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Modelling Asymmetric Impact of Home Country Macroeconomic Variables on American Depository Receipts: Evidence from Eurozone

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This study investigates the impact of home country macroeconomics variables on ADR price for the period 2000-2016 for France, Germany, Greece, Italy and Spain using NARDL. The results indicate the existence of asymmetries (nonlinearity) and hidden cointegration between positive and negative partial sum of underlying variables for all countries. Money supply, in general, affects ADR prices while inflation has positive (negative) impact on ADR prices in case of France and Italy (Germany, Greece and Spain) respectively. Economic growth is only significant determinant of ADR price for France, Greece and Spain. This study opens some new insights for ADR investors.

Key Words: American depository receipts; Inflation; Economic growth; NARDL; Multipliers; Eurozone.

JEL Classification Numbers: G15, C22.

1. INTRODUCTION

In the course of first half of the last century, American Deposit Receipts[1] (ADRs) emerged as attractive investment vehicles since they provided US investors with an opportunity to invest in foreign stocks without getting worried about foreign trading practices, differences in tax laws, transaction costs and loss of currency value (Wu, Hao, and Lu 2017). The core reasons

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[1]American Depositary Receipt (ADR) is a negotiable instrument representing an ownership interest in a specified number of securities that is deposited by the securities holders with a designated bank depository (Bodie, Kane, and Marcus 2014).

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behind choosing foreign equities were diversification as well as pursuit of superior returns (Lang, Lins, and Miller 2003). As Gupta, Yuan, and Roca (2016) argue, the ADR investors are positive about the future outlook of underlying economies and hence design their ADR portfolios in view of the economic progress of host countries. At this point, a natural question arises whether ADR prices are affected by the economic conditions of the countries where these companies operate? Intuitively, they should, as ADRs, in essence, are derivatives that derive their value from the performance of their underlying stocks and in efficient and frictionless markets, redundant assets trade at same price (Kato, Linn, and Schallheim 1991). If the stock markets perform well, the economies also boost and hence ADR prices would be directly affected by economic boom / bust. Nevertheless, it is equally probable that ADRs are different from their underlying stocks mainly due to stricter regulations in US, divergence in risk perceptions of US investors and local investors and lesser connectivity between foreign market and United States (Gupta, Yuan, and Roca 2016). Hence, in such scenario, the changes in ADR prices will not necessarily be guided by the underlying stocks and their respective equity markets.

The relationship of ADRs and economic fundamentals becomes more complex when we look at the linkage of financial markets and the real economy in the light of existing studies. This nexus is widely discussed in contemporary literature and several studies highlight the relationship between financial securities (i.e. stocks, bonds, money market and other market securities) and macro-economic indicators (like Gross Domestic Product, inflation, unemployment, and interest rates). For example, the earlier studies determine the association of stock market returns and inflation in the context of monetary policy effect and mainly focus on the impact of inflation rates on stock markets in the developed countries (see Bodie (1976), Nelson (1976), Miller, Jeffrey, and Mandelker (1976), Fama and Schwert (1977), Fama (1981), Geske and Roll (1983), Kaul (1987) and Du (2006)). However, later works like Chen, Roll, and Ross (1986) extend these studies and test the relationship of other macroeconomic variables and stock market and find that the strong impact of macroeconomic variables on the stock market returns.

These studies report conflicting results. One strand of literature argues that a well-developed stock market can accelerate the economic development process by efficiently providing the funds from savers to investors in the economy and hence the stock markets stimulate economic growth and development in the long run. On the contrary, another strand of literature suggests that the real economic variables drive the stock market growth and a progressing and developing economy will affect the growth of firms, industries and financial markets and hence growth in the economic fundamentals leads to the development of the stock market (Allen, Bali, and

Tang 2012, Bali, Brown, and Caglayan 2014, Bloom 2009, Bloom, Bond, and Van Reenen 2007, Chen 2010). Finally, some studies find that stock market returns and real economic activity demonstrate very weak relationship owing to movements in foreign portfolio investment and emergence of speculative bubbles (Binswanger 2000, 2004, Hosseini, Ahmad, and Lai 2011, Narayan and Narayan 2012).

This paper contributes to the existing literature in following ways: First, we investigate the connection of economic fundamentals of home country and ADR performance for EU countries. The available evidence on this linkage is very little and to the best of our knowledge, only Gupta, Yuan, and Roca (2016) has determined the relationship of ADRs with macroeconomic variables in BRICs countries. They have come up with mixed findings and there is visibly a need for further probe into this area. Second, the notable contribution of this paper comes from testing the cointegration relationship between underlying variables by using nonlinear ARDL modeling, newly developed by Shin, Yu, and Greenwood-Nimmo (2014) and has an advantage over some other nonlinearity approaches such as threshold cointegration introduced by Enders and Siklos (2001) and Markov-switching VECM of Hamilton (1989) and Krolzig (2013). The NARDL is superior because it estimates both short- and long-run asymmetries simultaneously, while, the threshold cointegration model accounts only for the long-run asymmetry.

Our results reveal that all variables are stationary at their first difference in case of France, Germany, Greece and Italy. But, only ADR prices are stationary at level in case of Spain. The asymmetric bound testing of Pesaran, Shin, and Smith (2001) and t-statistics of BDM test confirms the existence of nonlinear cointegration between positive and negative partial sum of variables for all countries. Furthermore, a negative relationship between inflation and ADR Prices in case of France and Italy, But, positive relationship in case of Germany, Greece and Spain have been noted. Similarly, economic growth has positive impact on ADR Prices only for France, Greece and Spain. Moreover, money supply positively determined ADR Prices for all countries.

Rest of the paper is organized as follow: section-2 shows review of literature. Section-3 represents data collection, model construction and methodology development. Results and their discussion are presented in section-4. Similarly, conclusion and implications are discussed in section-5.

2. BRIEF REVIEW OF LITERATURE

The ADR market is assumed to be an extension of the underlying stock market. Theoretically, the ADR price co-move with the underlying stock market. This means that ADR market exhibits the similar relationship with macroeconomic variables as stock markets. In this contest, there are numerous existing studies that concentrate on stock market relationship with macroeconomic variables for a group of emerging markets. For example, Wongbangpo and Sharma (2002) examined the basic linkage between macroeconomic variables (namely; Gross National Product (GNP), Consumer Price Index (CPI), money supply, exchange rate and interest rates) and stock prices in ASEAN region. The study reveals that stock market is fundamental factor among other macroeconomic indicators. Furthermore, Narayan and Narayan (2012) investigated the impact of US macroeconomic conditions on the financial markets of seven Asian economies. Using daily frequencies for the sample period 2000-2010, the study shows a significant impact of interest rate on stock returns only in Philippines. In addition, the results also suggest that exchange rates have negative effect on stock returns for all countries except China. The VECM analysis reveals that financial crisis has weakened relation between economic variables and price of stocks.

On the contrary, there are several studies looking at the association of economy and stock market in a single market. For instance, Hosseini, Ahmad, and Lai (2011) examined the relationship between stock market indices and macroeconomic variables (crude oil price, money supply, inflation rate and industrial production) for China and India for the sample period from January 1999 to January 2009 on monthly data. They found that crude oil has a negative impact on stock markets for India and positive impact on Chinese stock market in the long run. While, a long run negative impact of money supply has observed for China and negative for stock market in India. The results of industrial production suggest only a negative impact in China. Finally, the effect of rise in inflation in positive for stock markets in both countries.

