

Analyzing the Dynamics Between Macroeconomic Variables and the Stock Indexes of Emerging Markets, Using Non-linear Methods

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Abstract

This study empirically considers five emerging markets from January 1995 to July 2019 to see whether nonlinearity helps to investigate responses to macroeconomic shocks in stock prices. With Vector Smooth Transition Regression, it uses real effective exchange rates, interbank interest rates, industrial production indices, and stock market returns. It confirms that nonlinearity in emerging markets may stem from their susceptibility to high volatility arising from political and geopolitical turnovers or global financial liquidity. It highlights significant differences in the asymmetric patterns. Some emerging markets respond asymmetrically to macro-variables, while others suggest that stock returns adjust from high or low towards the middle ground. Policy-makers seeking acceptable, accessible, sustainable and replicable actions that help stakeholders to invest may get help from our study to understand the properties of emerging markets central to each country's economic activity.

Keywords: asymmetric behaviour, vector smooth transition regression, stock return, macroeconomic, emerging markets

JEL Classification: C58, F31, E32, E4

1. Introduction

The financial markets have emerged as powerful platforms for economic development due to their crucial role in attracting external and internal capitals alike (Nazir et al. 2010; Fama, 1965, among others). Moreover, from the money demand point of view, these markets are considered important channels that meet people's financial needs at the least possible cost and risk. The latter is possible thanks to their capacity to build economic units which communicate with each other, spreading more knowledge than ever before about financial issues and working out firms' performance by inference. The prices of stocks are also published, which in turn plays a major role in making investment decisions (Sir, 2012; Ferson and Harvey, 1993; Balvers et al., 1990).

Recent developments in analyzing the financial market have heightened the need to understand the influence of macroeconomic variables. On the one hand, policymakers shed light on stock price fluctuations in order to create the appropriate policy to control economic recessions and maintain stability in the financial markets (e.g. Chen et al., 1986). On the investment decision side, investors are constantly keen to track the changes in stock markets in order to make profits or at least to avoid a loss (see, e.g., Jamaludin et al., 2017; Singh, 2016).

A considerable amount of literature has been published on the role of financial and macroeconomic variables in predicting stock market returns. For example, the seminal work of Fama and French (1989) highlight the significant effect of interest rates, inflation and output growth on predicting equity returns in the US (see also Fama, 1981). In their influential paper, Chen et al. (1986) illustrate that the industrial production index growth is a strong candidate for being a risk factor, while inflation plays a minor role. In the same way, Lamont (2000) shows that portfolios tracking industrial production and consumption earn abnormal returns compared with those that merely track inflation. Similarly, Chuang et al. (2007) examine whether money supply and budget deficit are important in predicting stock returns. Their results suggest that a long-run equilibrium relationship exists between macroeconomic policies and stock prices. However, in the short run stock prices do not adjust quickly and fully to changes in either monetary or fiscal policies. Gan et al. (2006) and Liu and Shrestha (2008) find a negative relationship between stock prices and interest rates in the long run, while Pilinkus and Boguslankas (2009) conclude that short term interest rates negatively influence stock market prices.

The aforementioned studies, however, are limited to examining the interaction between stock returns and macroeconomic variables in a linear regression framework. Recently, a great deal of theoretical discussion has proposed that stock returns may be better characterized by a model that allows for non-linear behavior (Note 1). According to Timmermann (2008), such asymmetry may be due to the data-generating processes for stock price dynamics that change over time, and thus individual models can reveal only evidence of local predictability. Other potential sources of this nonlinearity in stock return may stem from stock return determinants, since the nonlinear type models have been used to consider the behaviour of such macroeconomic and financial variables as the interest rate spread, GDP and the unemployment rate (Sarantis, 2001; Brock and Hommes, 1998; Hsieh, 1991).

