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PAPER

# Asymmetrical Linkages between Exchange Rate Shocks And Investment in Agriculture

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**Abstract** Issue of administering a currency regulatory system has always been one of the key issues in developing countries. The inharmonic exchange rate fluctuates with economic changes, indicating that the direction of domestic and foreign macroeconomic policies are inappropriate, which in turn create problems in assessment of investment projects efficiency. Yearly time series of 1978–2017 are used and a Non-linear Autoregressive Distributed Lag (NARDL) model checks the asymmetrical relationship between Exchange rate shocks and Investment in agriculture. In this study, the Hodrick Prescott filter is used to derive exchange rate shocks. Results have shown that there are asymmetrical linkages between these two variables and therefor negative exchange rate shocks have positive effect and positive exchange shocks have negative and significant effect on investment in agriculture. The occurrence of any currency shock causes a turbulence in economy and leads to reallocation of resources from investing in productive activities- such as agricultural production- to nonproductive activities such as speculating in foreign exchange market, gold and coins. One way to cope with this situation, could be stabilizing exchange rate market in order to minimize uncertainty at financial markets.

**Key words:** Exchange volatilities; NARDL; Hodrick Prescott; investment; agriculture.

**JEL Classification:** C22; E22.

## Introduction

Developing economies suffer from a high degree of macroeconomic uncertainty. Growth, inflation, real exchange rates and other key macroeconomic variables are much more volatile, and the consequences of this excess volatility for aggregate performance in several dimensions - growth, investment and trade -have attracted some attention in recent empirical literature. In the case of investment, this concern

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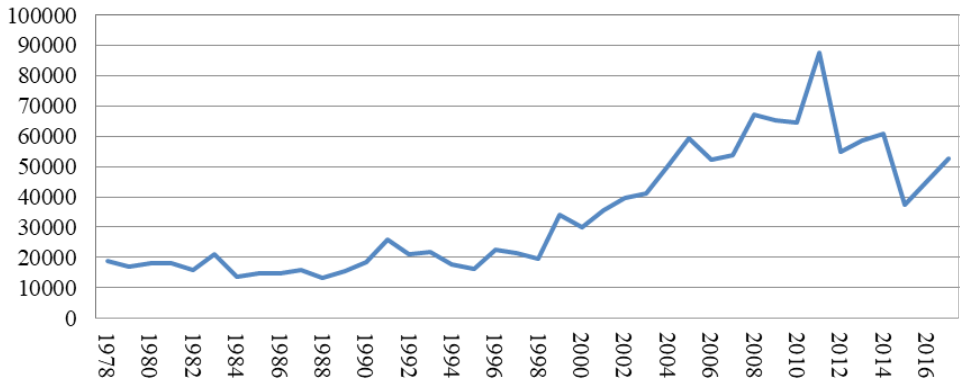
has been renewed by recent theoretical work identifying several channels through which uncertainty can impact on investment, under various assumptions about risk aversion, adjustment costs to investment and other factors. Iran, has a high degree of uncertainty in the macroeconomic variables (Luis Serven 2002). One of the major challenges related to the management of the foreign exchange market in Iran comes back to agricultural investment. Among different investments in economic sectors, investment in agricultural sector possesses a special prominence and position since investment in agricultural sector not only induce the growth of production and employment in this very sector, but also encourages production and employment growth in other economic sectors and henceforth identifying effective factors on investment in agricultural sector and adopting suitable policies for increasing investment, possesses a supreme prominence (Chabokrou and Jokar, 2007). In Iran, the notions of finance and investment have always been facing several difficulties due to deep independence to oil revenues and instability of its price as well as the high risk involves around it; and for this reason, investing in different sectors, including agriculture, has always experienced severe fluctuations (Jalaee and etal, 2014).

