

Neifar, Malika; Harzallah, Amira

Article

The Fisher's hedge hypothesis: What about homogeneity and stability properties?

Journal of Derivatives and Quantitative Studies: Seonmul yeon'gu (JDQS)

Provided in Cooperation with:

Korea Derivatives Association (KDA)

Suggested Citation: Neifar, Malika; Harzallah, Amira (2024) : The Fisher's hedge hypothesis: What about homogeneity and stability properties?, Journal of Derivatives and Quantitative Studies: Seonmul yeon'gu (JDQS), ISSN 2713-6647, Emerald, Leeds, Vol. 32, Iss. 4, pp. 344-370, <https://doi.org/10.1108/JDQS-07-2024-0028>

This Version is available at:

<https://hdl.handle.net/10419/337286>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

The Fisher's hedge hypothesis: what about homogeneity and stability properties?

Malika Neifar

IHEC University of Sfax, Sfax, Tunisia, and

Amira Harzallah

University of Monastir, Monastir, Tunisia

Abstract

The purpose of this study is to see if the Fisher's hypothesis validation is robust in year or/and countries dimensions. We investigate whether nominal or real stock market returns are hedged against inflation rate, so as to determine the appropriate time and markets to invest in (from the 32 countries) over a period covering the 2008 global finance crisis (GFC) and the Covid 19 outbreak. Hedging property is found to be homogenous within countries and stable in time. Using either nominal or real return, based on cross-sectional data results, Fisher's hypothesis is generally validated with a few exceptions, while the time-series based results show that the hedge property is robust only in some countries. Using time series data (cross section data), in terms of homogeneity (homogeneity and stability), there is no difference between hedge property between Euro and non-Euro countries (groups of countries or between sub-periods) for both periods covering either 2008 GFC or the Covid 19 outbreak. Robust results are also the outcome of panel data investigations with or without the interest rate role as macro control variable.

Keywords Fisher hypothesis, Time series, Cross-sectional, Panel data, 2008 global financial crisis, Covid 19 outbreak, Stability and homogeneity of hedging property

Paper type Research paper

1. Introduction

In the context of the relationship between stock market returns and the inflation rate, the generalized (Fisher, 1930) Fisher's hypothesis implies a *positive link* between *nominal* stock returns and the inflation rate and the *independence* between *real* stock market returns and the *expected* inflation. In such a situation, the stocks offer a protection or hedge against inflation (Jaffe and Mandelker, 1976) [1]. According to Fisher (1930), assets that represent claims to physical or real assets, such as stocks, should offer a hedge against inflation.

The relationship between inflation rate and stock returns has been a subject of extensive empirical study by several financial economists around the world. The literature on Fisher hypothesis verification is conflicting. Some category of these studies showed a significant positive relationship between inflation rates and stock market (supports the hypothesis),

JEL Classification — E44, G11, G15.

© Malika Neifar and Amira Harzallah. Published in *Journal of Derivatives and Quantitative Studies: 선물연구*. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) licence. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this licence maybe seen at <http://creativecommons.org/licenses/by/4.0/legalcode>

The authors thank Prof. Byung Jin Kang the Editor for *Journal of Derivatives and Quantitative Studies* for coordinating the simultaneous submission and two anonymous referees for their valuable comments that helped to significantly improve our paper.

Competing interests: The authors declare that they have no competing interests.

Availability of data and materials: Data is available upon request



some found a significant negative relationship and others found no significant relationship between the two variables.

In view of the wide range of conflicting empirical studies on how inflation rates affect the stock returns, one cannot draw conclusions about the reasons: is it because of the type of the data? (time series vs cross section or panel data), or because of the period of study? (pre-during and post-crisis as the 2008 GFC and the Covid 19 outbreak), or because of the used Fisher hypothesis definition? (in terms of nominal vs real return), or because of the considered countries? (Euro vs non Euro, or developed vs emerging, single vs group of countries, etc . . .).

Recently, a few authors have conducted investigations based on group of countries; panel data (Neifar and Hachicha, 2022; Salisu *et al.*, 2019, 2020; Halit, 2016). But, each of these references does not consider comparative analysis by country groups.

This paper attempts not only to fill this gap but also to make a comparison of results based on three types of data: cross-sectional, time series and panel data. More precisely, this paper will verify the homogeneity and the stability of Fisher hedging hypothesis properties. Practically, this study will verify robustness results from Fisher's (1930) hypothesis verification over *time* (covering two crisis: the 2008 global financial crisis (GFC) and the Covid 19 outbreak; pre, during and post the crisis), over *countries or group of countries* (European vs non-European countries, or emerging vs developed countries), as well as over *year-country* dimension.

The *year dimension* (with time series data) will concern the verification of the hedge robustness in two ways:

- (1) Results based on nominal returns (R) are compared with ones based on real returns (RR),
- (2) Results based on actual inflation (INF) are compared with ones based on expected (EINF) and unanticipated inflation (UEINF),

From the homogeneity side via two groups of countries (Euro and non-Euro countries).

The Fisher hypothesis will be tested using monthly data during 2000:01 – 2019:01 for the 2008 GFC case and during 2016:06–2024:04 for the Covid 19 outbreak. The verification of this hypothesis requires the decomposition of the current inflation rate into the unexpected and expected inflation rate using the so-called Hodrick–Prescott (HP) filter (Hodrick and Prescott, 1997).

Besides the hedging robustness verification, as done in the *year dimension*, the *country dimension* (with cross-section data) concerns in addition the homogeneity vs heterogeneity investigations of financial market behavior in the group of emerging vs developed countries. Moreover, for stability question, robustness verification concerns also three sub-periods pre-during and post-considered crisis (2008 GFC or Covid-19).

For the cross-sectional data creation, each time series will be reduced to a point which sum up the information in time by a point estimation; the time average for each country. With cross-sectional data, estimation will be made over three sub-periods; a first one for pre-crisis [(2000 – 2007) for the financial one and (2016:06–2019:11) for the Covid one], a second one for the crisis period [(2008 – 2009) for financial one and (2019:12–2022:06) for the Covid one] and a third one for post-crisis [(2010 – 2019) for financial one and (2022:07–2024:04) for the Covid 19 one].

Using time series or cross-section data, estimation will be carried out for two groups of countries: Group I (European vs non-European countries) and Group II (emerging vs developed countries). Static linear simple and multiple models will be estimated by Quasi-Generalized Least Squares (QGLS) or robust least squares.

The *year-country dimension* (with panel data) will particularly concern robustness check from previous robust results once macro-economic (namely interest rate) impact is taken into account.

Based on panel data, random effect model versus fixed effect model choice will be based on Hausman test. For more robustness investigation, some augmented models with the interest rate as control economic variable are considered.

Besides the robustness check of all results, we seek to determine which markets and at which point in time investors are mostly interested to invest in.

The text begins with an introduction. [Section 2](#) provides a brief review of the literature. [Section 3](#) presents the data analysis after description, creation and the sources. [Section 4](#) gives several appropriate models for our study. [Section 5](#) discusses in a first steps the finding for the baseline models in two dimensions (years and countries) for the period covering the 2008 GFC. Then, in a second steps, we propose three extensions for more robustness check: (1) to take into account more recent data covering the Covid 19 crisis, (2) the use of panel data for simultaneous check of year stability and country group homogeneity, (3) as well as the check the control variable (interest rate) impact. We conclude in [Section 6](#).

2. Literature review

A vast literature on the link between equity returns (real or nominal) and the inflation rate (real, expected and/or unexpected) is available among the oldest economic and financial studies. The ability of financial assets returns to protect investors from inflation is not a new topic in both theoretical and empirical literature.

Numerous studies have empirically investigated the ability of stock returns to hedge inflation in both the developed and the emerging stock markets. Some studies found evidence of partial hedge for stock returns against inflation. Evidence of stock returns providing hedge against inflation at a given time periods and not in another periods also exist in the literature.

Most of the older studies are based on time-series data, with the exception of [Gultekin \(1983\)](#), which is based on both time-series and cross-section data.

From time series data side, three type of results can be summed up (see [Table 1](#) for more details):

- (1) Some papers have found a positive relationship between stock returns and inflation ([Boudoukh and Richardson, 1993](#); [Alagidede and Panagiotidis, 2010](#); [Owusu-Nantwi and Kuwornu, 2011](#); [Oprea, 2014](#); [Tiwari et al., 2015](#); [Bampinas and Panagiotidis, 2016](#); [Hau, 2017, . . .](#));
- (2) Others have found that stock prices and the inflation rate are negatively related, and then the Fisher hypothesis is not verified ([Bodie, 1976](#); [Fama and Schwert, 1977](#); [Gultekin, 1983](#); [Chatrath et al., 1997](#); [Zhao, 1999](#); [Eldomiaty and AboulSoud, 2020](#); [Chiang, 2023](#));
- (3) Some others have found mixed results ([Jaffe and Mandelker, 1976](#); [Spyrou, 2004](#); [Rushdi and al. 2012 . . .](#)).

[Gultekin \(1983\)](#) examined the Fisher hypothesis in 26 countries from January 1947 to December 1979 and found that for most of the considered countries the relationship between these two variables is negative (Fisher hypothesis is not valid).

Some recent studies have used both time series and panel data ([Salisu et al., 2019, 2020](#); [Neifar and Hachicha, 2022](#)). [Salisu et al. \(2019\)](#) found that both gold and palladium protect against inflation in OECD countries. The use of panel data in [Salisu et al., \(2019\)](#) is for the purposes of checking the robustness of their results. [Salisu et al. \(2020\)](#) in their investigations found that the equities become a good hedge against inflation *only post the 2008 GFC*. Subsequently, based on panel data [Neifar and Hachicha \(2022\)](#), showed that stock returns are hedged against inflation *only during the 2008 GFC* for the case of three developed countries (Canada, Suisse and the UK).

Reference	Period	Type of data	Model/Method	Hedge?
Gultekin (1983)	1947–1979	TS and CS	OLS	NO with nominal returns
Bodie (1976)	1953–1972	TS	OLS	NO with nominal returns
Fama and Schwert (1977)	1953–1971	TS	Simple regression	NO with nominal returns
Chatrath <i>et al.</i> (1997)	1984–1992	TS	OLS	NO with real returns
Zhao (1999)	1993–1998	TS	ARMA; GARCH	NO with nominal returns
Jaffe and Mandelker (1976)	1953–1971	TS	Multiple regression	NO with nominal returns
Choudhry (1998)	1981–1998	TS	Spectral regression method; Semi-parametric; Gaussian method	- YES with nominal returns - NO with real returns
Spyrou (2004)	1989–2000	TS	Simple regression	YES for some countries with nominal returns
Alagidede and Panagiotidis (2010)	Varies from country to country	TS	Johansen's multivariate method	YES for 3 African countries with nominal returns
Rushdi <i>et al.</i> (2012)	1969–2008	TS	ARDL	YES for the case of expected inflation with real returns NO for the case of observed inflation with nominal returns
Tiwari <i>et al.</i> (2015)	1961–2012	TS	Causality and continuous Wavelet transform	YES with real returns
Bampinas and Panagiotidis (2016)	1993–2012	TS	OLS regression; Quantile regression	YES with nominal returns
Salisu <i>et al.</i> (2019)	2009–2019	TS and PD	Simple regression; Threshold-based regression models	YES
Salisu <i>et al.</i> (2020)	Not specified	TS and PD	Linear regression; Asymmetric model	YES after GFC with real returns
Eldomiatty and AboulSoud (2020)	1999–2016	TS	Johansen cointegration; Granger causality; VECM	NO with nominal returns
Neifar and Hachicha (2022)	1999–2018	TS and PD	ARDL model; MG; PMG	YES during 2008 GFC for the case of three developed countries with nominal returns
Chiang (2023b)	1990–2022	TS	GARCH; - APARCH-M	NO with real returns
Almeida <i>et al.</i> (2024)	1953–2023	TS	Fractional Cointegrating Vector Autoregressive (FCVAR)	YES with real returns
Abdali and Alm (2024)	2000–2023	TS	Linear regression models	NO with nominal returns
Farahani <i>et al.</i> (2023)	2020–2021	TS and PD	Mixed data sampling (MIDAS) regression model	YES with nominal returns
Chiang (2023)	1989–2023	TS	GED-APARCH	NO with both Nominal and Real return
Chola (2024)	2001–2021	TS	Johansen Tests	NO with nominal returns

Note(s): TS: time series and PD: panel data. CS: cross section. No: Fisher's hypothesis not validated. Yes: the opposite of No. OLS: ordinary least square. ARDL: autoregressive dynamic linear. MG: mean group. PMG: pooled mean group. GARCH: generalized autoregressive conditional heteroscedastic
Source(s): Authors' elaboration

Table 1.
Sum up of a selected
literature review

Studies on the relationship between stock market returns (nominal or real) and the inflation rate (real or anticipated) are numerous (see [Table 1](#)). However, to our knowledge, apart from [Gultekin \(1983\)](#) who tested Fisher's hypothesis with cross-sectional data, all the literature considers (rarely) the time series (group of countries; panel) data in testing Fisher's hypothesis.

