

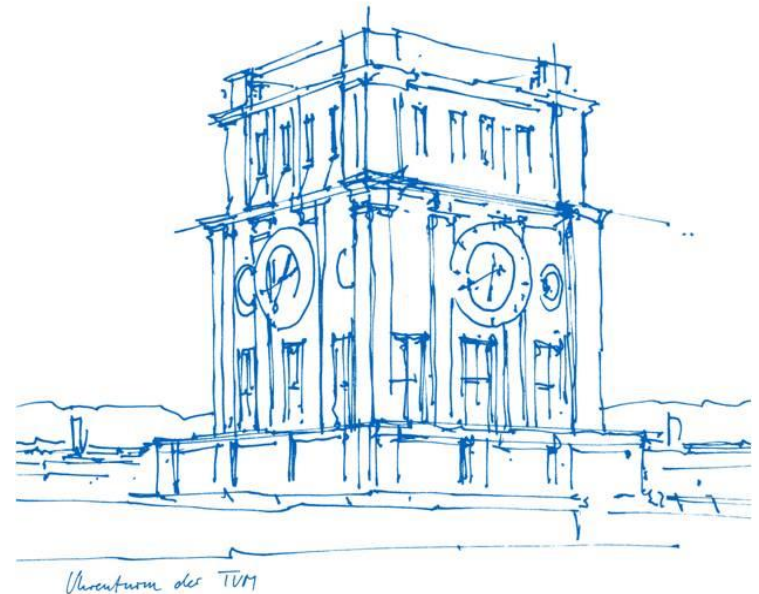
Listed Real Estate as an Inflation Hedge across Regimes

Presenter: Jan Muckenhaupt; Co-Authors: Martin Hoesli & Bing Zhu

Technical University of Munich

TUM School of Engineering and Design

Professorship of Real Estate Development



The Washington Post

Free copy of a newspaper subscription

THURSDAY, JANUARY 10, 2022 - \$3

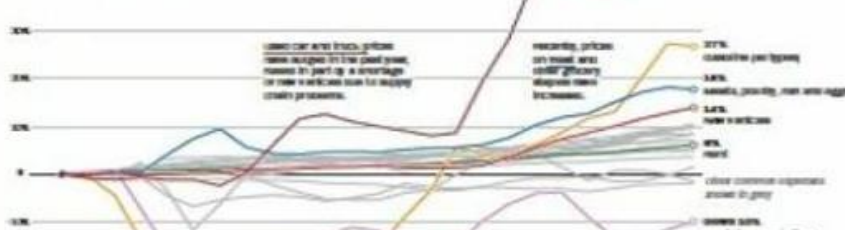
East Coast sees signs of omicron slowdown

Variant's trajectory in cities seems to indicate approach of turning point

BY FRANK NERAMUS AND MANALI KNOWLES
The escalation of omicron cases

Inflation at a 40-year high with price increases across consumer and household essentials

40% increase in prices since Dec. 2020



Inflation for 2021 highest in 40 years

TREND EXPECTED TO LAST FOR MONTHS
Breadth of problem alarm U.S. policymakers

BY MICHAEL M. GREGG

THE WALL STREET JOURNAL

THURSDAY, JULY 28, 2022 - VOL. CCLXXX NO. 23 WSJ.com

DIA 32197.59 ▲ 436.05 1.4% NASDAQ 12032.42 ▲ 4.1% STOXX 600 428.12 ▲ 0.5% 10-YR. TREAS. 15/32, yield 2.731% OIL \$97.26 ▲ \$2.28 GOLD \$1,719.10 ▲ \$1.40 EURO \$1.0198 YEN 136.60

What's News

Business & Finance

Fed Lifts Rates by 0.75 Point Again

Powell expects further increases even as some indicators show signs of softening

BY NICK TIMIRAKOS

WASHINGTON—The Federal Reserve continued a sprint to reverse its easy-money policies by approving on Wednesday another unusually large 0.75-percentage-point interest-rate increase and signaling more tightening was likely this year to combat 40-year-high inflation. A1

U.S. stocks rallied after the Fed's meeting, extending earlier gains. The S&P 500, Nasdaq and Dow added 2.6%, 4.1% and 1.4%, respectively. Treasury yields fell. B1, B11

Facebook parent Meta posted its first decline in revenue and issued a muted outlook on weakness.

federal-funds rate to a range between 2.25% and 2.5%. Markets rallied after the meeting because Fed Chairman Jerome Powell offered fewer specifics about the magnitude of coming rate rises and hinted at an eventual slowdown.