**Agricultural investment trend**

Investigating investment trend at 2011constant prices indicates a slowdown in investment. Many of the investments have been depreciated due to inflation and have lost their true value. In spite of the uptrend, with a mild slope, the trend of investment at constant prices, has been fluctuating and decreasing since 2011 then. Hence, inflation seems to have led to a sharp decline in investment in fixed prices.

**Chart 1.** agricultural investment trend during 1978-2016 in constant price (2011=100) billion Rials

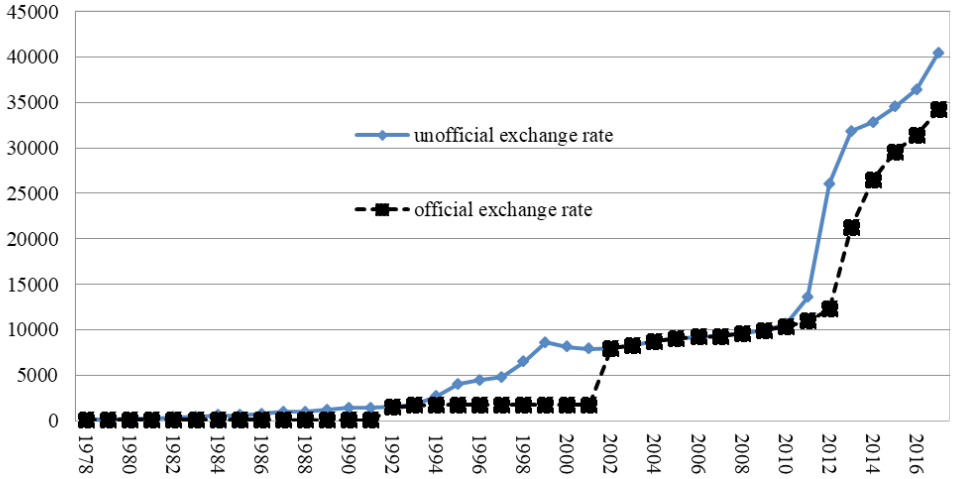



**Real exchange rate trend**

The general trend of exchange rate over 1978-2016 has been incremental. The increment

of the exchange rate, followed by fluctuations in relative prices, with unsustainable economic conditions and rising inflation, can increase uncertainty in foreign trade, the consequences of which include the reduction of trade volumes, foreign direct investment, and slow economic growth. On the other hand, the fluctuation of the exchange rate can remove interest rates from its equilibrium path and cause damage to the real economy. In addition, exchange rate risk can cause fluctuations in foreign exchange earnings, in which case economic development planning will take place in an uncertain environment.

**Chart 2.** (Un)official dollar exchange rate trend during 1978-2016 in Rials




## Literature review

Darby et al. (1999) demonstrate that if a firm's opportunity cost of waiting is lower than its present value or scrapping price, the firm will not invest. However, under lower uncertainty, the same firm will invest. This suggests that uncertainty may promote or hurt investment. By estimating an aggregate investment function for France, Germany, Italy, U.K, and the U.S., Darby et al. (1999) found that investment increases if exchange rate uncertainty is lowered. Similarly, Sarkar (2000), using the real option model of McDonald and Siegel (1986) and Dixit and Pindyck (1994), demonstrate that uncertainty may be negatively or positively associated with investment. Bernard Njindan and Sin-Yu Ho (2017) used annual data for Ghana covering the period 1980–2015, found that exchange rate uncertainty has differential impacts on domestic investment in the short run. That is, while the current level of uncertainty enhances investment, previous levels of uncertainty dampen investment. In the long run, exchange rate uncertainty has a positive impact on domestic investment. Zardashty(2014) determined uncertainty index of the real exchange rate through auto-regressive patterns of conditional variance heterogeneity(EGARCH). His results showed that the index of real exchange rate uncertainty has a significant negative effect on private investment to GDP ratio, and imports of capital commodity and inflation have negative effects on private investment