For the Fisher's hypothesis verification, this paper is the first which will consider both the years and countries dimensions as well as the year–country dimension to test homogeneity and/or stability of financial market behavior in European versus non-European countries, as well as in emerging versus developed countries covering two crisis: the 2008 GFC and the Covid 19 outbreak. Three types of data will be investigated: time series, cross section and panel data to see if hedging property is robust from different specifications.

3. Data analysis and processing

3.1 Data description and variable creation

The collected data are the consumer price indices (CPI), the stock market indices (SP) and the interest rate (IR). Sources of data are indicated in [Table 2](#).

The considered sample of $n = 32$ countries (for which data are available from January 2000 to January 2019 covering the 2008 GFC crisis and from June 2016 to April 2024 that cover the Covid 19 outbreak) will be gathered in two groups of countries (that as given in the 2021 IMF classification):

- (1) The first group includes 19 European countries and 13 non-European countries.
- (2) The second group involve 25 developed countries and 7 emerging countries.

The conventional considered variables; mainly the stock market returns and the inflation rate are defined and given in [Table 2](#) (Panel A). Some other variables are useful in this paper: the real return, the expected inflation and the unanticipated inflation rates that are computed as shown in [Table 2](#). Each variable computation and the sample of studied countries are given in [Table 2](#) (Panel B).

To get rid of the time factor, and in order to obtain cross-sectional data, each variable Y_{it} of country i , $t = 1, \dots, T$, can be estimated by a point in the space; it is the mean of the T observations for the variable, which will be noted by \bar{Y}_i , for each country $i = 1, \dots, n = 32$.

3.2 Graphic analysis

Before starting modeling the return–inflation relationship, we give the graphical relationship between them in order to detect the direction of any association (positive or negative). We also seek to build an idea about the stability of these relationships. Several graphs are constructed in different spaces and different range of periods.

In the country dimension, we try to distinguish the behavior of individuals from different groups of countries (developed vs emerging or European vs non-European). In the time dimension, we are looking to see whether any association between variables remains stable from one sub-period to the next, particularly in relation to the 2008 GFC.

The graphical representation of the linear relationship between nominal yields and the inflation rate for Euro vs non-Euro countries and for emerging vs developed countries for the global period (2000 – 2019), the pre-financial crisis sub-period (2000 – 2007), the financial crisis sub-period (2008 – 2009) and the post-financial crisis sub-period (2010 – 2019) is illustrated in [Figures 1–4](#), respectively.

We note *a priori* that for the overall period (2000 – 2019) and for the sub-period (2000 – 2007), the Fisher hypothesis is verified on average for both groups with a greater positive slope ($\beta > 0$) for non-euro countries (group I) and for emerging countries (group II); see

Panel A: variables Variables	Descriptions	Sources
Stock market indices (SP)	Price of ordinary shares in companies listed on domestic or foreign stock exchanges	OECD and IMF
Consumer price index (CPI)	CPI is a measure of the overall change in the prices of goods and services consumed	IMF
Interest rate (IR)	Money Market Rate for Russia and Iceland and long run interest rate for other countries	OECD and IMF
Inflation (INF)	<i>Time Series data</i> It is the difference between the log-transformed CPI at time (t) and time ($t - 1$)	<i>Definitions</i> $INF_t = LCPI_t - LCPI_{t-1}$
Expected inflation (EINF)	It is calculated using the (Hodrick and Prescott, 1997) filter	$EINF = E(INF_t \Omega_{t-1})$
Unanticipated inflation (UNINF)	It is the difference between inflation and expected inflation	$UNINF = INF_t - EINF$
Nominal return (R)	It is the difference between the log (LSP) share price at time (t) and time ($t - 1$)	$R_t = LSP_t - LSP_{t-1}$
Real return (RR)	It is the difference between nominal return (R) and inflation (INF)	$RR_t = R_t - INF_t$
\bar{R}_i	<i>Cross-sectional data creation</i> It is the average of nominal yield over time, for $i = 1, \dots, 32$	$\bar{R}_i = \frac{\sum_t R_{it}}{T}$
\overline{RR}_i	It is the average of real yield over time, for $i = 1, \dots, 32$	$\overline{RR}_i = \frac{\sum_t RR_{it}}{T}$
\overline{INF}_i	It is the average of inflation over time, for $i = 1, \dots, 32$	$\overline{INF}_i = \frac{\sum_t INF_{it}}{T}$
\overline{EINF}_i	It is the average of expected inflation over time, for $i = 1, \dots, 32$	$\overline{EINF}_i = \frac{\sum_t EINF_{it}}{T}$
\overline{UNEINF}_i	It is the average of unexpected inflation over time, for $i = 1, \dots, 32$	$\overline{UNEINF}_i = \frac{\sum_t UNEINF_{it}}{T}$

Panel B: sample of countries

Group I: euro vs non-euro countries

European countries

Austria, Germany, France, Belgium, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Luxembourg, Poland, Portugal, Spain, United Kingdom, Russia

Non-European countries

China, India, Indonesia, Japan, Turkey, Bangladesh, Mongolia, Malaysia, USA, Canada, Brazil, Colombia and Chile

Group II: developed vs emerging countries

Developed countries

Austria, Germany, Belgium, Denmark, Spain, France, Italy, Portugal, United Kingdom, Russia, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Latvia, Luxembourg, Poland, Canada, United States, Chile, Japan, Malaysia and Turkey

Emerging countries

Brazil, Colombia, Indonesia, Mongolia, Bangladesh, China and India

Note(s): The (Hodrick and Prescott, 1997) HP filter requires the minimum of $\sum_{t=0}^T (x_t + \bar{x}_t)^2 + \theta \sum_{t=0}^{T-1} [(\bar{x}_{t+1} - \bar{x}_t)(\bar{x}_t - \bar{x}_{t-1})]$, for $\theta > 0$. This method breaks down an x-series into its trend (the expected components) and cyclical components (the unexpected components). OECD: Organization for Economic Cooperation and Development. IMF: International Monetary Fund. The country classification is based on the 2021 IMF classification

Source(s): Authors' elaboration

Table 2.
Data description

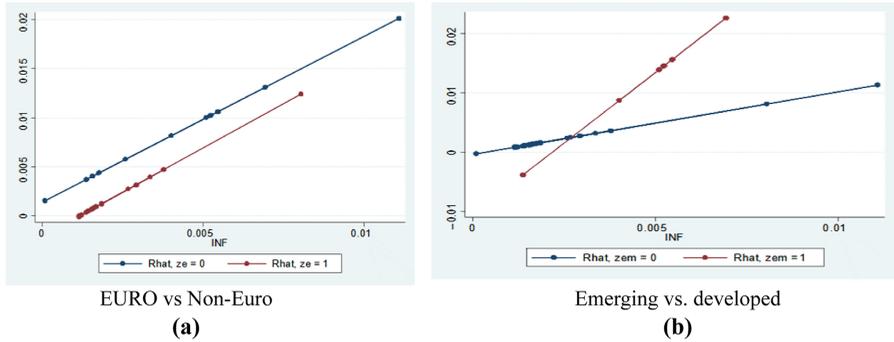


Figure 1. Relationship between nominal returns (R) and inflation for different groups for the full period (2000 – 2019)

Note(s): $ze = 1$ for the euro zone and $ze = 0$ otherwise, and $zem = 1$ for the emerging countries zone and $zem = 0$ otherwise (developed). Rhat is used to indicate the Return adjusted value; $\hat{R} = \hat{\alpha} + \hat{\beta} INF$. $\hat{\beta}$ is the slope of the fitted line, $\hat{\beta} > 0$ in all cases. For case a, lines are parallel (similar effect for Euro and Non-Euro). For case b, $\hat{\beta}$ for emerging countries is higher than one for developed countries. Fisher hypothesis is valid in all case for full period

Source(s): Authors' elaboration

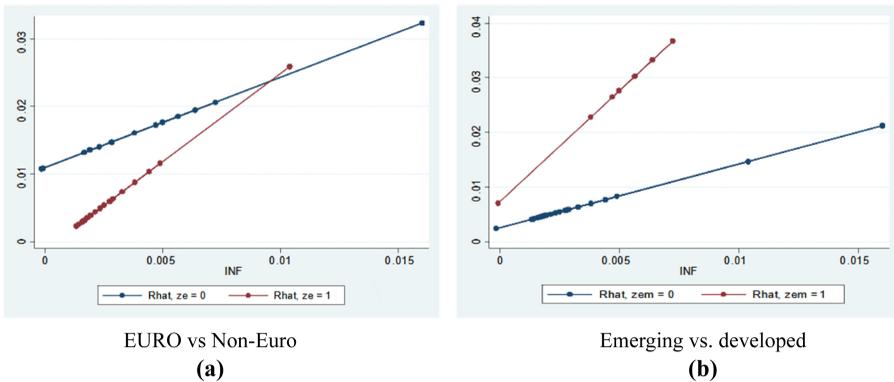


Figure 2. Relationship between nominal returns (R) and inflation for different groups for the pre-crisis period (2000 – 2007)

Note(s): $ze = 1$ for the euro zone and 0 otherwise, and $zem = 1$ for the emerging countries zone and 0 otherwise (developed). Rhat is used to indicate the Return adjusted value; $\hat{R} = \hat{\alpha} + \hat{\beta} INF$. $\hat{\beta}$ is the slope of the fitted line. Results in c and d cases are similar to ones of b case in Figure 1. Fisher hypothesis is valid in all case pre crisis

Source(s): Authors' elaboration

Figures 1 and 2. However, for the financial crisis sub-period (2008 – 2009), we find that Fisher's hypothesis is on average not verified for both groups, since the slope is negative ($\beta < 0$), see Figure 3. On the other hand, post the financial crisis (2010 – 2019), the slope becomes positive for both groups, and is higher for Euro countries (group I) and developed countries (group II). Then, on average the Fisher hypothesis is verified; see Figure 4.

