The Long-run Relationship Between Inflation and Investment in Turkiye

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Abstract: In this study I investigate the long-run impact of inflation on investment level in Turkiye for the period of 1990-2023 by utilizing ARDL estimation method. ADF unit root test findings implied that economic growth variable is stationary at level while inflation and investment variable are stationary at first differences. The results of ARDL bounds test disclosed that economic growth, inflation, and investment variables are co-integrated and thus they move together in the long-run. Regarding to the long-run coefficient estimation findings, as anticipated, statistically significant negative coefficient estimation for inflation variable and statistically significant positive coefficient estimation for economic growth variable were obtained. Put it differently, 1% increase in inflation level induces to a decrease in investment level by 0.2195% while 1% rise in economic growth leads to a jump in investment level by 0.3128%. Several diagnostic tests were conducted and the results of diagnostic tests indicated that the estimated ARDL(1,0,0) model is free from parameter instability, non-normality, autocorrelation, heteroscedasticity, and model misspecification problems.

Keywords: Inflation, Investment, Stationarity, Co-integration, ARDL Technique.

1. INTRODUCTION

Investment level in an economy is determined and explained by several factors. In addition to well-known determinants of investment in the literature, inflation is another factor which can be used to explain investment level. The observations in an inflation series of an economy contain information on economic uncertainty, political uncertainty, and funding cost of investments. Therefore inflation may adversely affect investment level in an economy.

By utilizing different dataset in terms of period covered, number of countries included, and estimation technique employed there are numerous studies in the literature addressing to the association between inflation and investment level.

Madsen (2003) by applying a panel data analysis for OECD countries and the period of 1982-1999 showed that inflation adversely affected the investments in non-residential buildings, machinery and equipment. His findings indicate that the low inflation of the 90s had an increasing effect on investments in OECD countries.

Nurudeen (2009) analyzed the long-run determinants of private investment for Nigeria by using error correction model. According to the study results, if inflation increases by 1% in the previous year, private investment decreases by 0.007%, meaning that increasing inflation negatively affects private investment.

In the study of Costamagna(2015) examining the effect of inflation on R&D investments for the period 1981-2008 and OECD countries using the panel data method, it is revealed that there is a negative relationship between high inflation and R&D investments of firms.

Mallick and Mohsin(2010) examined the short and long run impact of inflation on investment for USA, England, Canada and Italy by using VAR analysis. Short and long term results hint that the effect of inflation on investments is negative.

Atesoglu (2005) applied co-integration analysis to 3-month US data to reveal the relationship between inflation and investments in the US. He found a positive relationship between inflation and investments. He states that the policy understanding of low inflation targeting for the US, which is based on the negative relationship between inflation and real investment, does not coincide with the results he found and the arguments regarding this understanding are questionable.

Asaband Al-tarawneh (2018) examined the non-linear relationship between inflation and investment using the threshold model for Jordan in the time period of 1980-2016. They found that inflation has a downward effect on investments when the inflation rate reaches the 10% limit.

This study attempts to figure out if there is a long-run nexus between inflation and investment in Turkiye. The long-run estimation findings confirm the existence of statistically significant negative relationship between inflation and investment level in Turkiye over the estimation period.

The second part of the study explains data and methodology, third part reports and discusses estimation result, and the last part concludes.

2. DATA and METHODOLOGY

This study attempts to disclose long-run association between inflation and investment in Turkiye by using ARDL estimation method and an annual dataset for the period of 1990-2023.

The variable of investment (INVEST) is given by gross capital formation (current US$), the variable of inflation (INF) is given by inflation (GDP deflator: linked series (annual %)), and the control variable of economic growth (GROWTH) is given by GDP growth (annual %). All variables were obtained from WDI of the World Bank. The logarithmic forms of all variables were used in all analyses. Since inflation reflects economic and political uncertainty and funding cost of investment, negative coefficient estimation is anticipated for INF variable. Meanwhile as higher economic growth rate requires more production and hence increasing production capacity, positive coefficient estimation is expected for GROWTH variable.