to GDP ratio. LS. Thabetheand B. Nyhodo (2014), Determined the level of output gap for the South African agricultural sector and its link with food inflation. Three different methods, namely the linear trend, the Hodrick-Prescott filter, and the production function approaches were used. The results are inconsistent, with each one showing a different picture. The linear trend results show that the agricultural sector is under utilising the available resources (factors of production and available technology). Meanwhile, the HP method and production function results outline that the agricultural sector is over utilizing the available resources (hence high inflationary pressure). The South African agriculture GDP is higher than it can be supported by the existing labor and capital resources. Wong (2007) followed Sarkar (2000) by re-examining the effect of uncertainty on investment. However, unlike Sarkar (2000), Wong (2007) used investment timing instead of the probability of investment. He found that higher uncertainty shortens the expected exercise time and thus, enhances investment for relatively safe projects. This positive uncertainty investment nexus is more likely for high growth projects than for low growth projects. Harchaoui, and etal (2005) Using industry-level data for 22 Canadian manufacturing industries, to examine the relationship between exchange rates and investment during the period 1981–97. Their empirical results show that the overall effect of exchange rates on total investment is statistically insignificant. Lafrance and Tessier (2001) also find an insignificant link between the Canadian real exchange rate and aggregate investment. Lee and Shin (2000) emphasize the role of variable inputs - the larger their output share, the stronger the more likely is investment to rise with uncertainty. Campa and Goldberg (1995) attribute this difference in investment response between the 1970s and 1980s to the decline in industry export exposure as U.S. firms progressively increased their reliance on imported inputs. Furthermore, their empirical findings show distinct investment patterns across industries with different price-over-cost markup ratios. They find that investment in high-markup industries with an oligopolistic market structure is less responsive to exchange rates. Abel and Eberly (1994) comes into play that higher degrees of irreversibility and/or uncertainty make it more likely that firms will ex-post find themselves stuck with excessive capital, making the long-run capital stock and investment higher than they would have been otherwise. Goldberg (1993) finds that a real depreciation (appreciation) of the U.S. dollar was likely to generate an expansion (reduction) in investment in the 1970s, but that the opposite pattern prevailed during the 1980s.

## Objective of the Study

The focus of this research is to select the best estimates and explains of agricultural investment. Currency uncertainties with a nonlinear method, are simulated and explained. The validity of this nonlinear ARDL is tested with Wald test.

So, the study:

- Survey the effect of positive and negative shocks of exchange rate on agricultural investment.
- Determine which factor effects more on agricultural investment.

- Use Wald test for asymmetric exchange rate shocks hypothesis.

## Data

Data on agricultural investment in Iran were provided by annual statistics from 1978-2016. All of the following data is from the statistical office of the Central Bank of Iran:

- Investment in agricultural sector in Rials using a constant price of 2011 = 100
- Annual real GDP using a constant price of 2011 = 100
- Short run interest rate on bank facilities and loan
- loans Given to agricultural sector by banks

## Methodology

### *NARDL Method*

When the order of integration is not same of all variables then we use the lagged variables as proposed by Pesaran et al. (2001). Imagine two variables and their relation as follow:

$$y_t = \beta^+ X_t^+ + \beta^- X_t^- + u_t \quad (1)$$

$$X_t = X_0 + X_t^+ + X_t^-$$

To check the asymmetries, we have to make a separate series for appreciation and depreciation as proposed by Bahmani-Oskooee and Soharabian (1992). A series of exchange rate will be divided in its positive movements or appreciation, as indicated by $X_t^+$, and negative movements or depreciation, as indicated by $X_t^-$, and is given as follows:

$$X_t^+ = \sum_{j=1}^{t} \Delta X_j^+ = Max(\Delta X_j, 0), X_t^- = \sum_{j=1}^{t} \Delta X_j^- = Min(\Delta X_j, 0) \quad (2)$$