Against this background, if one wishes to address asymmetric stock returns, the nonlinear models apply (Enders and Siklos, 2001; Balke and Fomby, 1997). There is a growing body of literature that recognizes such nonlinearity in the stock return. Lin et al. (2018) show that stock prices are closely correlated with economic variables, particularly in the case of small, low-priced and extremely volatile shares with a high book-to-market ratio and excess returns. The latter complexity induces a need to consider nonlinearity when modelling the relationship between such macroeconomic factors and stock returns (see also Yang and Zhou, 2016). An early example is the study by Qi (1999), which investigates this relationship using a neural network model. Guidolin et al. (2018) highlight the central role of nonlinearity when modeling a relationship between macroeconomic variables and stock prices that allows for asymmetry. Signs of nonlinearity have also been reported in several studies (see, e.g., Lardic and Mignon, 2008; Zhang, 2017). A recent study by Lee and Ryu (2018) shows that stock price shocks respond insignificantly to macroeconomic variables under simple ARDL, whereas a significant and negative long-run effect is found for almost every explanatory variable, a market pair under the nonlinear model. The nonlinear ARDL is also used in Alqaralleh (2020), in which the author highlights that responses of stock return to macroeconomic variables are generally asymmetric.

However, the above evidence for such a relationship is inconclusive, since the transition function used to capture fluctuations from the conditional mean of the changes in the return series in the employed nonlinear models is, by definition, symmetric. Therefore, these models cannot explain whether all the switches in the financial market at different times are influenced by changes in the aggregate economic factors. In fact, investors may be prone to diverse degrees of institutional inertia (dependent, for example, on the efficiency of the stock markets in which they operate) and so they adjust with different time lags. Thus, when considering aggregate economic series, the time path of any structural change is liable to be better captured by a model whose dynamics undergo gradual, rather than instantaneous adjustment between regimes (see, e.g. Peters, 1994).

With these drawbacks in mind, the central task of this paper is to answer the following obvious question: Do many stock market returns react simultaneously to a given economic signal? In order to answer this question, we use the Vector Smooth Transition Regression (VSTR) (see Teräsvirta, Van Dijk, and Medeiros, 2005). The main advantage in favor of VSTR models is that a continuum of states between the extremes appears more realistic. In other words, this VSTR-type model allows exactly for gradual change and thus the possibility of modeling different types of market behavior, determined by the magnitude of the returns. Another advantage of such models is that they allow switching behavior to depend upon observable variables.

The VSTR- type model is one of the most common procedures for determining non-linear relationships in macroeconomic time series (see, among others, Granger and Teräsvirta, 1993; 1999). In the financial literature, however, only very few researchers have used this kind of model to study stock market behavior. One study by McMillan (2001) investigates the nonlinearity between stock returns and business cycle variables. Other applications of VSTR models in the financial literature include those by Sarantis (2001), Franses and van Dijk (2000) and Harvey and Mills (2001).

Part of the aim of this paper is to investigate this stock return/macroeconomic nexus in emerging markets. We chose emerging markets because they are more susceptible to crises of high volatility resulting either from political and geopolitical turnovers or an environment of global financial liquidity. Such volatility would result in, first, wide currency swings because these countries have too little power to influence commodities swings, such as in oil or food. Second, a capital outflow leaves its government with the choice of either letting reserves reduce or letting interest rates rise. However, on the one hand, letting reserves flow out can lead to higher inflation and severely threatens the external value of the currency. On the other, raising interest rates keeps inflation low, but has the effect of causing a recession. Over time, this could lead to social unrest, rebellion, and regime change.

The remainder of this paper is organized as follows. Section 2 describes the dataset employed in this study where economics as well as econometric techniques are used to model the relationship. Section 3 discusses the findings and draws some conclusions.

2. Data and Descriptive Statistics

The data employed in this study are monthly data over the period January 1995 to July 2019. This period was chosen to illustrate the macroeconomic variables-stock return nexus during both troubled and tranquil periods in certain countries. As mentioned to the introduction, investigating the macroeconomic variables-stock return nexus in emerging markets is of great interest because these markets are more susceptible to crises. However, for reasons of data availability we consider five markets, namely, those of Brazil, Poland, Mexico, Greece, and Malaysia. We make use of four macroeconomic variables: real effective exchange rate (REER), the interbank interest rate (IR), industrial production index growth (IPI), and stock market returns (SR). The data for all countries is taken from the International Financial Statistics (IFS), and the analytical database of the Organization for Economic Cooperation and Development (OECD).