Practically, ADR price is different from parity and sell at a premium or a discount to the value of the underlying stock (Arquette, Brown Jr, and Burdekin 2008). Furthermore, the economic exposure is different for ADRs and local stock market index because, ADRs are listed in cross-border securities and the impact of domestic macroeconomic factors on ADRs is affected by the extent to which the international markets are efficient and integrated with each other. In addition, the non-US listing firms have to fulfill are the conditions of the security exchange commission for listing the ADRs in US market. These listing conditions will lead to high transparency in the ADRs and lower the investment risk for ARDs as compared to foreign stock markets. The risk perception is different between investors in US and local investors in the underlying foreign equity markets. This shows the divergence between ADRs and underlying stocks (Gupta, 2016). However, underlying stock returns, US market, domestic market (Patro 2000, Kim, Szakmary, and Mathur 2000, Kutan and Zhou 2006, Esqueda and Jackson

2012) and exchange rate were most important determinants of ADRs (Kim, Szakmary, and Mathur 2000, Choi and Kim 2000, Fang and Loo 2002).

Many others empirical studies also argued that local market factors and home country factors play a significant role in ADRs pricing and returns more than the US market. For instance, Choi and Kim (2001) and Bae, Kwon, and Li (2008) suggested that ADR returns are largely affected by home country factors than that in the US. Furthermore, Xu and Fung (2002) and Fang and Loo (2002) documented that local market factors contributed a significant role for ADR pricing than the US market. In similar context, Mak and Ngai (2005) argued that Hong Kong stock exchange has significant impact on Chinese ADR pricing than US financial market. Furthermore, Kadapakkam and Misra (2003) found that Bombay stock exchange had played important role in ADR pricing in India than London stock exchange. In addition, the ADRs in Australian were also affected by other stock markets' shocks in the world. In case of relationship between ADRs and economic variables, Lee, Chang, and Chen (2015) specifies few fundamentals and economic factors that affect the linkage between ADRs with their local and US market. Recently, Gupta et al. (2016) identified the long-run relationship between ADRs returns on emerging market and their home countries' macroeconomic factors. Based on available empirical literature, there is no clear-cut association between ADRs and home market economic fundamentals. Furthermore, the existing ADR literature unable to address this issue in European economies as regards linkage between macroeconomic variables and ADRs.

3. DATA COLLECTION, MODEL CONSTRUCTION AND METHODOLOGY DEVELOPMENT

This study examines the macroeconomic determinants of ADR by using Nonlinear ARDL frame work for France, Germany, Greece Italy and Spain. The monthly data has been taken from 2000M01 to 2016M03. The ADR index has been collected for the bank of New York for each country. Remaining series have been collected from data stream. The functional form of our estimated model is following:

$$ADR_t = f(CPI_t, IIP_t, M3_t) \tag{1}$$

We have taken natural log of all series to get elasticities. The log function of estimated model is:

$$\ln ADR_t = \beta_1 + \beta_2 \ln CPI_t + \beta_3 \ln IIP_t + \beta_4 \ln M3_t + \varepsilon_t \tag{2}$$

Here, $\ln ADR_t$ is natural log of Bank of New York (BNY) Mellon American depository receipt (ADR) index[2], $\ln CPI_t$ is a natural log of consumer price index measured as inflation, $\ln IIP_t$ is natural log of economic growth measured by industrial production index and $\ln M3_t$ is a natural log of supply of money proxy by M3.

3.1. Non-linear ARDL Approach

In econometric literature, many cointegration techniques have been developed. Usually these techniques include Engle and Granger (1987), Johansen (1991), Phillips and Ouliaris (1990), Boswijk (1994) and Banerjee, Dolado, and Mestre (1998). The precondition for application of these traditional cointegration approach is series must be integrated at same level, i.e. $I(0)$ or $I(1)$. To deal with mixed ordered of integration i.e. $I(0)/I(1)$, Pesaran et al. (2001) developed ARDL bound testing. The methodology for standard linear ARDL with four variables is following:

$$\begin{aligned}\Delta ADR_t &= \alpha_1 + \alpha_T T + \alpha_{ADR} ADR_{t-1} + \alpha_{CPI} CPI_{t-1} + \alpha_{IIP} IIP_{t-1} \\ &+ \alpha_{M3} M3_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta ADR_{t-i} + \sum_{j=0}^{q-1} \alpha_j \Delta CPI_{t-j} \\ &+ \sum_{k=1}^{r-1} \alpha_k \Delta IIP_{t-k} + \sum_{l=0}^{s-1} \alpha_i \Delta M3_{t-l} + \varepsilon_t\end{aligned} \tag{3}$$

Here, α_T denotes trends or seasonal, Δ is for difference operator and ε is linear stochastic process. Under the null hypothesis of no cointegration, we compare the calculated F-statistics with upper and lower critical bounds. Pesaran et al. (2001) have identified the condition regarding rejection or acceptance of null hypothesis. If calculated F-statistics is greater than upper critical bound (UCB), we reject null hypothesis. Similarly, if calculated F-statistics is less than lower critical bound (LCB), we accept null hypothesis. When calculated F-statistics lies between upper and lower critical bounds, the results are inconclusive.

Later on, Bayer and Hanck (2013) introduced combine cointegration to enhance the power of cointegration approach. This approach combines previous cointegration approaches [Engle and Granger (1987); Johansen (1991); Phillips and Ouliaris (1990); Boswijk (1994) and Banerjee et al. (1998)] and calculates a new F-statistics that should be greater than critical values for rejection of null hypothesis of no cointegration.

[2]The BNY Mellon ADR Index is a free float-adjusted capitalization weighted index which tracks the performance of a basket of companies who have their primary equity listing on domestic stock markets and also have depositary receipts that trade on a US exchange.

When we talk about asymmetry, the classical cointegration approaches are unable to compute the nonlinear cointegration among variables. There are three types of nonlinear models available in existing literature. First is, threshold ECM introduced by Balke and Fomby (1997). Second is, Markov Switching ECM developed by Psaradakis, Sola, and Spagnolo (2004). Third is, the smooth transition autoregressive ECM established by (Kapetanios, Shin, and Snell 2006). In this regard, Shin et al. (2014) recently developed nonlinear autoregressive distributive lag model known as NARDL based on these three nonlinear models. Granger and Yoon (2002) predicted the concept of hidden cointegration. They argue that if variables are not cointegrating in a conventional sense, there must be cointegration between their positive and negative components, said to be hidden cointegration. To detect the nonlinear (asymmetric) impact of macroeconomic variables on ADR, we decompose inflation, economic growth and money supply into positive and negative partial sums as followed:

$$CPI_t = CPI_0 + CPI_t^+ + CPI_t^- \tag{4}$$

Where,

$$CPI_t^+ = \sum_{i=1}^{t} \Delta CPI_i^+ = \sum_{i=1}^{t} \max(\Delta CPI_i, 0) \tag{5}$$

$$CPI_t^- = \sum_{i=1}^{t} \Delta CPI_t^- = \sum_{i=1}^{t} \min(\Delta CPI_i, 0) \tag{6}$$

$$IIP_t = IIP_0 + IIP_t^+ + IIP_t^- \tag{7}$$

Where,

$$IIP_t^+ = \sum_{i=1}^{t} \Delta IIP_i^+ = \sum_{i=1}^{t} \max(\Delta IIP_i, 0) \tag{8}$$

$$IIP_t^- = \sum_{i=1}^{t} \Delta IIP_i^- = \sum_{i=1}^{t} \min(\Delta IIP_i, 0) \tag{9}$$

$$M3_t = M3_0 + M3_t^+ + M3_t^- \tag{10}$$

Where,

$$M3_t^+ = \sum_{i=1}^{t} \Delta M3_i^+ = \sum_{i=1}^{t} \max(\Delta M3_i, 0) \quad (11)$$

$$M3_t^- = \sum_{i=1}^{t} \Delta M3_i^- = \sum_{i=1}^{t} \min(\Delta M3_i, 0) \quad (12)$$

