Suisse Stock Return, Macro Factors, and Efficient Market Hypothesis: Evidence From ARDL Model

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Abstract

This study investigates 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)'s test for no cointegration, and ARDL framework and F_{PSS} test of no cointegration hypothesis. Once ECM representation of the ARDL model is used, it confirms temporal causality between (inflation, interest rate, exchange rate) and the stock price. Finding say that there is dynamic short-run adjustment and long-run stable equilibrium relationship between considered macroeconomic variables (except exchange rate) and the 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.

Keywords: Suisse Stock market efficiency, macroeconomic variables, causality, cointegration, Autoregressive Dynamic Linear (ARDL) model

Jel classification: C32; E44; G14

funding agencies in the public, commercial, or not-for-profit sectors.

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1. 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. The contemporary financial theory asserts that stock prices are closely related to the movements of macro variables (Chittedi, 2015). The relationship 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.

In examining the causal relationship between the stock market and macroeconomic variables, most of the empirical studies agreed that there are significant relationships between macroeconomic variables and stock markets but concluded with different results (Tangjitprom, 2012). These different outcomes are due to different market regulations, investors, country location, different periods, and other factors as econometric tools in use (El-Nader & Alraimony, 2012; Bhunia (2012); Pramod Kumar and Puja (2012); and Ramathan, et al., 2016).

A brief empirical literature review indicates that studies investigated the relationship between macroeconomic variables and stock market can be classified into three groups (Ramathan, et al., 2016). Then, we can say that:

(i) Some researchers found that there is a significant relationship between macroeconomic variables and the stock market (Bilson et al., 2001; Hondroyiannis & Papapetrou, 2001; Ibrahim & Aziz, 2003; Tsoukalas, 2003; Maysami et al., 2004; Coleman & Tettey, 2008; Horobet & Dumitr, 2009; Buyuksalvarci, 2010; Geetha et al., 2011; Ali, 2011; Rafique et al., 2014; Lakshmi & Tuwajri, 2014; Wongbangpo & Subhash, 2002; Masuduzzaman, 2012; Ray, 2012; Abu Hassen and Abdul Wadud, 2015; and Ilam et al, 2020)).

(ii) Others found no significant relationship between macroeconomic variables and the stock market (Mohammad et al., 2009; Bhattacharya and Mookherjee., 2001; and Ali, 2011).

(iii) While others found mixed results that some variables are significant and some are not significant (Kurihara, 2006; Pal & Mittal, 2011; and Ullah et al., 2014).

This research aims to identify the nature of the relationship between three macroeconomic variables in a developed country (Suisse) and the stock market. The independent variables are consumer price index (CPI) as a proxy for inflation, Interest rate as a measure of opportunity cost against financial assets, and exchange rate as a measure for currency substitution, while dependent variable under investigation is Suisse market index price as a proxy for the stock market. The three considered macroeconomic variables are the most reliable macroeconomic variables that can explain stock markets fluctuations (Graham & Harvey, 2001; Kim, 2003; Adrangi et al., 2011; Ramathan, et al., 2016). Thus, the specific objectives of this study are as follows:

- To examine the short run dynamics and long run equilibrium links between the considered macroeconomic variables and the Suisse stock prices;

- To explore the causal relationships and direction of causality between the Suisse stock index and macroeconomic variables;

- To investigate the Efficient Market hypothesis of the stock market in Suisse economy.

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

H_1: Interest rate does not affect the stock market index in the long-run.

H_2: Inflation does not affect the stock market index in the long-run.

H$_3$: Exchange rate does not affect the 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 no cointegration, ARDL framework and F$_{PSS}$ test of no cointegration hypothesis, VAR model and Granger causality test and Toda and Yamamoto Wald causality tests. The study investigates the nature of the causal static and dynamic relationships between Suisse stock price and the key macro-economic variables in the Suisse economy for the period January, 1999 to April, 2018 using monthly data. Therefore, this paper has been organized as follows. Section 2 analyses the required mentioned data and their sources (subsection 2.1), outlines the methodology used (subsection 2.2), and provides the empirical results and analysis (subsection 2.3). Concluding remarks are given in section 3.

