

## Generalized Fisher Hypothesis Validity for Canada, UK, and Suisse Stock Markets: Evidence from ARDL Models

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### Abstract

In this paper we propose a decision support tool for the investor in terms of asset allocation. The key question is to know whether equities are perfect hedge against inflation. We chose three democratic countries having common monetary policy based on the Inflation rate stabilization targeting (including Canada, UK, and Suisse) over the period 1999M01-2018M04. We see how the stock return evolution is related to inflation rate Pre, during, and Post 2008 Global financial crisis (GFC). Then, some dynamic version of the Generalized Fisher hypothesis (GFH) models is explored by some univariate autoregressive dynamic linear (ARDL) frameworks. We conclude that during crisis period, being on either Suisse or Canadian stock market, investors can have important abnormal gains.

**Keywords:** generalized Fisher hypothesis; global financial crisis; ARDL models; Canada, UK and Suisse stock markets.

**JEL Classification:** G14; G15; C23; C32.

### Introduction

The original hypothesis that is attributed to the monetarist, Irvin Fisher offers the first preliminary study towards formalizing the relationship between asset returns and inflation. Fisher hypothesis assumes that nominal interest rate is expressed as the sum of real return and inflation rate<sup>2</sup>. Fisher (1930) hypothesized that the expected real interest rate is determined by real factors and is *independent* of the *expected inflation rate*. This hypothesis was generalized to asset in the efficient stock markets context (Fama & Schwert, 1977).

The generalized Fisher hypothesis (GFH) assumes independence between the expected real return and inflation. Invalidity of the GFH, that real returns on *financial assets* are likely to be dependent of inflation rates, has some implications. The more important implication is the uncertainty creation across financial markets, thereby adversely affecting investment and saving decisions in an economy. According to the GFH, in an efficient market, investors should be fully compensated for the increased price levels even if inflation decreases the value of money. Associated with perfectly competitive and informationally efficient capital markets in which investors are rational, the GFH postulates that stock prices should move *one-for-one* with goods prices to compensate investors for prices growth (inflation). This implies that stock returns should serve as a *hedge* against inflation, that is, *real* stock returns and inflation are independent. Consequently, we should observe a positive and *one-to-one* relationship between *nominal* stock returns and inflation rates.

The Fisher hypothesis has become the workhorse for motivating the inflation hedging question of any asset class including commodities (Arnold & Auer, 2015). However, existing empirical research on the relationship between stock returns and expected inflation hasn't reached a consensus yet. During the 1970s, new evidence contradicted the economic GFH. More specifically, (Nelson, 1976; Bodie, 1976; Fama & Schwert, 1977; Modigliani & Cohn, 1979) reported a negative relationship between stock returns and inflation. Later, from the consequence of proxy hypothesis effects, Fama (1981) concluded also for the negative correlation between stock returns and inflation. This proxy hypothesis garnered substantial support in some subsequent papers (Gultekin, 1983; Geske & Roll, 1983; Erb, et al. 1995).

The negative relationship between real stock returns and inflation rates has also been explained by four theories based on four hypotheses including Money Illusion Hypothesis (MIH), Tax Effect Hypothesis (TEH), Proxy Effect Hypothesis (PEH), and Reverse Causality Hypothesis (RCH) (Tiwari, et al. 2019).

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<sup>2</sup> Fisher (1930) asserted that the "nominal" interest rate consists of a "real" rate plus the expected inflation rate.

The positive relationship between nominal stock returns and inflation rates can also be explained by the Wealth Effect Hypothesis (WEH) since real stock returns can affect inflation rates through their impact on consumption and then on aggregate demand (Ando & Modigliani, 1963). According to WEH, there are different channels through which stock prices can affect consumption such as the realized gain (higher future income and wealth) via the expectation that raising the current stock price, the liquidity constraint effect, and the stock option value effect. Based on these two hypotheses (GFH and WEH), a positive relationship between nominal stock returns and inflation rates can be observed in the data.