Here,

$\Delta CPI_t = CPI_t - CPI_{t-1}$ $\quad \Delta IIP_t = IIP_t - IIP_{t-1}$ $\quad \Delta M3_t = M3_t - M3_{t-1}$

Therefore, the long run equilibrium relationship can be display as:

$$\begin{aligned} ADR_t &= \beta_0 + \beta_{CPI}^+ CPI_t^+ + \beta_{CPI}^- CPI_t^- + \beta_{IIP}^+ IIP_t^+ + \beta_{IIP}^- IIP_t^- \\ &+ \beta_{M3}^+ M3_t^+ + \beta_{M3}^- M3_t^- + \mu_t \end{aligned} \quad (13)$$

Here, β^+CPI and β^-CPI are the asymmetric long run parameters associated with positive and negative changes in inflation, respectively. Similarly, β^+IIP and β^-IIP are the asymmetric long run parameters associated with positive and negative partial sum decomposition in economic growth, respectively. β^+M3 and β^-M3 are the asymmetric long run parameters associated with positive and negative partial sum decomposition in money supply, respectively. Shin et al. (2014) developed asymmetric error correction model(equation 14) by adjusting equation (13) into simple linear ARDL model (equation 3).

$$\begin{aligned} &\Delta ADR_t = \vartheta + \delta ADR_{t-1} + \theta^+ CPI_{t-1}^+ + \theta^- CPI_{t-1}^- + \lambda^+ IIP_{t-1}^+ + \lambda^- IIP_{t-1}^- \\ &+ \pi^+ M3_{t-1}^+ + \pi^- M3_{t-1}^- + \sum_{i=1}^{p-1} \chi_i \Delta ADR_{t-i} + \sum_{i=0}^{q-1} (\phi_i^+ \Delta CPI_{t-i}^+ + \phi_i^- \Delta CPI_{t-i}^- \\ &+ \tau_i^+ \Delta IIP_{t-i}^+ + \tau_i^- \Delta IIP_{t-i}^- + v_i^+ \Delta M3_{t-i}^+ + v_i^- \Delta M3_{t-i}^-) + \varepsilon_t \end{aligned} \quad (14)$$

Where,

$$(\theta^+ = \lambda^+ = \pi^+) = -\rho/\beta^+ \text{ and } (\theta^- = \lambda^- = \pi^-) = -\rho/\beta^-$$

p and q denote the lag orders for dependent variable and independent variables respectively. The (+) and (−) signs describes the positive and negative partial sum processes. We can test cointegration relationship between ADR, CPI, IIP and $M3$ through mean of modified F-statistics (F_{PSS}), mean of a Wald test (W_{PSS}) and means of the t_{BDM} test. We reject null hypothesis of no cointegration against the alternative of cointegration when calculated values are greater than critical bounds.

We define NARDL analysis into four procedures. In first step, we estimate asymmetric equation (14) through simple OLS regression. In second step, we test the cointegration relationship between ADR, CPI, IIP and $M3$. The null hypothesis with no asymmetric cointegration ($\delta = \theta^+ = \theta^- = \lambda^+ = \lambda^- = \pi^+ = \pi^- = 0$) against the alternative hypothesis of cointegration ($\delta \neq \theta^+ \neq \theta^- \neq \lambda^+ \neq \lambda^- \neq \pi^+ \neq \pi^- \neq 0$)is tested by F_{PSS}, W_{PSS} and t_{BDM}. In third step, we test the long and short run asymmetry by Wald test. For short run, we test null hypothesis of short run symmetry ($\phi^+ = \phi^-$, $\tau^+ = \tau^-$, $v^+ = v^-$) for alternative of short run asymmetry ($\phi^+ \neq \phi^-$, $\tau^+ \neq \tau^-$, $v^+ \neq v^-$). For long run, the null hypothesis is long run symmetry ($\theta^+ = \theta^-$,$\tau^+ = \tau^-$,$v^+ = v^-$) for alternative of short run asymmetry ($\phi^+ \neq \phi^-$,$\lambda^+ \neq \lambda^-$, $\pi^+ \neq \pi^-$). At last, we address the derivation of positive and negative multipliers associated with CPI^+, CPI^-, IIP^+, IIP^-, $M3^+$ and $M3^-$. Their calculations are following:

$m_h^+ = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial CPI_t^+}$ and $m_h^- = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial CPI_t^-}$ with $h = 0, 1, 2, \ldots$ for CPI_t^+ and CPI_t^- respectively.

$n_h^+ = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial IIP_t^+}$ and $n_h^- = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial IIP_t^-}$ with $h = 0, 1, 2, \ldots$ for IIP_t^+ and IIP_t^- respectively.

$o_h^+ = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial M3_t^+}$ and $o_h^- = \sum_{j=0}^{h} \frac{\partial ADR_{t+j}}{\partial M3_t^-}$ with $h = 0, 1, 2, \ldots$ for $M3_t^+$ and $M3_t^-$ respectively.

Here, $h \to \infty, m_h^+, n_h^+, o_h^+ \to \beta^+$ and $m_h^-, n_h^-, o_h^- \to \beta^-$.

4. RESULTS AND DISCUSSION

Testing the integrating properties of variable is very important in econometric literature. Any variable can be stationary at level $I(0)$ or 1st difference $I(1)$ or mixed order $I(0)/I(1)$ but no variable should be stationary at 2nd difference. To test the level of integration, we apply the ADF and PP unit root tests and the results are reported in table-1. The results of ADF test suggest that all series are not stationary at level but found to be stationary after taking first difference in all countries except Spain. In Spain, only ADR prices are stationary at level but remaining variables are stationary at first difference. The PP unit root test same findings of ADF and confirms the findings of ADF test. It concludes that no one variable is stationary at 2nd difference.

Table 2 shows the results of Wald statistics to test asymmetries in short run and long run. The evidence suggests that Wald test rejects the null hypothesis of symmetries for both long and short in case of France, Greece and Spain. It explains that all data series are nonlinear (asymmetry) in France, Greece, and Spain. In case of Germany and Italy, Wald test also rejects the null of symmetries for all data series except economic growth

TABLE 1.