To check the impact of positive and negative movements of one variable on the other variable, Equation (2) will be transformed as:

$$z_t = \beta_0^+ Y_t^+ + \beta_0^- Y_t^- + \beta_1^+ X_t^+ + \beta_1^- X_t^- \quad (3)$$

The non-linear ARDL model can be described as follows

$$y_t = \sum_{j=1}^{p} \varphi_j Y_{t-j} + \sum_{j=0}^{q} (\theta_j^+ X_{t-j}^+ + \theta_j^- X_{t-j}^-) + \varepsilon_t \quad (4)$$

We can obtain the error correction variable; the slope of the ECM must be negative and significant to confirm that there is short-run relationship between the variables. That also indicates the speed of adjustment towards the long-run relationship of Banerjee et al. (1998).

$$\Delta Y_t = \rho Y_{t-1} + \theta^+ X^+_{t-1} + \theta^- X^-_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta Y_{t-j} + \sum_{j=0}^{q-1} (\vartheta^+_j \Delta X^+_{t-j} + \vartheta^-_j \Delta X^-_{t-j}) + \varepsilon_t$$

$$= \rho \xi_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta Y_{t-j} + \sum_{j=0}^{q-1} (\vartheta^+_j \Delta X^+_{t-j} + \vartheta^-_j \Delta X^-_{t-j}) + \varepsilon_t \quad (5)$$

In which

$$\rho = \sum_{j=1}^{p} \varphi_j - 1, \quad \gamma_j = -\sum_{i=j+1}^{p} \varphi_i \quad for \ \ j = 1, ...., p-1 \quad (6)$$

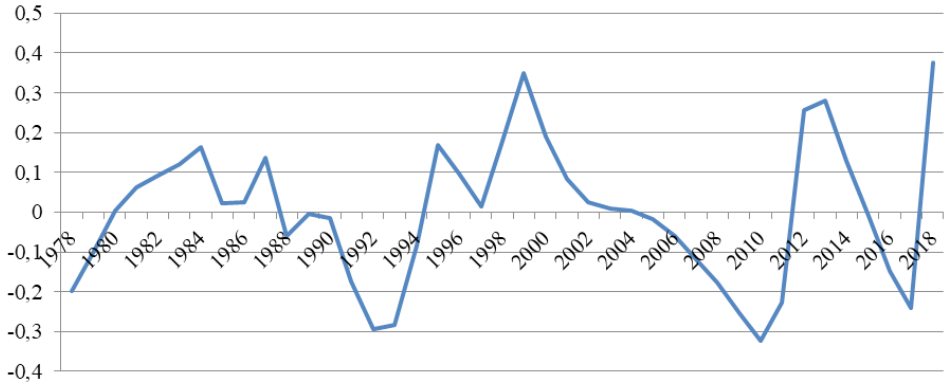
$$\theta^+ = \sum_{j=0}^{q} \theta_j^+, \qquad \theta^- = \sum_{j=0}^{q} \theta_j^-, \qquad \vartheta_0^+ = \theta_0^+, \vartheta_j^+ = -\sum_{i=j+1}^{q} \theta_i^+ \quad for \ \ j = 1, ..., q-1$$

$$\vartheta_0^- = \theta_0^-, \vartheta_j^- = -\sum_{i=j+1}^{q} \theta_i^-, \quad for \ i = 1, ...., q-1$$

**Calculate exchange shocks with Hodrick Prescott filter (HP)**

The trend of exchange rate changes is one criteria for uncertainty or risk in economic activities. In this study, Hodrick Prescott filter is used to investigate currency shocks. With this filter, you can distinguish between positive and negative shocks of the exchange rate. The chart number 3 shows the trend of currency shocks. Changing the shock sign also indicates uncertainty and exchange rate risk. In this study, with the help of the Hodrick-Prescott filter (HP), currency shock has been extracted.

