain or native Directed Acyclic Graph. At the same time, a token is generated on and dependent on an existing distributed ledger (Oliveira et al., 2018, p. 5 f.). In this way, tokenization is similar to traditional asset securitization (Laurent et al., 2018, p. 2). In asset tokenization, existing assets are mapped onto the distributed ledger. This is done by linking the economic values and rights derived from these assets to digital tokens (BaFin, 2019; Přívara et al., 2019; Shatila, 2022; Androniceanu et al., 2022). The real assets continue to exist outside the distributed ledger and are typically taken into custody. In this case, the token is fully backed by the real asset. Tokenized assets can thus be seen as dematerialized assets operated and recorded on decentralized distributed ledgers and no longer managed in electronic book entries or central securities registers (OECD, 2020, p. 11 ff.). If assets are tokenized, it must be decided whether fungible or non-fungible tokens will be used. Fungible tokens are particularly suitable for tokenizing metals, as they can be exchanged for each other at will. For example, if gold is tokenized, it is irrelevant which bar or part of a bar the token represents. The metal is arbitrarily interchangeable or fungible.

Distributed ledger technology thus offers the possibility of eliminating the only two disadvantages of gold, whereby gold can be used as an alternative means of payment in times of crisis. Gold in tokenized form can perform the medium of exchange function, the unit of account function, and a currency's store of the value function. Since the function as a store of value, in particular, has been impaired by inflation in recent times, we focus in this paper on whether gold, which assumes the functions of a medium of exchange in tokenized form, also offers protection against inflation (Wang et al., 2022; Kabir, 2021;).

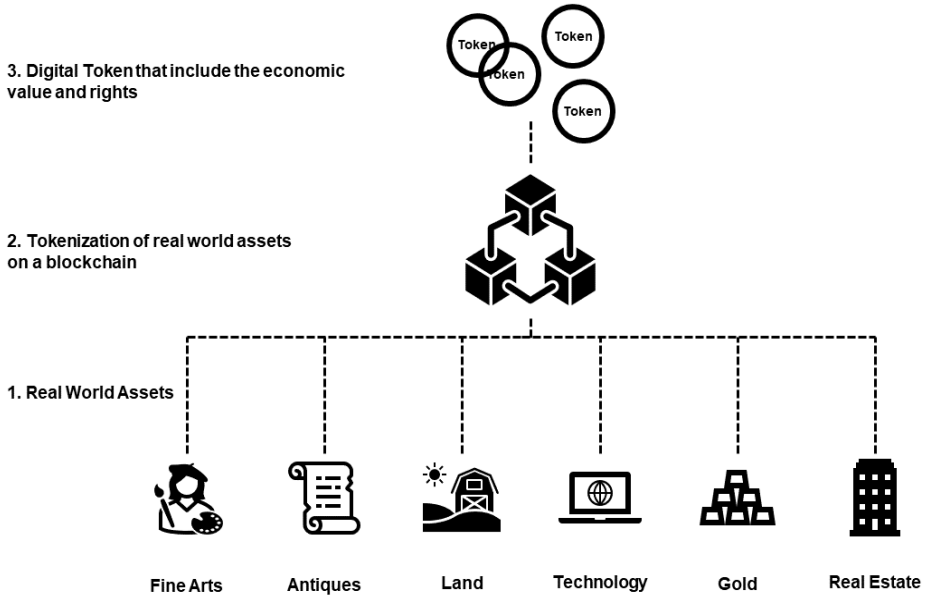

Fig. 1. Tokenization of real-world assets, own creation and based on OECD (2020)