2. 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 interdependence. 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.

2.1 Data Analysis

Monthly Suisse data are selected from International Monetary Fund (IMF) database from the period January 1999 until April 2018. The market stock price (SP) will serve as an indicator for the stock market while the macroeconomic variables including 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;

$$R_t = \triangle \, LSP_t = LSP_t - LSP_{t-1},$$

$$LSP_t = \log(SP_t),$$

where $\triangle = 1 - B$, 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 $t - 1$. The analysis will be based on the EViews 10 econometric software packages.

Table 1. Data collection sources

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

Note: L is to indicate for log transformation. OCDE ≡ Organisation de Coopération et de Développement Economique.

Table 2 shows the monthly returns of Suisse stock price (R) with an average return equal to 0.4488%, volatility of 0.048059; and maximum and minimum returns of 13.7 % and −23.4 % recorded in a 1999M12 and 2008M10 respectively. The average interest rate (INT) is recorded to be around 1.8; while, the maximum interest rate is documented as being up to 4.49. The average consumer price index (LCPI) is 4.64 and the maximum went up to around 4.47. The average reduction in Suisse money is around 0.45% per month. Results of the kurtosis showed that all considered time series data do not follow the normality patterns at 5% level (except LSP) because the p-value for Jarque-Bera statistics is lower than 5% (all the series are negatively skewed except for exchange rate (LEXC) and the Kurtosis values are lesser than 3 except for Return R).

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 indicates from the plots of considered series (LCPI, LSP, INT, and LEXC) that all the series are trending and potential I (1) processes. Also, from Figure 1, the evolution of the eventual non-stationary data series present some outliers, particularly in the 2002 and 2008 crisis. The Suisse stock price in log (LSP) and consumer price index in log (LCPI) do appear to move together from 1999 to 2011, while an opposite movement appears in the second part of the considered time horizon. The same revelation can be said for both of INT and LEXC series but from 1999 to 2008. Then, a long- run relationship (cointegration) between the considered series needs to be investigated in the subsequent sections.
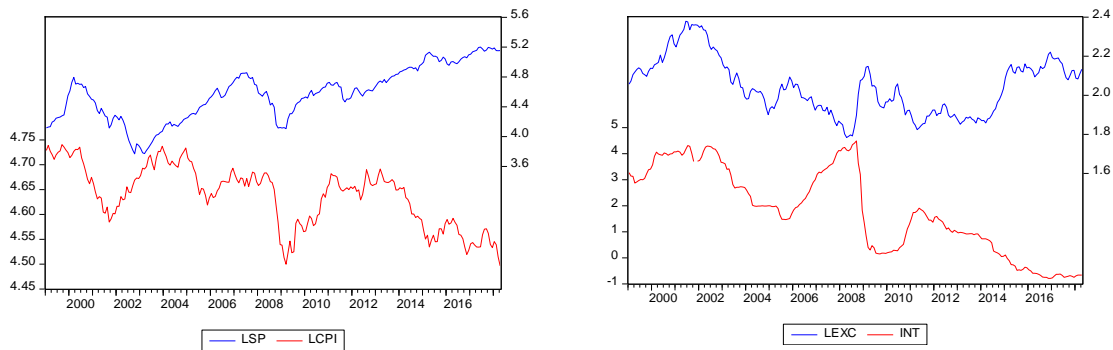

Figure 1. Stock price, consumer price index, Exchange rate in log, and interest rate evolution from January 1999 to April 2018

