# Suisse stock return, Macro Factors, and Efficient Market Hypothesis: evidence from ARDL model

NEIFAR, MALIKA

IHEC SFAX UNIVERSITY

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**NEIFAR Malika**[1]

**Sfax university – IHEC**

## Abstract

This study investigates the short run and the long run equilibrium relationship between Suisse stock market (SSM) prices and a set of macroeconomic variables (inflation, interest rate, and exchange rate) using Monthly data for the period 1999:1 to 2018:4. Different specifications and tests will be carried out, namely unit root tests (ADF and PP), Vector Auto Regression (**VAR**) to select the optimal lag length and for **Granger** causality and Toda and Yamamoto (**TY**) Wald non causality testing, **VEC** Model and (**Johansen**, 1988)' test for no cointegration, and **ARDL** framework and $\mathbf{F_{PSS}}$ test of no cointegration hypothesis. **ECM** representation of the **ARDL** model confirm temporal causality between (inflation, interest rate, exchange rate) and the stock price. There is dynamic **short run** adjustment and long run stable equilibrium relationship between macroeconomic variables (except exchange rate) and stock prices in the SSM. This imply that the SSM is informationally **inefficient** because publicly available information on macroeconomic variables (inflation and interest rate) can be potentially used in predicting Suisse stock prices.

Key words: Suisse Stock market efficiency; Macroeconomic variables; Causality; cointegration; ARDL model.
Jel classification: C32; E44; G14



[1] Associate Professor in Quantitative Methods at New Economic Department, Postal address: Route Sidi Mansour Km 10, B.P. 43, 3061. Sfax, Tunisia.

Email : malika.neifar@ihecs.usf.tn and mneifar68@gmail.com

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# I. Introduction

According to the Efficient Market Hypothesis (EMH) (Fama, 1970), an **efficient** capital market is one in which **stock prices** change rapidly as the new information becomes available.

Several studies suggest that the movement of stock market indices is highly sensitive to the changes in the **fundamentals** of the economy and to the changes in the expectation about future prospects (Ahmed, 2008). "Moreover, the predictability of returns by using macroeconomic information could be regarded as evidence of **market inefficiency**. Therefore by investigating the short and long run relationship between macroeconomic variables and stock returns, conclusions regarding the efficiency of the stock market can be derived and relevant policy regulations to improve stock market conditions can be assessed," (Theophano & Sunil, 2006).

"Traditionally, equities have been regarded as a **good hedge** against inflation because of the fact that equities are claimed against physical assets whose **real returns should remain unaffected by inflation**. Investors need to know whether equities can serve as a hedge against inflation. If a company is able to sustain its profit margin despite high inflation, then the stock price is likely to hold. If the **high inflation** sustains, at some stage it will lead to a chain reaction across the economy, **pushing up interest rates** and even affecting demand. An increase in interest rates will push up borrowing costs for corporate while lower demand will hurt growth in revenues," (Chittedi, 2015).

Empirical researchers have tried to identify determinants of stock prices. Contemporary financial theory asserts that stock prices are closely related to the movements of macro variables (Chittedi, 2015).

The relations between exchange rate movements and stock prices are based on the rise in the domestic interest rate that leads to capital inflows and makes the exchange rate appreciate.

This research aims to identify the nature of the relationship between the stock market and macroeconomic variables. The variables under investigation are Suisse market index price as proxy for the stock market, CPI as proxy for inflation, Interest rate, and exchange rate.

Three testable hypotheses are considered to test the relationship between dependent variable (stock market index price) and independent variables (inflation, interest rate, and exchange rate):

$H_1$: Interest rate does not affect stock market index in the long run.
$H_2$: Inflation does not affect stock market index in the long run.
$H_3$: Exchange rate does not affect stock market index in the long run.

To reach the objective of the study various econometrics tests for different specifications will be carried out, namely unit root tests (ADF and PP), Vector Auto Regression (VAR) to select the optimal lag length, VEC Model and (Johansen, 1988)' test for cointegration, ARDL framework and $F_{PSS}$ test of no cointegration hypothesis, VAR model and Granger causality test and Toda and Yamamoto Wald causality test.

The study investigates the nature of the causal static and dynamic relationships between Suisse stock price and the key macro-economic variables in Suisse economy for the period January, 1999 to April, 2018 using monthly data.

Therefore this paper has been organized as follows. Section II analyses the required mentioned data and their sources (subsection 1), outlines the methodology used (subsection 2), and provides the empirical results and analysis (subsection 3). Concluding remarks are given in section **III**.

# II. Econometric Models and Estimation

VAR model, (Granger, 1969) non causality test, and (Toda & Yamamoto, 1995) Granger non causality test have been applied to explore the long-run or short-run interdependance. VECM, Autoregressive distributed lag (ARDL) approach and cointegration tests (techniques of (Johansen, 1988) and (Pesaran, Shin, & Smith, 2001)) are used in this study to examine the short-run and long-run dynamic relationship between stock prices and macroeconomic variables.

## 1. The Data

Monthly Suisse data are selected from International Monetary Fund (IMF) database through the period January 1999 until April 2018. The market stock price (SP) will serve as an indicator for the stock market while for the macroeconomic variables nominal interest rates (INT), inflation (consumer price index, CPI), and nominal exchange rate (EXC) will be used (see Table 1).