Empirically, the relationship between (nominal or real) stock returns and inflation has been analyzed in the literature for *short or long horizons*. For *short-run*, many have found a negative correlation (Bodie, 1976; Fama & Schwert, 1977; Fama, 1981; Ghazali & Ramlee, 2003; Koustas & Lamarche, 2010; Tsong & Lee, 2013), while for *long-run*, the results are more likely to support the Fisher hypothesis (Schotman & Schweitzer, 2000; Lothian & McCarthy, 2001).

Two other important questions on the correlation between real stock returns and inflation rates are treated in the literature. The first is about the sign and the strength of the correlation that may depend on the frequency scale (price level vs index level). The second is about how the correlations can evolve heterogeneously overtime (Valcarcel, 2012; Antonakakis, et al. 2017).

Previous studies have dealt with different models and inferential (estimation and test) approaches in order to detect and explain the hedging inflation ability. Recently, for *robustness question*, the panel data-based approach was used in a few numbers of papers (Afees, et al. 2019, 2020; Halit, 2016). For example, Afees, et al. (2019) found that the GFH test results based on panel data (the price level data for the individual constituents of US stock returns) were opposite to those based rather on the index level data (univariate time series).

In this paper, GFH test will be verified within the univariate time series type data. We consider three developed countries having in common a monetary policy based on inflation rate targeting stabilization including Canada, the UK, and Suisse stock markets for the period from 1999M01 to 2018M04 covering 2008 GF crisis. The objective is to examine the inflation-hedging ability within each stock market. We want to know if hedging ability results from each stock markets may be different from ones of the portfolio asset from the three stock markets. In addition, since the long run relationship between stock return and inflation can be instable through time, the analysis will be done for the following four periods: the full data set and the three sub periods: Pre the Global Financial Crisis (GFC), during the GFC period, and Post the GFC period. To the best of our knowledge, our paper is the first which uses a univariate ARDL approaches to explore the stability of the GFH relationship that examining the inflation-hedging ability.

This study is organized as follows: after introduction, we give an empirical literature review; we mention then the required data and their sources and we give some descriptive analysis and present data analysis; after that, we outline the methodology used and we provide the empirical results and analysis; concluding remarks will be given at the end.

## 1. Literature Review

The generalized Fisher hypothesis assumes the *independence* between the expected real return and inflation and a *positive* relationship between nominal stock returns and expected inflation. These conditions have also been extensively explored for developing and advanced economies over the past three decades (Lintner, 1973; Fama, 1981; Geske & Roll, 1983; Basse & Reddemann, 2011; Arnold & Auer, 2015; Baker & Jabbouri, 2016; Baker & Jabbouri, 2017; Adekoya, et al. 2021; Simpson, et al. 2007). Some studies highlighted the existence of *positive and/or negative* associations (Hardin, et al. 2012; Hoesli, et al. 1997; Barnes, et al. 1999; Lee & Lee, 2012), while others have detected *only a negative* relationship (Chatrath, 1997; Maysami & Koh, 2000).

More recent studies are based on recent models and techniques in order to detect the hedging inflation ability such as the NARDL model (Thi, et al. 2016), the time variation investigation (Salisu, et al. 2019; Kuang, 2017), the cointegration tests (Al-Nassar & Bhatti, 2019), the comparative analysis (Akinsomi, 2020), the ARDL model (Afees, et al. 2020), the VAR model (Sangyup & Junhyeok, 2022), etc.

Based on *Markov-switching GRG copula model*, Kuang (2017) explored tail quantile dependences between the inflation rate and the real estate investment trust (REIT) return. Finding say that the positive and negative co-movements coexist. In the negative co-movement state, the REIT cannot hedge inflation risk, while in the positive co-movement state, the REIT has a partially hedging ability.