4. Methodologies for the Fisher hypothesis testing

There are three possible definitions of inflation hedging (Bodie, 1976). The definition, which has been used in almost all empirical studies of inflation hedging, states that an asset is an

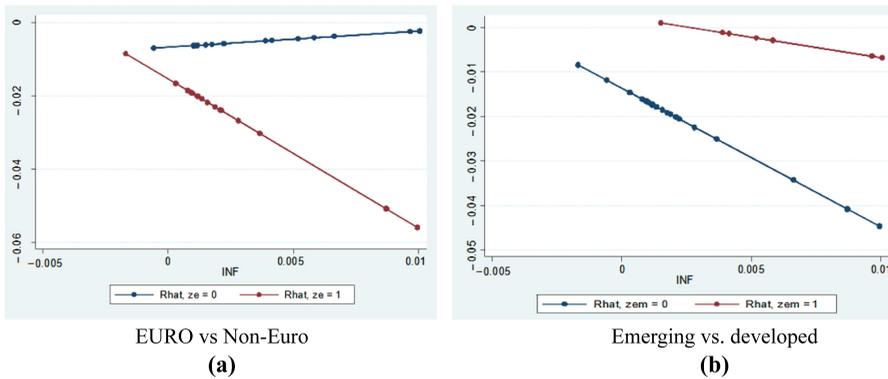


Figure 3. Relationship between nominal returns (R) and inflation for different groups during the crisis (2008 - 2009)

Note(s): ze = 1 for the euro zone and ze = 0 otherwise, and zem = 1 for the emerging countries zone and zem = 0 otherwise (developed). Rhat is used to indicate the Return adjusted value; $\hat{R} = \hat{\alpha} + \hat{\beta} INF$. $\hat{\beta}$ is the slope of the fitted line. $\hat{\beta} < 0$ for EURO, Emerging and developed countries. Fisher hypothesis is valid only for non- Euro countries during the crisis
Source(s): Authors' elaboration

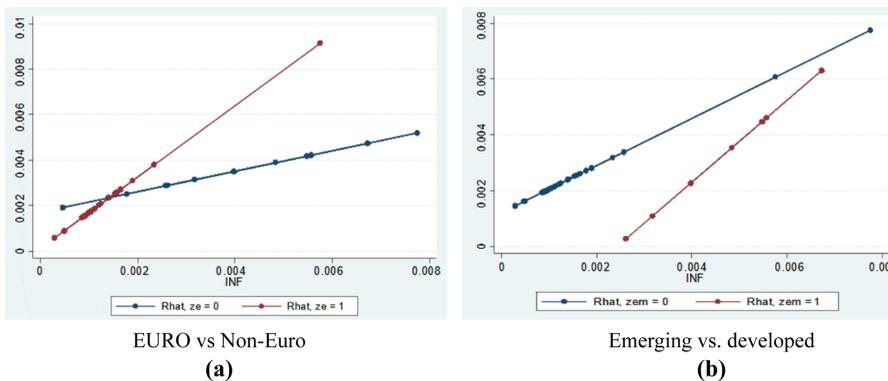


Figure 4. Relationship between nominal yields (R) and inflation for different groups over the post-crisis period (2010 - 2019)

Note(s): ze = 1 for the euro zone and 0 otherwise, and zem = 1 for the emerging countries zone and 0 otherwise (developed). Rhat is used to indicate the Return adjusted value; $\hat{R} = \hat{\alpha} + \hat{\beta} INF$. $\hat{\beta}$ is the slope of the fitted line. Fisher hypothesis is valid in all case post crisis
Source(s): Authors' elaboration

inflation hedge if its real return (RR_t) is independent of the rate of inflation (INF_t), which imply a positive correlation between the nominal return (R_t) and inflation.

The traditional view that nominal rates of returns should move one-to-one with inflation is first attributed to Fisher (1930). A correlation of 1 is called a perfect hedge since price increases are perfectly compensated by the corresponding hedging asset returns. According to this hypothesis, rational individuals are concerned with real return on investment. If an asset does not provide a perfect hedge, a stable positive return–inflation relationship can still make the asset valuable.

In this paper, the most empirically applied Fisher hypothesis will be tested in a first step with two types of data. In the first subsection, we consider time series data based models,

while in the second subsection we consider cross-section data based models (with either RR_t , or R_t and INF_t or $EINF_t$). Then, for further robustness check, we consider panel data based models.

4.1 Time series data based models

In this section, four specifications will be proposed. In each specification, we formulate the Fisher hypothesis which supposes some conditions (hedge property) on the appropriate marginal effect (slope coefficients).

The first baseline model is the following static linear relationship between *nominal* yield (R_t) and inflation (Gultekin, 1983):

$$R_t = \alpha + \beta INF_t + \varepsilon_{1t}, t = 1, \dots, T, \quad (1)$$

where INF_t is the inflation rate, α and β are real parameters, β is the marginal effect of the inflation rate and ε_{1t} is the error term ($\varepsilon_{1t} \sim (0, \sigma^2)$).

From Eq. (1), by definition, if the slope

- (1) $\beta = 1$, the nominal returns (R_t) are *fully hedged against inflation*,
- (2) If $0 < \beta < 1$, the nominal returns are *partially hedged against inflation*, and while
- (3) If $\beta > 1$, the nominal returns are *highly hedged against inflation*.

The second baseline specification is the static linear relationship between *real* return (RR_t) and inflation rate which can be presented as (Jaffe and Mandelker, 1976):

$$RR_t = \alpha_1 + \beta_1 INF_t + \varepsilon_{2t}, t = 1, \dots, T, \quad (2)$$

where α_1 and β_1 are real parameters, β_1 is the marginal effect of the inflation rate and ε_{2t} is the error term ($\varepsilon_{2t} \sim (0, \sigma^2)$).

Then, from Eq. (2), if the slope $\beta_1 = 0$, the real returns (RR_t) are *hedged against inflation*.

According to Fisher (1930), the nominal interest rate is made up of the “real” rate plus the expected inflation rate. Thus, he argued that the expected real interest rate depends on real factors (such as the productivity of capital and the time preference of savers) and is independent of the expected inflation rate.

As previous empirical research on this topic, here we test the *generalized* Fisher hypothesis, which states that the market is *efficient* and that the expected real return on common stocks and the expected inflation rate vary *independently* so that, on average, investors are compensated for changes in purchasing power. The *generalized* Fisher hypothesis can be expressed within the following third baseline regression:

$$RR_t = \alpha_2 + \beta_2 EINF_t + \varepsilon_{3t}, t = 1, \dots, T \quad (3)$$

where $EINF_t$ is the expected inflation, α_2 and β_2 are real parameters, β_2 represents the marginal effect of the expected inflation and ε_{3t} is the error term.

Then, from Eq. (3), if the slope $\beta_2 = 0$, the real returns (RR_t) are *hedged against expected inflation*.

In the framework of the (Fama and Schwert, 1977), the Fisher hypothesis can be expressed in two joint hypotheses; stock market *efficiency*, and the independence of real returns from expected inflation (Chatrath and Song, 1997). By decomposing inflation into expected and unexpected inflation, Eq. (3) can be augmented as the following fourth model (Chatrath and Song, 1997):

$$RR_t = \alpha_3 + \beta_3 EINF_t + \beta_4 UNEINF_t + \varepsilon_{4t}, t = 1, \dots, T, \quad (4)$$

where $EINF_t$ and $UNEINF_t$ are respectively the expected and the unexpected inflation rates, α_3, β_3 and β_4 are real parameters, β_3 and β_4 represent the marginal effect of expected and unexpected inflation respectively, and ε_{4t} is the error term ($\varepsilon_{3t} \sim (0, \sigma^2)$).

From Eq. (4), by definition, if the slope

- (1) $\beta_3 = 0$, the real returns (RR_t) are *hedged against expected inflation*, and
- (2) if $\beta_3 = \beta_4 = 0$, the real returns are *perfectly hedged against expected and unexpected inflation*, which supports the Fisher hypothesis (Chatrath and Song, 1997; Adrangi et al., 2000).

Each equation will be estimated by ordinary least square (OLS) if the model is classical (in particular, if $\varepsilon_{jt} \sim i.i.d.(0, \sigma^2), j = 1, 2, 3, 4$). Otherwise, in the case of correlated errors [2], the quasi-generalized least squares (QGLS) method will be applied [3] (Neifar, 2011; Greene, 2018). The quality judgment of each regression will be based on the R^2 value. The significance of the parameters will be based on Student's t -test [4].

4.2 Cross-sectional data based model

Based on cross-sectional data, the relationship between nominal yields and the inflation rate (INF) is shown in Eq. (5), while the relationship between real yields and the expected inflation rate (EINF) is illustrated in Eq. (6). Eq. (7) shows the relationship between real yields and the expected and unexpected inflation rate as follow. We begin by

$$\bar{R}_i = \alpha + \beta \overline{INF}_i + v_{1i}, i = 1, \dots, n \quad (5)$$

where

$$\bar{R}_i = \frac{\sum_t R_{it}}{T}, \overline{INF}_i = \frac{\sum_t INF_{it}}{T},$$

which are respectively the average of nominal stock returns (R_{it}) and the average of inflation rate (INF_{it}), α and β are real parameters and v_{1i} is an error term ($v_{1i} \sim i.i.d.(0, \sigma^2)$).

From Eq. (5), as in Eq. (1), the *fully, partially or the highly hedge* properties depend respectively on if $\beta = 1, 0 < \beta < 1$ or if $\beta > 1$.

We consider then

$$\overline{RR}_i = \alpha + \beta_1 \overline{EINF}_i + v_{2i}, i = 1, \dots, n \quad (6)$$

where

$$\overline{RR}_i = \frac{\sum_t RR_{it}}{T}, \overline{EINF}_i = \frac{\sum_t EINF_{it}}{T},$$

which are respectively the average of real stock returns (RR_{it}) and the average of expected inflation rate ($EINF_{it}$), α and β_1 are real parameters and v_{2i} is the error term ($v_{2i} \sim i.i.d.(0, \sigma^2)$).

As in Eq. (2), from Eq. (6), if the slope $\beta_1 = 0$, then the real returns are *hedged against inflation*.

And finally, we give

$$\overline{RR}_i = \alpha + \beta_1 \overline{EINF}_i + \beta_2 \overline{UNEINF}_i + v_{3i}, i = 1, \dots, n \quad (7)$$

where

$$\overline{UNEINF}_i = \frac{\sum_t^T UNEINF_{it}}{T},$$

which represents the average of unanticipated inflation rate, α , β_1 and β_2 are real parameters and v_{3i} is the error term ($v_{3i} \sim i.i.d.(0, \sigma^2)$).

By definition, from Eq. (7), if the slope

- (1) $\beta_1 = 0$, then real returns are *hedged against expected inflation*. And,
- (2) if $\beta_1 = \beta_2 = 0$, then real returns are *perfectly hedged against expected and unexpected inflation*, which supports the Fisher hypothesis (Gultekin, 1983; Adrangi et al., 2000).

Again, each equation will be estimated by OLS for classical models (in particular, if $v_{ji} \sim i.i.d.(0, \sigma^2), j = 1, 2, 3$). Otherwise, in the case of *heteroscedasticity* problems, the *robust least squares* method will be applied. Again, the quality question of each regression will be based on the value of the R^2 and the significance of the parameters will be based on Student's *t*-test (Neifar, 2011; Greene, 2018).

5. Empirical results

The Fisher hypothesis verification are carried out within two types of data and several models. In the first subsection, we consider time-series data case, while in the second we consider cross-sectional data investigations. A third sub-section is deserved to more robustness check. Basely, we use panel data covering the Covid 19 outbreak period for several countries (for which the hedge or no hedge properties are already found robust) within FE or RE linear static models to check the role of the interest rate as macroeconomic control variable.

5.1 Results based on time series data for the period covering the 2008 GFC

To check the validity of the Fisher hypothesis, Eqs. (1)–(4) are estimated for the case of Euro countries. When these equations are applied to non-Euro countries data, they are instead indicated by Eqs. (1)'–(4)'. To avoid autocorrelation error problem, all these models are estimated by the quasi-generalized least squares method [5].

Results for the period covering the 2008 GFC crisis are summed up in Table 3. For simplicity, *Red color* is used for the *rejection* case of Fisher hypothesis (indicated by NO), while *green color* is used for the *non-rejection* case of Fisher hypothesis (indicated by YES). Details of these results are available upon request.

Looking at Table 3's results for the period covering the 2008 GFC crisis, we conclude that:

- (1) From columns (1) and (1)', there is no hedge against the *inflation rate* and the Fisher hypothesis is not verified except for the USA and Canada.