An essential source in this context for this paper is the study by Baur and Lucey (2010). Is gold a hedge against sudden changes in stock and bond returns, or does it instead have a subtly different property, that of a haven? The authors address these two interrelated questions. The literature defines a haven as security uncorrelated with stocks and bonds in the event of a market collapse (Rashid et al., 2022; Behun et al., 2018; Přívara, 2022; Sahoo & Pradhan, 2021; Tkáčová et al. 2022). Business cycles and market collapses send economies into a turmoil age (Bilan et al., 2017; Liu et al., 2021; Přívara et al., 2020; Lv et al., 2023; Nicolescu et al., 2020). The authors examine U.S., U.K., and German stock and bond returns and their relationship to gold returns. They find that gold provides a safe haven in extreme equity market conditions, but this effect is short-term in nature. Sui et al. (2021) studied gold's hedging potential against adverse movements of inflation and exchange rates. They used three countries: the USA (benchmark), Turkey (highly dollarized), and Peru (low dollarized). They found that gold is a good hedge in USA and Turkey. Though, Turkey fails during hyperinflation times. Valadkhani et al. (2022) researched when gold is an effective hedge against inflation. Their final argument is that asymmetric and size-dependent responses are the leading causes for the lack of consensus concerning the hedging qualities of gold. Oloko et al. (2021) examined the responsiveness of the inflation rate persistence of selected countries to gold price shocks. Their results showed that the effect of gold price shock lingers for a long time on the inflation rate persistence of developing countries (Androniceanu & Tvaronavičienė, 2019) . On the other hand, it lingers for a short time on inflation rate persistence for developed countries. Salisu et al. (2020) found that hedging tendencies of assets are heterogeneous for stocks, gold, and real estate in the U.S. Us investors have a good hedge against inflation with stock and real estate assets but not with gold.

Materials and Methods

The listed literature presents several approaches to test whether gold can serve as an alternative asset class or a hedge against inflation. In addition to analyzing the correlation with equities and bond yields, we examine regression models in which the variable to be explained is the gold price or the gold price yield, and the explanatory variables are inflation and prices of various asset classes. In principle, analyzing gold's anti-inflationary properties must be tested in several ways. The problem is that the gold price intrinsically reflects the inflation trend. Moreover, the gold price is influenced by portfolio shifts, especially in times of crisis. Given these listed factors, we choose a multi-stage test of our hypothesis that gold has anti-inflationary properties and is also suitable as an alternative means of payment. We define the following examination stages:

1. Descriptive analysis of gold price development versus consumer price development HICP Europe.
    a. Analysis of rolling 12-month cumulative returns of gold and HICP
    b. Analysis of the cumulative returns of gold and HICP
    c. Analysis of HICP and inflation-adjusted gold prices
2. Analysis of price and yield differentials
    a. Analysis of price differences between gold and HICP on an index basis
    b. Analysis of the returns of gold and HICP

3. Regression analysis of the relationship between gold and inflation
    a. Analysis of logarithmized prices
    b. Analysis of logarithmized returns
    c. Analysis of time shift relationships

The empirical analysis examines the period from January 2008 to February 2023 on a monthly basis. Gold prices were taken from the westmetall.de platform and corresponded to the LME gold price fixing. The data for inflation was taken from Eurostat. The consumer price index HICP Europe was taken on a monthly basis. The harmonized index of consumer prices (HICP) measures how the prices of goods and services purchased by households change over time. The HICP provides a comparable measure of inflation because it is calculated using a harmonized approach and uniform definitions. The data are available monthly as index values.

The analysis of price and yield differences is done using a two-sample t-test. The difference is tested at 0. The hypotheses to be tested are:

$H0_1$: There is no difference between the returns of gold and HICP.

$$\boldsymbol{\mu_{Gold,t} = \mu_{HICP,t}} \tag{1}$$

Where:

$$\boldsymbol{\mu_{Gold,t} = ln\left(\frac{P_{Gold,t}}{P_{Gold,t-1}}\right) and\, \mu_{HICP,t} = ln\left(\frac{P_{HICP,t}}{P_{HICP,t-1}}\right)} \tag{2}$$

$H0_2$: There is no difference between the change in log prices of gold and HICP.

$$ln\left(\frac{\log\left(P_{Gold,t}\right)}{log\left(P_{Gold,t-1}\right)}\right) = ln\left(\frac{log(HICP_t)}{log(HICP_{t-1})}\right) \tag{3}$$

In the regression analyses, the significance of the relationship between gold as the variable to be explained and HICP as the explanatory variable is functionally examined. The hypotheses to be tested are:

$H0_3$: There is no relationship between the steady returns of gold and the HICP.

$$\boldsymbol{ln\left(\frac{P_{Gold,t}}{P_{Gold,t-1}}\right) = \alpha + \beta \times ln\left(\frac{HICP_t}{HICP_{t-1}}\right)} \tag{4}$$

$H0_4$: There is no relationship between the steady returns of log gold prices and the log HICP.

$$\boldsymbol{ln\left(\frac{log\left(P_{Gold,t}\right)}{log\left(P_{Gold,t-1}\right)}\right) = \alpha + \beta \times ln\left(\frac{log(HICP_t)}{log(HICP\ _{t-1})}\right)} \tag{5}$$