Unit Root Analysis

ADF unit root test								
Countries	ln ADR		ln CPI		ln IIP		ln $M3$	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
France	−2.12	−14.22*	−2.56	−9.09*	−2.44	−6.88*	−2.49	−6.27*
Decision	NS	S	NS	S	NS	S	NS	S
Germany	−3.10	−14.53*	−2.73	−6.54*	−2.06	−8.70*	−1.87	−13.09*
Decision	NS	S	NS	S	NS	S	NS	S
Greece	−2.16	−23.36*	−0.43	−10.58*	−2.10	−23.25*	−0.27	−5.00*
Decision	NS	S	NS	S	NS	S	NS	S
Italy	−1.87	−14.58*	−1.99	−6.65*	−2.44	−5.59*	−1.18	−16.01*
Decision	NS	S	NS	S	NS	S	NS	S
Spain	−4.05*	—	−0.93	−7.22*	−1.76	−5.93*	−2.65	−5.22*
Decision	S	—	NS	S	NS	S	NS	S
PP unit root test								
Countries	ln ADR		ln CPI		ln IIP		ln $M3$	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
France	−2.31	−14.21*	−2.55	−13.68*	−2.66	−18.97*	−1.48	−15.17*
Decision	NS	S	NS	S	NS	S	NS	S
Germany	−3.04	−14.56*	−2.44	−16.61*	−2.51	−14.63*	−1.90	−13.09*
Decision	NS	S	NS	S	NS	S	NS	S
Greece	−2.91	−25.39*	−1.16	−14.12*	−2.58	−26.90*	0.00	−11.56*
Decision	NS	S	NS	S	NS	S	NS	S
Italy	−1.84	−14.59*	−1.65	−13.35*	−2.40	−15.8*	−1.00	−16.09*
Decision	NS	S	NS	S	NS	S	NS	S
Spain	−4.07*	—	−1.11	−15.38*	−1.67	−15.68*	−0.49	−14.02*
Decision	S	—	NS	S	NS	S	NS	S

Note: NS is for not stationary and S is for Stationary. * indicates the significance level at 1 % level of significance.

in both long and short run. This implies that series are nonlinear for all countries.

The existence of nonlinearity (asymmetries) in both short and long run suggest us to apply nonlinear cointegration bound testing approach developed by shin et al. (2014). To analysis the cointegration relationship, the results of bound testing for asymmetric cointegration are reported in table 3. The calculated F-statistics for Pesaranet. al. (2001) and t-statistics of BDM test are greater than upper critical bounds that rejects the null hypothesis of no cointegration against the alternative hypothesis of cointegration. This predicts the existence of long run relationship between ADR

TABLE 2.

Wald Test for Short and Long Run Symmetries

Statistics	France	Germany	Greece	Italy	Spain
$W_{LR,CPI}$	-4.6432^{*}	3.7647^{*}	6.7044^{*}	-2.1645^{**}	-4.4555^{*}
$W_{SR,CPI}$	5.5342^{*}	6.6957^{*}	13.170^{*}	3.2844^{**}	9.0569^{*}
$W_{LR,IIP}$	3.3345^{**}	0.6354	-5.8917^{*}	-1.4802	2.1820^{**}
$W_{SR,IIP}$	4.0494^{**}	0.3305	18.828^{*}	1.2762	10.2360^{*}
$W_{LR,M3}$	1.9938^{***}	-4.4029^{*}	6.1508^{*}	2.0584^{**}	1.8999^{***}
$W_{SR,M3}$	4.4318^{**}	6.6449^{*}	12.784^{*}	3.6104^{**}	4.8063^{*}

Note: W_{SR} denotes the Wald test for the short-run symmetry testing the null hypothesis whether $\phi^{+} = \phi^{-}$, $\tau^{+} = \tau^{-}$, $v^{+} = v^{-}$. W_{LR} represents the Wald test for the long run symmetry testing the null hypothesis whether $\theta^{+} = \theta^{-}$, $\lambda^{+} = \lambda^{-}$, $\pi^{+} = \pi^{-}$. *, ** and *** indicate the rejection of the null hypotheses of short and long-run symmetry at the 1%, 5 % and 10% level of significance, respectively.

prices, nonlinear inflation, nonlinear economic growth and nonlinear money supply.

TABLE 3.

Bound testing for Asymmetric Cointegration

	France	Germany	Greece	Italy	Spain
F_{PSS}	5.3318^{*}	5.9014^{*}	11.1054^{*}	3.5696^{***}	22.9908^{*}
T_{BDM}	-4.6671^{**}	-4.8660^{*}	-6.3080^{*}	-3.9518^{***}	-11.1332^{*}

Pesaran et. al. (2001)[3]			Benargee et. al. (1998)[4]	
Significance level	LCB $I(0)$	UCB $I(1)$	Significance level	Critical values
1 %	3.27	4.39	1 %	-4.71
5 %	2.63	3.62	5 %	-4.03
10 %	2.33	3.25	10 %	-3.67

T_{BDM} shows the calculated value of the BDM t-statistics and F_{PSS} denotes calculated F-statistics to test the null hypothesis no asymmetric cointegration. We adopt conservative approach to the selection of critical values as recommended by shin et al. (2014).

After confirming the long run relationship between mentioned variables, we proceed for nonlinear autoregressive distributive lagged (NARDL) model

[3]The values of lower and upper critical bound are calculated from Pesaranet. al. (2001) by using conservative approach ($K = 6$).

[4]We have taken the critical values of BDM T-statistics from Benargeeet. al. (1998) for $K = 4$ and $T = 100$.

to analysis nonlinear relationship between ADR prices, inflation, economic growth and money supply and the empirical findings are reported in table 4. The NARDL analysis has a power to estimate nonlinear relationship between underlying variables by decomposing variables into positive and negative partial sum. The findings suggest that positive shock in inflation ($\ln CPI^{+}_{t-1}$) has negative and significant impact on ADR prices but, negative shock in inflation ($\ln CPI^{-}_{t-1}$) has positive and significant impact on ADR prices for France, Italy and Spain in long run. In case of Germany and Greece, the relationship between inflation and ADR prices is positive and significant. A positive change in inflation (CPI^{+}_{t-1}) adds in ADR prices but, a negative change in inflation (CPI^{-}_{t-1}) decreases the ADR prices in case of Germany and Greece for long run.

However, economic growth has positive and significant impact on ADR prices for France, Greece and Spain in long run. In case of Germany and Italy, economic growth has positive but insignificant impact on ADR prices in long run. It demonstrates that a positive shock in economic growth (IIP^{+}_{t-1}) increases ADR prices and negative shock in economic growth (IIP^{-}_{t-1}) reduces the ADR prices in France, Greece and Spain. Moreover, the positive and significant impact of money supply on ADR prices is detected for France, Greece, Italy and Spain in long run. It explains that ADR prices increase with a positive shock in money supply ($M3^{+}_{t-1}$). A negative shock in money supply ($M3^{-}_{t-1}$) reduces the ADR prices. But, in case of Germany, the impact of many supply on ADR prices is negative and significant for long run. It predicts that ADR prices increase with a negative shock in money supply ($M3^{-}_{t-1}$) and reduce with a positive shock in money supply ($M3^{+}_{t-1}$) in Germany.