Based on Eq. (1) and (1)', the Fisher hypothesis ($\beta > 0$) is verified only for the USA and Canada (with high coverage for both countries). These results are consistent with those of Boudoukh and

Euro Countries										Non-Euro Countries									
Equations	(1)		(2)		(3)		(4)		Equations	(1)'		(2)'		(3)'		(4)'			
Dep Var	R		RR		RR		RR		Dep Var	R		RR		RR		RR			
Indep Var/ Countries	INF	Hedge ?	INF	Hedge ?	EINF	Hedge ?	EINF	UNEINF	Hedge ?	Indep Var/ Countries	INF	Hedge ?	EINF	Hedge ?	UNEINF	Hedge ?	EINF	UNEINF	Hedge ?
Austria	0.253	NO	-0.747	YES	-1.801	YES	-1.493	-0.645	YES	Bangladesh	-0.042	NO	-1.042*	NO	-1.326	YES	-1.302	-1.028*	NO
Germany	0.427	NO	-0.573	YES	3.593	YES	4.086	-0.613	YES	Brazil	0.184	NO	-0.816	YES	-3.642	YES	-3.560	-0.406	YES
Belgium	0.220	NO	-0.779	YES	-0.714	YES	-0.665	-14.097	YES	Canada	1.761***	YES	0.761	YES	-3.253	YES	-3.296	0.786	YES
Denmark	0.376	NO	-0.624	YES	-7.434	YES	-7.428	-0.518	YES	China	-0.441	NO	-1.441***	NO	0.568	YES	0.684	-1.471***	NO
Estonia	-0.558	NO	-1.558*	NO	-0.767	YES	-5.333	-1.366*	NO	Chile	-0.651	NO	-1.651***	NO	-7.304*	NO	-6.455*	-1.446***	NO
Spain	0.769	NO	-0.230	YES	-5.802	YES	-0.715	-0.220	YES	Colombia	0.897	NO	-0.103	YES	-2.209	YES	-2.201	0.088	YES
France	0.384	NO	-0.616	YES	-13.170*	YES	-7.398	-0.523	YES	United States	1.214*	YES	0.334	YES	10.138	YES	10.083	0.154	YES
Finland	-0.073	NO	-1.073	YES	-7.546	NO	-13.037*	-0.689	NO	India	-0.272	NO	-1.272***	NO	-1.457	YES	-1.378	-1.249***	NO
Greece	-0.390	NO	-1.390***	NO	-3.582	YES	-3.371	-1.369***	NO	Indonesia	0.620	NO	-0.380	YES	-0.701	YES	-0.627	-0.374	YES
Hungary	0.890	NO	-0.110	YES	-4.674*	NO	-4.686*	0.328	NO	Japan	1.531	NO	0.531	YES	16.303**	NO	16.245***	0.205	NO
Iceland	-1.029	NO	-2.029***	NO	-15.9***	NO	15.612***	-1.784***	NO	Malaysia	-0.559	NO	-1.559**	NO	9.624*	NO	10.240*	-1.857***	NO
Ireland	-0.488	NO	-1.488**	NO	0.733	YES	1.044	-1.670***	NO	Mongolia	-1.039	NO	-2.039	YES	12.142	YES	13.132	-2.744	YES
Italy	2.570	NO	1.570	YES	-8.607	YES	-8.960	2.653	YES	Turkey	-0.033	NO	-1.033**	NO	-2.048***	NO	-2.026***	-0.405	NO
Latvia	-1.478**	NO	-2.478***	NO	-3.584*	NO	-3.226*	-2.308***	NO										
Luxemburg	-0.070	NO	-1.070**	NO	-3.133	YES	-3.182	-1.063**	NO										
Poland	0.302	NO	-0.698	YES	-6.837*	NO	-6.823*	-0.107	NO										
Portugal	0.483	NO	-0.517	YES	-4.610	YES	-4.496	-0.413	YES										
UK	-0.246	NO	-0.075	YES	-1.196	YES	-1.178	-0.054	YES										
Russia	1.440	NO	0.440	YES	-8.206	YES	-7.813	0.610	YES										

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. Also significant slopes are presented in bold. The results of equations $R_t = \alpha + \beta INF_t + \varepsilon_{1t}$, $RR_t = \alpha_1 + \beta_1 INF_t + \varepsilon_{2t}$, $RR_t = \alpha_2 + \beta_2 EINF_t + \varepsilon_{3t}$ and $RR_t = \alpha_3 + \beta_3 EINF_t + \beta_4 UNEINF_t + \varepsilon_{4t}$ are presented respectively in columns (1), (2), (3) and (4) for European countries, and in columns (1)', (2)', (3)' and (4)' for non-European countries. With R_t (nominal return) in Eq (1), inflation hedging is achieved if β is significant and positive. With RR_t (real return) in Eq. (2), (3) and (4) there is hedging against inflation, unanticipated inflation and/or anticipated inflation if β_j is not significant, $j = 1, 2, 3, 4$. Green color and YES (Red color and NO) are used to indicate evidence for (against) an inflation hedging property

Source(s): Authors' elaboration

Richardson (1993), Choudhry (1998), Spyrou (2004), Owusu-Nantw and Kuwornu (2011), Oprea (2014), Hau (2017). Findings therefore affirm the ability of the USA and Canada stock markets, as a long-term investment avenue, to protect investors against inflation in the long-run. As a result, investors are fully compensated for increases in the general price level through corresponding increases in nominal stock market returns and the real returns remain unaffected.

- (2) From columns (2) and (2)', there is a hedge against the *inflation rate* and the Fisher hypothesis is verified except for some countries.

Based on Eqs. (2) and (2)', Fisher's hypothesis ($\beta_1 = 0$) is supported except for some European countries (namely Estonia, Greece, Iceland, Ireland, Latvia and Luxemburg) and some non-European countries (namely Bangladesh, China, Chile, India, Malaysia and Turkey) whose inflation rate have a *negative significant* effect. These results are in line with those of (Bodie, 1976; Chatrath *et al.*, 1997).

- (3) From columns (3) and (3)', there is a hedge against the *expected inflation rate*, and the Fisher hypothesis is verified except for some countries.

Based on Eqs (3) and (3)', real returns on European stock markets are hedged against the *expected inflation rate* ($\beta_2 = 0$), with the exception of Finland, Hungary, Iceland, Latvia and Poland (associations are significantly negative). The majority of non-European real returns are hedged against the *expected inflation rate*, except for Chile and Turkey (where the relationship between real returns and the inflation rate is significant and negative), Japan and Malaysia (the relationship is positive but insignificant).

- (4) From columns (4) and (4)', there is no value *perfectly* hedged against *expected and unexpected inflation* with some exceptions.

Based on Eqs (4) and (4)', for European countries, the real yields of Austria, Germany, Belgium, Denmark, Spain, France, Italy, Portugal, the UK and Russia are perfectly hedged against expected and unexpected inflation ($\beta_3 = \beta_4 = 0$). However, for non-European countries only the real returns of Brazil, Canada, Colombia, Indonesia, Mongolia and the USA which are *perfectly hedged* against expected and unexpected inflation.

There is a consistent lack of positive (insignificant) relation between nominal (real) stock returns and inflation (expected inflation) in some of the considered countries. For each of these countries, we recommend then to government to ensure a more realistic price level and to the monetary policies to find inflation stabilization that can be beneficial to the investors.

Moreover, robust time series data based results are found only in some cases:

- (1) The USA and Canada for which stock markets are hedged against inflation (Almeida *et al.*, 2024), and
- (2) Iceland, Latvia, Chile, Malaysia and Turkey for which stock markets are not hedged against inflation (Geetha *et al.*, 2011)

In the period covering 2008 GFC that is well known by *deflation* period.

Using time series data, in term of *homogeneity*, there is no difference between hedge property between Euro and Non Euro countries. This result may or not be true in the period covering the Covid 19 outbreak which is well-known by *inflation* crisis. This robustness check will be done in sub-section 5.3 sub-sub-section A.

5.2 Results based on cross-sectional data for the period covering the 2008 GFC

In this section we test the Fisher hypothesis within Eqs (5)–(7) using the robust least squares method to avoid hetescedasticity problem. The Fisher hypothesis verification will be discussed by group of countries and by period slice (pre – during and post – crises).

Results for the period covering the 2008 GFC are summed up in Table 4. Details of these results are also available upon request. Again for simplicity, *Red color* is used for the *rejection* case of Fisher hypothesis (indicated by NO), while *green color* is used for the *non-rejection* case of Fisher hypothesis (indicated by YES).

Looking at Table 4 results, we conclude that:

- (1) From Eq. (5), mixed results are derived about hedge properties against *anticipated inflation*, and then Fisher's hypothesis can be verified.

From the cross-sectional regression Eq. (5), we can conclude that in the case of European countries, nominal stock market returns are *highly hedged* against inflation ($\beta > 1$) *Pre* financial crisis, and that the Fisher hypothesis is verified only during this sub-period. In the case of emerging countries, the Fisher hypothesis is verified *post-financial crisis*, and nominal stock market returns are *highly hedged* against inflation ($\beta > 1$), whereas in the case of developed countries, the Fisher hypothesis is verified *pre- and post-financial crisis*, and nominal returns are *partially* hedged against the inflation rate ($\beta < 1$).

- (2) From Eq. (6), it can be seen that there is hedge against *anticipated inflation*, and then Fisher's hypothesis is verified.

We can say that Fisher's hypothesis is verified for both groups of countries (Group I: European vs non-European countries and Group II: emerging vs developed countries), and that the latter's equities admit hedging against expected inflation ($\beta_1 = 0$) *pre-financial crisis* (2000 – 2007), during the crisis (2008 – 2009) and *post-financial crisis* (2010 – 2019).

- (3) From Eq. (7), there is perfect hedge against *expected and unexpected inflation* with few exceptions.

The Fisher hypothesis is verified for both groups of countries (Group I and Group II); their equities are *perfectly hedged* against inflation ($\beta_1 = \beta_2 = 0$) for all three sub-periods, except for equities in developed countries. The latter are only hedged *against expected inflation* during the financial crisis.

Pre-crisis						Crisis period						Post-crisis					
Group I: European vs. non-European countries						Group II: Emerging vs. Developed countries											
Groups	INF	Hedge ?	INF	Hedge ?	INF	Hedge ?	Groups	INF	Hedge ?	INF	Hedge ?	INF	Hedge ?				
Euro	2.6022**	YES	-4.0710	NO	1.2647	NO	Em	4.0549	NO	-3184	NO	1.4679**	YES				
Non_Euro	1.3318	NO	.4411	NO	.4490	NO	Dev	0.5701*	YES	-3.1267	NO	0.8436*	NO				
Eq (5): $\bar{R}_t = \alpha + \beta INF_t + v_{1t}$																	
Euro	1.5470	YES	-5.6053	YES	2.8027	YES	Em	2.5730	YES	-2.1718	YES	-0.4843	YES				
Non_Euro	0.1854	YES	-1.3021	YES	-0.1593	YES	Dev	-0.2484	YES	-2.6735	YES	-1.258	YES				
Eq (6): $\bar{R}_t = \alpha + \beta_1 EINF_t + v_{2t}$																	
Euro	1.5892	YES	-5.6054	YES	4.2311	YES	Em	1.2594	YES	-1.8967	YES	0.3033	YES				
Non_Euro	0.1989	YES	-1.2361	YES	-0.3330	YES	Dev	1.2594	YES	1.3456	YES	-0.2637	YES				
Eq (7): $\bar{R}_t = \alpha + \beta_1 EINF_t + \beta_2 UNEINF_t + v_{3t}$																	
Euro	0.2434	YES	1.0391	YES	4.8274	YES	Em	-0.3075	YES	-3.8397	YES	0.1525	YES				
Non_Euro	0.1330	YES	1.3953	YES	-1.2310*	NO	Dev	-2.2927	YES	-8.1375	YES	1.7728	YES				

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. With R_t (nominal return), there is a hedge against realized inflation if β is significant and positive. With RR_t (real return), there is a hedge against inflation expected and/or unexpected if β_j is non-significant, $j = 1, 2$. We use two groups of countries: group I for European vs non-European countries, and group II for emerging vs developed countries. Three sub-periods are considered: a pre-financial crisis sub-period (2000-2007), during the financial crisis (2008-2009), and a sub-crisis period (2010 - 2019). *Green color* and *YES* (*Red color* and *NO*) are used to indicate evidence for (against) an inflation hedging property

Source(s): Authors' elaboration

Table 4.
Sum up of cross-sectional regression results for the period covering the 2008 GFC

Moreover, cross-sectional data based results are found to be homogeneous and stable (robust) in almost all considered cases. Indeed, depending on the dependent variable type, we conclude that

- (2) From results based on *nominal* return, robust *no hedge* property against inflation is found in almost all cases (group I and group II). These results are in line with [Geetha et al. \(2011\)](#), [Eita \(2012\)](#), [Naik and Padhi \(2012\)](#), [Khumalo \(2013\)](#); [Uwubanmwun and Eghosa \(2015\)](#), [Emeka and Aham \(2016\)](#), [Bin and Celis \(2017\)](#), [Chiang \(2023b\)](#), [Abdali and Alm \(2024\)](#),
- (3) From results based on *real* return, robust *hedge* property against inflation is also found for almost all cases (group I and group II). These findings are consistent with studies of [Adam \(2010\)](#), [Antonakakis et al. \(2017\)](#), [Chiang \(2023\)](#), [Chola \(2024\)](#), [Almeida et al. \(2024\)](#).

