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Cointegration and regression analyses as alternative methods to verify the protective properties of inflation hedge investments.

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Agenda

1. Motivation of the research
2. Research objective and hypothesis
3. Literature review
4. Data used in the study
5. Methodology of the study
6. Results and conclusions

Motivation of the research

- In the face of rising inflation, a variety of financial tools are increasingly important to protect capital from loss of value.
- In the common consciousness of investors, the belief persists that gold, cryptocurrencies, real estate but also other equity investments are effective hedges against the negative effects of inflation.
- Research shows that investor conviction is not always right.

Motivation of the research

- Inflation forces a creative approach to personal finance.
- Passive investments such as the purchase of gold, cryptocurrencies, bonds or shares as well as investments in residential property for rental purposes appear to be great capital preservation.
- The basic condition of capital preservation only occurs when the value of investments in a dynamic equity market and a more stable property market follows inflation.
- Verification of the belief in the protective qualities of selected assets is valuable knowledge for the investor

Research objective and hypothesis

<u>This article objective:</u>

determine whether selected investment directions on the Polish capital market are able to protect capital against inflation-related depreciation.

<u>The research hypothesis:</u>

investments in bonds, Bitcoin, gold, shares, and real estate are able to effectively protect the capital held against the negative impact of inflation.

Literature review

The analysis of the possibility of inflation hedging is usually based on the belief presented by Fisher (1930) that the expected nominal interest rate should move in line with expected inflation.

Literature review

Lintner (1975) formulated the hypothesis that few issues are more important than the impact of inflation on financial markets and the investment process.

Literature review

Bodie (1976), Fama and Schwert (1977) came to conclusions, arguing that inflation hedging means matching returns on different asset classes with inflation.

Literature review

Stevenson and Murray (1999)

The authors found evidence that gold can act as an inflation fuse, but not all methods led to such conclusions. For example, cointegration analysis using the Engle-Granger test did not provide such evidence.