The natural log difference transformation is used to compute the **stock returns**;

$$R_t = \Delta LSP_t = LSP_t - LSP_{t-1},$$
$$LSP_t = \log(SP_t),$$

where $\Delta = 1 - B$, B is the lag operator, $SP_t$ and $SP_{t-1}$ are the current and previous month stock prices for the current month t and previous month t − 1.

Table 1. Data collection sources.

| Variable | Frequency | Source | Notation |
|---|---|---|---|
| Suisse stock price | Monthly | OCDE | LSP |
| Interest rate | Monthly | IMF | INT |
| Consumer Price Index | Monthly | IMF | LCPI |
| Exchange rate | Monthly | IMF | LEXC |

L is for log transformation. OCDE ≡ Organasation de Cooperation et de Developpement Economique.

Table 2. Descriptive statistics.

| | LCPI | LSP | INT | LEXC | R |
|---|---|---|---|---|---|
| Mean | 4.639171 | 4.569692 | 1.806580 | 2.044147 | 0.004488 |
| Median | 4.652710 | 4.586382 | 1.800000 | 2.038378 | 0.010359 |
| Maximum | 4.740535 | 5.200201 | 4.490000 | 2.378950 | 0.136811 |
| Minimum | 4.496705 | 3.767904 | -0.790000 | 1.783670 | -0.233855 |
| Std. Dev. | 0.060717 | 0.357447 | 1.651483 | 0.143063 | 0.048059 |
| Skewness | -0.389108 | -0.147882 | -0.001572 | 0.382077 | -0.843526 |
| Kurtosis | 2.191222 | 2.288374 | 1.706326 | 2.396036 | 6.141381 |
| Jarque-Bera | 12.17750 | 5.740927 | 16.10843 | 9.170813 | 122.3763 |
| Probability | 0.002268 | 0.056673 | 0.000318 | 0.010200 | 0.000000 |

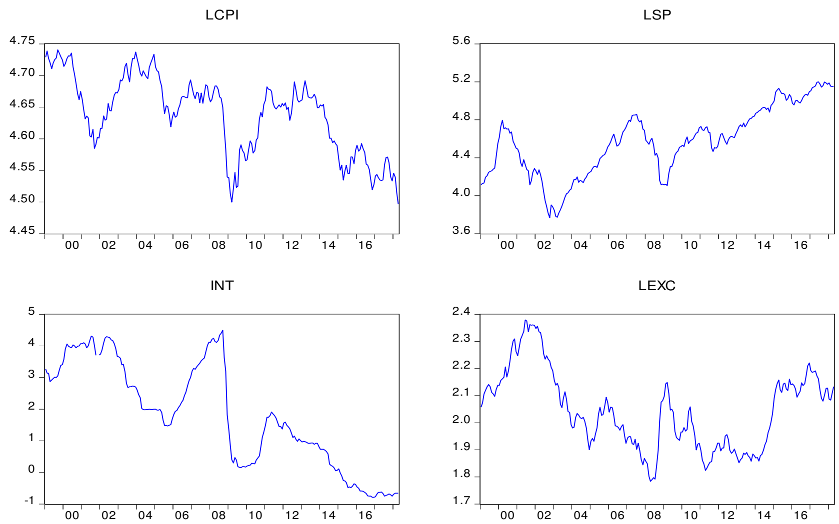


Figure 1: Stock price, consumer price index, Exchange rate in log, and interest rate evolution from January 1999 to April 2018.

Prior to the testing of cointegration, we conducted a test of order of integration for each variable using Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP). The results on variables at level and at 1st difference are given in Table

3, which on the whole shows that the variables under study can be considered integrated of order one, i.e., I(1).

Table 3. Results of non stationarity ADF test and PP test.

| **PP UNIT ROOT TEST** | | **With Cons** | | **With C& T** | | **Without C & T** | |
|---|---|---|---|---|---|---|---|
| | | **t-Stat** | **Prob.** | **t-Stat** | **Prob.** | **t-Stat** | **Prob.** |
| At Level | LSP | -1.3295 | 0.6161 | -2.3663 | 0.3963 | 0.8827 | 0.8986 |
| | LCPI | -1.6234 | 0.4690 | -2.5611 | 0.2987 | -0.9797 | 0.2924 |
| | INT | -1.1349 | 0.7022 | -2.7807 | 0.2060 | -1.4029 | 0.1493 |
| | LEXC | -1.8628 | 0.3495 | -1.8663 | 0.6687 | 0.0111 | 0.6853 |
| At 1st Difference | Δ LSP | -11.1558 | 0.0000 | -11.1350 | 0.0000 | -11.1724 | 0.0000 |
| | Δ LCPI | -12.2227 | 0.0000 | -12.2013 | 0.0000 | -12.1893 | 0.0000 |
| | Δ INT | -8.0982 | 0.0000 | -8.0900 | 0.0000 | -8.0593 | 0.0000 |
| | Δ LEXC | -10.2503 | 0.0000 | -10.2342 | 0.0000 | -10.2724 | 0.0000 |
| **ADF UNIT ROOT TEST** | | **With Cons** | | **With C& T** | | **Without C & T** | |
| | | **t-Stat** | **Prob.** | **t-Stat** | **Prob.** | **t-Stat** | **Prob.** |
| At Level | LSP | -1.2180 | 0.6670 | -2.2237 | 0.4737 | 0.9063 | 0.9023 |
| | LCPI | -1.6968 | 0.4316 | -2.7040 | 0.2361 | -1.0218 | 0.2756 |
| | INT | -1.8875 | 0.3378 | -3.7959 | 0.0185 | -1.8747 | 0.0582 |
| | LEXC | -1.9721 | 0.2991 | -1.9460 | 0.6270 | -0.0241 | 0.6737 |
| At 1st Difference | Δ LSP | -10.9284 | 0.0000 | -10.9085 | 0.0000 | -10.8820 | 0.0000 |
| | Δ LCPI | -12.2498 | 0.0000 | -12.2291 | 0.0000 | -12.2098 | 0.0000 |
| | Δ INT | -5.3042 | 0.0000 | -5.2813 | 0.0001 | -5.2513 | 0.0000 |
| | Δ LEXC | -10.3672 | 0.0000 | -10.3553 | 0.0000 | -10.3890 | 0.0000 |