$H0_5$: There is no relationship between the log price of gold and the log HICP.

$$log\left(P_{Gold,t}\right) = \alpha + \beta \times log\left(HICP_{Gold,t}\right) \tag{6}$$

In the context of time shift, we analyze the shift in the relationship by three months, six months, nine months, and 12 months. The hypotheses to be tested are:

$H0_5$: There is no relationship between the log price of gold and the log HICP.

$$log\left(P_{Gold,t}\right) = \alpha + \beta \times log\left(HICP_{Gold,t-3}\right) \tag{7}$$

$$log\left(P_{Gold,t}\right) = \alpha + \beta \times log\left(HICP_{Gold,t-6}\right) \tag{8}$$

$$log\left(P_{Gold,t}\right) = \alpha + \beta \times log\left(HICP_{Gold,t-9}\right) \tag{9}$$

$$log\left(P_{Gold,t}\right) = \alpha + \beta \times log\left(HICP_{Gold,t-12}\right) \tag{10}$$

Results

The results of the evaluations are varied and show, on the one hand, that gold can serve as a hedge against inflation. On the other hand, however, they are not uniform, which means that the yield analysis, in particular, does not allow a clear conclusion on a safe haven. The results evaluated are discussed in detail.

The descriptive analysis of the results first compares inflation with the gold price, using three different approaches. First, we look at the cumulative monthly rolling returns of the HICP index and the gold price from January 2008 to February 2023. The returns were determined as continuous returns by using the natural logarithm. It should be noted here that the yield calculation for the HICP is purely auxiliary. This is because the HICP in yield form corresponds to the inflation rate and does not represent a yield figure per se.