Using cross-section data, in terms of *homogeneity and stability*, there is no difference about hedge properties between groups of countries or between sub-periods. This result may or not to be true in the period covering the Covid 19 outbreak which is well-known by *inflation crisis*. Based on time series, cross section and panel data, this robustness check will be done in the following sub-section.

5.3 More robustness check investigations for the period covering the covid 19 outbreak

For stability and homogeneity properties of hedging results verification, three others robustness check are the subject of this section:

- (1) Based on time series and cross section data, the first check is about comparison to the outcome from more recent period covering the Covid 19 outbreak,
- (2) The second is about the panel data based investigations,
- (3) The third is about the check of the interest rate impact as control variable.

5.3.1 Time series and cross-section data investigations. Homogeneity and stability of the hedging property with more recent data covering the Covid 19 crisis period that is well known by *inflation period* is the subject of this sub-section.

Results based on [Eq\(1\)–Eq\(4\)](#) (and on [Eq\(1'\)–Eq\(4'\)](#)) for *time series data* covering the Covid 19 outbreak crisis are summed up at [Table A1](#) (in [Appendix](#)). Hence, looking at [Table A1](#), as for the case of the results of the 2008 GFC period (given at [Table 3](#)), we conclude that robust results are found only for some countries:

- (2) 2 Euro countries: Hungary and Chile, and 2 Non Euro countries: Colombia and Malaysia for which stock markets are hedged against inflation.
- (3) 3 Euro countries: Spain, Iceland, Russia and one Non Euro country: Canada for which stock markets are not hedged against inflation.

In addition, based on time series data, we tend to have the Fisher's hypothesis verification more often in the period covering the Covid crisis than during the period covering the 2008 GFC (more green zone than red zone in [Table A1](#) compared to [Table 3](#)).

As in the case of the 2008 GFC period, we also test the Fisher hypothesis within [Eqs \(5\)–\(7\)](#) using cross-section data covering the Covid 19 outbreak period. Results are presented at [Table A2](#) (in [Appendix](#)).

Now, looking at [Table A2](#) for the cross section data investigations, from the period covering the Covid 19 outbreak results, we conclude that:

- (1) As found in some works (Wongbampo, 2002; Gunasekarage, 2004; Sohail, 2009; Geetha *et al.*, 2011; Eita, 2012; Naik and Padhi, 2012; Khumalo, 2013; Zoa, 2014; Uwubanmwun and Eghosa, 2015; Emeka and Aham, 2016; Bin and Celis, 2017; Chiang, 2023b; Abdali and Alm, 2024) once *nominal return* is used as dependent variable, no hedge property is found for all sub-periods and sub-groups (except for Euro-zone case post Covid period), and
- (2) In line with some (Adam, 2010; Tiwari *et al.*, 2015; Antonakakis *et al.*, 2017; Salisu *et al.*, 2020; Almeida *et al.*, 2024; Chiang, 2023; Chola, 2024)' findings, from the use of *real return* as dependent variable, hedge property is not rejected for all groups as well as for sub-periods (with few exceptions).

The difference observed in the results when nominal versus real returns were used as the dependent variable can be explained by the fact that during the COVID-19 pandemic, the lack of hedging of stock market returns against inflation observed when nominal returns are used as the dependent variable, compared with existing hedging with real returns, can be explained by several factors. Nominal returns reflect gains in terms of current monetary value and are directly influenced by immediate fluctuations in inflationary expectations and central bank interventions. Massive expansionary monetary policies and economic uncertainties during COVID-19 disrupted this relationship, making nominal returns less predictable in response to inflation (Baker *et al.*, 2020). By contrast, real returns, adjusted for inflation, better isolate the effect of rising prices on purchasing power, revealing a more stable and direct relationship between stock market returns and expected inflation (Fama, 1981; Mishkin, 1992). Investors, seeking to protect their real purchasing power in the face of anticipated inflation, adjusted their portfolios accordingly, which explains why hedging against inflation is more apparent with real returns.

We note also that the coefficients β during the covid 19 period (see Table A2 in the appendix) are less than those during the GFC 2008 crisis (see Table 4). This implies that hedging against the inflation rate is less important during the covid 19 period than during the GFC 2008 crisis (deflation period). This can be explained by the fact that the COVID-19 pandemic, as an exogenous public health shock, rapidly led to containment measures and global economic disruption. Investors initially reacted with a massive sell-off in risky assets, causing high volatility in the financial markets. However, rapid and massive policy responses, including direct transfers to households, increases in public spending and interest rate cuts by central banks, contributed to a relatively rapid recovery in investor confidence (Baker *et al.*, 2020; Shiller, 2020). Inflationary expectations have risen as a result of expansionary policies, leading investors to adjust their portfolios in favor of assets likely to benefit from expected inflation, thereby increasing the hedging of equity returns against inflation (Andrade, 2021; Forbes, 2020).

Hence, based on cross-sectional data, the results are *invariant* with respect to both considered periods of the study: 2008 GFC and Covid 19 outbreak. Then, we can say that the results from the period covering the Covid 19 crisis are similar to those from the period covering the 2008 GFC.

5.3.2 Panel data models investigation. For the second robustness verification, we use panel data to see if Fisher hypothesis verification results are invariant simultaneously to both dimension year and country.

Eqs (1)–(4) can be rewritten as follow:

$$R_{it} = \alpha_i + \beta INF_{it} + \varepsilon_{1it}, \quad (8)$$

$$RR_{it} = \alpha_{i1} + \beta_1 INF_{it} + \varepsilon_{2it}, \quad (9)$$

$$RR_{it} = \alpha_{i2} + \beta_2 EINF_{it} + \varepsilon_{3it}, \quad (10)$$

$$RR_{it} = \alpha_{i3} + \beta_3 EINF_{it} + \beta_4 UNEINF_{it} + \varepsilon_{4it}, \quad (11)$$

where $t = 1, \dots, T, i = 1, \dots, n, \alpha_i, \alpha_{i1}, \alpha_{i2}, \alpha_{i3}$ are the individual effects (fixed or random), $\beta, \beta_1, \beta_2, \beta_3$ and β_4 are real parameters, and $\varepsilon_{jit} \sim (0, \sigma_j^2)$.

As can be seen from [Table A1](#) for the period covering the Covid-19 outbreak, group of the robust hedged stock returns includes Hungary, Chile, Colombia and Malaysia' cases, while group of the robust no hedged stock returns includes Spain, Iceland, Russia and Canada' cases. Hence, two panel data will be studied: one for the group of the countries with hedged stock returns and another for the group of the countries with no hedged stock returns.

Before estimation, correlation matrices for dependent variables are built to forestall multicollinearity in linear model (11). This matrix is not reported here but are available upon request. Then, from both panel data, only countries for which model (11) does not suffer from collinearity problem are used.

Each of the considered models in [Eqs \(8\)–\(11\)](#) are estimated by fixed effect (FE) or random effect (RE) technic depending on the Hausman test result. Findings are presented at [Table A3](#) (in [Appendix](#)). Now, looking at [Table A3](#), from panel data based models, we conclude that generally hedge or no hedge property is a robust result for each of considered groups with only few exceptions.

5.3.3 Role of the interest rate with panel data. The channel of undesirable inflation impact on investments is explained by [Asab and Al-Tarawneh \(2018\)](#). They highlighted that [...] "when inflation is high, monetary authorities respond by increasing real interest rates, thereby raising the marginal costs of business operations. As a consequence, investments fall. For financial intermediaries, they could just find out that the increase in real interest rates is just to the extent of compensating them for the reduction in the value of money due to the high inflation" ([Adekoya et al., 2021](#)).

Inflation is in general an increase of price level of goods and services in an economy resulting in a fall in purchasing power or value of money. The inflation hedge of any asset class is usually predicated on the ([Fisher, 1930](#)) hypothesis which renders the first attempt to formally state the hypothetical relation between asset returns and inflation. Under this hypothesis, the nominal interest rate is expressed as the *sum of real returns and inflation rate*.

For the third robustness verification about the role of interest rate, some augmented models will be considered to check if the interest rate can alternate hedge properties among considered groups and sub-periods. [Eqs \(8\)–\(11\)](#) can then be rewritten as follows:

$$R_{it} = \alpha_i + \beta INF_{it} + \lambda I_{it} + \varepsilon_{1it}, \quad (12)$$

$$RR_{it} = \alpha_{i1} + \beta_1 INF_{it} + \lambda I_{it} + \varepsilon_{2it}, \quad (13)$$

$$RR_{it} = \alpha_{i2} + \beta_2 EINF_{it} + \lambda I_{it} + \varepsilon_{3it}, \quad (14)$$

$$RR_{it} = \alpha_{i3} + \beta_3 EINF_{it} + \beta_4 UNEINF_{it} + \lambda I_{it} + \varepsilon_{4it}, \quad (15)$$

where $t = 1, \dots, T, i = 1, \dots, n, \alpha_i, \alpha_{i1}, \alpha_{i2}, \alpha_{i3}$ are the individual effects (fixed or random), $\beta, \beta_1, \beta_2, \beta_3, \beta_4$ and λ are real parameters and $\varepsilon_{jit} \sim (0, \sigma_j^2)$.

Before estimation, correlation matrices for dependent variables are built to forestall multicollinearity in linear models. These matrices are not reported here but are available upon request. Then, from the two panel data studied in the previous section, only countries for which considered models do not suffer from collinearity problem are used. Again, each of the considered models in [Eqs \(12\)–\(15\)](#) are estimated by FE or RE technic depending on the Hausman test result.

Estimation results from [Eqs \(12\)–\(15\)](#) are summed up at [Table A4](#) (in [Appendix](#)). Now, looking at [Table A4](#), from augmented models, we conclude that findings are similar to [Table A3](#)'s results. Hence taking into account the role of the interest rate in the augmented

models does not impact the hedge or no hedge properties given by models in Eqs (8)–(11) in Table A3.

6. Conclusion

Theoretically, a strong association is supposed to exist between stock returns and domestic inflation rate. Indeed, if the value of money diminishes during high inflation rate, then inflation rate influences stock market risk (diminishes the level of stock returns). From Fisher's hypothesis, it can be inferred that *real assets returns* should not move with expected inflation rates. Thus, there should be a positive relationship between inflation and nominal stock returns which provides investors a hedge against inflation.

In stock markets where the Fisher hypothesis holds true, *nominal* stock prices should fully reflect expected inflation and the relationship between stock returns and inflation should be *positive*. As a result, the real returns remain unaffected since investors are fully compensated for increases in the general price level through corresponding increases in nominal stock market returns.

The literature on the relationship between inflation and stock returns has been examined by numerous studies. The empirical findings are mixed. This paper contributes to the empirical discussion and has sought to find the relative impact of inflation rate on stock returns not only in time (for stability) but also in country dimension (for homogeneity). Besides the stability and the homogeneity question, Fisher hypothesis was investigated within two definitions (in term of *nominal* return or *real* return) for robustness question.

Practically, to test Fisher's hypothesis, we proceed in two steps:

- (1) In the first step, we used two types of data: time series (19 European countries vs 13 non-European countries) and cross-sections (two groups; group I includes European vs non-European countries, and group II includes emerging vs developed countries). The study in this step is based on a sample of monthly data for the period 2000:01 – 2019:01 covering the 2008 GFC. Then, cross-sectional database was built by point estimation of each variable for each sub-period (pre, during and post 2008 GFC).
- (2) In a second step, we used 3 types of data for more robustness check. The study was based on a second sample of monthly data for a recent period from June 2016 to April 2024 that covers the Covid 19 outbreak. Then besides cross section data creation (as in the first step), we build panel data for only countries with robust hedge/no hedge properties based on time series data investigations. Then in this step, we used three types of data: time series, cross section and panel data. Moreover, a control macro variable (the interest rate) is used for additional robustness check.