**Chart 3.** Exchange Shock using the HP filter




**Results**

Econometric modeling using time series in usual and traditional manner is based upon the assumption of fixed variables of time series. Investigating the state of fixed data prevents the estimation of false regressions. Hence, in the first stage the structure of the

utilized data should be evaluated regarding their fixed state. In order to test for the fixed variables, the Augmented Dickey – Fuller test (ADF) is used. The results for Dickey – Fuller test (in table 1) shows that logarithm of GDP (LGDP) and logarithm of currency shocks (shockLNOR) are stationary I(0), but logarithm of agricultural investment (LI), logarithm of given loan to agricultural sector (Lloan) and logarithm of interest rate of given loan to agricultural sector (LR) are non-stationary at level but stationary at 1st difference I(1).

**Table 1.** The Results for Variable Stability

| Variables | AIC | ADF in level | ADF with one difference |
|---|---|---|---|
| LI | 2 | -0.94 | -4.87*** |
| SHOCKLNOR | 1 | -3.96** | |
| LGDP | 1 | -4.74*** | |
| LLOAN | 1 | -3 | -4.61*** |
| LNOR | 0 | -2.39 | -3.56** |
| LR | 0 | -2.15 | -5.74*** |
| Critical value | | | |
| 1% | | -4.22 | -3.61 |
| 5% | | -3.53 | -2.93 |
| 10% | | -3.2 | -2.6 |

Ref: finding research

In order to investigate the nonlinear and asymmetric linkage between exchange rate and its shock on investment in agriculture, a Non ARDL model estimated. The optimal lag has been selected through Akaic criterion. The results of the NARDL model are presented in table 2. Ramsey Reset Test has been used for validation test. The results of this test show that the model is well-specified. LM test has been used to investigate auto correlation. The results of this test also show that the zero hypothesis is not rejected, and the final model does not have the problem of a consistent correlation. The Bryus-Pagan-Gadfree test (BPG) has been used to investigate the phenomenon of heteroskedasticity. The results of this test also show that for the final model, the zero hypothesis is not rejected, and therefore the pattern do not have the problem of variance Heteroskedasticity. Results of NARDL show Positive shocks of exchange rate (SHOCKLNOR_POS) has had a negative effect on investment in agriculture in the current and previous two period (which shocks are derived by Hodrick Prescott Filter). While negative shocks of exchange rate have had a positive effect on current investment.

**Table 2.** Results of initial pattern

| **Selected Model: NARDL(1, 2, 0, 0, 0)** | | | | |
|---|---|---|---|---|
| **Variable** | **coefficient** | **Standard error** | **T statistic** | **Prob.** |
| LI(-1) | 0.37 | 0.10 | 3.57 | 0.002 |
| SHOCKLNOR_POS | -0.667 | 0.252 | -2.646 | 0.014 |
| SHOCKLNOR_POS(-1) | -0.801 | 0.238 | -3.361 | 0.003 |
| SHOCKLNOR_POS(-2) | -0.765 | 0.298 | -2.564 | 0.017 |
| SHOCKLNOR_NEG | 0.699 | 0.334 | 2.094 | 0.047 |
| LGDP | 0.203 | 0.608 | 3.625 | 0.001 |
| LR | 0.329 | 0.145 | 2.261 | 0.033 |
| LLOAN | 0.951 | 0.246 | 3.862 | 0.001 |
| LNOR | -0.7 | 0.167 | -4.2 | 0 |
| C | -45.224 | 9.73 | -4.647 | 0 |
| adj $R^2$ | F-statistics | RESET | LM | BPG |
| 0.99 | 881.08 | 2.9 (0.17) | 0.217 (0.806) | 0.908 (0.504) |

The numbers in parentheses are minus one representing a significant level.
Ref: research Findings

Then this paper use Wald test to check (A)symmetric linkage between positive and negative shocks. The results of the F test in table 3 shows that the hypothesis of symmetry between positive and negative shocks is rejected and hence the effect of currency shocks are asymmetric.