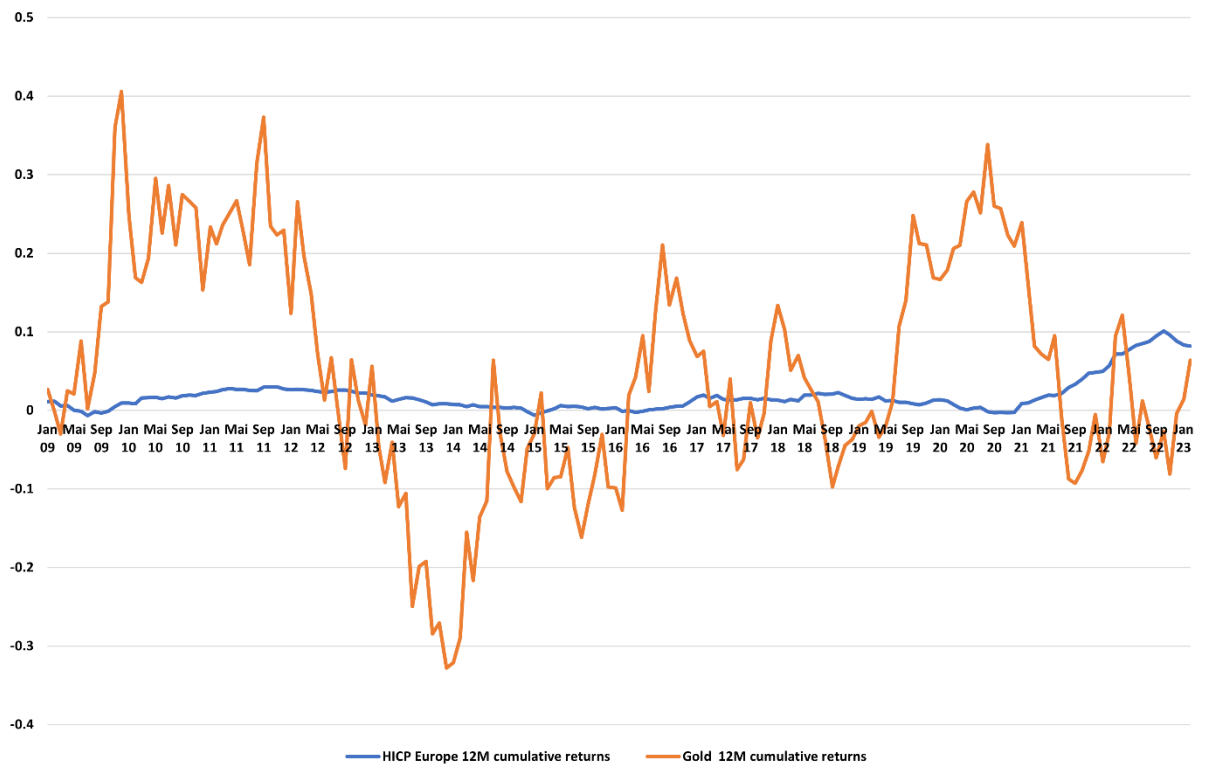

Fig. 2. Rolling 12-month cumulative return of HICP and gold price, own creation

The above chart clearly shows that the cumulative gold price return is below inflation in the short term, especially in times of crisis. This is after the financial crisis of 2008 and the sovereign debt crisis, which has been increasingly aggravated by the bailouts of the central banks (especially the FED and the ECB) from 2013 onwards. Finally, the Covid19 pandemic and the Ukraine crisis can also be seen from the chart. However, gold price yields recovered relatively quickly and were always above inflation shortly after the crises began.

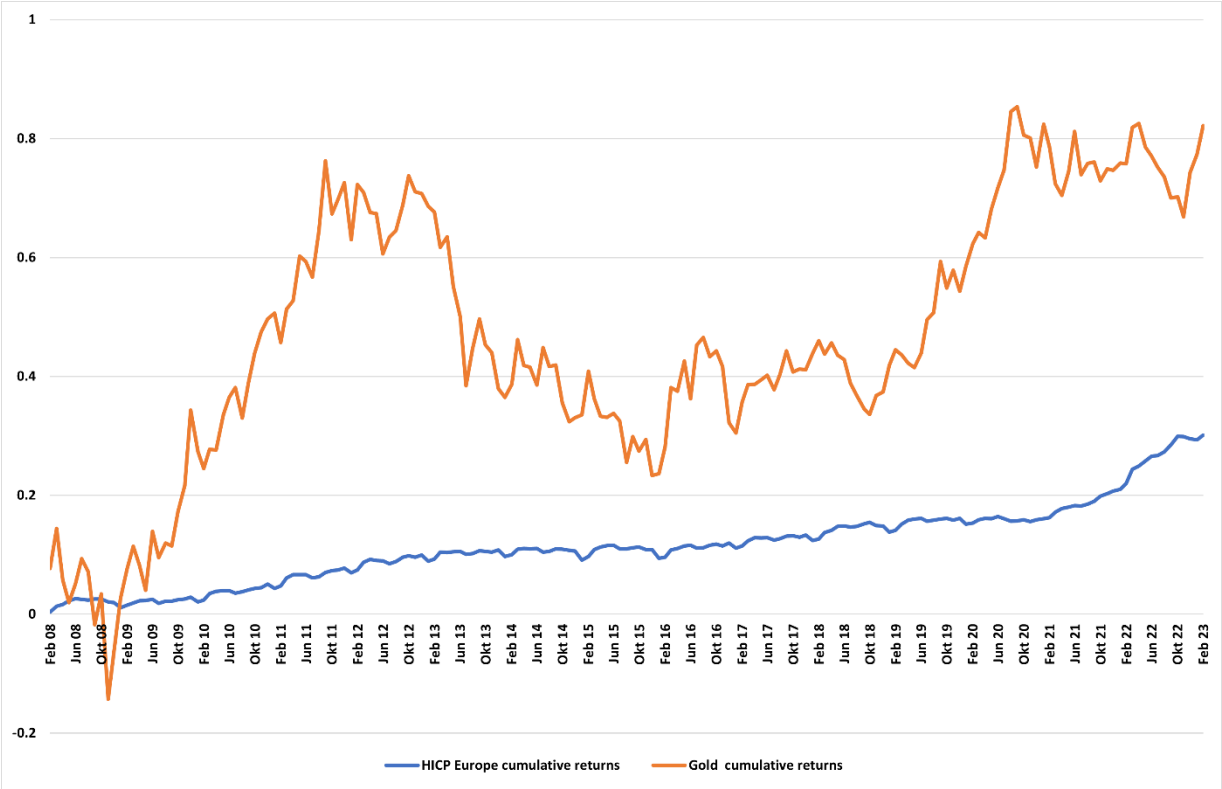

Fig. 3. Cumulative monthly return of the HICP and the gold price, own creation

Looking at cumulative returns provides a clearer picture than looking at 12-month returns. The fact that the returns are cumulative means that they de facto reflect the performance of the variables under consideration. It can be seen here that, except for the 2008 financial crisis, the cumulative return of the gold price has consistently outperformed inflation. This is a strong signal supporting the thesis of gold's anti-inflationary character.