From the first period investigations covering the 2008 GFC, we conclude that:

- (1) Using time series data, in term of *homogeneity side*, there is no difference between hedge property between Euro and Non Euro countries. Robust results are found only for some countries,
- (2) Using cross section data, in term of *homogeneity and stability*, there is no difference about hedge properties between groups of countries (group I of European vs non-European countries and group II of emerging vs developed countries) or between sub-periods (pre-, during and post- 2008 GFC) in almost all considered cases; Particularly
 - Robust *no hedge* property against inflation is found from results based on *nominal* return,
 - Robust *hedge* property against inflation is found from results based on *real* return.

From the investigations on the second period covering the Covid 19 outbreak, we conclude that:

- (1) Using time series data, robust results are found only for some countries,
- (2) Using cross-section data,
 - once *nominal return* is used as dependent variable, no hedge property is found for all sub-periods and sub-groups (with few exceptions),
 - from the use of *real return* as dependent variable, hedge property is not rejected for all groups as well as for sub-periods (with few exceptions),
- (3) from panel data based models,
 - Hedge or no hedge property is generally a robust result for each of considered groups (with only few exceptions).
 - Taking into account of interest rate role as control variable, there is no impact on the hedge or no hedge properties.

Then, we can say that

- (1) Based on cross-sectional data, the results are *invariant* with respect to both considered periods of the study: 2008 GFC and Covid 19 outbreak.
- (2) Based on time series data, we tend to have the Fisher's hypothesis verification more often in the period covering the Covid 19 outbreak than during the period covering the 2008 GFC.
- (3) Based on the nominal return as dependent variable, we tend to reject hedge property (with few exception).

Our study is among the first works to explore robustness hedging question in different dimensions and with three types of data. In light of the empirical findings our results can contribute to academic discourse. Hence, we propose our findings as an initial ground that needs further confirmation in future research.

In this paper, among the macroeconomic variables, inflation and interest rate are considered to be the most crucial factors affecting stock returns. However, our investigations may be subject to the critic that other variables can have significant impact on stock return since stocks may react to some micro-variables related to firm and customer behaviors, as well as to other macro-variables that react to the relationship of the company to the overall economy (Neifar and Harzallah, 2024; Neifar, 2021a, b; Neifar *et al.*, 2021).

It is essential to acknowledge the limitations of our study by using only interest rate as control variable. But, we are confident that our framework will serve as an aide to future researchers in focusing their work on stock return robust hedging properties with larger dataset, longer data frame and additional models to explore other macroeconomic indicators impact like the money supply and the exchange rates (Chiang T. C., 2023b).

Also, besides academics and researchers, for investors [6], portfolio managers, policy-makers and economic decision-makers, our results have crucial policy and practical implications. It is essential for the potential investors within the robust hedged stock markets (namely in Chile, Colombia, Malaysia and Hungary for the period covering the Covid 19 outbreak) to note that the hedging potential of each stock varies across the sub-periods, which should be put into consideration in their investment designs. The portfolio managers in the robust hedged markets should care about deflationary periods (as the 2008 GFC period) since it leads to opposite results. It is necessary for policy makers to put time variation into

consideration when modeling returns of stock market viz-a-viz inflation. For the economic decision-makers, when stock markets are hedged against inflation, they need to redirect their attention to other economic policy objectives, such as financial stability, risk management and economic growth stimulation.

Finally, we also have more suggestions for future researchers. Subsequent studies should endeavor to examine if some precious tradable metals (such as gold, silver, platinum, . . .) can hedge investors against inflation risks, against different macroeconomic risks including exchange rate, oil price and inflation across countries and against economic policy uncertainty.

Notes

1. According to Fisher (1930) hypothesis, rational individuals are concerned with real return on investment. Hence, the nominal stock returns needed to sustain investors' confidence in a stock market is the sum of the desired real return plus expected inflation. The real return on investment here implies rate of return that is earned after subtracting inflation rate.
2. The verification of non-auto-correlated errors of order one is based on Durbin–Watson (DW) statistics (Neifar, 2011; Greene, 2018).
3. With the cross-section (time series) data, we can have heteroscedasticity (autocorrelation) problem. Then, regressions are estimated with quasi-generalized least square QGLS (Hildruth lue procedure or Cochrane – Orcutt procedure) so to get robust Student *t*-statistics (Neifar, 2011; Greene, 2018). The Cochrane-Orcutt procedure was used in this work.
4. Based on the quasi-generalized least squares (QGLS) results, Student's *t* follows asymptotically the Normal distribution. At 5% (10%), significance will be based on the critical point 1.96 (1.64) (Neifar, 2011; Greene, 2018).
5. Student's *t* asymptotically follows the Normal distribution. At 5% (10%), significance will be based on the critical point 1.96 (1.64).
6. [. . .]“We identify four theories that explain the correlation between stock returns and subsequent investment. The first says that the stock market is a passive predictor of future activity that managers do not rely on to make investment decisions. The second theory says that, in making investment decisions, managers rely on the stock market as a source of information, which may or may not be correct about future fundamentals. The third theory, which is perhaps the most common view of the stock market's influence, says that the stock market affects investment through its influence on the cost of funds and external financing. Finally, the fourth theory says that the stock market exerts pressure on investment quite aside from its informational and financing role, because managers have to cater to investors' opinions in order to protect their livelihood” (Morck *et al.*, 1990). [. . .]“According to Reilly and Brown (2006) investment is commitment of funds for a period of time in order to derive a *rate of return* that will compensate the investor for the period during which the funds are invested, for the *expected rate of inflation* during the investment horizon and for the uncertainty involved” (Mutua, 2015).

References

- Abdali, K. and Alm, A. (2024), *The Impact of Inflation on Stock Returns: An Empirical Study of the Swedish Stock Market*, Gothenburg University Publications Electronic Archive, available at: <https://hdl.handle.net/2077/82345>
- Adam, A. (2010), “Can stocks hedge against inflation in the long run? Evidence from Ghana stock market”, *International Journal of Business and Management*, Vol. 5, pp. 188-194.
- Adekoya, O.B., Oliyide, J.A. and Tahir, H. (2021), “What do we know about the inflation-hedging property of precious metals in Africa? The case of leading producers of the commodities”, *Resources Policy*, Vol. 72, pp. 102-120, doi: [10.1016/j.resourpol.2021.102120](https://doi.org/10.1016/j.resourpol.2021.102120).

- Adrangi, B., Chatrath, A. and Sanvicente, A.Z. (2000), "Inflation, output and stock prices: evidence from Brazil", *The Journal of Applied Business Research*, Vol. 18 No. 1, pp. 61-77, doi: [10.19030/jabr.v18i1.2101](https://doi.org/10.19030/jabr.v18i1.2101).
- Alagidede, P. and Panagiotidis, T. (2010), "Can common stocks provide a hedge against inflation? Evidence from African countries", *Review of Financial Economics*, Vol. 19 No. 3, pp. 91-100, doi: [10.1016/j.rfe.2010.04.002](https://doi.org/10.1016/j.rfe.2010.04.002).
- Almeida, A., Feria, J., Golpe, A. and Vides, J.C. (2024), "Financial assets against inflation: capturing the hedging properties of gold, housing prices, and equities", *National Accounting Review*, Vol. 6 No. 3, pp. 314-332, doi: [10.3934/NAR.2024014](https://doi.org/10.3934/NAR.2024014).
- Andrade, G.S. (2021), "Global supply Chain disruptions and economic recovery", *International Journal of Economic Research*, Vol. 45 No. 3, pp. 123-145, doi: [10.5678/ijer.2021.12345](https://doi.org/10.5678/ijer.2021.12345).
- Antonakakis, N., Cunado, J., Gupta, R. and Tiwari, A.K. (2017), "Has the correlation of inflation and stock prices changed in the United States over the last two centuries?", *Research in International Business and Finance*, Vol. 42, pp. 1-8, doi: [10.1016/j.ribaf.2017.04.005](https://doi.org/10.1016/j.ribaf.2017.04.005).
- Asab, N. and Al-Tarawneh, A. (2018), "The impact of inflation on investment: the non-linear nexus and inflation threshold in Jordan", *Modern Applied Science*, Vol. 12, pp. 113-118, doi: [10.5539/mas.v12n12p113](https://doi.org/10.5539/mas.v12n12p113).
- Baker, S.R., Bloom, N., Davis, S.J. and Terry, S.J. (2020), *COVID-induced Economic Uncertainty*, National Bureau of Economic Research (NBER), doi: [10.3386/w26983](https://doi.org/10.3386/w26983).
- Bampinas, G. and Panagiotidis, P. (2016), "Hedging inflation with individual US stocks: a long-run portfolio analysis", *The North American Journal of Economics and Finance*, Vol. 37, pp. 374-392, doi: [10.1016/j.najef.2016.05.007](https://doi.org/10.1016/j.najef.2016.05.007).
- Bin, W. and Celis, E. (2017), "Causal relationship of stock performance and macroeconomic variables: Empirical evidences from Brazil, Russia, India and China (BRIC)", *Archives of Business Research*, Vol. 5 No. 3, doi: [10.14738/abr.53.2779](https://doi.org/10.14738/abr.53.2779).
- Bodie, Z. (1976), "Common stocks as a hedge against inflation", *The Journal of Finance*, Vol. 31 No. 2, pp. 459-470, doi: [10.2307/2326617](https://doi.org/10.2307/2326617).
- Boudoukh, J. and Richardson, M. (1993), "Stock returns and inflation: a long-horizon perspective", *The American Economic Review*, Vol. 83, pp. 1346-1355.
- Chatrath, A.R. and Song, F. (1997), "Stock prices, inflation and output: evidence from India", *Applied Financial Economics*, Vol. 7 No. 4, pp. 439-445, doi: [10.1080/096031097333556](https://doi.org/10.1080/096031097333556).
- Chatrath, A.R., Ramchander, S. and Song, F. (1997), "Stock prices, inflation and output : evidence from India", *Applied Financial Economics*, Vol. 7 No. 2, pp. 439-445, doi: [10.1016/s1049-0078\(96\)90005-6](https://doi.org/10.1016/s1049-0078(96)90005-6).
- Chiang, T. (2023), "Stock returns and inflation expectations: evidence from 20 major", *Quantitative Finance and Economics*, Vol. 7 No. 4, pp. 538-568, doi: [10.3934/QFE.2023027](https://doi.org/10.3934/QFE.2023027).
- Chiang, T.C. (2023b), "Real stock market returns and inflation: evidence from uncertainty hypotheses", *Finance Research Letters*, Vol. 53, 103606, doi: [10.1016/j.frl.2022.103606](https://doi.org/10.1016/j.frl.2022.103606).
- Chola, C. (2024), "The effect of selected macroeconomic factors on a stock market performance in Zambia", *Management Journal for Advanced Research*, Vol. 4 No. 1, pp. 102-113, doi: [10.5281/zenodo.10775342](https://doi.org/10.5281/zenodo.10775342).
- Choudhry, T. (1998), "Inflation and rates of return on stocks: evidence from high inflation countries", *Journal of International Financial Markets Institutions and Money*, Vol. 11, pp. 75-96.
- Eita, J. (2012), "Modelling macroeconomic determinants of stock market prices: evidence from Namibia", *Journal of Applied Business Research*, Vol. 28 No. 5, pp. 871-884, doi: [10.19030/jabr.v28i5.7230](https://doi.org/10.19030/jabr.v28i5.7230).
- Eldomiaty, T. and AboulSoud, S. (2020), "The associations between stock prices, inflation rates, interest rates are still persistent Empirical evidence from stock duration model", *Journal of Economics, Finance and Administrative Science*, Vol. 25 No. 49, pp. 149-161, doi: [10.1108/JEFAS-10-2018-0105](https://doi.org/10.1108/JEFAS-10-2018-0105).