## 2. ARDL specification

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

$$\Delta LSP_t = \mu(t) + \gamma_1 LSP_{t-1} + \gamma_2' X_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LSP_{t-i} + \sum_{i=1}^{p} \beta_i' \Delta X_{t-i} + \varepsilon_t, \quad (1)$$

where

$$\mu(t) = C_1 + C_2 t + \mu_1 D2002 + \mu_2 D2008,$$

$$X = (LCPI, INT, LEXC)',$$

$$D2002 = 1 \text{ for year 2002 and zero if not,}$$

and

$$D2008 = 1 \text{ for year 2008 and zero if not.}$$

$C_1$ is the intercept of this equation, t is the trend, $\alpha_i$ and $\beta_i$ represent **short**-term relationship, $\gamma_1$, and $\gamma_2$ represent **long-term** relationship (all are real parameters), $p$ is the maximum lag to be used, and $\varepsilon_t \sim$ WN (0, $\sigma^2$).

## $F_{PSS}$ Test Procedure

Another way to test for cointegration and causality is the Bounds Test for Cointegration within the **ARDL** framework developed by (Pesaran, Shin, & Smith, 2001)**,** which can be applied irrespective of the order of integration of the variables (irrespective of whether regressors are purely I(0), purely I(1), or not). (Pesaran, Shin, & Smith, 2001) test is based on **F type statistic** (noted by **$F_{PSS}$**) to resolves **null hypothesis of no cointegration** in the **ARDL** model. It is a **bound test** [with two sets of critical values (lower and upper)].[2] 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).

**$F_{PSS}$** test is based on the following steps:

[2] 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).

**Step 1:** Testing for the unit root of $LSP_t$ and $X_t$ (using either ADF or PP tests, or both ).

**Step 2:** Testing for cointegration between $LSP_t$ and $X_t$ (using Bounds test approach). The null hypothesis of no cointegration is

$$H_0: \gamma_1 = 0, \gamma_2{}' = 0$$

and the alternative hypothesis of cointegration is

$$H_1: \gamma_1 \neq 0, \gamma_2{}' \neq 0.$$

## Causality

If cointegrating relationship is established between LSP and X = (LCPI, INT, LEXC)′, Granger causality test will be done in the following error correction representation:

$$\Delta LSP_t = \mu_1(t) + \delta_1 ECT_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LSP_{t-i} + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + \varepsilon_t \quad (2)$$

where

$$\mu_1(t) = C_1 + C_2 t + \mu_1 D2002 + \mu_2 D2008,$$

$ECT_{t-1}$ is the error correction term representing the long-run relationship between LSP and X = (LCPI, INT, LEXC)′, $\delta_1$ captures the sensitivity of the error correction term. The $ECT_{t-1}$ estimated coefficient in the model shows how quickly/ slowly variables return to their equilibrium values. The ECM coefficient, $\delta_1$, should be statistically significant with a negative sign.

A negative and significant coefficient of the error correction term, $\delta_1$, indicates that there is a long-run **causal** relationship between LSP and X = (LCPI, INT, LEXC)′. Precisely, $\delta_1$ indicates a **causality** from X = (LCPI, INT, LEXC)′ to LSP that implying that X = (LCPI, INT, LEXC)′ drives LSP toward long-run equilibrium. LSP will be predictable and Stock market is then said to be informationally **inefficient**.

## 3. Empirical Results

To test for cointegration and before employing causation analysis, we must specify how many lags to include in the VAR models. Therefore, in order to find out the lag length, we followed a lag length selection criterion, the AIC information criterion which suggests 3 lags for the time series data as the least value of AIC, i.e -**16.0315** corresponds to 3 lags in the selected sample period as displayed Table 4**.**

Table 4. Optimum lag length for VAR specification.