**Table 3.** Results of Wald test

| **Null hypothesis: symmetric ( there is no difference between positive and negative shocks)** | | | |
|---|---|---|---|
| **Test statistic** | **value** | **Degree of freedom** | **prob** |
| t-statistic | -2.99 | 25 | 0.0062 |
| F-statistic | 8.95 | (1.25) | 0.0062 |
| Chi-square | 8.94 | 1 | 0.0028 |

Ref: finding research

**Estimating the Long-Run Pattern**

NARDL pattern is a method which considers the short-run dynamics among the variables and estimates the long-run relationships as well. In this pattern first the dynamic model, then the long-run relation and error correcting pattern are fitted. The results for estimating the dynamic pattern of private investment model in agricultural

sector are in tables 4 and 6. Among the advantages of estimating the dynamic pattern is that we can test for the presence of a long-run equilibrium relation. In the long run, changes in positive currency shocks have had a negative effect on investment.

**Table 4.** The results of long-run relationship between Asymmetric shocks of foreign exchange and investment inagriculture

| **Variable** | **بي‌رض** | **دراداناتسا ىاطخ** | **t هرامآ** | **Prob.** |
|---|---|---|---|---|
| C | -45.22 | 7.884 | -5.73 | 0.000 |
| LI(-1) | -0.629 | 0.111 | -5.64 | 0.000 |
| SHOCKLNOR_POS(-1) | **-0.56** | **0.401** | **-1.41** | **0.169** |
| SHOCKLNOR_NEG | **0.699** | **0.340** | **2.05** | **0.051** |
| LGDP | 2.203 | 0.515 | 4.27 | 0.000 |
| LR | 0.329 | 0.193 | 1.699 | 0.102 |
| LLOAN | -0.95 | 0.270 | -3.52 | 0.002 |
| LNOR | **-0.7** | **0.205** | **-3.41** | **0.002** |

Ref: finding research

Results of F test also accept the long run relation. H0 in table 5 is rejected and the presence of long-run relation is confirmed.

**Table 5.** Results of F test that show nonlinear long run relation between Currency shocks and agricultural investment

| **F-Bounds Test** | | Null hypothesis: no long run relation | | |
|---|---|---|---|---|
| **Test Statistic** | Value | Significant. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| **F-statistic** | **8.0284** | 10% | 2.2 | 3.09 |
| **k** | 4 | 5% | 2.56 | 3.49 |
| | | 2.50% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |
| **Actual Sample Size** | 36 | | Finite Sample: n=40 | |
| | | 10% | 2.427 | 3.395 |

| | | | | |
|---|---|---|---|---|
| **Actual Sample Size** | 36 | | Finite Sample: n=40 | |
| | | 5% | 2.893 | 4 |
| | | 1% | 3.967 | 5.455 |
| | | | | |
| | | | Finite Sample: n=35 | |
| | | 10% | 2.46 | 3.46 |
| | | 5% | 2.947 | 4.088 |
| | | 1% | 4.093 | 5.532 |

Ref: finding research

**Estimating the Error Correction pattern**

The presence of co-integration among a set of economic variables provides a statistical base for using the error correction pattern. The main reason behind the popularity of these patterns is that they connect the short-run fluctuations of variables with the long-run equilibrium values. In the short term, current currency shocks and the two past period currency shocks have had a negative and significant impact on investment in agriculture. In Short term changes in negative shock had no effect on investment. Results of ETC (-0.629) show that the short-term imbalances and inequalities will adjusted in the long run and it lasts about 1.6 period (a year and 6 months) till all these imbalances would adjusted.