I constructed and estimated following model for co-integration analysis:

$$\Delta \text{INVEST}_t = \alpha_0 + \sum_{i=1}^{p} \delta_i \Delta \text{INVEST}_{t-i} + \sum_{i=0}^{q} \phi_i \Delta INF_{t-i} + \sum_{i=0}^{r} \lambda_i \Delta GROWTH_{t-i} + \theta_0 \text{INVEST}_{t-1} + \theta_1 INF_{t-1} + \theta_2 GROWTH_{t-1} + \varepsilon_t \quad (1)$$

In Equation 1 above: θ_0, θ_1, and θ_2 symbols show long-term coefficients; δ_i, ϕ_i, and λ_i symbols represent short-term coefficients; Δ symbol stands for first degree difference operator; α_0 is constant term of the model, and ε_t symbol reflects white noise error term of the model.

H_0:$\theta_0=\theta_1=\theta_2=0$ represents the null hypothesis of ARDL bounds test and hints the absence of co-integrating association among the variables of INVEST, INF, and GROWTH. H_1: $\theta_0\neq\theta_1\neq\theta_2\neq0$ gives the alternative hypothesis of ARDL bounds test and implies the presence of co-integrating association among the variables of INVEST, INF, and GROWTH. As long as F-statistic value of ARDL bounds test is bigger than upper limit at a given significance level then it can be concluded that there exists co-integrating association among the variables of INVEST, INF, and GROWTH. Otherwise it cannot be said so.

The following model was constructed and estimated to obtain short-run and long-run coefficient estimations:

$$\text{INVEST}_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta \text{INVEST}_{t-i} + \sum_{i=0}^{q} \mu_i \Delta INF_{t-i} + \sum_{i=0}^{r} \theta_i \Delta GROWTH_{t-i} + \gamma ECM_{t-1} + \varepsilon_t \quad (2)$$

In Equation 2 above: α_i, μ_i, and θ_i notations show dynamic coefficients returning the model back to the balance in the long-run; ECM term is error correction term of the model; γ notation represents the speed of adjustment at which the model returns back to long run in response to a shock occurred in short-run. The speed of adjustment term must have statistically significant negative sign.

In Table 1 below I provided summary statistics for the variables of INVEST, INF, and GROWTH.