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 95.95729 | NA | 4.83e-06 | -0.888476 | -0.824076 | -0.862433 |
| 1 | 1638.190 | 3009.961 | 1.91e-12 | -15.63468 | -15.31268 | -15.50447 |
| 2 | 1688.390 | 96.03607 | 1.37e-12 | -15.96512 | **-15.3855*** | **-15.7307*** |
| **3** | 1711.266 | 42.87861 | 1.28e-12* | **-16.0315*** | -15.19435 | -15.69300 |
| 4 | 1721.509 | 18.80336 | 1.36e-12 | -15.97593 | -14.88113 | -15.53320 |
| 5 | 1733.133 | 20.88829 | 1.42e-12 | -15.93365 | -14.58124 | -15.38675 |
| 6 | 1740.160 | 12.35695 | 1.55e-12 | -15.84695 | -14.23694 | -15.19588 |
| 7 | 1753.352 | 22.68825 | 1.60e-12 | -15.81983 | -13.95222 | -15.06458 |
| **8** | **1772.829** | **32.74376*** | 1.55e-12 | -15.85342 | -13.72821 | -14.99400 |
| 9 | 1786.042 | 21.70335 | 1.60e-12 | -15.82650 | -13.44368 | -14.86291 |
| 10 | 1800.989 | 23.97261 | 1.62e-12 | -15.81632 | -13.17591 | -14.74856 |
| 11 | 1805.153 | 6.516683 | 1.83e-12 | -15.70196 | -12.80394 | -14.53003 |
| 12 | 1821.765 | 25.35987 | 1.84e-12 | -15.70787 | -12.55226 | -14.43177 |

## Causality

For the identification of the direction of causal association among considered variables, and to find out directional causality, we used in ***first stage*** the pairwise Granger (1969) non causality test on stationary series (in first difference). **Table 5** shows significant one-way unidirectional causal relation from **stock return** to **exchange rate growth** and from **stock return** to **interest rate growth** at 5% significance level ($p < 0.05$) at 2 lags. The other pairs of variables do not have any causation in either direction as demonstrated at **Table 5**.

Thus Granger causality results suggest that changes in **stock return in the Suisse** stock market has significant **short run** effects on the **exchange rate growth** and **interest rate growth**.

Table 5: Results of pairwise Granger non causality with 2 lags (**p=3**).

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| DLEXC $\nrightarrow$ R | 229 | 0.19323 | 0.8244 |
| R $\nrightarrow$ DLEXC | | 3.38039 | **0.0358** |
| INF $\nrightarrow$ R | 229 | 0.06210 | 0.9398 |
| R $\nrightarrow$ INF | | 0.26483 | 0.7676 |
| DINT $\nrightarrow$ R | 225 | 1.31941 | 0.2694 |
| R $\nrightarrow$ DINT | | 6.59698 | **0.0017** |

Note: The rejection of null hypotheses at 5% ($p < 0.05$). All variables are in **first difference**. $\nrightarrow \equiv$ does not Granger Cause. **P-1=2**. Source: Authors' calculations.

**In** second **stage,** we employed (Toda & Yamamoto, 1995) Wald test. **Table 6** shows a significant one-way **unidirectional** causal relation from **stock price** (Interest rate) to **consumer price index, and** from **stock price** to exchange rate at the 5% level ($p < 0.05$) and. A unique significant **bidirectional** causal relation is depicted between stock price and Interest rate at the 5% level ($p < 0.05$).

Table 6. Toda and Yamamoto (TY) Modified Wald non causality test analysis.[3]

| **Dependent variable** | **Test results** | **LSP** | **LCPI** | **INT** | **LEXC** | **All** | **Conclusion** |
|---|---|---|---|---|---|---|---|
| LSP | χ2 | _ | 6.53258 | 20.4905 | 2.02381 | 27.3107 | INT →LSP |
| | P-value | | 0.1627 | 0.0004 | 0.7314 | 0.0070 | |
| LCPI | χ2 | 16.8074 | _ | 10.2116 | 3.30388 | 24.4104 | LSP & INT→LCPI |
| | P-value | 0.0021 | | 0.0370 | 0.5083 | 0.0179 | |
| INT | χ2 | 9.86603 | 5.66141 | _ | 6.03307 | 28.3525 | **LSP →INT** |
| | P-value | 0.0427 | 0.2259 | | 0.1967 | 0.0049 | |
| LEXC | χ2 | 21.3307 | 4.08120 | 2.00777 | _ | 25.7460 | **LSP→LEXC** |
| | P-value | 0.0003 | 0.3951 | 0.7343 | | 0.0117 | |

Note: The rejection of null hypothesis at 5% ($p < 0.05$) or at 10% ($p < 0.1$). All variables are **in level**. **P+dmax=4**. Source: Authors' calculations.

## Cointegration

Using all four series and a model with 2 lag, we find that there are one or two cointegrating relationships (Table 7). From the results shown Table 7, it is clear that there is one or two cointegrating vector; therefore, one or two long-run association can be established between LSP and the consumer price, interest rate, and exchange rate.

Table 7. Johansen test results (trace and Max-Eig tests).

| Selected (0.05 level*) Number of Cointegrating Relations by Model | | | | | |
|---|---|---|---|---|---|
| Data Trend: | None | None | Linear | Linear | Quadratic |
| Test Type | No Intercept | Intercept | Intercept | Intercept | Intercept |
| | No Trend | No Trend | No Trend | Trend | Trend |
| Trace | 1 | 1 | 1 | 1 | 2 |
| Max-Eig | 1 | 1 | 1 | 2 | 2 |

[3] See https://www.youtube.com/watch?v=YyiLBpf-xk8

Using Trace statistic results (case 4), we investigate a VECM with one cointegration relationship.[4] Long-run relation results are illustrate at Table 8. Even no specification problem was detected (see Table 9), no macroeconomic factor seems to have significant effect on Suisse stock price in long-run. The same results persist even if we take account of **GFC 2008** effect.