Recently, Salisu, et al. (2019) examined the inflation hedging potential of the two most valuable precious metals namely gold and palladium. They employed both *time series and panel data techniques* for country-specific and group analyses. They concluded that both gold and palladium provide hedge against inflation in OECD countries notwithstanding the varying results across the individual countries. While the inflation-hedging potential

of gold has been sustained, it only improves for palladium after the Global Financial Crisis. Their conclusions are sensitive to data frequency. Also, in order to investigate the relationship between property returns and inflation hedging ability, Akinsomi (2020) used a *comparative analysis of the year-to-date (YTD)* returns of global returns index and REITs sectors in the United States. Finding reveal that most sector REITs during the pandemic have lost considerable value based on YTD returns as at May 2020. Flight to quality is expected during this uncertain period to REITs such as data REITs, grocery-anchored REITs and storage REITs. These REITs are not as adversely affected by COVID-19 in comparison to other REITs.

Afees, et al. (2020) analyzed asset-inflation hedging nexus for the US with the aim of determining inflation hedging characteristics of selected assets; stocks, gold, and real estate's using the *bivariate and multivariate modelling* frameworks that taking into account of the asymmetry, the time-variation and the structural breaks. Founding says that inflation hedging tendencies of assets are heterogeneous across the considered assets. The real estates and stocks are proved to be good hedges against inflation, while gold investment defied Fisher's hypothesis. However, even the results are robust to alternative data frequencies, they are sensitive to the decomposition of data for pre- and post-GFC periods, indicating that asset-inflation hedging relationship for the US is time-varying.

Sangyup & Junhyeok (2022) used a *Vector Autoregression (VAR)* model. They provide systematic evidence on the relationship between inflation, uncertainty, and Bitcoin. Bitcoin appreciates against inflation (or inflation expectation) shocks, confirming its inflation-hedging property claimed by investors. The main findings hold with or without the COVID-19 pandemic episode.

To the best of our knowledge, only one study in the above literature has consider the *ARDL model* (Afees, et al. 2020) and only one which consider both univariate time serie and panel data analysis (Salisu, et al. 2019).

In this paper, we'll conduct an analyses on three developed countries including the United Kingdom, Canada and Switzerland for a period spanning from 1999 to 2018 covering the 2008 GFC period using univariate ARDL models. We which to see if the asset-inflation hedging relationship for the considered sample is time-varying or not (say if results are sensitive to the decomposition of data for pre- during and post- GFC periods).

## 2. Econometric Models and Estimation Results

GFH verification can be implemented in different specifications (static or dynamic). Dynamic specifications are considered and applied in the following sub-sections.

### 2.1. The Auto Regressive Dynamic Distributed Lag (ARDL) models

To explore the long- and short-run linear relationships between stock market returns and inflation, the following equation in the ARDL form will be used:

$$\Delta R_t = C_1 + \delta_1 R_{t-1} + \delta_2 INF_{t-1} + \sum_{i=1}^p \alpha_i \Delta R_{t-i} + \sum_{i=1}^q \beta_i \Delta INF_{t-i} + \varepsilon_t, \quad (1)$$

where  $R = \Delta \log(SP)$  and  $INF = \Delta \log(CPI)$ ,  $SP$  is the stock price, and  $CPI$  is the consumer price index.  $C_1$  is the intercept,  $\delta_1$ , and  $\delta_2$  represent long-term relationship (all are real parameters),  $\alpha_i$  and  $\beta_i$  represent short-term relationship,  $p$  and  $q$  are the optimal lags to be used,  $\Delta = 1 - B$ ,  $B$  is the lag operator, and  $\varepsilon_t \sim WN(0, \sigma^2)$ .