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

		At Level				At 1st Difference			
PP test		**LSP**	**LCPI**	**INT**	**LEXC**	**Δ LSP**	**Δ LCPI**	**Δ INT**	**Δ LEXC**
With C	t-Stat	-1.3295	-1.6234	-1.1349	-1.8628	-11.156*	-12.223*	-8.098*	-10.25*
With C& T	t-Stat	-2.3663	-2.5611	-2.7807	-1.8663	-11.135*	-12.201*	-8.090*	-10.234*
Without C & T	t-Stat	0.8827	-0.9797	-1.4029	0.0111	-11.172*	-12.189*	-8.059*	-10.272*
ADF test		**LSP**	**LCPI**	**INT**	**LEXC**	**Δ LSP**	**Δ LCPI**	**Δ INT**	**Δ LEXC**
With Cons	t-Stat	-1.2180	-1.6968	-1.8875	-1.9721	-10.928*	-12.249*	-5.304*	-10.367*
With C& T	t-Stat	-2.2237	-2.7040	-3.7959	-1.9460	-10.909*	-12.229*	-5.281*	-10.355*
Without C & T	t-Stat	0.9063	-1.0218	-1.8747	-0.0241	-10.882*	-12.209*	-5.251*	-10.389*

Note: * significant at 1% level (in all of these cases p-value is equal to 0.000). Both ADF test and PP test indicate that all considered series are I (1) process at 5% level.

2.2 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, α_i and β_i represent the short-term relationship, γ_1, and γ_2 represent the long-term relationship (all are real parameters), *p* is the maximum lag to be used, and $\varepsilon_t \sim$ WN $(0, \sigma^2)$.

2.2.1 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 resolve the null hypothesis of no cointegration in the ARDL model. It is a bound test [with two sets of critical values (lower and upper)].[1] 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. And, if the F_PSS falls below the lower critical bounds value, it suggests that there is no cointegrating relationship (we do not reject the null hypothesis).

The F_PSS test is based on the following steps:

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[1] 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 the 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

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

2.2.2 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:

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

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 = $(LCPI, INT, LEXC)'$, δ_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, δ_1, should be statistically significant with a negative sign.

A negative and significant coefficient of the error correction term, δ_1, indicates that there is a long-run causal relationship between LSP and X = $(LCPI,\ INT,\ LEXC)'$. Precisely, δ_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 the Stock market is then said to be informationally inefficient.

2.3 Empirical Results

To test for cointegration and before employing causation analysis, we should specify how many lags to include in the VAR model. 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

2.3.1 Causality

For the identification of the direction of causal association among considered variables, and to find out directional causality, it has been used in the *first stage* the pairwise Granger (1969) noncausality test on stationary series (in first difference for I(1) process). Table 5 shows significant one-way unidirectional causal relation from the stock return to exchange rate growth and from the stock return to interest rate growth at a 5% significance level (p- value < 0.05) at 2 lags. The other pairs of variables do not have any causation in either direction as demonstrated in Table 5.

Thus Granger causality results suggest that changes in the stock return for the Suisse stock market have 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.	Conclusion
DLEXC ↛R	229	0.19323	0.8244	DLEXC ↛R
R ↛DLEXC		3.38039	**0.0358**	R →DLEXC
INF ↛R	229	0.06210	0.9398	INF ↛R
R ↛INF		0.26483	0.7676	R ↛INF
DINT ↛R	225	1.31941	0.2694	DINT ↛R
R ↛DINT		6.59698	**0.0017**	R →DINT

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

In the 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 the consumer price index, and from stock price to exchange rate at the 5% level (p-value < 0.05). A unique significant bidirectional causal relation is depicted between stock price and Interest rate at the 5% level (p- value < 0.05).

Table 6. Toda and Yamamoto (TY) Modified Wald noncausality test analysis.

Dependent variable	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*- value < 0.05) or at 10% (*p*- value < 0.1). All variables are in level. P+dmax=4. Source: Authors' calculations.