Table 8: Suisse normalized cointegrating coefficients from VECM(2)!!

| LSP | LCPI | INT | LEXC | TREND | C |
|---|---|---|---|---|---|
| 1.000000 | 0.324866 | 0.057533 | -0.262355 | -0.002924 | -5.305608 |
| | (1.11469) | (0.05703) | (0.37670) | (0.00134) | |
| | [ 0.29144] | [ 1.00880] | [-0.69645] | [-2.18785] | |

Notes: Cointegrating Eq: case 4 (one equation). t-values are in square brackets while SEs are in parentheses.

Table 9: Diagnostic check

Null hypothesis: No serial correlation at lag h.

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 17.52178 | 16 | 0.3526 | 1.098111 | (16, 630.0) | 0.3527 |
| 2 | 22.38854 | 16 | 0.1311 | 1.408515 | (16, 630.0) | 0.1311 |
| 3 | 20.24810 | 16 | 0.2093 | 1.271704 | (16, 630.0) | 0.2093 |

Now, two alternatives can be considered: a VAR(2) model for stationary variables (in 1st difference) or an ARDL model for non stationary variables (in level and in 1st difference). Here after, we see which of these alternatives is more adequate for Suisse stock market price during this period of study.

## VAR(2) for variables in 1st difference

We employed the **impulse response function** to carry out further analysis. Figure 2 demonstrates the impulse response function analysis to investigate occurrence of transmission from one variable to another in 1st difference within VAR(2) model. The impulse response graphs show that the stock return behaves like an exogenous variable and the maximum part of the effect of shocks is because of its own past values. Observing the impact of other monetary indicators, no important significant affect was found. However, no specification problem was detected for VAR(2) model in 1st difference since the results clearly indicate no serial

[4] We get similar results if two cointegration relationships are considered.

correlation in the residuals (see Table 10). We then consider rather an ARDL model.

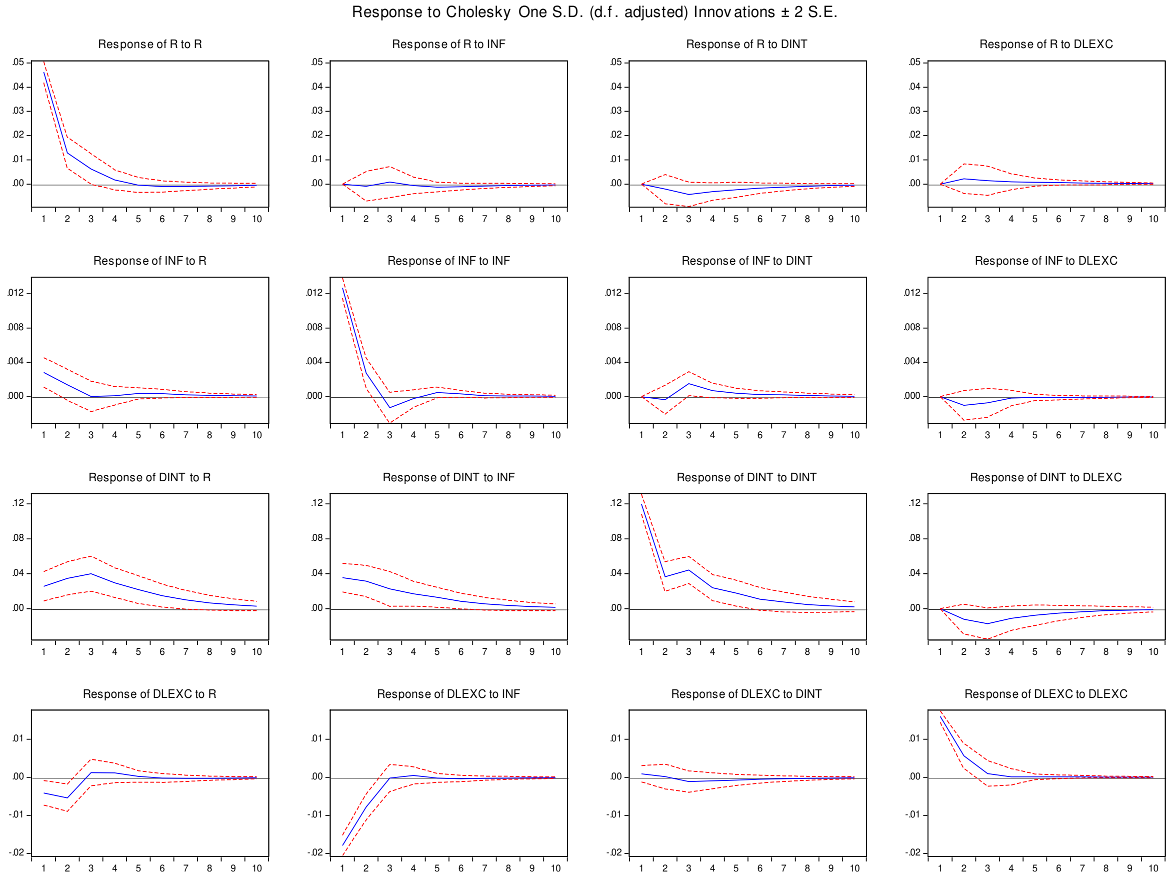


Figure 2. Impulse response analysis from VAR(2) for variables in first difference.

Source: Authors' calculations. Note: X-axis represents the period of 12 months, Y-axis represents the fluctuations of the variables in percent (%).

Table 10: Diagnostic: Null hypothesis: No serial correlation at lag h.