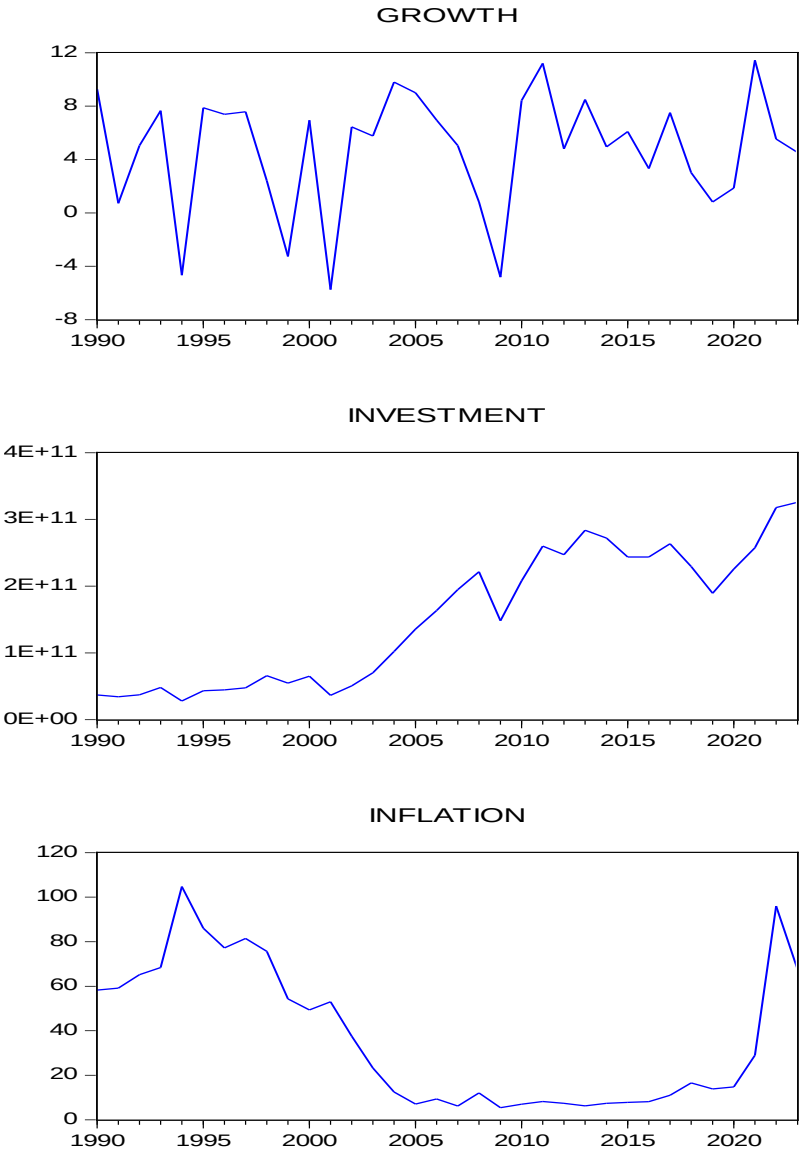
In Graph 1 below I displayed how the series of investment, inflation, and economic growth act over the estimation period of 1990-2023. The GROWTH variable fluctuates with no discernable upward or downward trend over the estimation period. The INVEST variable possesses a quite strong increasing trend over the estimation period. Inflation drops up to 2005 and moves horizontally until 2020 and increases after that.

Table 1: Summary Statistics

	GROWTH	INVEST	INF
Mean	4.767047	1.53E+11	36.67883
Median	5.648338	1.56E+11	19.90078
Maximum	11.43938	3.26E+11	104.7491
Minimum	-5.750007	2.79E+10	5.446449
Std. Dev.	4.456584	1.00E+11	31.73550
Skewness	-0.881879	0.119072	0.595159
Kurtosis	3.123693	1.462482	1.913732
Jarque-Bera	4.428703	3.429289	3.678849
Probability	0.109224	0.180028	0.158909
Sum	162.0796	5.20E+12	1247.080
Sum Sq. Dev.	655.4176	3.32E+23	33235.69

Observations	34	34	34

Graph 1: Series of INVEST, INF, and GROWTH over time



3. ESTIMATION RESULTS

Augmented Dickey-Fuller (ADF) unit root test was implemented and the test results are displayed in Table 2. As indicated by the findings of Table 2, INVEST and INF variables are integrated order one (i.e., I(1)) while GROWTH variable is integrated order zero (i.e., I(0)). Since none of the three variables are integrated order no more than one, ARDL bounds test can be employed for co-integration analysis.