2.3.2 Cointegration

Using all four series and a model with 2 lags, we find that there are one or two cointegrating relationships (Table 7). From the results shown in Table 7, it is clear that there is one or two cointegrating vectors; 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

Using Trace statistic results (case 4; forth column in Table 7), we investigate a VECM with one cointegration relationship.[2] Long-run relation results are illustrate in Table 8. Though 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 ~~considers~~ take into account of the 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)	0.3527
2	22.38854	16	0.1311	1.408515	(16, 630)	0.1311
3	20.24810	16	0.2093	1.271704	(16, 630)	0.2093

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

2.3.3 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 the occurrence of transmission from one variable to another in 1st difference within the 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 effect was found. However,

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

no specification problem was detected for VAR (2) model in 1st difference since the results clearly indicate no serial correlation in the residuals (see Table 10). Then an ARDL model will be considered.
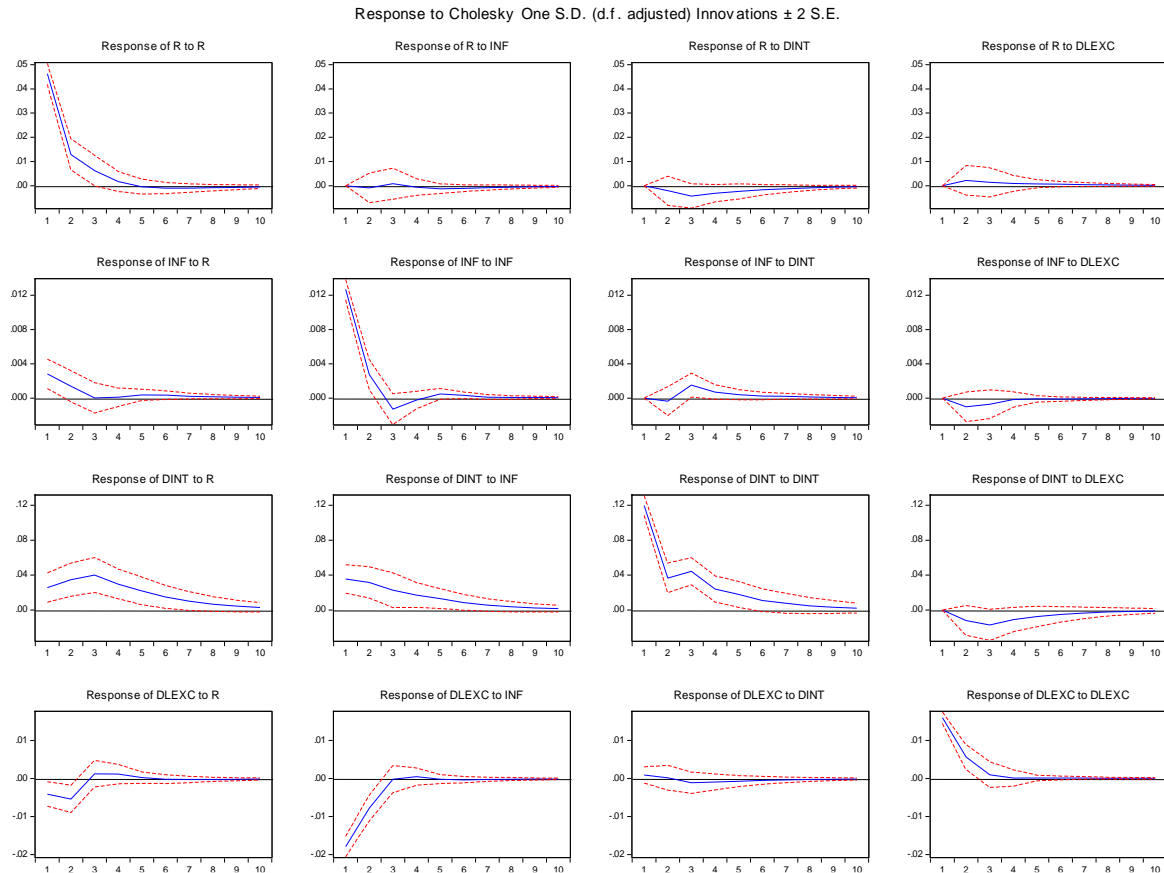

Figure 2. Impulse response analysis from VAR (2) for variables in first difference

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

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

2.3.4 ARDL Model

In order to implement the ARDL model, we have to determine the length of the appropriate lag. 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 the F_{PSS} test-statistic are reported in Table 11. The calculated F_{PSS} -statistic for joint significance is above the upper bound critical value at a 5% level of significance (3.63). This result confirms the existence of a long-run equilibrium relationship among the variables used for the 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.