Table 1 presents the summary statistics for the time series in question. As shown in Panel A of the table, most of these series depart from normal Gaussian distribution. Therefore, the KSS test of Kapetanios et al (2003) was applied since the unit root tests based on the traditional AR model might have resulted in a misleading conclusion. This test computes a first order Taylor series to examine the nonlinear adjustment in time series under the null hypothesis that the stock return series follows a linear unit root process (see, among others, Kapetanios et al, 2003). The results of the KSS test are presented in Panel B of Table 1. At the 5% level, the null hypothesis of stationarity is rejected, which implies that the adopted stock return series are nonlinearly stationary and, thus, exhibit nonlinear characteristics. It is also worth noting that all the variables in the model were stationary on the level.

Table 1. Descriptive statistics and stationarity

	Brazil	Poland	Mexico	Greece	Malaysia
Panel A; Descriptive Statistics					
Skewness	0.226	0.052	0.124	0.875	0.061
Kurtosis	1.893	1.546	1.381	2.721	1.640
JB	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Panel B; Unit Root Test					
KSS Test	1.679	1.036	0.927	1.572	1.112

Note: the values in [] refer to measures of probability according to the Jarque-Bera test for normality. "KSS" relates to the Kapetanios, Shin and Shell unit root tests. Asymptotic 5% Critical Values of KSS Statistic is -2.93 . It's worth noting that the test is conducted using Stata module proposed by Otero and Smith (2017).

3. Modelling the Relationship Between Stock Return and Macro-Variables

3.1 The Economic Model

The issue of incorporating nonlinearity in the relationship between the aggregate stock price level and the macroeconomic variables in an empirical analysis has received considerable critical attention. Drawing on the seminal papers (among others; Yang et al. 2018; Lee and Ryu, 2018; Han et al., 2012; Lee and Ryu, 2013) that highlight the asymmetric response of stock returns to related macroeconomic variables, we see that different variables have been found in previous studies to be included in order to empirically investigate this relationship. This study uses the following general specification:

$$SR = \alpha_0 + \alpha_1 IPI + \alpha_2 IR + \alpha_3 REER + \varepsilon_t \quad (1)$$

Where the real effective exchange rate is denoted by REER), the interbank interest rate is IR, the industrial production index growth is IPI, and the stock market returns are defined as SR. From the literature review, the interaction between these variables and stock returns seems to be inconclusive. Below is a detailed explanation for the expected signs of these variables.

3.1.1 Real Effective Exchange Rate (REER)

Many recent studies (e.g. Ratanapakorn and Sharma, 2007; Tripathy, 2011) have demonstrated that the real exchange rate can affect stock prices in several ways. However, the interaction will be different depending on whether the economy imports or exports more and whether it hedges against exchange rate fluctuation (Dimitrova, 2005).

From the macroeconomic perspective, on the one hand, a depreciated currency impacts domestic output positively because it depresses imports and boosts exports. Consequently, investors tend to boost share prices since growing output is seen to indicate a wealthy economy. If, however, a depreciation of the exchange rate creates expectations of inflation for the future, the depreciation tends to curb consumer spending and therefore company earnings (Kwon and Shin, 1999). On the other hand, at the firm level, exchange rate fluctuation may negatively affect the value of firms' stock prices. Loosely speaking, currency depreciation erodes the return on a foreign investor's investment and thus makes investors unwilling to hold assets (Ajayi and Mougoue, 1996).

Taken together, these studies support the notion that stock prices may negatively interact with a real effective exchange rate, especially in countries with emerging markets that are susceptible to crises.

3.1.2 Interest Rate (IR)

Interest rates can play an important role in addressing the issue of the movement of stock prices. According to Fama (1981, 1990), interest rates negatively influence stock returns through the discount rate. This negative relationship may also through the higher cost of funding stem indirectly from a rise in interest rates (*ceteris paribus*), lower future profits, an increase in the discount rate for equity investors; and then a decrease in stock prices. In addition, Bjørnland and Leitemo (2009) claim that interest rates may affect stock markets because monetary policy provides feedback to central banks about what the private sector expects the about future macroeconomic variables to be (see also, Bernanke and Gertler, 2000).

Numerous studies have investigated this relationship in both developing and emerging markets (e.g. Alam, 2017; Hussain et al., 2013; Humpe and Macmillan, 2009). All of the studies reviewed here support the hypothesis that stock prices are negatively correlated to interest rates.