To resolve null hypothesis of no cointegration in the ARDL framework, Pesaran, et al. (2001) provided the bound test based on  $F_{PSS}$  Fisher type statistic that can be applied regardless of whether the series are  $I(0)$ ,  $I(1)$  or fractionally integrated (but not  $I(2)$ ). If cointegrating relationship is established between stock returns and inflation, Granger causality test can be done in the following error correction model (ECM):

$$\Delta R_t = C_1 + \delta_1 ECT_{t-1} + \sum_{i=1}^p \alpha_i \Delta R_{t-i} + \sum_{i=1}^q \beta_i \Delta INF_{t-i} + \varepsilon_t, \quad (2)$$

where:  $ECT_{t-1} = R_{t-1} - \gamma_2 INF_{t-1} + c$  is the error correction term representing the long-run relationship between stock returns and inflation,  $\delta_1$  captures the sensitivity of the error correction term.

A negative and significant coefficient of the error correction term, the *speed of adjustment*  $\delta_1$ , indicates that there is a *long-run causal relationship* between stock returns and inflation. Precisely, the *unidirectional causality* from inflation to stock returns hints an *inefficiency* of the stock market which suggests that information on past values of inflation could *provide opportunities* for *abnormal gains* from the return  $R$ .

The *positive* relationship between inflation and stock market returns in *long run* ( $\gamma_2 > 0$ ) is the *Fisher hypothesis*. It suggests that as inflation rises, investors on stock market are compensated for it in the long run.

Theoretically, *negative* relationship in *short-run* ( $\beta_i < 0$  or  $\sum_{i=1}^p \beta_i < 0$ ) is in tandem with (Fama, 1981) *proxy hypothesis* (and the standard stock valuation model which predict a *negative* relationship between inflation and stock market returns).

## 2.2. Empirical results

The paper uses a dataset for three (N=3) countries, including Suisse, UK, and Canada over the period from 1999M01 to 2018M04 (T=232). The stock price SP data is obtained from the investing.com while the consumer price CPI series is obtained from OCDE. We use a large sample that includes both the pre- and post-2008-2010 periods of the Global Financial Crisis (GFC).

In order to implement the ARDL model, we determine the appropriate lags length. All lags selections are based on the lowest value of the Akaike Information Criterion (AIC). All these results are reported at Table 2 (see note). We consider then the question of cointegrating relationship test between stock return (R) and Inflation (INF). The results of  $F_{PSS}$  test-statistic are reported in Table 1. The  $F_{PSS}$  -statistics for joint significance are above the upper bound critical value at 5% level of significance (4.16). This result confirms the existence of long-run equilibrium relationship among the variables used for each of the three considered stock markets and for the full period as well as for the three sub-periods (pre, during, and post crisis). Then, we can investigate whether the stock return responds positively or negatively, *completely* or *partially* to changes in inflation.

Table 1. Cointegration test results:  $F_{PSS}$  -Bounds Test. Null Hypothesis: No long-run relationship

	Full period	Pre crisis	Crisis period	Post crisis
	$F_{PSS}$ Test Statistics			
Suisse	43.42028	16.68444	7.294046	23.95723
UK	12.21969	31.31641	4.365888	41.59613
Canada	23.83447	23.17971	15.23084	18.35527

Note: The lower critical bound assumes that all the variables are I (0), meaning that there is no cointegration among the variables, while the upper bound assumes that all the variables are I (1), see (Pesaran, et al. 1999); henceforth PSS. If the  $F_{PSS}$  is greater than the upper critical bound, then the null hypothesis is rejected, suggesting that there is a cointegrating relationship between the variables under consideration. If the observed  $F_{PSS}$  lies within the lower and upper bounds, then the test is inconclusive. If the  $F_{PSS}$  falls below the lower critical bounds value, it suggests that there is no cointegrating relationship (we do not reject null hypothesis). Critical values for 1%, 5%, and 10% level are respectively 4.94, 3.62, 3.02 for I(0) and 5.58, 4.16, 3.51 for I(1).

We further go to the long-run stability relationships. The results of the long run coefficients are presented in Table 2. The negative and statistically significant coefficients of the Error Correction Terms ( $ECT_{t-1}$ ) suggests that there is a *unidirectional* causality running from inflation to stock market returns for each country and for all considered periods.