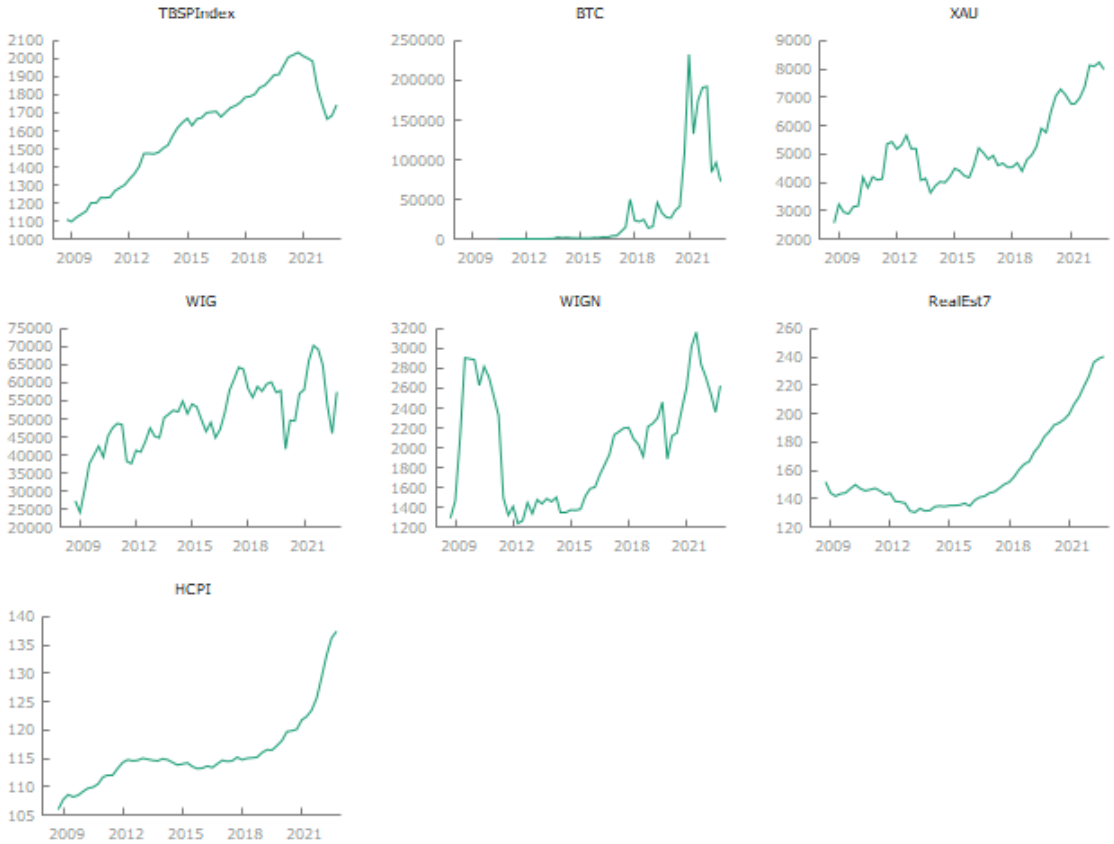
Data used in the study

- The sovereign bond market index (TBSPIndex),
- Bitcoin in PLN (BTC)
- Gold in PLN (XAU)
- The broad stock exchange index from Warsaw Stock Exchange (WIG)
- Sector stock exchange index for companies from the real estate sector (WIGN)
- The hedonic index quotes for the secondary residential property market (RealEst7)
- Harmonised Consumer Price Index (HCPI)

Data used in the study

- All data had a quarterly frequency and covered the period from Q4 2008 to Q4 2022.
- The duration of the research period was determined by the identified business cycle.
- Bitcoin quotes have been available since 2010.

Data used in the study



Methodology of the study

- Four tests for normality of distribution were performed: the Doornik-Hansen, Shapiro-Wilk, Lilliefors and Jarque-Bera tests.
- Due to the lack of normal distribution of almost all return series, a correlation analysis was performed using Spearman's method.
- A cointegration analysis was performed with the Engle - Granger procedure. Cointegration was tested between successive investments and the HCPI.
- Linear regression estimated with the ordinarily least squares (OLS) model was performed .

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Methodology of the study

A similar methodological approach was used in their work by, for example, Stevenson & Murray (1999), Lee (2013). Cointegration tests were performed on the values of the individual variables.

Results and conclusions

Veriable Test	TBSPIndex (p value)	BTC (p value)	XAU (p value)	WIG (p value)	WIGN (p value)	RealEst7 (p value)	HCPI (p value)
Doornik-Hansen	16.72 (0)***	454.24 (0)***	8.42 (0.01)**	**4.07 (0.13)**	26.67 (0)***	6.23 (0.04)**	29.21 (0)***
Shapiro-Wilk W	0.88 (0)***	0.42 (0)***	0.93 (0)***	**0.97 (0.15)**	0.91 (0)***	0.95 (0.03)**	0.86 (0)***
Lilliefors	0.16 (0)***	0.3 (0)***	0.12 (0.03)**	**0.09 (0.23)**	0.1 (0.13)	0.11 (0.08)*	0.15 (0)***
Jarque-Bera	58.03 (0)***	1873.52 (0)***	16.33 (0)***	**2.17 (0.34)**	26.04 (0)***	8.22 (0.02)**	41.17 (0)***

*** Significant at 0.01 (2-tailed significance).

** Significant at 0.05 (2-tailed significance).

* Significant at 0.1 (2-tailed significance).

In all four tests, the null hypothesis of a normal distribution of the observations in the time series was set against the alternative hypothesis of no normal distribution.

Only the distribution of WIG returns was a normal distribution

Results and conclusions

Spearmans correlation coefficient calculated percentage of return with HCPI as benchmark, N=57 except BTC, where N=49

Variable Coefficint	TBSPIndex	BTC	XAU	WIG	WIGN	RealEst7
Speaman's correlation coefficient	-0.33**	0.08	0.14	-0.02	-0.05	0.24

Results and conclusions

There is evidence for a cointegrating relationship if:

(a) The unit-root hypothesis is not rejected for the individual variables, and

(b) the unit-root hypothesis is rejected for the residuals (uhat) from the cointegrating regression.

Results and conclusions

Augmented Dickey-Fuller test, testing down from 10 lags, criterion AIC, unit-root null hypothesis: a = 1, model: (1-L)y = b0 + (a-1)*y(-1) + e.