The study goes further 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 the Inflation rate and interest rate are the only macroeconomic variables that affect the Suisse stock price in the long run. Hence, no cointegrating relationship is found between the exchange rate and stock price.

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.

The interest rate can be considered an important risk factor. When the 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 lead to a decrease in the stock prices. This explains the long-run negative impact of interest rates on the Suisse stock market index.

When inflation increases because of an increase in demand that exceeds the 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 the Suisse stock market index.

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, δ_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 the adjustment process is quite moderately significant. About 5 percent of the disequilibrium of the previous month's shock is adjusted back to equilibrium in the current month for the Suisse stock market.

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

Selected ARDL (2, 5, 1, 0) Model results.[3]

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔLSP$_{-1}$	0.177402	0.063508	2.793365	**0.0057**
Δ LCPI	0.333082	0.236192	1.410221	0.1599
Δ LCPI$_{-1}$	-0.268251	0.236051	-1.136411	0.2571
Δ LCPI$_{-2}$	-0.149588	0.239283	-0.625152	0.5325
Δ LCPI$_{-3}$	0.227930	0.235329	0.968561	0.3339
Δ LCPI$_{-4}$	-0.469884	0.223136	-2.105814	**0.0364**
Δ 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.

To ascertain the goodness of fit of the selected ARDL model, the stability and the diagnostic

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

tests are conducted. Table 14 shows that, the selected ARDL model fulfills the conditions of no specification errors. Considered Diagnostic test statistics are serial non correlation test and homoskedasticity test at a 5% level. The structural stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM). Figure 3 presents a 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 14. Diagnostic tests

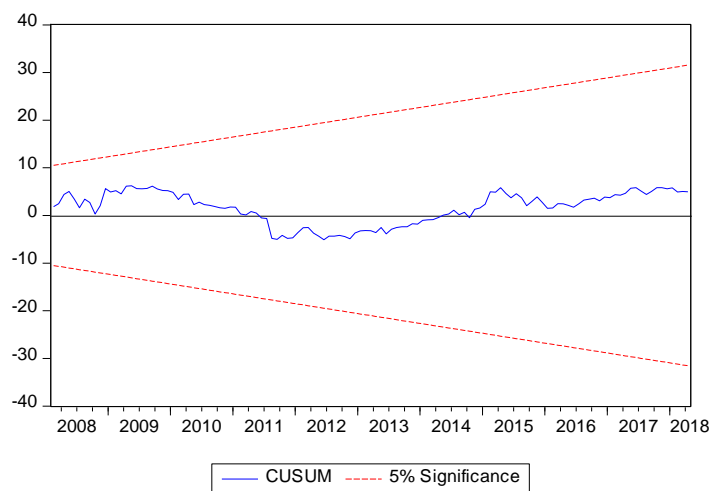| Breusch-Godfrey **Serial Correlation** LM Test:			
F-statistic	1.00896	Prob. F(2, 210)	0.3664
Obs*R-squared	2.141483	Prob. Chi-Square(2)	0.3428
Heteroskedasticity Test: ARCH			
F-statistic	0.041574	Prob. F(1, 221)	0.8386
Obs*R-squared	0.041942	Prob. Chi-Square(1)	0.8377

Figure 3. Plot of cumulative sum of recursive residuals from ARDL model

3. 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 Suisse stock market. The economic variables comprise inflation, interest rate, and the exchange rate.

This investigation has been done in 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 nonstationary series (in level) reveals that only interest rate (INT) which has an effect on Suisse stock market price.