**Table 6.** The results of short-term imbalances adjustment in the ECM model with regard to the exchange rate asymmetry

| Name | Variable | coefficient | Standard error | T statistic |
|---|---|---|---|---|
| D(SHOCKLNOR_POS) | **-0.667** | **0.255** | **-2.613** | **0.015** |
| D(SHOCKLNOR_POS(-1)) | **-0.702** | **0.252** | **-2.782** | **0.010** |
| D(SHOCKLNOR_POS(-2)) | **-0.765** | **0.269** | **-2.845** | **0.009** |
| LLOAN | 0.951 | 0.122 | 7.802 | 0.000 |
| LNOR | **-0.700** | **0.098** | **-7.151** | **0.000** |
| CointEq(-1)* | **-0.629** | 0.083 | -7.603 | 0.000 |

Ref: finding research

In order to eliminate the effects of the scale, standardized coefficients are estimated. Comparing the standardized coefficients of currency shock with other variables, while

showing negative effects, shows that the effect of GDP and loan and free market exchange rate are stronger than the effect of currency shock. In all three dynamic model, long run and standardized model, LGDP had positive effect on investment in agriculture which is in accordance to theory. Economic production and growth, what GDP represents, has a large impact on nearly everyone within [the] economy. When GDP growth is strong, firms hire more workers and can afford to pay higher salaries and wages, which leads to more spending by consumers on goods and services. Firms also have the confidence to invest more when economic growth is strong, and investment lays the foundation for economic growth in the future. When GDP growth is very low or the economy goes into a recession, the opposite applies (workers may be retrenched and/or paid lower wages, and firms are reluctant to invest). In all four estimated model, logarithm of exchange rate (LNOR) had negative effect on investment. The exchange rate can play a crucial role in investment decisions. Investment reacts differently to exchange rate shocks in low- and high-volatility. When the exchange rate variability is very high (shock LNOR_pos) firms may be uncertain about the persistence of exchange rate movements. As a result, the corresponding changes in the output demand and the price of imported investments are treated as transitory. Firms delay their adjustment process. This, in turn, weakens the link between investment and exchange rates.

**Table 7.** Standardized Final Results of the NARDL Model for the Study of the Nonlinear Effects of Currency Shocks and Exchange Rate on Investments in Agriculture

| **Variables** | **Coefficient** | **Standard coefficient** |
|---|---|---|
| LI(-1)*** | 0.37 | 0.374 |
| ***SHOCKLNOR_POS | **-0.667** | **-0.147** |
| SHOCKLNOR_POS(-1)*** | **-0.801** | **-0.176** |
| SHOCKLNOR_POS(-2)*** | **-0.765** | **-0.165** |
| SHOCKLNOR_NEG** | **0.699** | **0.160** |
| LGDP*** | 2.203 | 0.309 |
| LR*** | 0.329 | 0.053 |
| LLOAN** | 0.951 | 0.183 |
| LNOR*** | -0.7 | -0.392 |
| C | -45.2244 | - |

Represents a significant at 10%*
Ref: finding research

**Consequence**

This study, used time series data from 1978–2017 and a non-linear autoregressive distributed lag (NARDL) model to check the asymmetrical relationship between Exchange volatilities and agricultural Investment. This study used Hodrick Prescott filter to derive exchange rate volatilities. Results have shown that:

- in accordance to Wald test There is a negative and significant relationship between exchange rate shocks and investment in the agricultural sector in the short and long term.
- There are asymmetrical linkages between these two variable and therefor negative exchange volatilities have positive effect and positive exchange volatilities have negative and significant effect on agricultural investment.
- The effect of negative shocks were less than positive shocks.
- With respect to negative impact of exchange rate on investing in agricultural sector, if this exchange rate increases remain stable, investment in the agricultural sector is declining very severe. Given the direct and historical impact of investing in the current period, investment will also be a problem for future years. Since given loan have had a positive impact on the investment, it is suggested that government increases these loans and facilities. The purpose of this policy is to prevent the current investments decreases.
- With respect to negative reaction of investment to dollar-denominated shocks, the decline in dollar dependency and the use of other high-yielding currencies such as the euro are appropriate.

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