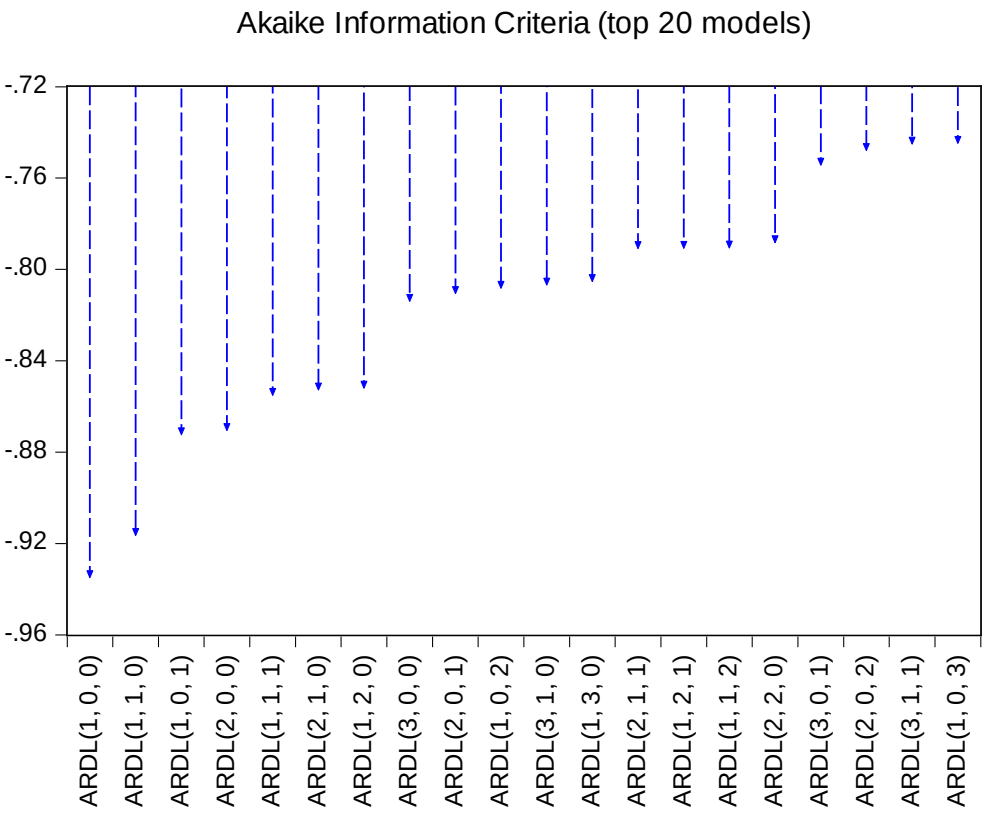
Table 2: Unit Root Test

Null Hypothesis: GROWTH has a unit root		
Model: Constant, Linear Trend		
Lag Length: 0 (Automatic - based on SIC, maxlag=8)		
	t-Statistic	Prob.
Augmented Dickey-Fuller test statistic	-6.333207	0.0000
Null Hypothesis: INVEST has a unit root		
Model: Constant, Linear Trend		

Lag Length: 0 (Automatic - based on SIC, maxlag=8)		
	t-Statistic	Prob.
Augmented Dickey-Fuller test statistic	-2.40719	0.3695
Null Hypothesis: D(INVEST) has a unit root		
Model: Constant, Linear Trend		
Lag Length: 0 (Automatic - based on SIC, maxlag=8)		
	t-Statistic	Prob.
Augmented Dickey-Fuller test statistic	-7.372773	0.0000
Null Hypothesis: INF has a unit root		
Model: Constant, Linear Trend		
Lag Length: 0 (Automatic - based on SIC, maxlag=8)		
	t-Statistic	Prob.
Augmented Dickey-Fuller test statistic	-0.115751	0.9924
Null Hypothesis: D(INF) has a unit root		
Model: Constant, Linear Trend		
Lag Length: 0 (Automatic - based on SIC, maxlag=8)		
	t-Statistic	Prob.
Augmented Dickey-Fuller test statistic	-5.80383	0.0002

The AIC criterion was utilized in order to identify the best ARDL model in terms of optimal lag length. As seen from Figure 1, after evaluation of 48 different ARDL models, AIC criterion indicated the ARDL(1,0,0) model as the optimal model. Therefore I employed ARDL(1,0,0) model in all analyses.