3. The empirical evidence obtained from Johansen's cointegration tests reveal the presence of one or two long run stable relationships, while the error correction model suggests that none of the considered macroeconomic factor seems to have a significant effect on Suisse stock price (in the long-run or in the 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. Once the dynamic ARDL model is used, it implies that Inflation and interest rate have significant effects on the Suisse stock price in the long-run. In addition, results of the ECM representation confirm temporal causality between inflation, interest rate, 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. Hence, investors can enjoy excess returns to their investment in SSM. However, more recent data and further macro-economic variables are recommended for future investigation to see if Covid 2019 crisis had some effect on SSM efficiency. In addition, since exchange rate had no significant effect in the long run, we can rather use non-linear ARDL model to see if asymmetric significant effect of appreciation and depreciation can exist.

Annex 1: Test Toda and Yamamoto (TY) results

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

			0.953609 - 0.082378i	0.953609 + 0.082378i		
Root	0.990373	0.965560			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.

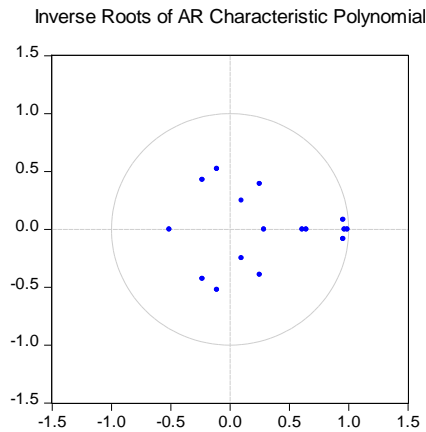VAR satisfies the stability condition. P + dmax = 3+1 = 4

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

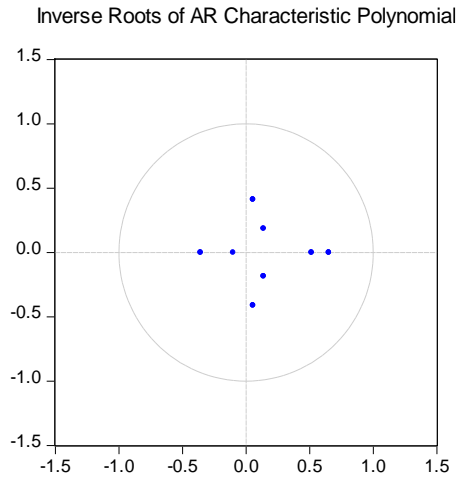VAR (p + dmax = 4).

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

			0.054763 - 0.411173i	0.054763 + 0.411173i	
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.

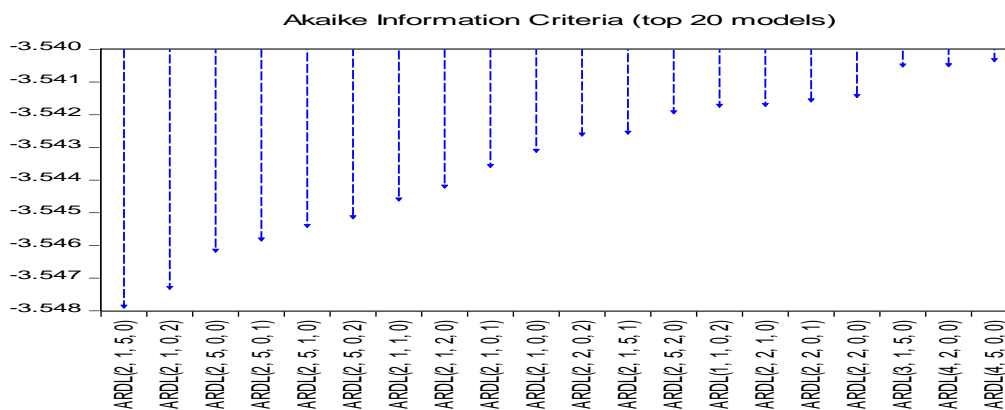**Annex 3: ARDL model results**

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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