The S&P 500 rose 2.6%, while the Nasdaq Composite had its biggest one-day percentage gain in more than two years, surging 4.1%. Yields on the benchmark 10-year Treasury note fell to 2.731%.

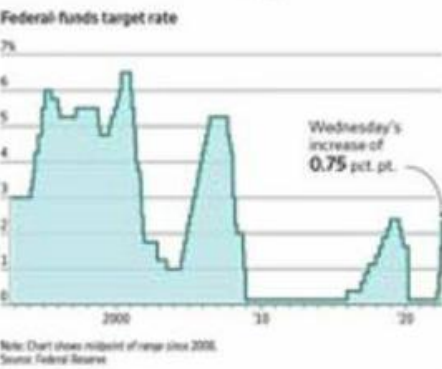
Given Mr. Powell's insistence that the Fed has to cause slower growth and accept rising recession risks to bring down inflation, "it is a

bit surprising that all assets reacted in such an exuberant manner," said Michael de Pass, global head of linear rates trading at Citadel Securities.

Mr. Powell said it was too soon to say whether the Fed would dial down the size of its rate increases to a half or even a quarter point at its next meeting, in September. But he said that at some point, it

Please turn to page A6

- ◆ Federal Reserve rate move fuels stock jump..... B1
- ◆ Powell's remarks send Treasury yields lower..... B11
- ◆ Heard on the Street: How the Fed could lose its nerve.... B12



Protesters Storm Iraqi Parliament Over Prime Minister Race

Facebook

n Post

THURSDAY, JULY 28, 2022 - \$3

Fed raises rates for a 4th time as it fights inflation

Tuesday 10 May 2022 The Guardian

FTSE 100 171.36	All share -95.49	Dow Indl 524.65
7216.58	3987.87	32374.72

High inflation squeeze could last longer and be worse than predicted, say UK economists

Introduction



large price swings in energy and commodity markets



in September 2022, the year-on-year US inflation rose to 8.2%



Central Banks attempting to curb the massive inflation



important to take a fresh look at real estate's inflation hedging capability



crucial for long-term institutional investors and individual investors

Ideas from literature

- Real estate can deliver an adequate inflation hedge:



Rent or lease payments (tenant leases contain rent escalation clauses and/or pass expense increases through to tenants)



Land values and building costs typically rise with inflation. Empirical evidence for listed real estate is mixed

Ideas from literature / contribution



the paper extends the literature in two ways:

- ➔ we allow for non-linear inflation hedging characteristics
- ➔ the project compares the hedging characteristics across asset classes



a lack of conclusive evidence regarding the inflation hedging capabilities across different asset classes

Ideas from literature



previous literature combines Fama and Schwert (1977) framework and the cointegration technique
→ assume a stable relationship



most of the research in portfolio optimisation has been done within a mean-variance framework

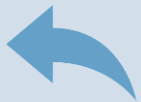


using listed real estate (LRE) performance in the EU area, Lizieri et al. (2022) also show that the mean-variance approach often yields extreme and unrealistic asset allocations to listed real estate

Data and method



Time-series variables that are available monthly from 1990 to the end of 2021



LRE total return indexes come from the European Public Real Estate Association (EPRA)



Stock total return indexes are obtained from Refinitiv Datastream:

- S&P 500 index for the US
- FTSE 250 index for the UK
- Nikkei 500 index for Japan
- S&P/ASX 200 index for Australia