In short run, the positive ($\Delta \ln CPI^{+}, \Delta \ln CPI^{+}_{t-2}$) and negative ($\Delta \ln CPI^{-}_{t-1}, \Delta \ln CPI^{-}_{t-2}$) shocks of inflation have negative and significant impact on ADR prices in case of France, Italy and Spain. But, positive ($\Delta \ln CPI^{+}_{t-1}, \Delta \ln CPI^{+}_{t-2}$) shocks of inflation have positive and significant impact on ADR prices in case of Greece and Italy. Similarly, the positive ($\Delta \ln IIP^{+}_{t-1}, \Delta \ln IIP^{+}_{t-1}, \Delta \ln IIP^{+}_{t-2}$) and negative ($\Delta \ln IIP^{-}_{t-1}$, $\Delta \ln IIP^{-}_{t-1}, \Delta \ln IIP^{-}_{t-2}$) shocks of economic growth have positive and significant relationship with ADR prices in short run for all countries. In short run, the ADR prices increase with positive ($\Delta \ln M3^{+}, \Delta \ln M3^{+}_{t-1}, \Delta \ln M3^{+}_{t-2}$) and negative ($\Delta \ln M3^{-}, \Delta \ln M3^{-}_{t-1}, \Delta \ln M3^{-}_{t-2}$) shocks in money supply in case of France, Greece, Italy and Spain. But, we found negative relationship between ADR prices and money supply in case of Germany for Short run. We have accommodated structural break that are streaming in dependent variable determined by Kim and Perron, (2009) in our NARDL analysis. The structure break years 2008:M05, 2005:M04, 2008:M10, 2003:M03 and 2004:M07 belong to France, Germany, Greece, Italy and Spain respectively. The R squared for France, Germany, Greece, Italy and Spain is 0.61, 0.55, 0.91, 0.72 and 0.51 respectively.

TABLE 4.

NARDL Estimation

Variables	France	Germany	Greece	Italy	Spain
C	0.9659*	1.0339*	1.5994*	0.4722*	1.79498*
$\ln ADR_{t-1}$	−0.1743*	−2.2078*	−0.3317*	−0.1134*	−0.4099*
$\ln CPI^{+}_{t-1}$	−2.5292**	3.5549**	0.0409***	−1.5476***	−3.4970*
$\ln CPI^{-}_{t-1}$	−3.7054*	3.3737*	0.0733*	−2.0332***	−5.1061*
$\ln IIP^{+}_{t-1}$	0.4154**	0.2139	0.2931*	0.1572	0.4942*
$\ln IIP^{-}_{t-1}$	0.4952***	0.0074	0.3191*	0.2345	1.4598***
$\ln M3^{+}_{t-1}$	0.2498**	−1.5391*	0.0132**	0.4565**	1.0813***
$\ln M3^{-}_{t-1}$	1.8949**	−1.0288**	0.0150**	0.9180*	1.4076***
$\Delta \ln CPI^{+}$	−3.6649*	13.9738*	—	—	−4.8269**
$\Delta \ln CPI^{+}_{t-1}$	—	—	0.1174**	—	—
$\Delta \ln CPI^{+}_{t-2}$	—	—	—	−0.1354*	—
$\Delta \ln CPI^{-}$	—	—	—	—	—
$\Delta \ln CPI^{-}_{t-1}$	−4.8637**	13.9501*	—	—	—
$\Delta \ln CPI^{-}_{t-2}$	−5.8563*	9.8578*	—	—	—
$\Delta \ln IIP^{+}$	—	1.2957*	0.9912*	—	2.0308***
$\Delta \ln IIP^{+}_{t-1}$	—	−3.0440*	0.1946*	1.4498**	—
$\Delta \ln IIP^{+}_{t-2}$	1.0377***	—	—	1.3092***	—
$\Delta \ln IIP^{-}$	—	—	1.0446*	—	3.1430*
$\Delta \ln IIP^{-}_{t-1}$	—	2.6730*	0.1617**	—	—
$\Delta \ln IIP^{-}_{t-2}$	—	—	0.0343*	1.5457*	1.8665**
$\Delta \ln M3^{+}$	1.2480**	−4.4588*	—	0.8844***	—
$\Delta \ln M3^{+}_{t-1}$	—	—	—	—	−2.2123***
$\Delta \ln M3^{+}_{t-2}$	—	—	—	—	−1.7523**
$\Delta \ln M3^{-}$	—	—	0.1135*	—	—
$\Delta \ln M3^{-}_{t-1}$	1.5260***	—	—	—	—
$\Delta \ln M3^{-}_{t-2}$	—	—	0.0356**	—	—
DU_t	2008M05	2005M04	2008M10	2003M03	2004M07
R^2	0.6194	0.5508	0.9178	0.7240	0.5125
Adj. R^2	0.5820	0.5212	0.8961	0.6933	0.4893

Note: The superscripts "+" and "−" denote positive and negative partial sums respectively. DU_t shows the dummyof structural breaksfor dependent variable determined by Kim and Perron, (2009). *, ** and *** denote the significant at 1 %, 5 % and 10 % level of significance.

The authentication of estimated model is tested by sensitivity analysis. The results of diagnostic tests are displayed in table 5. The Durban-Watson test shows that there is no autocorrelation. LM test explains that there is no serial correlation. ARCH test confirms that there is no problem of conditional heteroscedasticity. RESET test expresses that our estimated models are well specified. The CUSUM and CUSUM of square (see figure 1 to 5) lies between the critical bounds which suggest that parameters of our estimated models are stable over the period for all countries.

TABLE 5.

Sensitivity Analysis

Statistics	France	Germany	Greece	Italy	Spain
D.W Test	1.9434	2.1360	2.1921	2.2578	1.4962
χ^2_{ARCH}	0.8577	0.8271	0.1722	0.3344	0.1083
χ^2_{RESET}	0.4782	0.8973	0.3438	0.1436	0.3298
χ^2_{SERIAL}	0.9340	0.2827	0.1325	0.1243	0.1349
CUSUM	Stable	Stable	Stable	Stable	Stable
CUSUMsq	Stable	Stable	Stable	Stable	Stable

Note: D.W, SERIAL, ARCH and RESET denote Durban-Watson test for autocorrelation, LM test for serial correlation, autoregressive conditional heteroscedasticity test for conditional heteroscedasticity and Ramsey Regression Equation Specification Error Test (RESET) test for model misspecification (functional form).