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 21.13431 | 16 | 0.1734 | 1.328187 | (16, 639.1) | 0.1734 |
| 2 | 26.14501 | 16 | 0.0520 | 1.649507 | (16, 639.1) | 0.0520 |
| 3 | 21.65424 | 16 | 0.1547 | 1.361413 | (16, 639.1) | 0.1548 |

## ARDL model

In order to implement the ARDL model, we have to determine the appropriate lags length. To ensure comparability of results for different lag lengths, all estimations were computed over the same sample period and the selection of ARDL(2, 5, 1, 0) is based on the lowest value of the Akaike Information Criterion (see Figure B 3 given at Annex 3).

After deciding the optimal lags orders, the results of $F_{PSS}$ test-statistic is reported in **Table 11**. The calculated $F_{PSS}$ -statistic for joint significance is above the upper bound critical value at 5% level of significance (**3.63**). This result confirm the existence of long-run equilibrium relationship among the variables used for Suisse Stock market.

Table 11: $F_{PSS}$- Statistic of Cointegration between Macro Variables and Stock Prices

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | **6.994713** | 10% | 2.01 | 3.1 |
| | | 5% | 2.45 | **3.63** |
| | | 2.5% | 2.87 | **4.16** |
| | | 1% | 3.42 | **4.84** |

Note: (Pesaran, Shin, & Smith, 2001) the critical values are estimated with the assumption of No Constant and No Trend.

We further go to the long run stability relation and the short run dynamics. The results of the long run coefficients are presented in **Table 12**. It implies that Inflation rate and interest rate are the only macroeconomic variables which affect the Suisse stock price in the long run. Hence, no cointegrating relationship is found between the exchange rate and stock price.

The **interest rate** can be considered an important risk factor. When interest rate increases, it affects the cost of finance and the value of the financial assets and liabilities that are being held by firms. Indeed, people tend to shift their funds from the stock market to any other interest paid financial security, which will leads to a decrease in the stock prices. This explains the **long run negative** impact of **interest** rate on the Suisse stock market index.

When **inflation** increases because of an increase in demand that exceeds current supply, firms' earnings increase along with their dividends, which will make stocks more attractive and people more willing to invest in the stock market resulting in a rise in stock prices. Hence, the **long run positive** relationship between **inflation** and Suisse stock market index.

Table 12: Long run relationship results:

ECT = LSP - (1.1921× LCPI - 0.2368× INT - 0.2013× LEXC )

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **LCPI** | 1.192106 | 0.212719 | 5.604147 | **0.0000** |
| **INT** | -0.236808 | 0.042235 | -5.606889 | **0.0000** |
| LEXC | -0.201283 | 0.475361 | -0.423431 | 0.6724 |

Since the cointegration results show that stock prices are cointegrated with LCPI, INT and LEXC, the Error Correction Model (ECM) will be used in testing the long run causal relationship.

In order to capture the short-run dynamics of the model, error correction mechanism was applied and the results are reported in the **Table 13**. The results show that the ECM term, has negative sign (- **0.049968**) and is statistically significant at 5 percent level, ensuring that long-run equilibrium can be attained in the case of Suisse stock market.

There is then a **long-run** causal relationship between LSP and X = (LCPI, INT, LEXC)′. Precisely, $\delta_1$ indicates a **causality** from X = (LCPI, INT, LEXC)′ to LSP that implying that X = (LCPI, INT, LEXC)′ drives LSP toward long-run equilibrium.

The magnitude of the coefficient of the ECM term suggests that adjustment process is quite **moderate significant**. About 5 percent of disequilibrium of the previous month shock is adjusted back to equilibrium in the current month for Suisse stock market.

To ascertain the goodness of fit of the selected ARDL model, the stability and the diagnostic tests are conducted. **Table 14** shows that, the selected ARDL model fulfils the conditions of no specification errors. Considered Diagnostic test statistics are serial non correlation tests and homoskedasticity test at 5% level. The structural stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM). **Figures 3** presents plot of the CUSUM test statistics that fall inside the critical bounds of 5% significance. The stability tests further confirm the stability of the estimated coefficients.

Table 13: Error Correction model of LSP for the Suisse Stock Market.

Selected ARDL(2, 5, 1, 0) Model results.[5]

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **$\Delta LSP_{-1}$** | 0.177402 | 0.063508 | 2.793365 | **0.0057** |
| $\Delta$ LCPI | 0.333082 | 0.236192 | 1.410221 | 0.1599 |
| $\Delta$ $LCPI_{-1}$ | -0.268251 | 0.236051 | -1.136411 | 0.2571 |
| $\Delta$ $LCPI_{-2}$ | -0.149588 | 0.239283 | -0.625152 | 0.5325 |
| $\Delta$ $LCPI_{-3}$ | 0.227930 | 0.235329 | 0.968561 | 0.3339 |
| **$\Delta$ $LCPI_{-4}$** | -0.469884 | 0.223136 | -2.105814 | **0.0364** |
| **$\Delta$ INT** | 0.054891 | 0.022331 | 2.458091 | **0.0148** |
| D2008 | -0.013532 | 0.013176 | -1.026971 | 0.3056 |
| **D2002** | -0.030369 | 0.012555 | -2.418920 | **0.0164** |
| **ECM(-1)*** | **-0.049968** | **0.009380** | **-5.326798** | **0.0000** |

Case 1: No Constant and No Trend. * p-value incompatible with t-Bounds distribution.