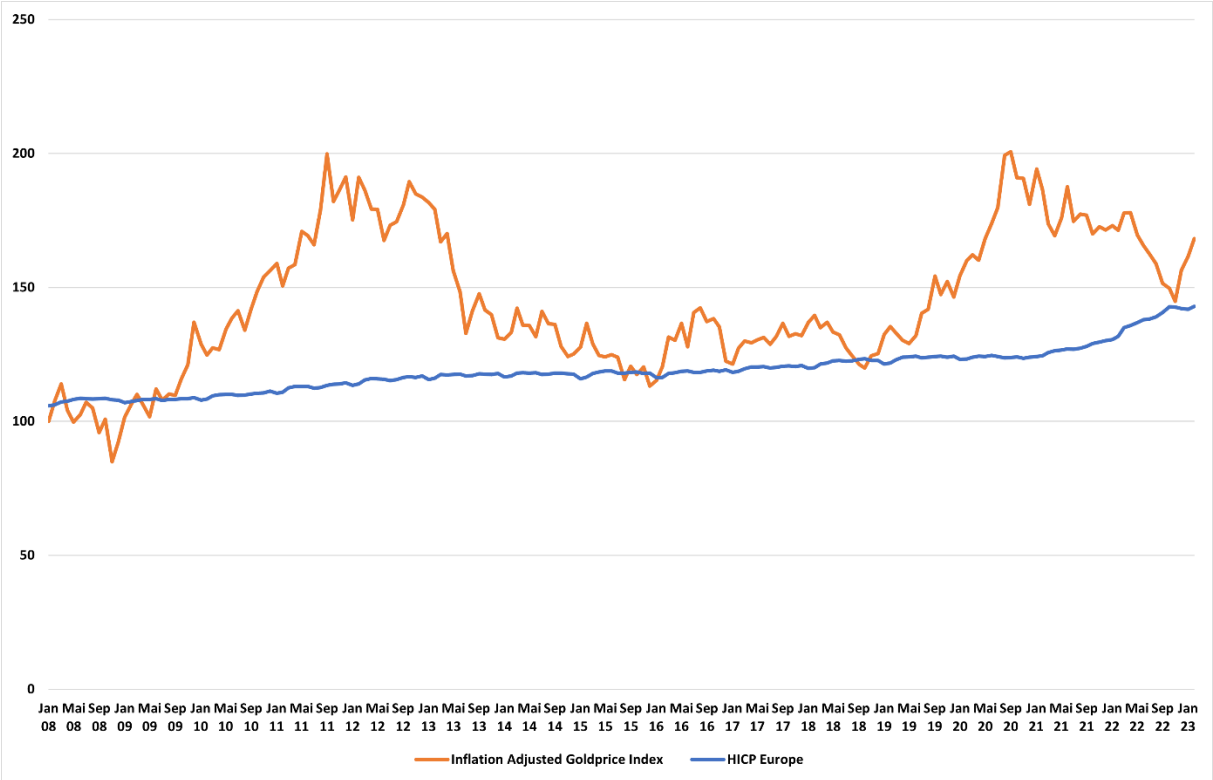

Fig. 4. Index performance of the HICP and the inflation-adjusted gold price

Finally, we adjusted the gold price for purchasing power losses and plotted it as an index against the HICP index over the period under consideration. Again, a clear outperformance of the inflation-adjusted gold price index against the HICP is evident.

In what follows, we analyze the comparison of means using two-sample t-tests and looking at selected regression relationships, all of which examine the impact of inflation on the price of gold.

The analysis of gold and HICP returns was done in two ways. First, the steady returns were compared. Second, we used the approach in the literature in which both the gold price and HICP were calculated as decadic logarithms. We then calculated a continuous yield using the natural logarithm based on these logarithmized prices.