- Emeka, N. and Aham, K.U. (2016), "Exchange rate and inflation volatility and stock prices volatility: evidence from Nigeria, 1986-2012", *Journal of Applied Finance and Banking*, Vol. 6 No. 6, pp. 57-70.
- Fama (1981), "Stock returns, real activity, inflation, and money", *The American Economic Review*, Vol. 71 No. 4, pp. 545-565, doi: [10.3386/w26983](https://doi.org/10.3386/w26983).
- Fama, E.A. and Schwert, G. (1977), "Asset returns and inflation", *Journal of Financial Economics*, Vol. 5 No. 2, pp. 115-146, doi: [10.1016/0304-405x\(77\)90014-9](https://doi.org/10.1016/0304-405x(77)90014-9).
- Fama, E.F. and Schwert, G.W. (1977), "Asset returns and inflation", *Journal of Finance and Economics*, Vol. 5 No. 2, pp. 115-146, doi: [10.1016/0304-405x\(77\)90014-9](https://doi.org/10.1016/0304-405x(77)90014-9).
- Farahani, Y., Adeli, O. and Barati, L. (2023), "Common stocks as a hedge against inflation through the shares of tehran stock exchange member companies", *International Journal of Finance and Managerial Accounting*, Vol. 10 No. 38, pp. 1-11.
- Fisher, I. (1930), *The Theory of Interest*, The Macmillan Company, New York.
- Forbes, K.J. (2020), "Capital flow volatility and financial stability", *Journal of International Finance*, Vol. 65 No. 1, pp. 89-112, doi: [10.6789/jif.2020.89112](https://doi.org/10.6789/jif.2020.89112).
- Geetha, C., Mohidin, R., Chandran, V. and Chong, V. (2011), "The relationship between inflation and stock market: Evidence from Malaysia, United States and China", *International Journal of Economics and Management Sciences*, Vol. 1 No. 2, pp. 1-16.
- Greene, W.H. (2018), *Econometric Analysis*, 8th ed., Pearson, New York.
- Gultekin, N.B. (1983), "Stock market returns and inflation: evidence from other countries", *The Journal of Finance*, Vol. 38 No. 1, pp. 49-65, doi: [10.1111/j.1540-6261.1983.tb03625.x](https://doi.org/10.1111/j.1540-6261.1983.tb03625.x).
- Gunasekarage, A.P. (2004), "Macroeconomic influence on the stock market: evidence from an emerging market in South Asia", *Journal of Emerging Market Finance*, Vol. 3, pp. 285-304.
- Halit, A. (2016), "Do stock returns provide a good hedge against inflation? An empirical assessment using Turkish data during periods of structural change", *International Review of Economics and Finance*, Vol. 45, pp. 230-246, doi: [10.1016/j.iref.2016.06.002](https://doi.org/10.1016/j.iref.2016.06.002).
- Hau, L. (2017), "Fisher Theory and Stock Returns: an empirical investigation for industry stocks on Vietnamese stock market", *International Journal of Engineering Science*, Vol. 6 No. 5, pp. 39-45, doi: [10.9790/1813-0605023945](https://doi.org/10.9790/1813-0605023945).
- Hodrick, R. and Prescott, E. (1997), "Postwar us business cycles: an empirical investigation", *Journal of Money, Credit, and Banking*, Vol. 29 No. 1, pp. 1-16, doi: [10.2307/2953682](https://doi.org/10.2307/2953682), available at: <http://www.jstor.org/stable/2953682>
- Jaffe, J.A. and Mandelker, A. (1976), "Fisher effect for risky assets: an empirical investigation", *The Journal of Finance*, Vol. 31 No. 2, pp. 447-458, doi: [10.2307/2326616](https://doi.org/10.2307/2326616).
- Khumalo, J. (2013), "Inflation and stock prices interactions in South Africa: VAR Analysis", *International Journal of Economics and Finance Studies*, Vol. 5 No. 2, pp. 1309-8055.
- Mishkin (1992), "Is the Fisher effect for real? A reexamination of the relationship between inflation and interest rates", *Journal of Monetary Economics*, Vol. 30 No. 2, pp. 195-215, doi: [10.1016/0304-3932\(92\)90064-B](https://doi.org/10.1016/0304-3932(92)90064-B).
- Morck, R., Shleifer, A., Vishny, R.W., Shapiro, M. and Poterba, J.M. (1990), "The stock market and investment: is the market a sideshow?", *Brookings Papers on Economic Activity*, Vol. 1990 No. 2, p. 157, doi: [10.2307/2534506](https://doi.org/10.2307/2534506).
- Mutua, P.K. (2015), *The Relationship Between Domestic Investment Activity and Market Returns at The Nairobi Securities Exchange*, University of Nairobi, Nairobi.
- Naik, P. and Padhi, P. (2012), "The impact of macroeconomic fundamentals on stock prices revisited : Evidence from Indian data", *Eurasian Journal of Business and Economics*, Vol. 5 No. 10, pp. 25-44.
- Neifar, M. (2011), *Econométrie classique, théorie et applications économiques*, CPU, Mannouba-Tunis.

- Neifar, M. (2021a), *Multivariate Causality between Stock Price Index and Macro Variables: Evidence from Canadian Stock Market*, Munich Personal RePEc Archive, MPRA, available at: <https://mpr.ub.uni-muenchen.de/105715/>
- Neifar, M. (2021b), *Suisse Stock Return, Macro Factors, and Efficient Market Hypothesis: Evidence from ARDL Model*, Munich Personal RePEc Archive, MPRA, available at: <https://mpr.ub.uni-muenchen.de/105717/>
- Neifar, M. and *et al* (2021), "The impact of macroeconomic variables on stock markets in United Kingdom", MPRA Paper 106246, available at: <https://mpr.ub.uni-muenchen.de/106246/>
- Neifar, M. and Hachicha, F. (2022), "Generalized Fisher hypothesis validity for Canada, UK, and Suisse stock markets: evidence from panel ARDL models", *Theoretical and Practical Research in Economic Field*, Vol. 2 No. 26, pp. 188-200, doi: [10.14505/tpref.v13.2\(26\).08](https://doi.org/10.14505/tpref.v13.2(26).08).
- Neifar, M. and Harzallah, A. (2024), "ROP, RIP, and R effects on RSP, symmetric or asymmetric? Case of oil exporter and importer countries", available at: <https://mpr.ub.uni-muenchen.de/120938/>
- Oprea, D. (2014), "The Fisher effect: evidence from the Romanian stock market", *International Journal of Academic Research in Business and Social Sciences*, Vol. 4 No. 5, pp. 637-644, doi: [10.6007/ijarbss/v4-i5/889](https://doi.org/10.6007/ijarbss/v4-i5/889).
- Owusu-Nantwi, V. and Kuwornu, J.K.M. (2011), "Analysing the effect of macroeconomic variables on stock market returns: evidence from Ghana", *Journal of Economics and International Finance*, Vol. 3, pp. 605-615.
- Reilly, F. and Brown, K. (2006), *Investment Analysis and Portfolio Management*, Thomson Learning, South Western.
- Rushdi, M., Kim, J. and Silvapulle, P. (2012), "ARDL bounds tests and robust inference for the long run relationship between real stock returns and inflation in Australia", *Economic Modelling*, Vol. 29 No. 29, pp. 535-543, doi: [10.1016/j.econmod.2011.12.017](https://doi.org/10.1016/j.econmod.2011.12.017).
- Salisu, A., Onipede, S. and Adekunle, W. (2019), "Stock returns-inflation nexus in Africa during tranquil and crisis periods: new evidence", *Review of Development Finance*, Vol. 9 No. 1, pp. 22-31.
- Salisu, A., Raheem, I.D. and Ndakoc, B.U. (2020), "The inflation hedging properties of gold, stocks and real estate: a comparative analysis", *Resources Policy*, Vol. 66, 101605, doi: [10.1016/j.resourpol.2020.101605](https://doi.org/10.1016/j.resourpol.2020.101605).
- Shiller, R.J. (2020), "Behavioral economics and market efficiency", *Journal of Financial Economics*, Vol. 78 No. 2, pp. 345-367, doi: [10.5678/jfe.2020.34567](https://doi.org/10.5678/jfe.2020.34567).
- Sohail, N.A. (2009), "Long-run and short-run relationship between macroeconomic variables and stock prices in pakistan: the Case of Lahore Stock Exchange", *Pakistan Economic and Social Review*, Vol. 47, pp. 183-198.
- Spyrou, S. (2004), "Are stocks a good hedge against inflation?", *Applied Economics Letters*, Vol. 36 No. 1, pp. 41-48, doi: [10.1080/0003684042000177189](https://doi.org/10.1080/0003684042000177189).
- Tiwari, A.D., Teulon, F., Bhanja, N. and Arouri, M. (2015), "Stock returns and inflation in Pakistan", *Economic Modelling*, Vol. 47, pp. 23-31, doi: [10.1016/j.econmod.2014.12.043](https://doi.org/10.1016/j.econmod.2014.12.043).
- Uwubanmwun, A. and Eghosa, I. (2015), "Inflation rate and stock returns: evidence from the Nigerian stock market", *International Journal of Business and Social Science*, Vol. 6 No. 11, pp. 155-167.
- Wongbampo, P.A. (2002), "Stock market and macroeconomic fundamental dynamic interactions: Asean-5 countries", *Journal of Asian Economics*, Vol. 13, pp. 27-51.
- Zhao, X. (1999), "Stock prices, inflation and output: evidence from China", *Applied Economics Letters*, Vol. 6 No. 8, pp. 509-511, doi: [10.1080/135048599352835](https://doi.org/10.1080/135048599352835).
- Zoa, C.C. (2014), *The Impact of Macroeconomic Variables on The Stock Market Performance in Japan*.

Further reading

- Afees, A.I. and Ndakoc, B. (2000), "The inflation hedging properties of gold, stocks and real estate: a comparative analysis", *Resources Policy*, Vol. 66, doi: [10.1016/j.frl.2019.101384](https://doi.org/10.1016/j.frl.2019.101384).
- Afees, A.S., Ndakoc, U.B. and Akannid, L.O. (2019), "New evidence for the inflation hedging potential of US stock", *Finance Research Letters*, Vol. 37, pp. 1-7, 101384.
- Alqahtani, A. and Hakim, S. (2021), "Impact of inflation and interest rate toward Saudi Arabia stock market", *Palarch's Journal Of Archaeology Of Egypt/Egyptology*, Vol. 18 No. 13, pp. 874-880.
- Asravor, R. and Fonu, P. (2020), "Dynamic relation between macroeconomic variable stock market returns and stock market development in Ghana", *International Journal of Finance and Economics*, Vol. 26 No. 2, pp. 2637-2646, doi: [10.1002/ijfe.1925](https://doi.org/10.1002/ijfe.1925).
- Harzallah, A. (2022), "Stock markets and economic factors: what kind of relationship?", Sfax: FSEG-Université de Sfax.
- Jana, S. (2013), "Can Indian Stock Index return provide complete hedge against Inflation?", *International Journal of Research in Management*, Vol. 1, pp. 96-106.
- Pole, H.C. (2021), "The effect of macroeconomic variables on stock return volatility in the Nigerian stock exchange market", *Asian Journal of Economics, Finance and Management*, Vol. 3 No. 1, pp. 32-43.
- Salisu, A.R. and Ndako, U. (2020), "The inflation hedging properties of gold stocks and real estate: a comparative analysis", *Resources Policy*, Vol. 66, 101605, doi: [10.1016/j.resourpol.2020.101605](https://doi.org/10.1016/j.resourpol.2020.101605).
- Sami, J. (2021), "Stock market investment and inflation", *Review of Economic Analysis*, Vol. 13 No. 3, pp. 339-365, doi: [10.15353/rea.v13i3.4047](https://doi.org/10.15353/rea.v13i3.4047).
- Tiwari, A., Cunado, J., Gupta, R. and Wohar, M. (2019), "Are stock returns an inflation hedge for the UK? Evidence from a wavelet analysis using over three centuries of data", *Studies in Nonlinear Dynamics and Econometrics*, Vol. 23 No. 3, doi: [10.1515/snde-2017-0049](https://doi.org/10.1515/snde-2017-0049).