3.1.3 Industrial Production Index Growth (IPI)

Awareness of the relationship between stock prices and the industrial production index growth is not recent. Much of the literature emphasizes that an increasing industrial production index growth is a positive sign of investors' expectations about future economic performance (Ikoku, 2010, among others). In Fama's seminal work (1990), he argues that future production growth rates reflect certain information about cash flows that informs stock prices. In line with this conclusion, other authors maintain that output growth is the main driving force behind stock market performance because this growth contributes to the ability of firms to generate cash flows (e.g., Humpe and Macmillan, 2009; Nishat and Shaheen, 2004).

Together, these studies suggest a positive relationship between real economic activities, proxied by the industrial production index growth and stock returns.

3.2 Econometric Model

Several methods are currently used to assess the relationship between macroeconomic variables and stock prices. In this study, Vector Smooth Transition Regression (VSRT) was selected for its reliability and validity in modeling the interaction between macroeconomic factors and stock market in periods of financial stress (e.g., Alqaralleh, 2019). Moreover, the nonlinear structure of the models leads to important improvements over forecasting with an incorrectly specified linear model (Canepa et al. 2020; Balcilar et al., 2015; Cabrera et al., 2011).

To describe the relationships between these variables, we follow Hubrich and Terasvirta (2013) and make use of the generalization single-equation STR model for the vector case, as follows

$$SR_t = A_0 + A_1 G(\gamma, c; s_t) + \sum_{j=1}^p \{ \phi_j + G(\gamma, c; s_t) \psi_j \} SR_{t-j} + [\Gamma + G(\gamma, c; s_t) \Xi] \chi_t + \varepsilon_t \quad (2)$$

where SR_t is an $m \times 1$ vector of stationary stock return variables; A_0 and A_1 are $m \times 1$ intercept vectors; χ_t is the $n \times 1$ vector of stationary exogenous regressor including (*REER*), (*IR*), and (*IPI*); ϕ_j and ψ_j are $m \times m$ parameter matrices; and Γ and Ξ are $m \times n$ parameter matrices.

For a given stationary transition variable s_t , the $m \times m$ transition matrices have the following form

$$G_j(\gamma_j, c_j; s_{jt}) = \text{diag}\{G_1(\gamma_1, c_1; s_{1t}), \dots, G_m(\gamma_m, c_m; s_{mt})\} \quad (3)$$

The transition matrices defined in Equation (2) can be defined as a standard Logistic function (Equation 4) or an Exponential function (Equation 5), viz.

$$G_j(\gamma_j, c_j; s_{jt}) = \left[\frac{1}{1 + e^{-\gamma_j(s_{jt}-c_j)}} \right] \quad (4)$$

$$G_j(\gamma_j, c_j; s_{jt}) = [1 - e^{-\gamma_j(s_{jt}-c_j)}]^2 \quad (5)$$

The Logistic transition function of the form defined in Equation (4) along with the generalized STR model in Equation (2) yield VLSTR, while plugging Equation (5) into Equation (2) yields VESTAR. In both cases, the regime-specific dynamics governs the transition between 0 and 1 regime, depending on the values of the location parameters c and the smoothness parameter γ . The delay parameter d of the transition variable can take values in the range of $1 \leq d \leq p$ or $d > p$ (van Dijk, 1999; Siliverstovs, 2005).

The model specification steps of VSTR models generally consist of estimating an appropriate VAR (P) model that can be chosen on the basis of information criteria and a serial correlation test. Next, a set of linearity tests against the nonlinear alternative should be deployed. The latter is usually tested by means of the Taylor expansion-based linearity test from Luukkonen et al. (1988). The third step concerns the type of transition function which can be guided by economic theory, or, alternatively, can involve a procedure suggested in Tsay (1989) and Teräsvirta (1994). Finally, before the estimated VSTR model can be accepted as adequate, it should be subjected to mis-specification tests that include a test for no remaining nonlinearity and the hypothesis of parameter constancy.

3.3 Estimation Results and Discussion

In this section, we report the results of the dynamic interaction between stock returns and selected macroeconomic variables. First, the maximal lag order of the VAR(P) model along with an optimal delay parameter are presented in Panel A of Table 2. Interestingly, using the information criterion and the portmanteau test for serial correlation, the persistence of the fitted model was observed to vary in the countries under consideration. However, in all cases, with any shock in macro-variables, the stock returns experience a slow reversion to their mean. It seems possible that these mean reversions are due to the asymmetric response of these stock markets to the macroeconomic shocks.