Data and method



EPRA LRE Indexes for the US, the UK, Japan, and Australia



Price of gold, silver, and oil in US Dollars, along with the total return index of the S&P GSCI Agriculture



real three-month Treasury Bill rates
nominal GDP

Inflation decomposition



Decomposition of observed inflation (I_t) into expected inflation (EI_t) and unexpected inflation (UI_t) (Fama and Schwert, 1977)



we can define inflation based on the prior anticipated inflation rate, adjusted for differences between actual inflation and the prior expectation for each period



this leads to a univariate time series approach using Box-Jenkins / ARIMA (1,0,1) procedures to inflation:

Markov-Switching Vector Error Correction Model (MS-VECM)



following Beckman and Czudaj (2013), a MS-VECM is used to examine the relationship between the price of assets and expected and unexpected inflation



the parameters of this model are designed to take a constant value in each regime and to shift discretely from one regime to the other with different switching probabilities

Empirical Results – Long-term Hedging

Country	Rank	$r_{LRE,t-1}$	$r_{stock,t-1}$	$r_{oil,t-1}$	$r_{gold,t-1}$	$r_{silver,t-1}$	$r_{agri,t-1}$	GDP_{t-1}	ir_{t-1}	EI_{t-1}	UI_{t-1}
US	2	1.000	0.000	0.356**	1.811***	-1.445***	-1.315***	-0.077***	0.113	0.124***	-0.074
		(0.000)	(0.000)	(0.179)	(0.296)	(0.291)	(0.406)	(0.010)	(0.083)	(0.027)	(0.152)
		0.000	1.000	0.333**	1.099***	-0.123	0.185	0.025***	-0.119***	-0.148***	-0.470***
		(0.000)	(0.000)	(0.152)	(0.251)	(0.248)	(0.346)	(0.008)	(0.037)	(0.023)	(0.130)
UK	2	1.000	0.000	0.022***	-0.032	-0.546	-1.176**	-0.058***	-0.173***	0.019**	-0.175
		(0.000)	(0.000)	(0.008)	(0.431)	(0.342)	(0.552)	(0.012)	(0.035)	(0.010)	(0.137)
		0.000	1.000	0.007*	0.035	-0.602***	0.378	-0.045***	-0.053***	-0.008	-0.327***
		(0.000)	(0.000)	(0.004)	(0.238)	(0.189)	(0.305)	(0.007)	(0.019)	(0.006)	(0.076)
JPN	2	1.000	0.000	0.012	-0.775	-1.049***	1.495***	-0.088***	0.005	0.061***	0.065***
		(0.000)	(0.000)	(0.008)	(0.535)	(0.406)	(0.499)	(0.021)	(0.054)	(0.027)	(0.042)
		0.000	1.000	-0.016***	-0.592**	0.128	0.501**	-0.063***	-0.123***	-0.042***	-0.100***
		(0.000)	(0.000)	(0.004)	(0.254)	(0.193)	(0.237)	(0.010)	(0.026)	(0.013)	(0.020)

Notes: US stands for United States of America, UK for United Kingdom, JPN for Japan. The analysis of the US, UK, and Japan is conducted by using an unrestricted constant. $r_{LRE,t-1}$ denotes the FTSE/EPRA/NAREIT real estate stock total return index. $r_{stock,t-1}$ denotes for each country the corresponding total return of the stock market index. $r_{oil,t-1}$ denotes the oil price in US Dollars. $r_{gold,t-1}$ denotes the gold price in US Dollars. $r_{silver,t-1}$ denotes the silver price in US Dollars. Australia is not reported because the rank of listed real estate, stocks, oil, gold, silver, agricultural, GDP, interest rate, expected and unexpected inflation in Australia is zero, indicating that these variables are not co-integrated. $r_{agri,t-1}$ denotes the total return index of S&P GSCI Agriculture. GDP_{t-1} stands for GDP of each country. ir_{t-1} are the 3-month treasury bill rates. EI_{t-1} and UI_{t-1} stand for expected and unexpected inflation, respectively. Rank denotes the rank of π matrix. Standard errors are included in the parentheses. ***, **, * denotes significance level at 1%, 5% or 10%, respectively.