Table 14: Diagnostic tests

| Breusch-Godfrey **Serial Correlation** LM Test: | | | |
|---|---|---|---|
| F-statistic | 1.00896 | Prob. F(2, 210) | 0.3664 |
| Obs*R-squared | 2.141483 | Prob. Chi-Square(2) | 0.3428 |
| **Heteroskedasticity** Test: ARCH | | | |
| F-statistic | 0.041574 | Prob. F(1, 221) | 0.8386 |
| Obs*R-squared | 0.041942 | Prob. Chi-Square(1) | 0.8377 |

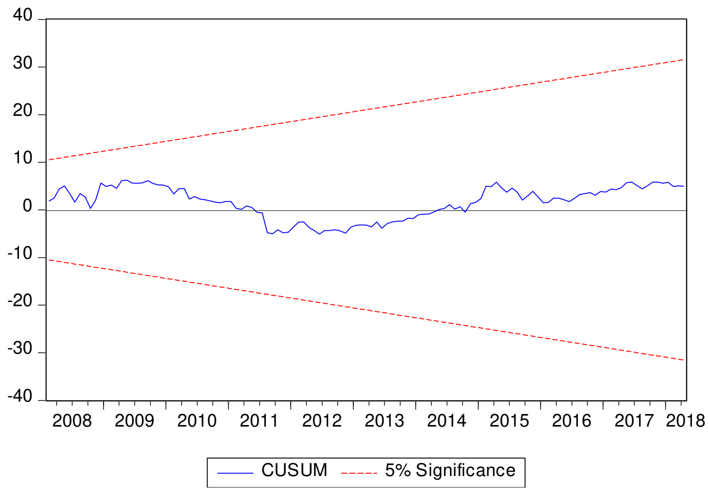


Figure 3: Plot of cumulative sum of recursive residuals.

[5] Model selection method: Akaike info criterion (AIC).

## III. Conclusions

This study investigates the short run and the long run equilibrium relationship between stock prices and a set of macroeconomic variables using data for the period 1999:1 to 2018:4 from the Suisse stock market. The economic variables comprise inflation, interest rate, and the exchange rate.

This investigation has been done in the successive steps:

1. From the pairwise (Granger, 1969) non causality test on stationary series (in first difference), macro factors **do not have any causation** on Suisse stock market price.
2. (Toda & Yamamoto, 1995) Wald non causality test on non stationary series (in level) reveal that only **interest rate** (INT) Which has effect on Suisse stock market price.
3. The empirical evidence obtained from Johansen' cointegration tests reveal the presence of **one or two long run stable relationships**, while the error correction model suggests that **no of** the considered macroeconomic factor seems to have significant effect on Suisse stock price (in long-run or in short run).
4. The impulse response graphs from VAR(2) model on stationary series (in first difference) show that the stock return behaves like an **exogenous** variable and the maximum part of the effect of shocks is because of its own past values.
5. ARDL model implies that **Inflation and interest rate** have significant effects on the Suisse stock price in the long run. Results of the ECM representation confirm temporal causality between inflation, interest rate and exchange rate and the stock price (since the error correction term is negative and significant). More specifically, causality runs from inflation and interest rate to the stock price index. These results are partially consistent with those obtained from TY non causality test and further confirm that there is short run adjustment dynamic and long run equilibrium relationship between macroeconomic variables (except exchange rate) and stock prices in the Suisse stock exchange.

These results imply that the SSM is informationally inefficient because publicly available information on macroeconomic variables (inflation and interest rate) can be potentially used in predicting stock prices.

## Annex 1: Test Toda and Yamamoto (TY) results

Table: A 1: Stability condition for VAR(4) model.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Root** | 0.990373 | 0.965560 | 0.953609 - 0.082378i | 0.953609 + 0.082378i | 0.644469 | 0.610144 |
| **Modulus** | 0.990373 | 0.965560 | 0.957160 | 0.957160 | 0.644469 | 0.610144 |
| **Root** | -0.110072 - 0.522419i | -0.110072 + 0.522419i | -0.511521 | -0.232959 - 0.427719i | -0.232959 + 0.427719i | |
| **Modulus** | 0.533889 | 0.533889 | 0.511521 | 0.487045 | 0.487045 | |
| **Root** | 0.250408 - 0.392314i | 0.250408 + 0.392314i | 0.286755 | 0.097334 - 0.249306i | 0.097334 + 0.249306i | |
| **Modulus** | 0.465419 | 0.465419 | 0.286755 | 0.267633 | 0.267633 | |

No root lies outside the unit circle.
VAR satisfies the stability condition. P+dmax=3+1=4

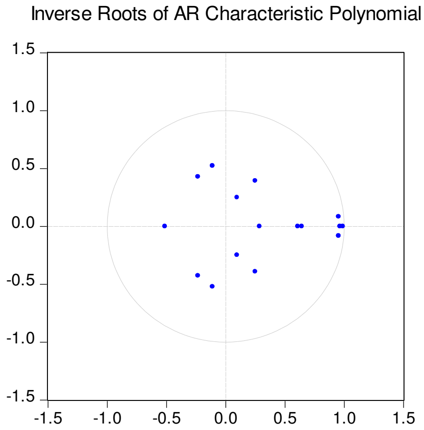


Figure B 1: Stability condition for VAR(4).