Such inefficiency in these markets results in a high level of fluctuations, which contribute to features of financial instability such as high persistence, positive dependence, and nonlinearity. Consequently, we test the possibility of this nonlinearity by applying the expression in Luukkonen et al. (1988) as the basis for LM tests. As can be seen from Panel B in Table 2, the hypothesis of linearity is strongly rejected at the 5% significance level. We therefore conclude that a nonlinear VSTR type model is better able than a VAR (p) model to capture the features of the variables under consideration.

Having rejected the linearity hypothesis, the next step is to validate our hypothesis that the dynamics of stock return and macro-variables can best be modelled using an econometric model which is, by construction, able to capture asymmetric cycles. In this manner, we can do this with the methodology of Van Dijk Et Al (2002), conducting a series of F-tests to test the following hypotheses:

$$H_{01} = \Phi_{4i} = 0$$

$$H_{02} = \Phi_{3i} = 0 = \Phi_{4i} = 0$$

$$H_{03} = \Phi_{2i} = \Phi_{3i} = \Phi_{4i} = 0$$

These hypotheses indicate that the rejection of H_{01} implies selecting the logistic transition function in Equation (3). If, however, we cannot reject H_{01} , the second part of the sequential test has to be estimated. Rejection of hypothesis H_{02} implies the selection of the exponential transition function in Equation (4). However, we move to the last part of the sequential test if we cannot reject H_{02} . Rejection of H_{02} implies the selection of the transition function in Equation (3) and therefore the VLSTR model.

However, Kapetanios (2001) suggests that the choice between various transition functions can be made by comparing the p-values. To this end, the VESTR model is selected when the P-value for H_{02} is less than H_{01} and H_{03} ; in other cases, the VLSTR model is selected. Accordingly, the results of Table 2 show that the both Poland and Mexico followed the nonlinear behavior of the Exponential VSTR model. A possible explanation for adopting

EVSTR is that in these markets the stock return similarly adjusts their periods from high to low levels towards the middle ground. The case in Brazil, and Malaysia is, however, interesting because the logistic transition outperforms the exponential one, suggesting an asymmetrical response to the macro-variables.

Table 2. Linearity test and model selection

	Brazil	Poland	Mexico	Greece	Malaysia
Panel A; Linearity Test					
VAR(P) =	4	6	3	5	4
Optimal delay parameter (d)	3 (0.000)	3(0.001)	3(0.000)	1(0.004)	2(0.000)
Panel B; LM test for model selection					
$H_{04}: \beta_{4i} = 0$	0.002	0.107	0.002	0.118	0.000*
$H_{03}: \beta_{3i} = 0$	0.024	0.001*	0.000*	0.240	0.001
$H_{02}: \beta_{2i} = 0$	0.000*	0.123	0.046	0.003*	0.003
Panel C; Suggested model					
	LVSTR(P)	EVSTR(P)	EVSTR(P)	LVSTR(P)	LVSTR(P)
Panel A reports the linearity tests. Note that the selection of the optimal lag, VAR (p)*, was made using the AIC statistic. Panel B The numbers in parentheses refer to the lowest p-value results of the LM-test. Panel C illustrates the best fitted model.					

The last step is concerned with estimating and evaluating the VSTR models. Table 3 reports the parameter estimates together with the diagnostic tests. For ease of interpretation, the estimated parameters for expansion and contraction regimes are reported separately. Starting with the overall goodness of fit of the model as shown in panel B, one interesting finding is that the SEs of the nonlinear parts (a high regime) are, generally, smaller than those of the linear parts (a lower regime) confirming the capacity of the nonlinear models to fit the data under scrutiny. Moreover, the nonlinearity in the relationship under investigation is not the outcome of any outliers in the data, since the residuals are normally distributed as suggested by the Jarque-Bera normality test. It is also encouraging to note that in all cases considered in this study there was also no evidence of remaining nonlinearity. In addition, the autocorrelation tests do not reject the null hypothesis of no autocorrelation against the q-order auto-regression for all the estimated models.