(The Appendix follows overleaf)

Table A1.
Sum up of the time series based fisher hypothesis verification results for the period covering the Covid-19 outbreak

Euro Countries										Non-Euro Countries									
Equations		(1)	(2)		(3)		(4)		Equations		(1)'	(2)'		(3)'		(4)'			
Dep var	R	RR	RR	RR	RR	RR	RR	RR	RR	Dep var	R	Hedge ?	RR	RR	RR	RR	RR		
Indep var/Countries	INF	Hedge ?	INF	Hedge ?	EINF	Hedge ?	EINF	UNEINF	Hedge ?	Indep var/Countries	INF	Hedge ?	INF	Hedge ?	EINF	Hedge ?	UEINF	UNEINF	Hedge ?
Austria	-0.150	NO	-0.2706***	NO	-0.1361	YES	-0.145	-0.202	YES	Bangladesh	.1193	NO	-0.05781	YES	.0102	YES	.0064	-0.0486	YES
Germany	-0.0374	NO	-0.0708	YES	-0.093	YES	-0.120	-0.1456	YES	Brazil	.4448***	YES	.10302	YES	-.2495**	NO	-.2421**	.1728*	NO
Belgium	-0.034	NO	-0.1378	YES	0.0597	YES	0.063	-0.060	YES	Canada	.0446	NO	-.27291***	NO	.2094*	NO	.2160*	-.2576**	NO
Denmark	-1.054	NO	-.1242	YES	-.1118	YES	-.1099	-.0871	YES	China	-.1131	NO	-.2050*	NO	.0727	YES	.0681	-.1903*	NO
Estonia	.1411	NO	-.0370	YES	.0945	YES	.1208	-.1549	YES	Chile	.3519***	YES	-.0580	YES	.0371	YES	.0277	-.0811	YES
Spain	-.0508	NO	-.1990**	NO	.2586**	NO	.2493**	-.1464	NO	Colombia	.3122***	YES	-.0686	YES	.1015	YES	.1129	-.0937	YES
France	-.0242	NO	-.0406	YES	-.1546	YES	-.1588	-.0145	YES	United States	-.3646***	NO	-.5600***	NO	-.1373	YES	-.0965	-.4744***	NO
Finland	-.0825	NO	-.1391	YES	-.1152	YES	-.1219	-.1280	YES	India	-.0861	NO	-.3320***	NO	.0704	YES	.0800	-.2818***	NO
Greece	.0311	NO	-.0204	YES	.1700	YES	.1715	.0099	YES	Indonesia	.0865	NO	-.1794*	NO	-.0622	YES	-.0559	-.1930*	NO
Hungary	.4110***	YES	.0841	YES	.0481	YES	.0499	.0237	YES	Japan	.0523	NO	-.1101	YES	-.3042***	NO	-.3067***	-.2722***	NO
Iceland	-.0697	NO	-.2879**	NO	.2394*	NO	-.2102*	-.2783**	NO	Malaysia	.2588**	YES	.1143	YES	.0699	YES	.0727	.1680	YES
Ireland	-.1139	NO	-.16951	YES	.1657	YES	.1837*	-.2044*	NO	Mongolia	.0329	NO	.0213	YES	.0055	YES	.0062	-.0231	YES
Italy	.01515	NO	-.12893	YES	-.0129	YES	-.0246	-.19423*	NO										
Latvia	.0740	NO	-.1244	YES	-.1250	YES	-.1095	-.1140	YES										
Luxemburg	.0117	NO	-.0560	YES	.0209	YES	.0166	-.0289	YES										
Poland	.4268***	YES	.2058**	NO	-.0039	YES	-.0298	.1281	YES										
Portugal	-.1190	NO	-.2444**	NO	.0924	YES	.0580	-.2052**	NO										
UK	.0011	NO	-.1102	YES	-.0806	YES	-.0800	-.1044	YES										
Russia	-.1310	NO	-.2585**	NO	-.2738**	NO	-.26531**	-.2378**	NO										

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. Also significant slopes are presented in bold. The results of equations $R_t = \alpha + \beta INF_t + \varepsilon_{1t}$, $RR_t = \alpha_1 + \beta_1 INF_t + \varepsilon_{2t}$, $RR_t = \alpha_2 + \beta_2 EINF_t + \varepsilon_{3t}$ and $RR_t = \alpha_3 + \beta_3 EINF_t + \beta_4 UNEINF_t + \varepsilon_{4t}$ are presented respectively in columns (1), (2), (3) and (4) for European countries, and in columns (1)', (2)', (3)' and (4)' for non-European countries. With dependent variable (Dep var) R_t (nominal return) in equation (1), inflation hedging is achieved if β is *significant and positive*. With dep var RR_t (real return) in Eq. (2), (3) and (4) there is hedging against inflation, unanticipated inflation and/or anticipated inflation if β_j is *not significant*, $j = 1, 2, 3, 4$. *Green color and YES (Red color and NO)* are used to indicate evidence for (against) an inflation hedging property. Turkey is dropped from the sample because of missing or unavailable data for CPI

Source(s): Authors' elaboration

		Pre-COVID		COVID period		Post-COVID		Pre-COVID		COVID period		Post-COVID	
Group I: European vs. non-European countries						Group II: Emerging vs. Developed countries							
Groups	INF	Hedge ?	INF	Hedge ?	INF	Hedge ?	Groups	INF	Hedge ?	INF	Hedge ?	INF	Hedge ?
Eq (5): $\overline{RR}_i = \alpha + \beta \overline{INF}_i + v_{it}$													
Euro	.03155	NO	.14258	NO	.47543***	YES	Em	0	NO	.678571	NO	.182608	NO
Non Euro	.06593	NO	.27972	NO	.08181	NO	Dev	-13388	NO	.07078	NO	.314285	NO
Eq (6): $\overline{RR}_i = \alpha + \beta_1 \overline{EINF}_i + v_{it}$													
Euro	-.04764	YES	-.06503	YES	.65614***	NO	Em	.28571	YES	.321428	YES	-.2	YES
Non Euro	.19780	YES	.08741	YES	.027272	YES	Dev	-.10835	YES	-.01994	YES	.330434**	NO
Eq (7): $\overline{RR}_i = \alpha + \beta_1 \overline{EINF}_i + \beta_2 \overline{UNEINF}_i + v_{it}$													
Euro	-.04957	YES	-.04913	YES	.64145***	NO	Em	.285714	YES	.35217	YES	-.23355	YES
Non Euro	.19722	YES	.05340	YES	-.00522	YES	Dev	-.20634	YES	.06400	YES	.369901**	NO
Euro	-.00719	YES	-.03978	YES	-.15789	YES	Em	.428571	YES	.047826	YES	-.391447	YES
Non Euro	-.00277	YES	-.26949	YES	-.06620	YES	Dev	-.27774	YES	-.21705	YES	.116975	YES

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. We use two groups of countries: group I for European (Euro) vs non-European (Non-Euro) countries, and group II for emerging (Em) vs developed (Dev) countries. Three sub-periods are considered: a pre- Covid 19 Outbreak crisis sub-period (2016:06 – 2019:11), a during the crisis (2019:12 – 2022:06), and a post sub-crisis period (2022:07 – 2024:04). Significant slopes are presented in bold. With R_t (nominal return), there is a hedge against realized inflation if β is significant and positive. With RR_t (real return), there is a hedge against inflation expected and/or unexpected if β_j is not significant, $j = 1, 2$. Also, green color and YES (Red color and NO) are used to indicate evidence for (against) an inflation hedging property

Source(s): Authors' elaboration

Table A2.
Sum up of cross-sectional regression results for the period covering the Covid-19 outbreak

Panel A: Group of the hedged stock returns									
Equation	(8)		(9)		(10)		(11)		
	INF	Hedge ?	INF	Hedge ?	EINF	Hedge ?	EINF	UNEINF	Hedge ?
full period	0.8099***	YES	-0.19000	YES	-0.2257	YES	-0.21216	-0.19003	YES
pre covid	0.5206***	YES	-0.4793***	NO	0.0391	YES	0.2295	-0.5065***	NO
covid	1.5078***	YES	0.5078*	NO	1.5211	YES	1.3426	0.28138	YES
post covid	0.3767*	YES	-0.6232***	NO	0.0170	YES			

Panel B: Group of the no hedged stock returns									
Equation	(8)		(9)		(10)		(11)		
	INF	Hedge ?	INF	Hedge ?	EINF	Hedge ?	EINF	UNEINF	Hedge ?
full period	0.2998***	YES	-0.7001***	NO	-2.9374***	NO	-2.4273***	-0.6725***	NO
pre covid	0.1826	NO	-0.8173***	NO	-0.80082***	NO	-1.55975***	-0.7817***	NO
covid	0.3800***	YES	-0.6199***	NO	-9.42060***	NO	-6.98630**	-0.5728***	NO
post covid	-0.02201	NO	-1.0220***	NO	-4.2413*	NO	-4.3672***	-0.9914***	NO

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. From Table A1, group of the hedged stock returns includes Hungary, Chile, and Colombia' cases, while group of the no hedged stock returns includes Spain, Iceland, Russia, and Canada' cases.

Fixed effect (FE) model and within estimation technic was used unless random effect (RE) model was not rejected by Hausman test. (+): indicates that the adequate model is the FE model. GLS technic is used for RE model estimation. Green color and YES (Red color and NO) are used to indicate evidence for (against) an inflation hedging property

Source(s): Authors' elaboration

Table A3.
Robustness of the Inflation-hedging property: the case of panel data covering the Covid-19 outbreak

Table A4.
Robustness of the
Inflation-hedging
property: the role of
interest rate with panel
data covering the
Covid-19 outbreak

Panel A: Group of the hedged stock returns												
Equation	(12)			(13)			(14)			(15)		
	INF	IR	Hedge ?	INF	IR	Hedge ?	EINF	IR	Hedge ?	EINF	IR	Hedge ?
full period	0.81787***	-0.00214**	YES	-0.18212	-0.00214**	YES	0.49761	-0.00251**	YES			
pre covid	0.5234***	-0.0016	YES	-0.4765***	-0.00167	NO	-0.029312	-0.001753	YES			
covid	1.4934***	-0.001188	YES	0.493450*	-0.001188	NO	1.2463	-0.0015***	YES			
post covid	0.236705 ⁽¹⁾	-0.01522**	NO	-0.7632***	-0.01522**	NO	1.041271	-0.00543*	YES			

Panel B: Group of the no hedged stock returns													
Equation	(12)			(13)			(14)			(15)			
	INF	IR	Hedge ?	INF	IR	Hedge ?	EINF	IR	Hedge ?	EINF	UNEINF	IR	Hedge ?
full period	0.3462*** ⁽¹⁾	-0.0062***	YES	-2.2741*** ⁽¹⁾	-0.0070***	NO	-2.2741***	-0.0070***	NO	-2.1178***	-0.6605***	-0.0021***	NO
pre covid	0.18210	-3.72E-05	NO	-0.81790***	-3.72E-05	NO	-1.6056***	0.00020	NO	-1.43435***	-0.7833***	0.000368	NO
covid	0.50481*** ⁽¹⁾	-0.0159***	YES	-0.4951*** ⁽¹⁾	-0.0159***	NO	-2.2780 ⁽¹⁾	-0.0176***	NO	-0.65104 ⁽¹⁾	-0.4944*** ⁽¹⁾	-0.0159***	NO
post covid	-0.022339	6.00E-05	NO	-1.02233***	6.00E-05	NO	-10.604*** ⁽¹⁾	-0.01485***	NO	-5.0983**	-0.9770***	-0.00142	NO

Note(s): *, **, ***: denote significance level of 10%, 5% and 1% respectively. From Table A1, group of the hedged stock returns includes Hungary, Chile, and Colombia' cases, while group of the no hedged stock returns includes Spain, Iceland, Russia, and Canada' cases.

Fixed effect model and within estimation technic was used unless RE model was not rejected by Hausman test. (+): indicates that the adequate model is the FE model. GLS technic is used for RE model estimation. *Green color and YES (Red color and NO)* are used to indicate evidence for (against) an inflation hedging property

Source(s): Authors' elaboration

Corresponding author

Malika Neifar can be contacted at: malika.neifar@ihecs.usf.tn

For instructions on how to order reprints of this article, please visit our website:

www.emeraldgroupublishing.com/licensing/reprints.htm

Or contact us for further details: permissions@emeraldinsight.com