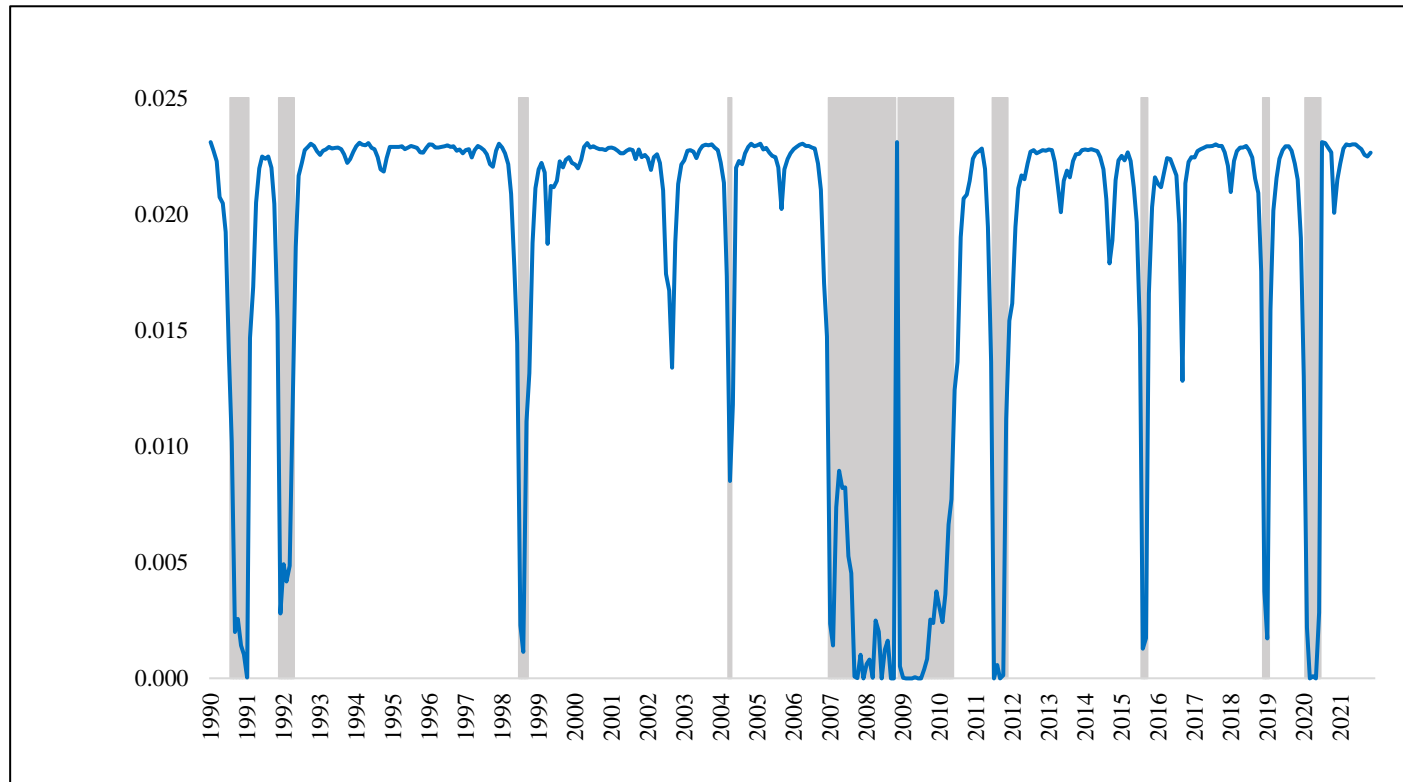
Empirical Results – Short-term Hedging

Short-term coefficients for Regime 1 and 2														Transition probability matrix P		
Country		$\Delta r_{LRE,t-1}$	$\Delta r_{stock,t-1}$	$\Delta r_{oil,t-1}$	$\Delta r_{gold,t-1}$	$\Delta r_{silver,t-1}$	$\Delta r_{agri,t-1}$	ΔGDP_{t-1}	Δir_{t-1}	ΔEI	ΔUI	ECT1	ECT2	Regime 1	Regime 2	
U.S.	Regime 1	-0.015 (0.070)	0.064 (0.073)	-0.074** (0.028)	-0.069 (0.078)	-0.012 (0.051)	-0.001 (0.005)	0.001 (0.001)	0.022 (0.018)	0.0231* (0.012)	0.025* (0.013)	0.006 (0.008)	0.009 (0.011)	Regime 1	0.951	0.183
	Regime 2	-0.666*** (0.170)	1.041*** (0.296)	0.205** (0.097)	0.456 (0.411)	-0.436** (0.222)	0.291 (0.200)	0.011*** (0.004)	-0.186*** (0.069)	-0.010 (0.035)	-0.168** (0.067)	0.033 (0.026)	-0.018 (0.032)	Regime 2	0.049	0.817
UK	Regime 1	-0.032 (0.063)	0.006 (0.080)	-0.001 (0.001)	-0.165*** (0.060)	-0.001 (0.012)	0.146** (0.061)	0.001 (0.001)	-0.024 (0.019)	0.018*** (0.006)	-0.007 (0.012)	0.016*** (0.004)	0.001 (0.024)	Regime 1	0.959	0.270
	Regime 2	0.001 (0.026)	0.587** (0.296)	0.002 (0.006)	0.435 (0.349)	-0.271 (0.221)	-1.125* (0.591)	0.086** (0.036)	0.004 (0.087)	-0.017 (0.224)	-0.122 (0.083)	-0.141** (0.070)	0.236* (0.126)	Regime 2	0.041	0.730
JPN	Regime 1	-0.315*** (0.077)	0.288*** (0.087)	-0.001 (0.001)	-0.707*** (0.100)	0.211*** (0.055)	0.099* (0.055)	-0.004 (0.0038)	0.015 (0.034)	-0.030** (0.015)	-0.056*** (0.015)	0.013* (0.008)	-0.043** (0.017)	Regime 1	0.900	0.040