Variable	TBSPIndex	BTC	XAU	WIG	WIGN	RealEst7	HCPI_52	HCPI_45
Estimated value of (a - 1):	-0.03	**-0.26**	-0.03	-0.18	-0.09	0.02	0.04	0.09
Test statistic tau_c(1):	-1.80	**-2.65**	-0.52	-2.05	-1.47	0.64	1.40	1.72
(Asymptotic p-value)	(0.38)	**(0.08)**	(0.89)	(0.27)	(0.55)	(0.99)	(1.00)	(1.00)
1st-order autocorrelation coeff, for e:	0.01	**0.06**	0.03	-0.03	0.02	-0.03	-0.01	-0.03
Lagged differences: F(4,46)=	4.58 (0.00)	**x**	0.61 (0.66)	0.95 (0.44)	1.00 (0.42)	1.95 (0.12)	4.25 (0.01)	x
Lagged differences: F(4,39)= (p-value)	x	**2.36 (0.07)**	x	x	x	x	x	2.14 (0.09)

Results and conclusions

Augmented Dickey-Fuller test for uhat varible/HCPI including 4 lags of (1-L)uhat

Variable	TBSPIndex	BTC	XAU	WIG	WIGN	RealEst7	HCPI_52	HCPI_45
Estimated value of (a - 1):	-0.05	**-0.72**	-0.28	-0.30	-0.15	-0.07	x	x
Test statistic tau_c(1):	-1.58	**-4.65**	-2.37	-2.53	-2.28	-2.13	x	x
(Asymptotic p-value)	(0.73)	**(0.00)*** **	(0.34)	(0.27)	(0.38)	(0.46)	x	x
1st-order autocorrelation coeff, for e:	0.02	**0.04**	0.00	-0.02	0.02	-0.04	x	x
Lagged differences: F(4,46)=	9.79 (0.00)	**x**	0.78 (0.54)	1.87 (0.54)	1.50 (0.22)	5.36 (0.00)	x	x
Lagged differences: F(4,39)= (p-value)	x	**4.62 (0.00)*** **	x	x	x	x	x	x

Results and conclusions

Research shows that bitcoin and inflation are integrated in an Engle - Granger sense.

Results and conclusions

Model: Ry = b_0 + b_1*ΔHCPI+ e , OLS, using observations: N = 57 and for BTC: N = 49, where Ry is a percentage rate of the return of subsequent variable, and ΔHCPI is percentage change of HCPI

Independent var.	TBSPIndex	BTC	XAU	WIG	WIGN	RealEst7
	-1.57	-28.92	**1.81**	-2.36	-1.23	**0.53**
std. error	0.32	54.06	**1.68**	1.96	2.35	**0.34**
t-ratio (p-value)	-4.9 (0)***	-0.53 (0.6)	**1.08 (0.29)**	-1.2 (0.23)	-0.52 (0.6)	**1.55 (0.13)**
Constant						
	0.02	1.03	**0.02**	0.02	0.02	**0.01**
std. Error	0	0.49	**0.01**	0.02	0.02	**0**
t-ratio (p-value)	5.76 (0)***	2.13 (0.04)**	**1.31 (0.19)**	1.44 (0.16)	0.89 (0.38)	**1.97 (0.05)****
R-squared	0.3	0.01	**0.02**	0.03	0	**0.04**
Adjusted R-squared	0.29	-0.02	**0**	0.01	-0.01	**0.02**
F(1, N-2) (p-value)	24 (0)***	0.29 (0.6)	**1.16 (0.29)**	1.45 (0.23)	0.28 (0.6)	**2.41 (0.13)**
Log-likelihood	149.11	-120.95	**54.7**	45.94	35.59	**145.07**
Schwarz criterion	-290.13	249.68	**-101.31**	-83.8	-63.09	**-282.06**
S.E. of regression (	0.02	2.92	**0.09**	0.11	0.13	**0.02**
Akaike criterion	-294.22	245.89	**-105.4**	-87.89	-67.17	**-286.15**
Hannan-Quinn	-292.63	247.33	**-103.81**	-86.3	-65.59	**-284.56**
Durbin-Watson	1.38	2.04	**2.06**	1.74	1.44	**1.25**

Results and conclusions

Investments whose directional coefficient of the regression function b_1 is greater than zero will be considered protective against the negative impact of inflation on the value of capital.