Figure 1: Selection of ARDL Model with Optimal Lag Length



Co-integration analysis was performed by using optimal ARDL(1,0,0) model for ARDL bounds test and the findings of ARDL bounds test are exhibited in Table 3. As pointed out by the results in Table 3, value of F-statistic is far beyond the critical values of upper limit at all significance levels and sample sizes, hence I can conclude that there is co-integrating relationship among the variables of investment, inflation, and economic growth. Thus the variables of investment, inflation, and economic growth move together in the long-run during the estimation period of 1990-2023.

Table 3: ARDL Bounds Test

	Signif.	Lower Limit	Upper Limit
		Asymptotic: n=1000	
F-statistic: **20.07277**	10%	3.38	4.02
k: 2	5%	3.88	4.61
	2.5%	4.37	5.16
	1%	4.99	5.85
Actual Sample Size: 34		Finite Sample: n=35	
	10%	3.698	4.42
	5%	4.433	5.245
	1%	6.328	7.408
		Finite Sample: n=30	
	10%	3.77	4.535
	5%	4.535	5.415
	1%	6.428	7.505

In Table 4 I reported the long-run coefficient estimation findings. As anticipated, statistically significant (at 1% significance level) negative coefficient estimation for INF variable was obtained. On the other hand, statistically significant (at 1% significance level) positive coefficient estimation for GROWTH variable was obtained. 1% rise in inflation level leads to a drop in investments by 0.2195% whereas 1% jump in economic growth causes to a rise in investments by 0.3128%. Therefore the impact of GROWTH variable on investment is higher than the INF variable. Also, as required, ECM term is negative and statistically significant.

Table 4: Long-run Coefficient Estimations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.2195	0.0692	-3.1705	0.0036
GROWTH	0.3128	0.1012	3.0923	0.0044
TREND	0.0561	0.0077	7.2604	0.0000
ECM(t-1)	-0.3997	0.0425	-9.4126	0.0000

EC = INVEST - (-0.2195*INF + 0.3128*GROWTH + 0.0561*TREND)

In Table 5 below diagnostic test results for non-normality, autocorrelation, heteroscedasticity, and model misspecification error were reported. As can be deduced from the test findings in Table 5, ARDL(1,0,0) model is not exposed to non-normality, autocorrelation, heteroscedasticity, and model misspecification problems. Put it differently, ARDL(1,0,0) model is free from non-normality, autocorrelation, heteroscedasticity, and model misspecification problems.

Table 5: Diagnostic Test Results

Tests	Test Value / (Prob.)
Jerque-Bera Normality Test	0.465378 *(0.792400)*
Breusch-Godfrey Serial Correlation LM Test	0.265547 *(0.7688)*
ARCH Heteroskedasticity Test	0.357342 *(0.5543)*
Ramsey RESET Test	0.394348 *(0.5351)*

CUSUM and CUSUM-Square tests also were implemented to check the stability of paremeters of ARDL(1,0,0) model. The results of CUSUM and CUSUM-Square parameter stability tests are given in Figure 2 and 3 and the findings of both tests reveal that the parameters of ARDL(1,0,0) model are stable.