Tab. 1. Return comparison and index comparison between HICP and gold

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Return ln(HICP)	0,002	181,000	0,005	0,000
	Return ln(Gold)	0,005	181,000	0,048	0,004
Pair 2	ln(logP/logP-1) Gold	0,001	181,000	0,007	0,001
	ln(logP/logP-1) HICP	0,000	181,000	0,001	0,000
Pair 3	log(HICP)	2,074	182,000	0,029	0,002
	log(Gold)	3,130	182,000	0,097	0,007

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Return ln(HICP) & Return ln(Gold)	181,000	0,080	0,284
Pair 2	ln(logP/logP-1) Gold & ln(logP/logP-1) HICP	181,000	0,083	0,265
Pair 3	log(HICP) & log(Gold)	182,000	0,690	0,000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Return ln(HICP) - Return ln(Gold)	-0,003	0,048	0,004	-0,010	0,004	-0,801	180,000	0,424
Pair 2	ln(logP/logP-1) Gold - ln(logP/logP-1) HICP	0,000	0,007	0,001	-0,001	0,001	0,573	180,000	0,567
Pair 3	log(HICP) - log(Gold)	-1,056	0,080	0,006	-1,067	-1,044	-178,875	181,000	0,000

The analysis of the mean values shows hardly any difference and is also not significant. In contrast, the two-sample t-test for the logarithmized index values shows a clear considerable superiority of the gold price over inflation. Thus, it can be argued that in the period under consideration from 2008 to February 2023, when the index is considered, and the index base is 100, the gold price has a statistically significantly higher index value than the HICP. Thus, this analysis provides statistical evidence that gold is suitable as an inflation hedge.

We divide the regression analyses into three groups. In the first group, we consider log returns, and in the second log prices. The third group considers the time shifts of 3, 6, 9, and 12 months, respectively. This tests whether shifts in the gold price over time are related to inflation.

1. Analysis of logarithmized prices

2. Analysis of logarithmized returns

3. Analysis of time shift relationships

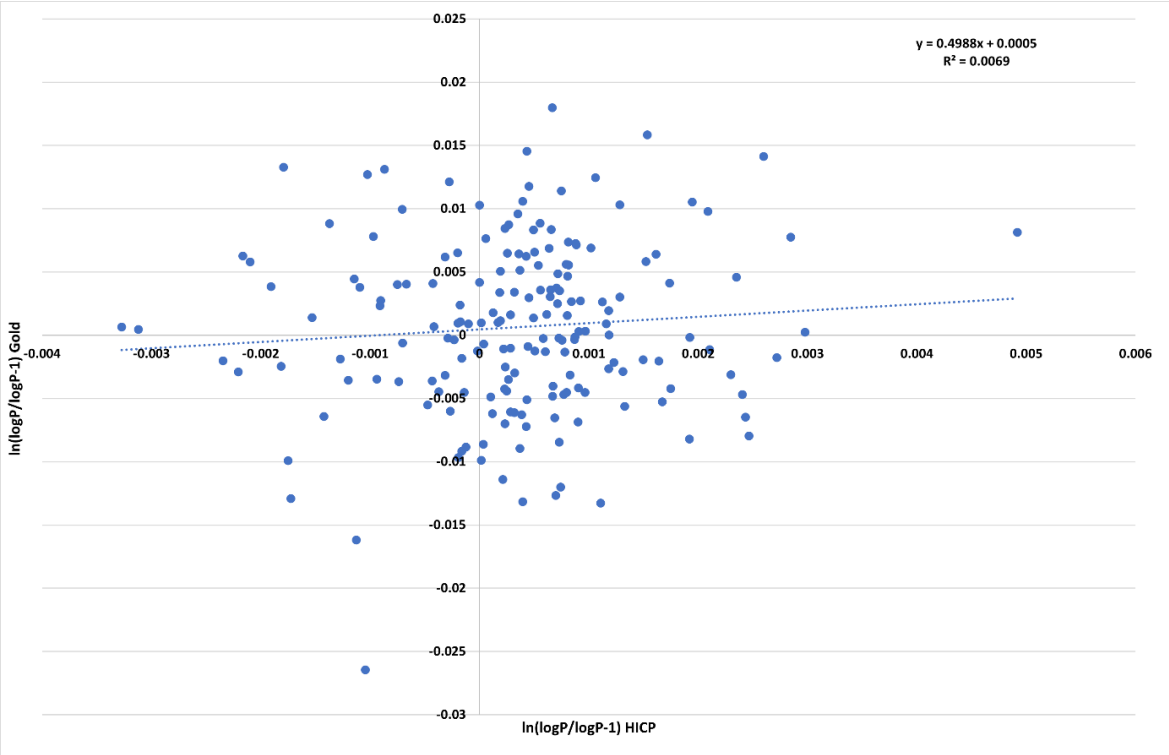

Fig. 5. Regression of the Returns of the HICP and the Gold Price

The regression of returns shows similar results for the two approaches chosen. Although the gold yield follows inflation and the correlation is positive, no significance of this relationship can be demonstrated.