FIG. 1. CUSUM and CUSUM of Square for France

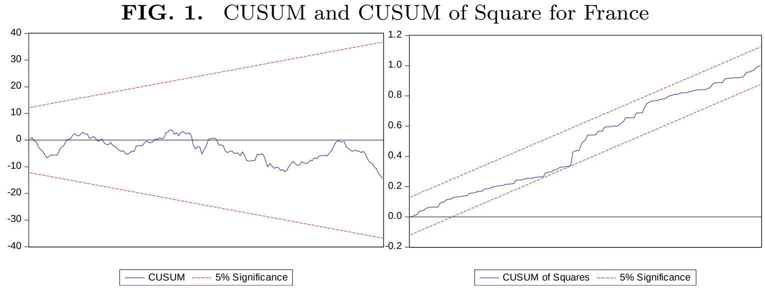


FIG. 2. CUSUM and CUSUM of Square for Germany

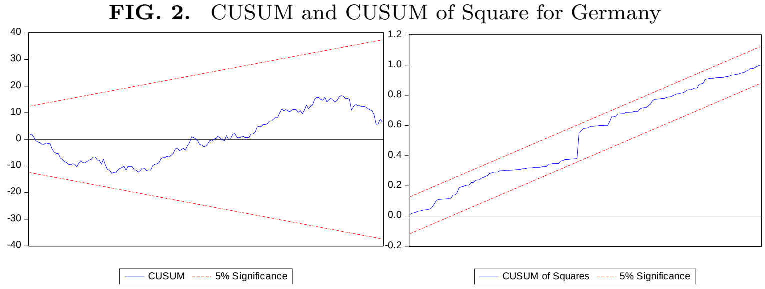


FIG. 3. CUSUM and CUSUM of Square for Greece

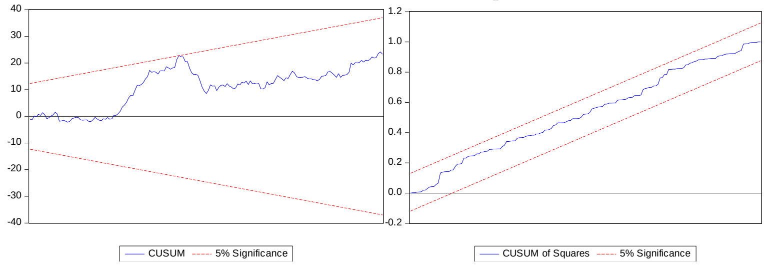


FIG. 4. CUSUM and CUSUM of Square for Italy

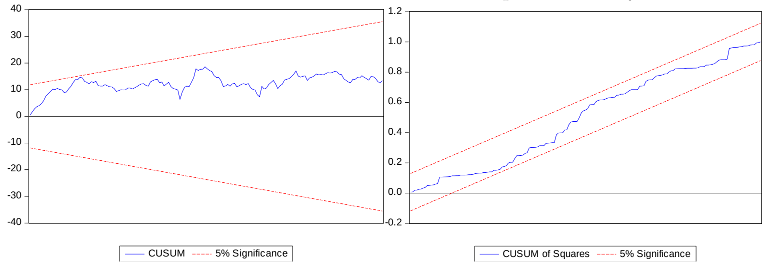
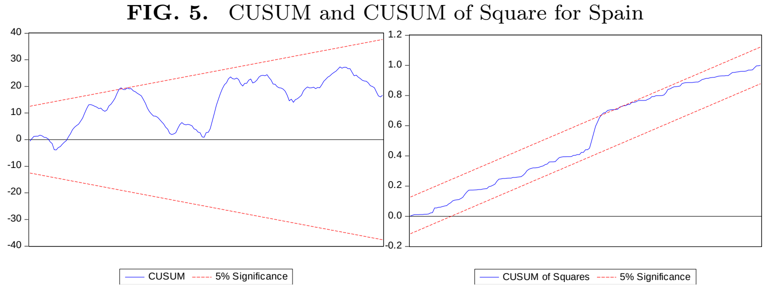


FIG. 5. CUSUM and CUSUM of Square for Spain



After analyzing short and long run impact of macroeconomic variables on ADR prices, the NARDL model provides the elasticity of long run asymmetric variables in table 6. The findings confirm the results of NARDL long run estimation. In case of France, Italy and Spain, inflation provides the negative impact on ADR prices but, in case of Germany and Greece, inflation confirms the positive impact on ADR prices. It predicts that a 1 % increase in inflation leads to decrease in ADR prices by 5%, 2.4 % and 2.7 % for France, Italy and Spain respectively. Similarly, when a 1 % decrease accrues in inflation, ADR prices increase by 2.4 %, 1.6 % and 3.3 % for France, Italy and Spain respectively. In case of Germany and Greece, a 1 % increase in inflation adds in ADR prices by 2.3 % and 1.7 % respectively. A 1 % decrease in inflation causes to decrease in ADR prices by 2.4 % and 5.6 % in case of Germany and Greece respectively. The signs of positive and negative parameters of economic growth provide the same results as provided by NARDL long run analysis. The parameters of economic growth predict that 1 % increase in economic growth pushes the ADR prices by 2.1 %, 59.8 % and 1.9 % for France, Greece and Spain respectively. On the other hand, a 1 % decline in economic growth drops the ADR prices by 4.5 %, 68.8 % and 3.2 % in case of France, Greece and Spain respectively.

For Germany and Italy, economic growth is unable to predict ADR prices. Moreover, the result of long run parameters of money supply is also consistent with NARDL long run analysis but, parameters discuss the elasticities. In France, Greece, Italy and Spain, ADR prices increase by 1.9 %, 2.1 %, 1.6 % and 1.7 % due to 1 % rise in money supply. For negative shock, 1 % reduction in money supply reduces the ADR prices by 3.2 %, 2.5 %, 2.0 % and 2.0 % in Case of France, Greece, Italy and Spain respectively. But, money supply drives ADR prices negatively. It explains that a 1 % increase (decrease) in money supply reduces (rise) the ADR prices by 2.7 % (4.0 %) for Germany. In case of all countries, the negative shocks of underlying variables are greater than their positive shocks as expected.

TABLE 6.

Long Run Parameters

	France	Germany	Greece	Italy	Spain
β^{+}_{CPI}	-5.0189^{*}	2.2859^{**}	1.7549^{***}	-2.4576^{**}	-2.7127^{*}
β^{-}_{CPI}	-2.4231^{**}	2.4629^{**}	5.6027^{*}	-1.6910^{***}	-4.3611^{*}
β^{+}_{IIP}	2.1671^{**}	0.7668	59.826^{*}	0.8586	1.9288^{***}
β^{-}_{IIP}	4.5628^{*}	0.0402	68.8044^{*}	1.5029	3.2074^{*}
β^{+}_{M3}	1.9030^{***}	-2.7352^{*}	2.1422^{**}	1.6219^{**}	1.7201^{***}
β^{-}_{M3}	3.2686^{**}	-4.0247^{*}	2.5574^{**}	2.0239^{**}	2.0206^{**}

Note: β^{+}_{CPI}, β^{-}_{CPI}, β^{+}_{IIP}, β^{-}_{IIP}, β^{+}_{M3} and β^{-}_{M3}, are estimated asymmetric long run coefficients associated with positive and negative changes in inflation, economic growth and money supply, defined by $\beta^{+}_{CPI} = -\theta^{+}/\rho$, $\beta^{-}_{CPI} = -\theta^{-}/\rho$, $\beta^{+}_{IIP} = -\lambda^{+}/\rho$, $\beta^{-}_{IIP} = -\lambda^{-}/\rho$, $\beta^{+}_{M3} = -\pi^{+}/\rho$, $\beta^{-}_{M3} = -\pi^{-}/\rho$, respectively. *, ** and *** denote the significant at 1 %, 5 % and 10 % level of significance.

The multipliers help to analysis the paths of adjustment from disequilibrium to long run equilibrium in the presence of positive or negative partial sum of inflation, economic growth and money supply. Figure 6-10 represent the asymmetric adjustment of ADR prices to its new long run equilibrium with positive and negative changes in inflation, economic growth and money supply for France, Germany, Greece, Italy and Spain respectively. The asymmetric curve must be lie within critical bounds for significant at 5 percent level of significance. In all countries, the asymmetric curve exists between critical bounds that confirm the significance of asymmetric relationship. In France, Italy and Spain, a positive change in inflation conducts to a decrease in ADR prices (see Green lines in figure 6,9 & 10) that confirms the previous negative long run effect coefficients (see table 6). Similarly, a negative change in inflation conducts to increase in ADR prices (see red lines in figure 6, 9 & 10). It takes approximately 6 years (80 months) to reach its new long run equilibrium through asymmetric inflation in case of France, Italy and Spain.