Figure 2: CUSUM Parameter Stability Test

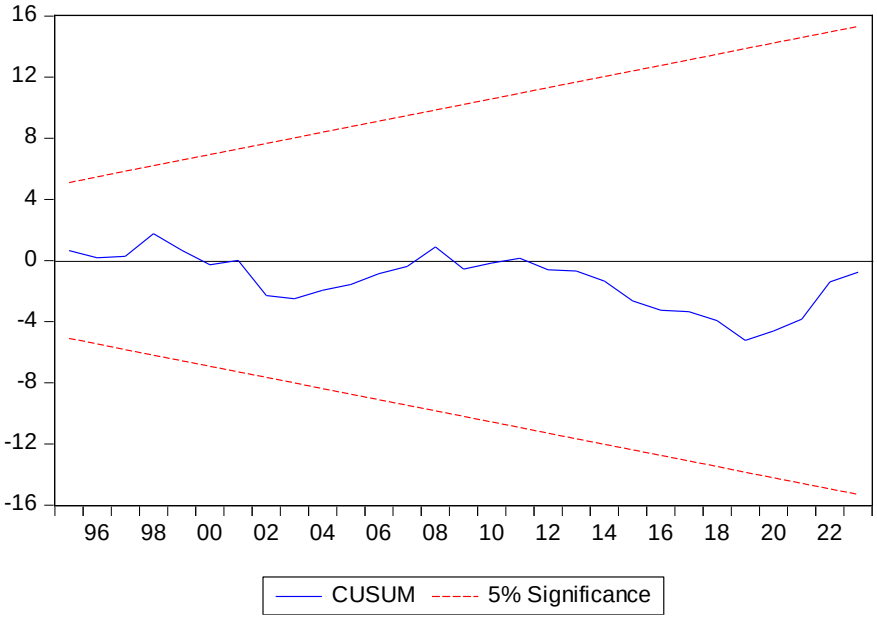
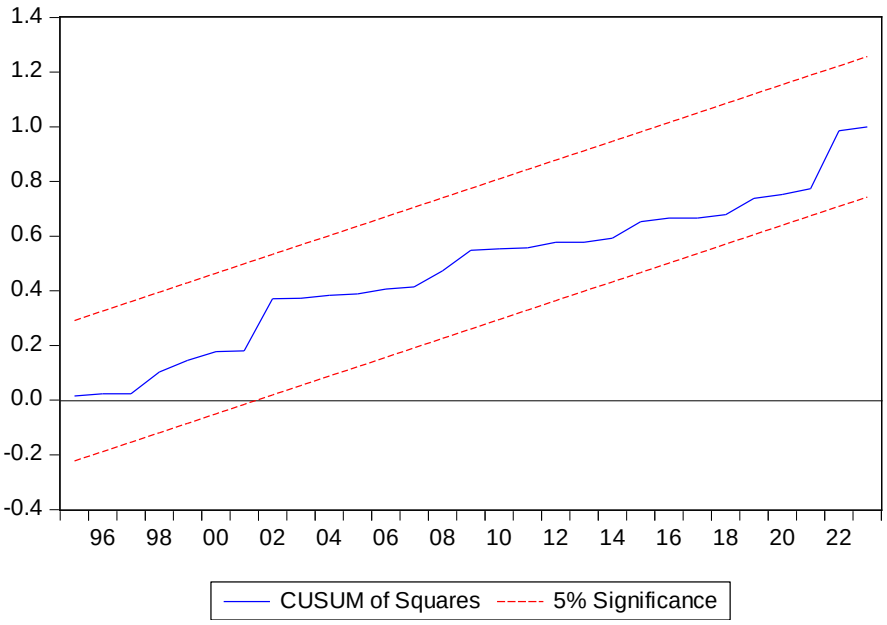


Figure 3: CUSUM-Square Parameter Stability Test



4. CONCLUSION

This study examines the long-run influence of inflation on investment level in Turkiye for the period of 1990-2023 by utilizing ARDL estimation method. The results of ADF unit root test disclosed that economic growth variable is stationary at level whereas inflation and investment variable are stationary at first differences. Co-integration analysis performed by employing ARDL bounds test and the findings of ARDL bounds test implied that economic growth, inflation, and investment variables are co-integrated and hence economic growth, inflation, and investment variables move together over the estimation period.

According to the long-run coefficient estimation results, in parallel to prior expectations, statistically significant negative coefficient estimation for inflation variable and statistically significant positive coefficient estimation for economic growth variable were obtained. In other words, 1% increase in inflation level induces to a decrease in investment level by 0.2195% while 1% rise in economic growth leads to a jump in investment level by 0.3128%.

Several diagnostic tests were conducted and the findings of diagnostic tests pointed out that the estimated ARDL(1,0,0) model is free from parameter instability, non-normality, autocorrelation, heteroscedasticity, and model misspecification problems.

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