If $b_1 \in (0,1)$, one can speak of partial protection against inflation.

When $b_1 > 1$ then inflationary processes are overtaken by investment.

Results and conclusions

Three investments that were positively correlated with inflation: Bitcoin, gold and real estate.

This warranted further research to better understand this relationship.

The Engle - Granger test showed a cointegration of Bitcoin quotes with inflation levels. This means that, according to this methodology, the inflation-protecting properties of bonds, gold, equities, and real estate cannot be demonstrated.

The regression analysis points to gold and real estate as assets whose returns follow (real estate) or outpace (gold) inflation.

In summary, three investments can be considered inflation headge: bitcoin, gold, and real estate.

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Thank you

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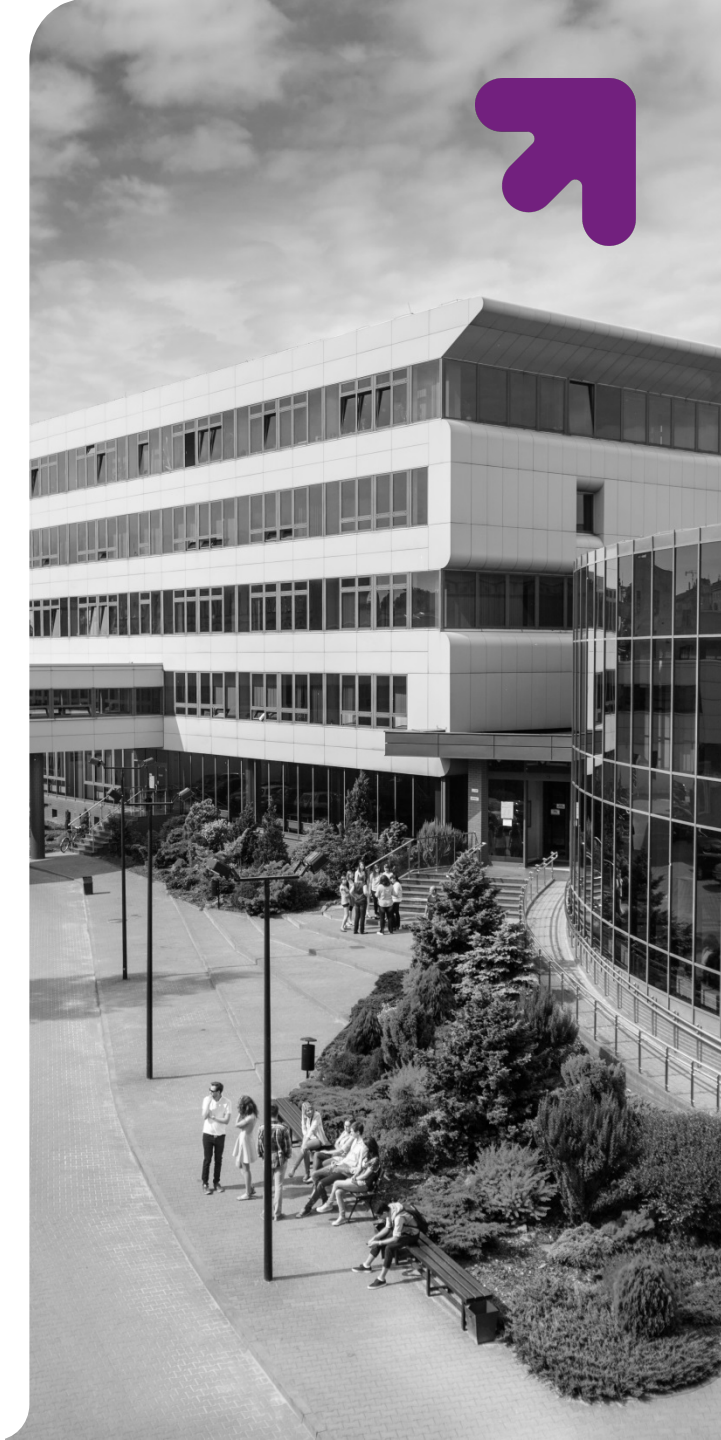

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