Tab. 3. Regression of log HICP and log gold price returns.

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0	.080[a]	0,006	0,001	0,048	2,191
1	.083[a]	0,007	0,001	0,007	2,194
0	a. Predictors: (Constant), Return ln(HICP)				
	b. Dependent Variable: Return ln(Gold)				
1	a. Predictors: (Constant), ln(logP/logP-1) HICP				
	b. Dependent Variable: ln(logP/logP-1) Gold				

ANOVA[a]						
Model		Sum of Squares	df (Total)	Mean Square	F	Sig.
0	Regression	0,003	181	0,003	1,153	.284[b]
1	Regression	0,000	181	0,000	1,251	.265[b]
0	a. Dependent Variable: Return ln(Gold)					
	b. Predictors: (Constant), Return ln(HICP)					
1	a. Dependent Variable: ln(logP/logP-1) Gold					
	b. Predictors: (Constant), ln(logP/logP-1) HICP					

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
0	(Constant)	0,003	0,004		0,891	0,374
	Return ln(HICP)	0,713	0,664	0,080	1,074	0,284
1	(Constant)	0,000	0,001		0,877	0,382
	ln(logP/logP-1) HICP	0,499	0,446	0,083	1,119	0,265

The regression of the log prices of gold and the HICP index shows a positive statistically significant relationship. Gold increases by 2.32% on average when inflation increases by 1%.

Tab. 4. Regression of the logarithmized values of the HICP and the gold price

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.690[a]	0,476	0,474	0,070	0,092
a. Predictors: (Constant), log(HICP)					
b. Dependent Variable: log(Gold)					

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0,806	1,000	0,806	163,834	.000[b]
	Residual	0,886	180,000	0,005		
	Total	1,692	181,000			
a. Dependent Variable: log(Gold)						
b. Predictors: (Constant), log(HICP)						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1,686	0,376		-4,481	0,000
	log(HICP)	2,322	0,181	0,690	12,800	0,000
a. Dependent Variable: log(Gold)						