	Regime 2	-0.203*** (0.054)	0.947*** (0.095)	0.002 (0.002)	0.311** (0.158)	-0.145 (0.090)	0.086 (0.088)	0.004 (0.005)	-0.014 (0.049)	-0.011 (0.021)	0.021 (0.024)	- 0.044*** (0.013)	-0.003 (0.025)	Regime 2	0.100	0.960
AUS	Regime 1	-0.125** (0.063)	0.041 (0.066)	-0.002** (0.001)	-0.0710 (0.060)	-0.008 (0.034)	-0.008 (0.049)	-0.002*** (0.001)	-0.027* (0.015)	0.014** (0.008)	0.015 (0.018)			Regime 1	0.990	0.106
	Regime 2	-0.689** (0.271)	0.971* (0.553)	0.003 (0.006)	0.663 (0.768)	-0.236 (0.512)	-1.726*** (0.472)	-0.000 (0.011)	0.613*** (0.170)	-0.129** (0.063)	0.388 (0.465)			Regime 2	0.010	0.894

Notes: US stands for United States of America, UK for United Kingdom, JPN for Japan, and AU for Australia. We only report the equation for LRE returns. $r_{LRE,t-1}$ denotes the FTSE/EPRA/NAREIT real estate stock total return index. $r_{stock,t-1}$ denotes for each country the corresponding total return of the stock market index. $r_{oil,t-1}$ denotes the oil price in US Dollars. $r_{gold,t-1}$ denotes the gold price in US Dollars. $r_{silver,t-1}$ denotes the silver price in US Dollars. $r_{agri,t-1}$ denotes the total return index of S&P GSCI Agriculture. GDP_{t-1} stands for GDP of each country. ir_{t-1} are the 3-month treasury bill rates. EI_{t-1} and UI_{t-1} stand for expected and unexpected inflation, respectively. ECT1, ECT2, and ECT3 are the coefficients of error correction terms. Regime 1 and 2 are reported. The transition matrix P reports the transition probabilities of the stochastic process.