Table 3. Estimated parameter

	Brazil	Poland	Mexico	Greece	Malaysia
Panel A; Estimated Results					
Lower Regime					
CONST	4.725**	-3.638**	0.084**	- 0.957*	-3.213**
	(1.585)	(1.127)	(0.037)	(0.244)	(2.033)
Share_log_d1(t-1)	-0.344**	0.485**	-0.044	0.174*	-0.119**
	(0.162)	(0.257)	(0.062)	(0.081)	(0.049)
Share_log_d1(t-2)	0.315**	- 0.753	- 0.035	-0.131	-0.588**
	(0.070)	(0.828)	(0.052)	(0.239)	(0.285)
Share_log_d1(t-3)	-0.512**	- 0.391	- 0.079**	0.216**	-0.335**
	(0.201)	(0.243)	(0.034)	(0.107)	(0.113)
IPI(t)	0.034**	0.068**	0.004**	0.012**	0.793**

	(0.016)	(0.027)	(0.002)	(0.006)	(0.423)
IR(t)	-0.229**	- 0.131**	-0.030**	-0.018	-0.264*
	(0.105)	(0.034)	(0.001)	(0.014)	(0.140)
REER(t)	0.131	0.396	0.020**	0.032*	0.294*
	(0.241)	(0.325)	(0.012)	(0.013)	(0.138)
Higher Regime					
CONST	-4.618**	1.005**	5.373*	0.653**	0.558*
	(2.185)	(0.501)	(2.259)	(0.314)	(0.133)
Share_log_d1(t-1)	0.504*	-0.666*	0.205**	0.374**	0.378**
	(0.162)	(0.257)	(0.100)	(0.163)	(0.144)
Share_log_d1(t-2)	-0.415*	0.177**	0.407*	0.398***	0.311**
	(0.171)	(0.088)	(0.182)	(0.201)	(0.149)
Share_log_d1(t-3)	0.650*	0.354**	0.459**	-0.163**	0.685***
	(0.298)	(0.164)	(0.226)	(0.069)	(0.491)
IPI(t)	0.135*	0.081	0.200*	0.042**	0.604*
	(0.030)	(0.069)	(0.042)	(0.017)	(0.283)
IR(t)	-0.321**	-0.108*	-0.222**	-0.032**	-0.370**
	(0.165)	(0.035)	(0.125)	(0.016)	(0.280)
REER(t)	-0.128*	-0.397*	-0.117**	-0.021***	-0.014
	(0.024)	(0.125)	(0.049)	(0.010)	(0.023)
Smooth Transition Parameter					
Gamma	4.810*	11.564*	19.642*	4.141*	7.335**
	(1.168)	(5.428)	(6.618)	(1.960)	(3.213)
C1	-0.198**	-0.348*	-0.168**	-0.029**	-0.145**
	(0.042)	(0.004)	(0.011)	(0.008)	(0.045)
C2		-0.120**	-0.114**		
		(0.005)	(0.011)		
Panel B; p-values for Misspecification Tests					
ARCH (5) Test	0.453	0.112	0.214	0.151	0.144
No Remaining Nonlinearity	0.259	0.782	0.479	0.137	0.201
Parameter Constancy	0.340	0.189	0.617	0.492	0.230
JB	0.521	0.542	0.217	0.234	0.162

Panel A reports the estimated parameters. Standard errors of the estimated parameters are given in parentheses. Panel B reports mis-specification tests. *) **) and ***) relate to the 1%, 5% and 10% significance levels, respectively.

Coming to the estimated results presented in Table 3, Panel A, it is apparent that the speed of transition between the two regimes is correctly signed and significantly different from zero, indicating a gradual transition between the times of expansion and recession. These results indicate that emerging markets such as Poland and Mexico exhibit a sharper transition, shown by the slope parameter, γ , which was about 11.5 for Poland and 19.6 for Mexico. This suggests that these markets are more prone to economic fluctuation than are Brazil, Greece, and Malaysia. These

three are all characterized by a relatively very smooth transition from one regime to another. Another important finding is that the location parameter(s) is also significant in all cases.