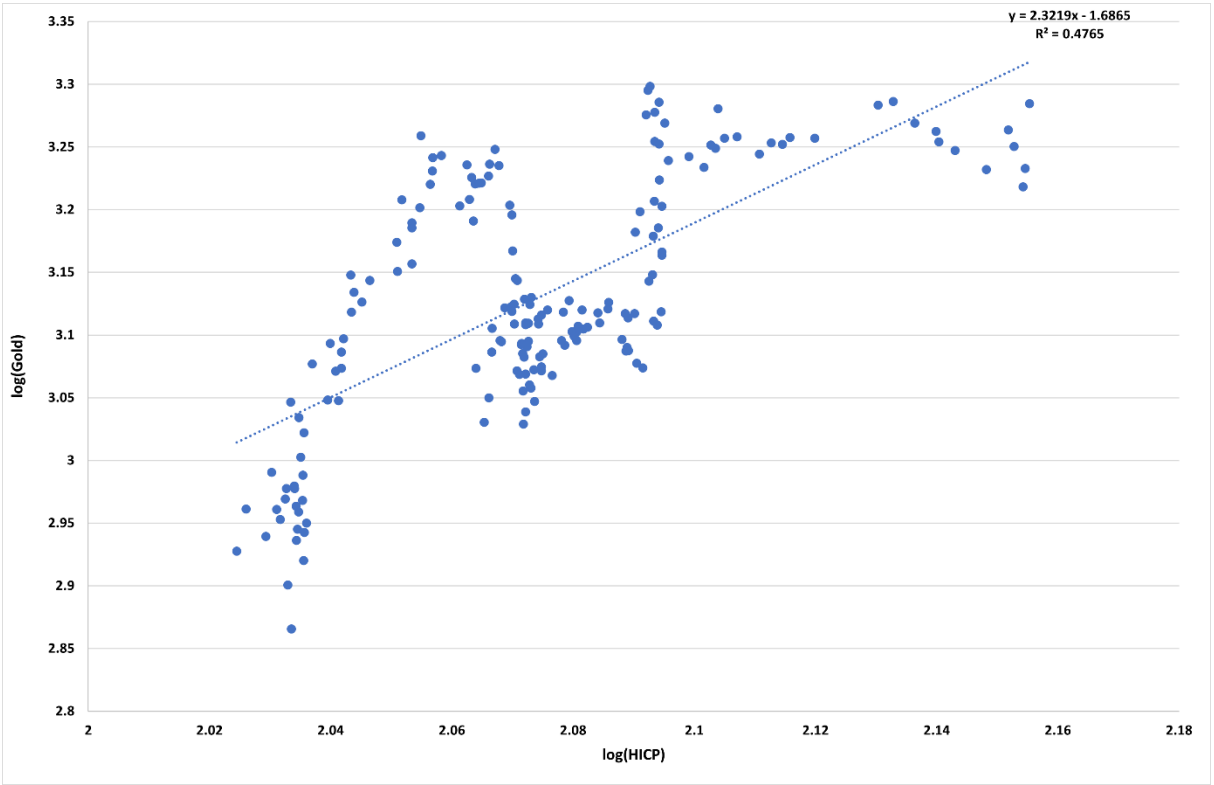

Fig. 6. Regression of the logarithmized values of the HICP and the gold price

The use of the last model in the context of time lags is to test the sensitivity of the relationship between the gold price and inflation.

Tab. 5. Regression of logarithmized values of HICP and gold price with time shift by 3, 6, 9, and 12 months.

Model Summary[b]

Model	Predictors (Constant)	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0	HICP Europe log	.690[a]	0,476	0,474	0,070	0,092
1	HICP Europe Shift -3 log	.659[a]	0,434	0,431	0,072	0,090
2	HICP Europe Shift -6 log	.628[a]	0,395	0,391	0,072	0,088
3	HICP Europe Shift -9 log	.593[a]	0,352	0,348	0,073	0,084
4	HICP Europe Shift -12 log	.545[a]	0,297	0,292	0,071	0,076

b. Dependent Variable: Gold

ANOVA[a]

Model		Sum of Squares	df (Total)	Mean Square	F	Sig.
0	Regression	0,806	181	0,806	163,834	.000[b]
1	Regression	0,695	181	0,695	135,799	.000[b]
2	Regression	0,590	181	0,590	113,476	.000[b]
3	Regression	0,489	181	0,489	92,866	.000[b]
4	Regression	0,360	181	0,360	70,865	.000[b]

a. Dependent Variable: Gold

b. Predictors: (Constant), HICP Europe Shift

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
0	(Constant)	-1,686	0,376		-4,481	0,000
	log(HICP)	2,322	0,181	0,690	12,800	0,000
1	(Constant)	-1,653	0,411		-4,024	0,000
	HICP Europe Shift -3 log	2,308	0,198	0,659	11,653	0,000
2	(Constant)	-1,637	0,448		-3,653	0,000
	HICP Europe Shift -6 log	2,304	0,216	0,628	10,653	0,000
3	(Constant)	-1,519	0,483		-3,142	0,002
	HICP Europe Shift -9 log	2,250	0,233	0,593	9,637	0,000
4	(Constant)	-1,131	0,508		-2,227	0,027
	HICP Europe Shift -12 log	2,066	0,245	0,545	8,418	0,000

a. Dependent Variable: Gold

The results show impressively that the gold price increases by at least 2% when inflation increases by 1% percent. Moreover, the adjusted R-squared is consistently above 30%.

Conclusions

This article analyzed the relationship between the gold price and inflation and asked whether gold is suitable as an alternative means of payment. If we consider the latter, a means of payment must be able to perform the functions of a medium of exchange, the function as a unit of account, and the function as a store of value of a currency. Concerning the mentioned tokenization possibility, gold fulfills all these three functions. The focus of the empirical analyses in this paper was to test the value storage capability of gold. This was tested by relating gold as a protection against inflation to HICP in regression analyses and mean comparisons. A total of six hypotheses were tested, of which three could be rejected, thus statistically demonstrating the anti-inflationary nature of gold. The methodology used in this paper differs in part from the methodology used in the literature. The literature mainly focuses on testing the correlation between gold and other assets to verify its safe haven property.

However, part of the papers also tests the regression relationship in which the dependent variable is represented by gold, and the independent variable is represented by inflation. Under this methodology, we demonstrated that a stable, statistically significant positive relationship exists when using log gold prices and log HICP values. The price of gold always increases by at least 2% with inflation of 1%. Based on the data available to us and the period studied, and the methodology used, we can demonstrate that gold can be used both as a means of payment and that it provides protection against inflation.

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