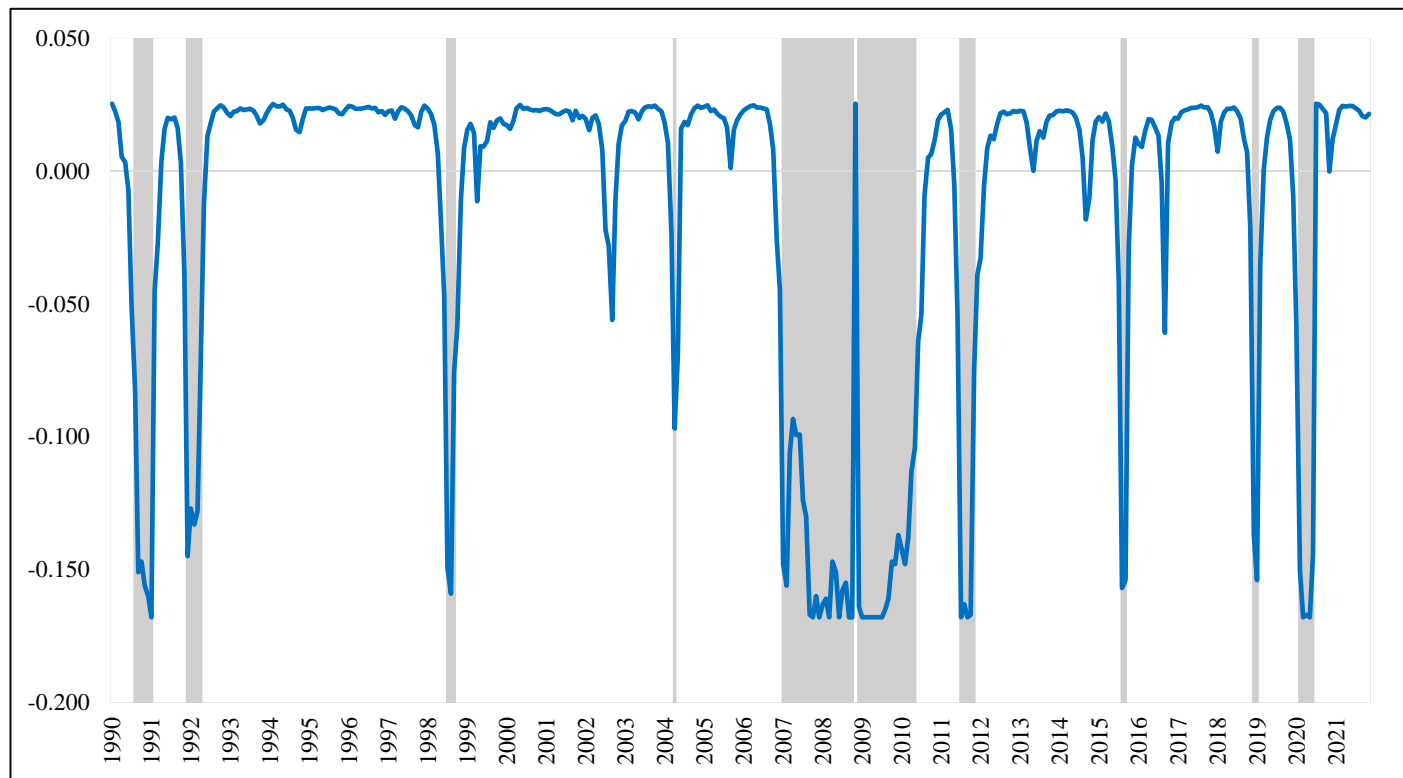
Empirical Results – Short-term Hedging

U.S. Time-Varying Coefficient of EI



Empirical Results – Short-term Hedging

U.S. Time-Varying Coefficient of UI



Inflation Hedging Portfolios



we present optimal portfolios using the shortfall probability approach for the US, UK, Japan, and Australia for a target real return of 3% and an investment horizon of T ($T = 2$ years, rebalancing every two years)