From Table 2, it is clear that the long run relationship between R and INF is 'significantly' positive only for Suisse stock market (during the GFC crisis) and Canadian stock market for all considered sub-periods. The positive long run relationship is in a chord with *Fisher hypothesis*. It suggests that as inflation rises, investors on the Suisse or Canadian stock market are compensated for it in the long run. Moreover, the unidirectional causality from inflation to stock returns hints of *inefficiency* of the *Suisse and Canadian* stock markets which suggests that information on past values of inflation could provide opportunities for *abnormal gains* from the Suisse and Canadian stock markets.

Besides, for the UK stock market, negative relationship implies that the Fisher effect is not only not valid in the long run but can be connoted by a *worse* hedging against inflation. This result is not surprising since UK stock return is the lowest in mean while the UK inflation rate on average is negative. Based on the theories mentioned in the introduction, we conclude that for post or pre GFC period, the Fisher and the Wealth Effect Hypothesis could be rejected in favor of the Money Illusion, Tax Effect, Proxy Effect and/or Reverse Causality Hypotheses.

Looking at different considered periods, *Suisse* stock market seems to be *inefficient* for only during crisis period. Indeed, between 2008M01 and 2009M12 (crisis period), *Suisse* stock market has superior performance as  $\hat{\beta} = 2.082296 \gg 1$ . However, *Canadian* stock market is found to be *inefficient* for all considered periods. Results support *partial* Fisher effects Pre crisis period ( $\hat{\beta}=0.67395 < 1$ ), *full* hedge hypothesis for post crisis period ( $\hat{\beta}=0.98384 \approx 1$ ), and a superior performance ( $\hat{\beta}=2.328087 \gg 1$ ) during crisis period.

Diagnostic tests (in Table 3) suggest adequate specifications for all countries and for all considered periods since the models show free autocorrelation errors and free conditional heteroscedasticity. The structural stability test is conducted by employing the cumulative sum of squares recursive residuals (CUSUMSQ). The stability tests confirm the stability of the estimated coefficients during crisis and post crisis periods.

Table 2. Long-run relationship results from univariate time series ARDL model (Eq (2))

	Full period			Pre crisis		
	Suisse	UK	Canada	Suisse	UK	Canada
$\hat{\gamma}_2$	0.87698*	-0.6612**	1.03202*	0.738967	-0.7513**	0.67395**
	(2.70658)	(-2.2289)	(3.92292)	(1.14247)	(-2.2067)	(2.24333)
Hedge?	Yes	No	Yes	No	No	Yes
$\hat{\delta}_1$	-0.70205*	-0.64027*	-0.66048*	-0.63087*	-0.86082*	-0.77281*
	(-11.4633)	(-6.08225)	(-8.49363)	(-7.14319)	(-9.78639)	(-8.41958)
	Crisis period			Post crisis		
	Suisse	UK	Canada	Suisse	UK	Canada
$\hat{\gamma}_2$	2.082296*	-0.06309	2.32809*	0.08599	-0.5692*	0.9838*
	(2.91619)	(-0.08176)	(5.30437)	(0.25494)	(-3.04583)	(3.71863)
Hedge?	Yes	No	Yes	No	No	Yes
$\hat{\delta}_1$	-0.86754*	-0.76009*	-0.90597*	-0.85125*	1.00633*	-0.71526*
	(-4.89552)	(-3.78749)	(-7.07419)	(-8.56467)	(-11.2855)	(-7.49753)

Note: \*, \*\* indicates 1% and 5% level of significance. Numbers in parenthesis are the  $t$  Student statistic. Three period are considered: Pre GFC from  $t = 1999M01$  to  $2007M12$  (TN = 324), crisis period from  $2008M01$  to  $2009M12$  (TN = 72), and Post GFC period from  $2010M01$  to  $2018M04$  (TN = 300).