FIG. 6. Multiplier effects -France

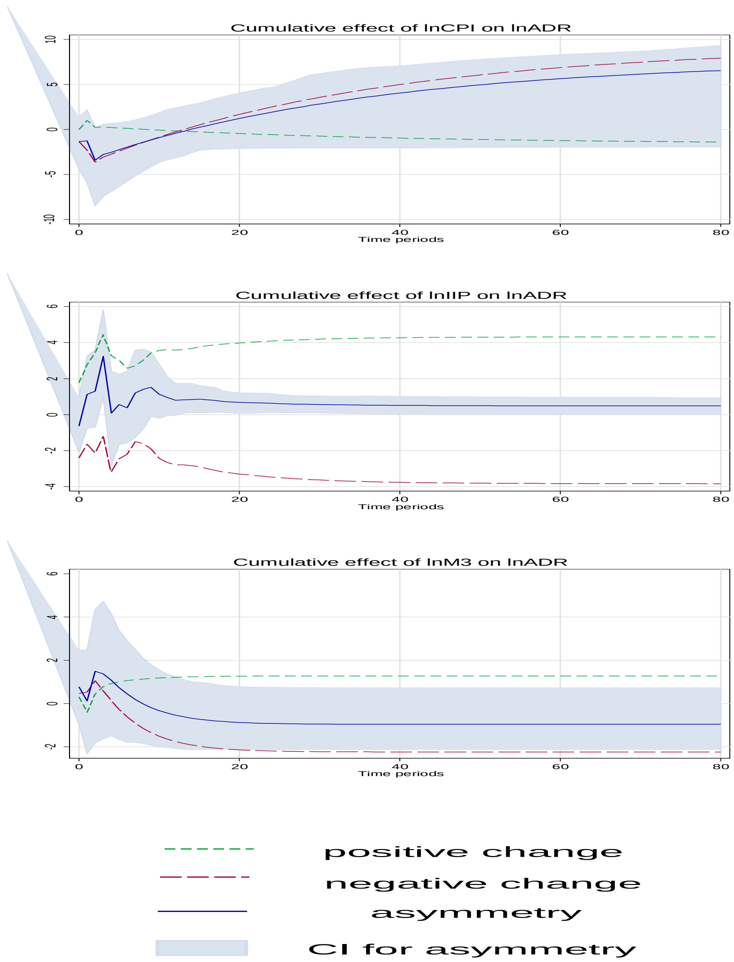
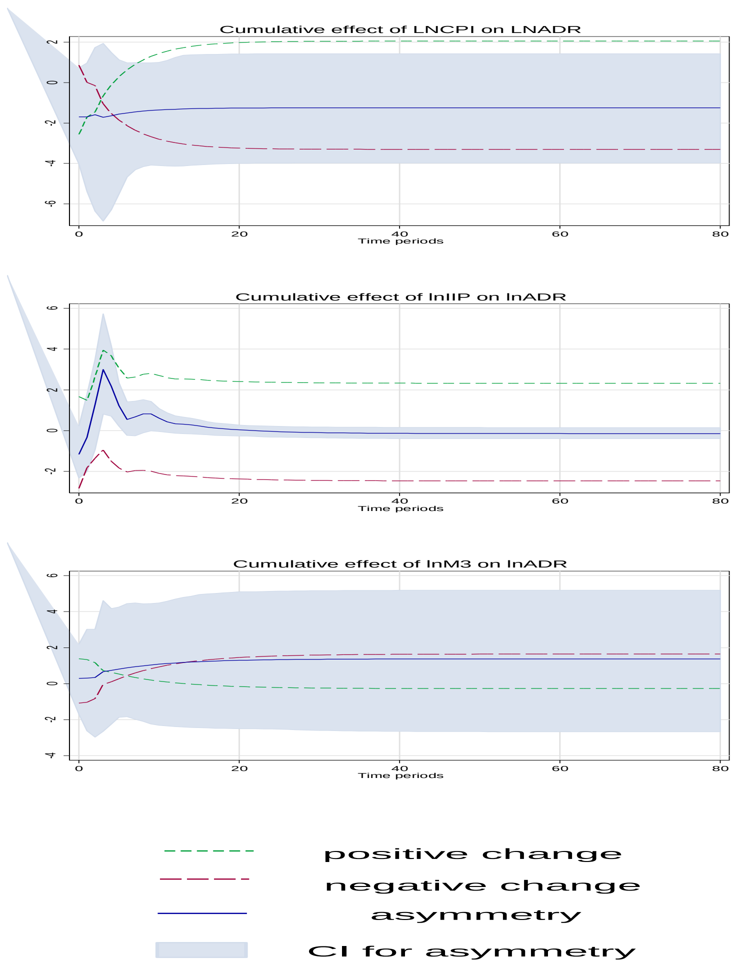
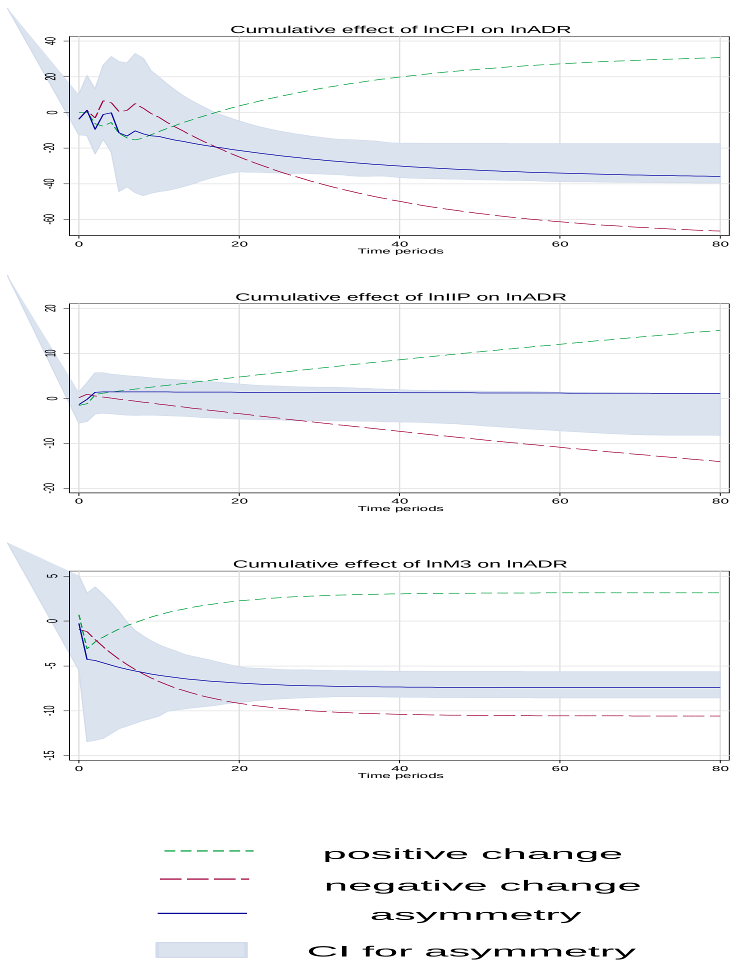