Together, these findings can, however, be interpreted in a different way if we denote $F(\cdot) = 0$ as the contraction regime and $F(\cdot) = 1$ as the expansion time. In the case of Brazil, for example, given that the market at the time of our survey was initially at the equilibrium period with the weights attached to the two pure regimes equal at [0.5, 0.5], one standard deviation positive shock to the Y_{t-d} yielded $F(Y_{t-d}) = 0.46$. Accordingly, we infer that the weight attached to the one regime differed slightly from that of the other regime, in which the linear combination adjustment of the two regimes was [0.46, 0.48], reducing the speed of adjustment only slightly. The case of Mexico is quite different: the speed of adjustment was relatively high since one standard deviation shock to the stock return index yielded a [-0.21, 0.48]. The same applied to the rest of the emerging markets under consideration.

As regards the estimation of the selected economic variables, the results indicate that the sign of impact was in line with economic theory and the previous studies in both advanced and emerging markets (e.g., Dasgupta, 2012; Humpe and Macmillan, 2009). In specific, the industrial production index growth had a significant positive impact on the stock returns in almost all the emerging markets that we considered. A possible explanation for this is that the volatility of stock returns increases during recoveries and decreases during economic contractions, which in turn contributes to the ability of firms to generate cash flows (see, e.g., Fama, 1981). Exchange rate changes are also statistically significant, implying that a negative shock in the exchange rate increases stock returns, while an increase in the real effective exchange rates reduces stock returns. Moreover, the positive effect of currency depreciation is rather different from the negative effects of currency appreciation in absolute terms, indicating that exchange rate fluctuations are likely to asymmetrically influence the stock returns. A possible theoretical explanation for these results is that currency depreciation leads to improved competitiveness among exporting firms, which in turn will positively affect stock returns (see Hajj et al., 2018; Ho and Odhiambo, 2017; Seong, 2013). Turning now to the short-term interest rate, which is also relatively important in describing returns, we find that the results also highlight the fact that a decrease in the short-term interest rates will depress the stock market. The latter is due to the maturity mismatch between bank assets and liabilities (see, Christie, 1982).

Lagged country stock returns, however, do not add any incremental information; the sign of impact varies across countries. These results reflect those of Sakti and Harun (2013); Ajmi et al. (2014); Ratanapakorn and Sharma, (2007) who also affirm that the nonlinearity results are more credible in the advanced countries because of the possible existence of structural breaks, asymmetry and regime switching in the markets and the relevant economic and financial variables.

4. Conclusion

This study set out to examine if the relationship between stock prices and macroeconomic variables is asymmetric and, if so, how this effect occurs. Using a sample of five emerging markets, we analysed monthly data over the period January 1995 to July 2019. The sample period was chosen to investigate the macroeconomic -variables-stock-return nexus during both troubled and tranquil periods in these countries. Because the relationships between variables took shape under the assumption that the behavior of stock markets return reacts simultaneously to a given economic signal, the current examination used the VSTR approach in order to identify the asymmetric reactions between variables.

One of the significant findings from this study is that the linear VAR (P) highlights a possibility of mean reversions, due to the inefficiency of these stock markets. This inefficiency contributes to financial instability, resulting in nonlinearity. The possibility of nonlinearity is further tested using the Taylor expansion-based linearity test from Luukkonen et al. (1988). Another important finding is that in both Poland and Mexico the stock returns similarly adjust their periods from high to low levels towards the middle ground. By contrast, the findings for Brazil, Greece, and Malaysia suggesting an asymmetrical response to the macro-variables. Another interesting finding is that the selected economic variables have the expected sign of impact in line with economic theory and the previous literature.

It may be hypothesized that the stock prices-macroeconomic -variables nexus is more likely than not to be modelled in a nonlinear fashion. These findings may help us to understand how the properties of emerging markets at the center of a country's economic activity may inform policy makers on the course of acceptable, accessible, and sustainable and replicable actions that help stakeholders to invest.

Despite these promising results, some questions remain. Future studies might investigate the role of other macroeconomic variables that would provide information about the stock return. Further study would also consider

other time series characteristics, such as volatility, in order to obtain better insight into the generation of returns. Further research could be also developed to determine the capability of such nonlinear structure of the models in the predictability of the stock return.

Data Availability Statement

Data supporting the findings of this study are available from the corresponding author on request.

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