Table A 2: Diagnostic results

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| | 17.56474 | 16 | 0.3500 | 1.100945 | (16, 608.6) | 0.3501 |
| 2 | 13.23468 | 16 | 0.6555 | 0.826616 | (16, 608.6) | 0.6556 |
| 3 | 20.90595 | 16 | 0.1822 | 1.313949 | (16, 608.6) | 0.1822 |
| 4 | 22.91067 | 16 | 0.1161 | 1.442307 | (16, 608.6) | 0.1162 |
| 5 | 17.28137 | 16 | 0.3676 | 1.082933 | (16, 608.6) | 0.3677 |

VAR(p+dmax=4).

## Annex 2: VAR(2) for variables in 1st difference

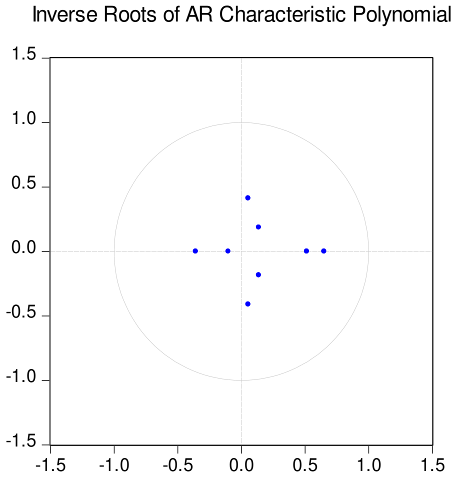


Figure B 2: Stability condition for VAR(2) of stationary series

Table A 3 : Stability condition for VAR(2) model.

| | | | | | |
|---|---|---|---|---|---|
| Root | 0.650665 | 0.515337 | 0.054763 - 0.411173i | 0.054763 + 0.411173i | -0.357560 |
| Modulus | 0.650665 | 0.515337 | 0.414804 | 0.414804 | 0.357560 |
| Root | 0.137638 - 0.184885i | 0.137638 + 0.184885i | -0.102282 | | |
| Modulus | 0.230492 | 0.230492 | 0.102282 | | |

No root lies outside the unit circle.
VAR satisfies the stability condition.

## Annex 3: ARDL model results

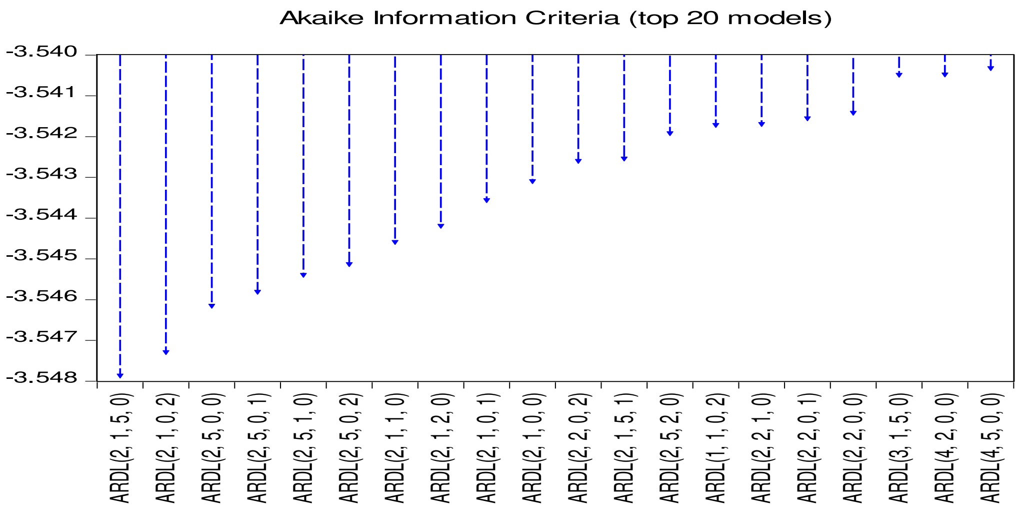


Figure B 3 : ARDL selection based on optimal AIC.

Table A 4: Estimated Long Run Coefficients between Macro Variables and Stock Prices.

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| **LSP(-1)** | 1.127434 | 0.066848 | 16.86571 | **0.0000** |
| **LSP(-2)** | -0.177402 | 0.064722 | -2.740965 | **0.0066** |
| **INT** | 0.054891 | 0.023103 | 2.375964 | **0.0184** |
| **INT(-1)** | -0.066724 | 0.024366 | -2.738407 | **0.0067** |
| LCPI | 0.333082 | 0.240902 | 1.382649 | 0.1682 |
| LCPI(-1) | -0.541766 | 0.357467 | -1.515571 | 0.1311 |
| LCPI(-2) | 0.118662 | 0.370168 | 0.320564 | 0.7489 |
| LCPI(-3) | 0.377519 | 0.375265 | 1.006006 | 0.3156 |
| **LCPI(-4)** | -0.697814 | 0.361692 | -1.929304 | **0.0550** |
| **LCPI(-5)** | 0.469884 | 0.228656 | 2.054986 | **0.0411** |
| LEXC | -0.010058 | 0.023268 | -0.432254 | 0.6660 |
| D2008 | -0.013532 | 0.015787 | -0.857117 | 0.3923 |
| **D2002** | -0.030369 | 0.015654 | -1.940017 | **0.0537** |

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