FIG. 7. Multiplier effect -Germany



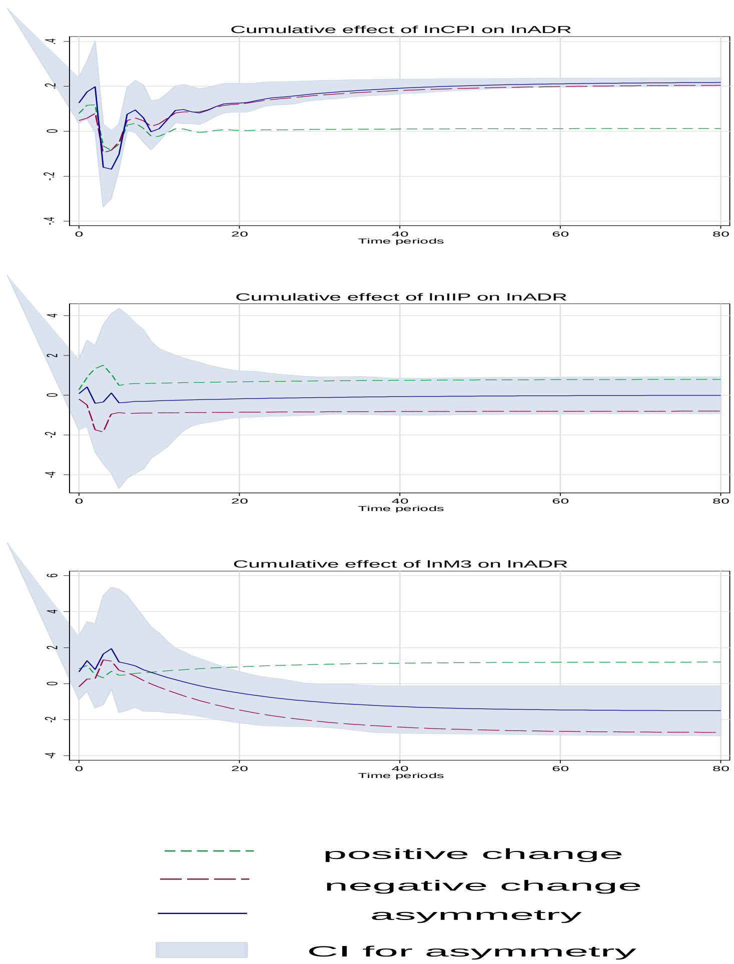
In case of Germany and Greece (see figure 7 & 8), the asymmetric behavior of inflation is positive. A positive change in inflation predicts ADR prices positively (see Green lines in figure 7 & 8). But a reduction in inflation pretends to decrease in ADR prices (see Red lines in figure 7 & 8). This also confirms the positive long run asymmetric coefficients of inflation in case of Germany and Greece. For Germany and Greece, it takes approximately 10 months and 6 years to reach its new equilibrium respectively. For economic growth, positive change in economic growth predicts

FIG. 8. Multiplier effects -Greece



ADR prices positively (see Green lines in figure 6,8,10) in case of France, Greece, Spain. But, Red lines in figures 6,8 and 10 determine the reduction in ADR prices due to decline in economic growth. Through asymmetric economic growth, new long run equilibrium can be attained by 1 Year and 5 months (20 months) in case of France, Spain. But in case of Greece, it will take approximately 6 years and 6 months (80 months). The positive and negative changes in economic growth is unable to conduct ADR prices (see figure 7 & 9) in case of Germany and Italy.

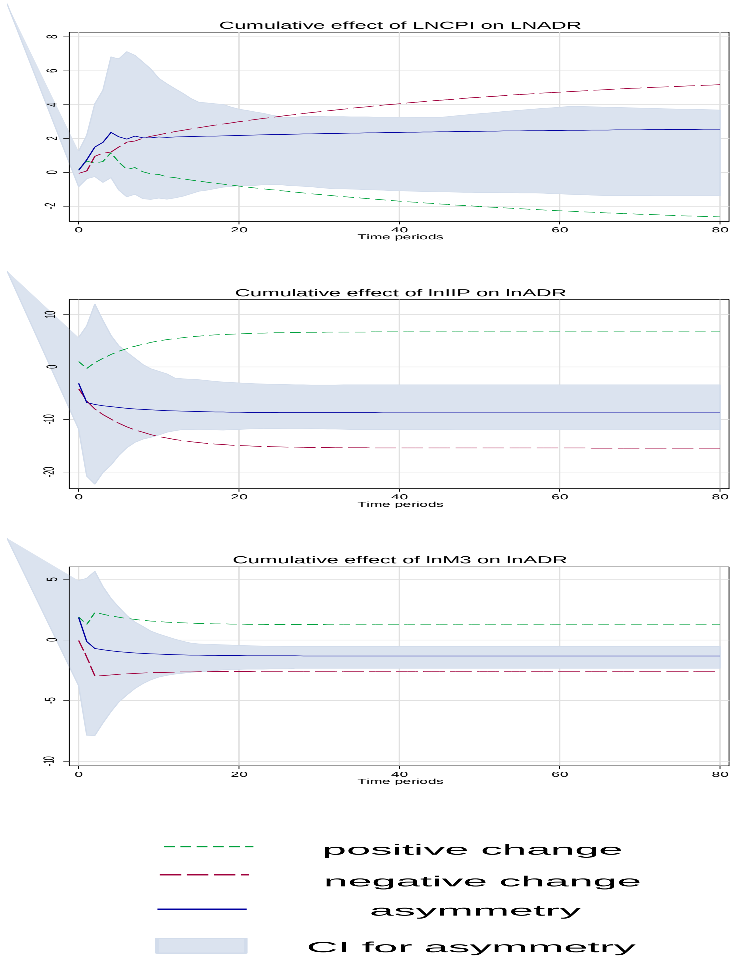
FIG. 9. Multiplier effect -Italy



5. CONCLUSION AND POLICY IMPLICATIONS

This study examines the relationship between ADR prices and macroeconomics variables over the period of 2000M1-2016M3 in case of European Union. The order of integration is checked by ADF and PP unit root test. The unit root statistics predicted that all variables are stationary at their first difference in case of France, Germany, Greece and Italy but, in Spain, only ADR prices are stationary at level. To explorer the long run relation-

FIG. 10. Multiplier effects -Spain



ship between ADR prices, inflation, economic growth and money supply, we applied NARDL approach. The results of Wald test for long and short run symmetries shows the existence of nonlinearity and asymmetries for all countries. The both bound testing of Pesaran et al. (2001) and t-statistics of BDM test confirm the hidden cointegration between positive and negative partial sum of variables for all countries. This implies that long run relationship exists between nonlinear parts of variables.

Once the long run relationship has been confirmed between variables, the NARDL analysis provides the long coefficients of independent variables. The determined coefficients explain that nonlinear parts of inflation have negative and significant relationship with ADR prices in case of France and Italy. But, in case of Germany, Greece and Spain, this impact is positive and significant. Similarly, a positive change in economic growth increases ADR prices significantly in case of France, Greece and Spain. For Germany and Italy, economic growth is unable to predict ADR prices due to insignificance. Same as economic growth, positive shocks in money supply also predicts ADR prices positively and significantly for all countries. The robustness of estimated long run results is confirmed by multipliers. Moreover, multipliers show the speed of adjustment from disequilibrium to equilibrium along with positive and negative changes in independent variables.

Our findings are specifically useful for US investors who wish to invest in EU countries. Since a long run relationship of economic fundamentals and ADR performance exists, they can shape their portfolios in ADRs keeping in view the economic conditions of these countries. Most of the EU countries have well established regulatory environment and therefore, the investment climate is, in many ways, similar to US conditions. The countries where ADRs and economic indicators hold both short term and long-term relationship can thus be preferred habitat for US investors.

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