For the Suisse market case, the selected model by AIC criteria is ARDL(1, 0) for the full period and for the three considered sub-periods (Pre, during, and Post crisis). For the UK stock market, we get the ARDL(5, 0) for full period and ARDL(1, 0) for the 3 sub-periods. For the Canada stock market, we get the ARDL(2, 1) for full period, ARDL(1, 0) for pre and during crisis and the ARDL(2, 0) for the post crisis period.  $\gamma_2$  is the long run effect of INF in equation (2). The positive relationship between inflation and stock market returns in long run ( $\gamma_2 > 0$ ) suggests that as inflation rises investors on stock market are compensated for it in the long run.  $\delta_1$  is the coefficient of  $ECM_{t-1}$  in equation (2). A negative and significant coefficient of the error correction term,  $\delta_1$ , indicates that there is a long-run causal relationship between stock returns and inflation. Precisely, the unidirectional causality from inflation to stock returns hints an inefficiency of the stock market which suggests that information on past values of inflation could provide opportunities for abnormal gains from the return  $R$ .

Table 3. Diagnostic adequacy for ARDL results

Full period	Suisse		UK		Canada	
ARCH	0.222321	(0.6373)	1.351922	(0.2449)	1.642901	(0.1999)
LM	0.106741	(0.9480)	2.982347	(0.2251)	0.998191	(0.6071)
Pre crisis	Suisse		UK		Canada	
ARCH	0.925765	(0.3360)	3.439095	(0.0637)	0.503573	(0.4779)
LM	0.081120	(0.9603)	0.509288	(0.7752)	2.862433	(0.2390)
Crisis period	Suisse		UK		Canada	
ARCH	0.478832	(0.4890)	0.107790	(0.7427)	0.056724	(0.8118)
LM	0.835477	(0.6585)	2.915113	(0.2328)	1.545418	(0.4618)
Post crisis	Suisse		UK		Canada	
ARCH	0.407737	(0.5231)	0.051566	(0.8204)	0.001532	(0.9688)
LM	1.195604	(0.5500)	2.097041	(0.3505)	3.433368	(0.1797)

Note: (.) are p-value. LM test against ARCH(1) and LM test against AR(2) test results are reported



## Conclusion

As mentioned earlier, there is no general consensus among empirical research on the validation of GFH (Antonakakis, et al. 2017). This paper intends to make some contributions to the empirical literature on the Generalized Fisher Hypothesis (GFH) and the inflation-hedging ability of countries common stocks market. As well, it is of great importance to see if the long run relationship between stock return and inflation can evolve heterogeneously overtime. To this end, we consider the three democratic countries, including Canada, UK, and Suisse from 1999M01 to 2018M04 covering the 2008 GFC period.

Based on univariate ARDL time series data models, we conclude that Canadian (UK) stock return is (not) a hedge against inflation for the three sub-periods, while Suisse market return is a hedge against inflation only during GFC crisis. During crisis both Suisse and Canadian stock returns are superior hedge against inflation. Post crisis, the Canadian stock market is unique to be full hedge against inflation (this result is in accordance with (Richard & Ran, 2021)). No significant relationship is found in the UK context during crisis period (period of deflation). In addition, post and Pre crisis, UK stock market is found to be worse hedge against inflation. Then, it would mean that being on the UK stock market, investors would be better off in reducing their stock market investments in times of high inflation rates. During crisis period (deflation period), being on either Suisse or Canadian stock market, investor can have important abnormal gains.

Findings confirm that GFH tests give different conclusions over considered sub-periods. Results are sensitive to the decomposition of data for pre- and post-GFC periods, indicating that asset-inflation hedging relationship for the considered sample is time-varying. Table 4 gives a sum up of all the previous results (from Table 2). Looking at Table 4, hedging ability is unchanged for the UK and the Canadian stock market, while Suisse case reveal unambiguous instability.

Table 4: Results for inflation hedging in the full period, pre- during and post- GFC

Data	Suisse	UK	Canada
Full period	Yes	No	Yes
Pre GFC	No	No	Yes
GFC	Yes	No	Yes
Post GFC	No	No	Yes

Note: This is a sum up of Table 2.

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