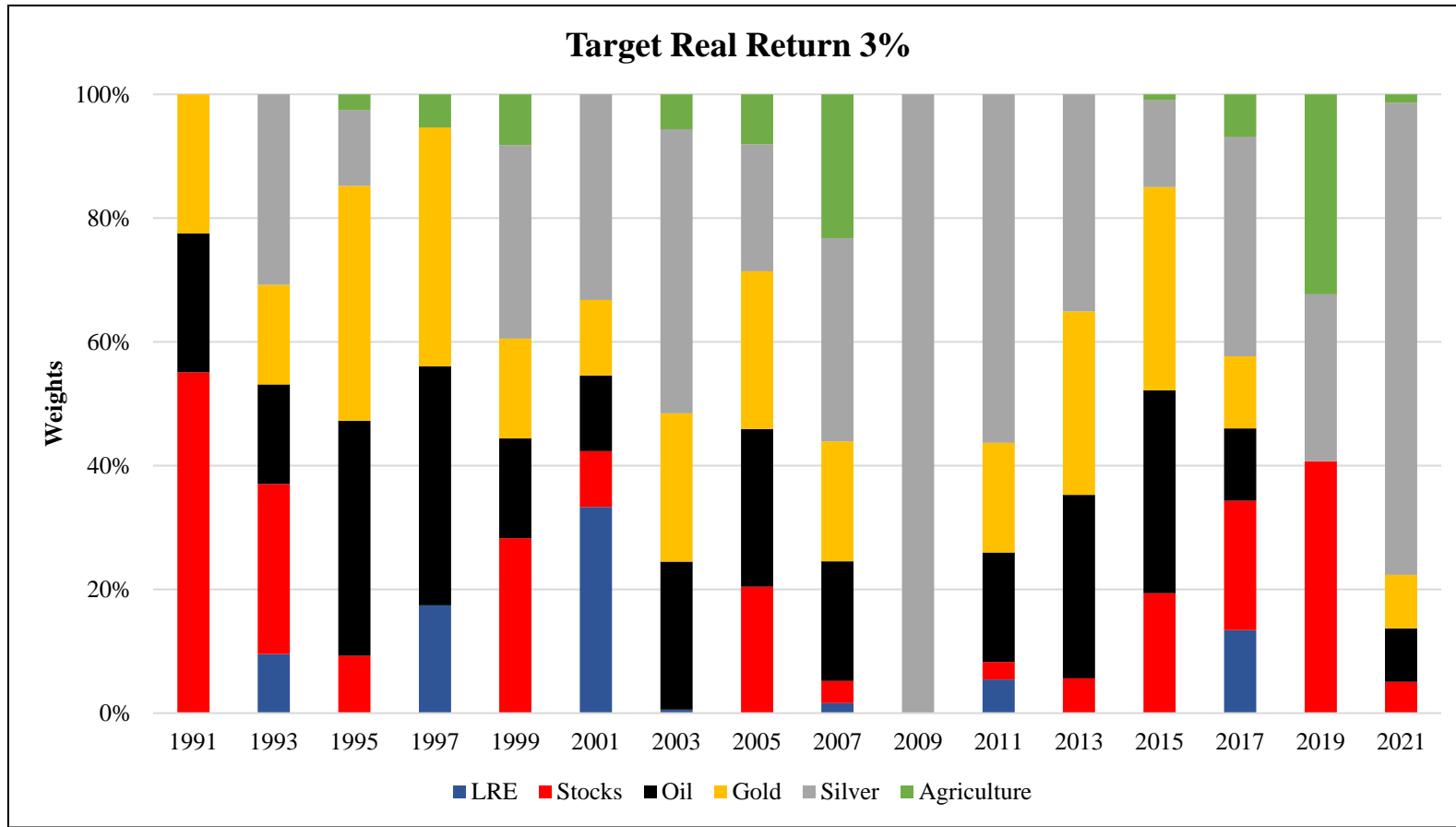
as expected, the weights for LRE vary over time



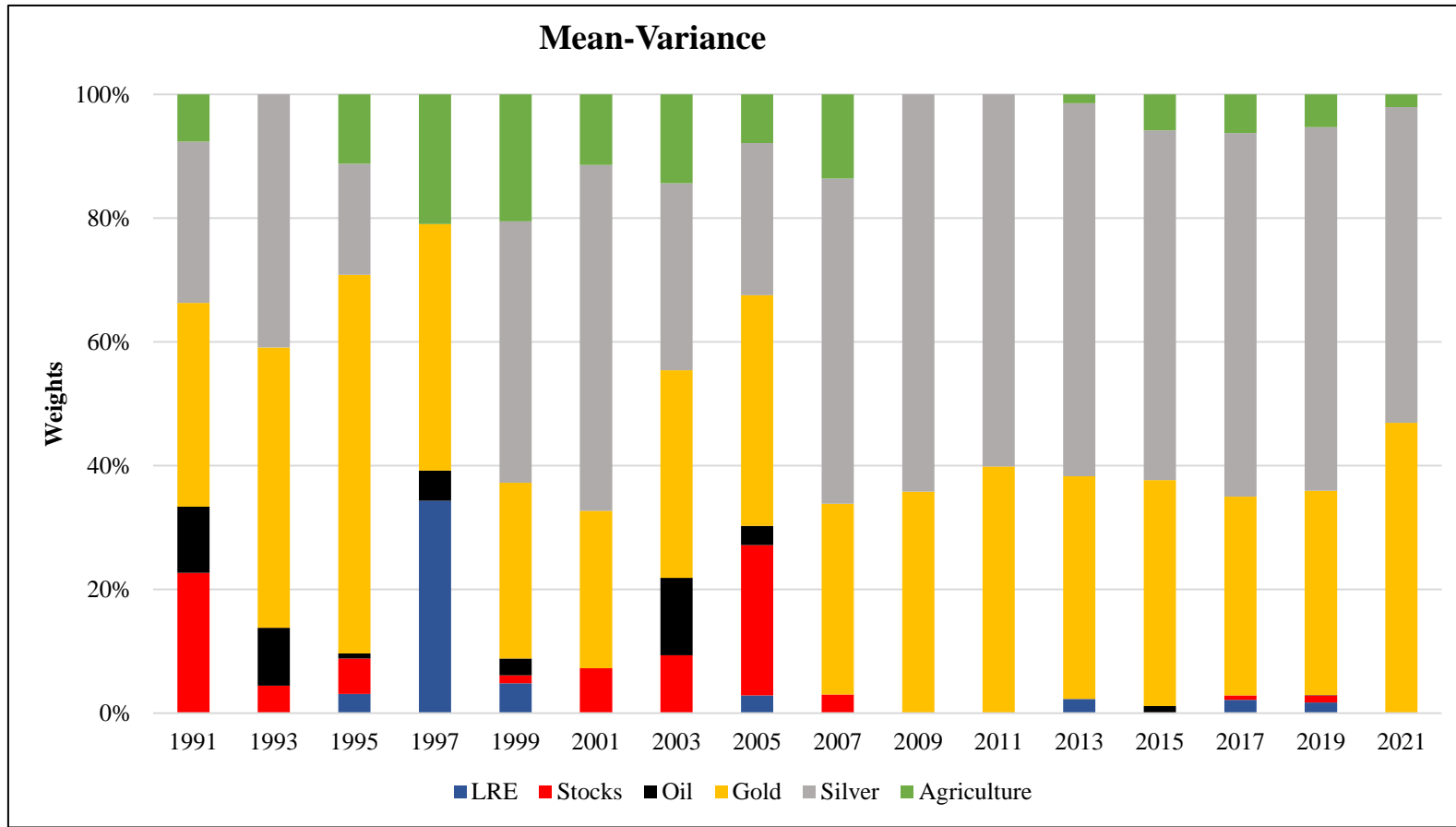
average percentages of the portfolios for the US, UK, Japan, and Australia over the entire period are 6.35%, 19.21%, 16.02%, and 48.81%, respectively

→ Highlighting benefits of holding LRE for investors

Inflation Hedging Portfolios



Inflation Hedging Portfolios



Main Findings



LRE is a good hedge against inflation, but mainly against expected inflation and in the long term



short-term hedging ability moves towards being negative during crisis periods



Inflation hedging ability of LRE also varies across countries



Inflation-hedging portfolios provide more realistic and less extreme allocations to listed real estate than when the standard mean-variance approach is used

Further research planned



Extension of the time series



Capital gain and income return



testing alternative inflation measure

Thank you for listening!

Jan Muckenhaupt

29th ERES Annual Conference

London, 12.07.2023



Appendix: Stationarity and cointegration



Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for stationarity



all series are $I(1)$, indicating stationarity in first differences



using trace test to test for cointegration