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A New Approach of Investment for the Future Economic Policies

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The investment takes the form of sums of money spent for the acquisition of capital goods, changes in business inventories, and the purchases of new residential housing that are not currently consumed, but will be used in the future for the growth of the wealth. The work covered by this study aims to identify the model that presents, in the best possible way, the method of investment's calculation and to determine the factors of influence. In the first part, the investment is analyzed as a linear function dependent on the interest rate; and the second part implies a new model for determining long-term investments.

Keywords*: investment, interest rate, taxes, regression equation*

JEL Classification*: E22*

1. Introduction

According to Keynesian theory, the investment depends on what he called "marginal efficiency of capital" - that is, the expected rate of return for the acquisition cost of the capital goods. This is compared with the market interest rate. If the marginal efficiency of the capital is higher than the interest rate, the investment will increase, and if it is lower, the investment will decrease. Keynes (1936) stated that "the investment rate will increase to the point where the marginal efficiency of capital in general is equal to the market interest rate". Thus, given the "propensity to consume" and "incentive to invest" (determined jointly by the marginal efficiency of capital and the market interest rate), the employment rate is uniquely determined.

This paper aims to identify factors that influence investments in a large economy, like the case of the U.S. economy. In macroeconomic models, the equilibrium condition is given by the equality between savings and investment. Also, in these equilibrium models (IS-LM and Mundell-Fleming), an important relationship is that planned investment depends on the interest rate indirectly.

2. Literature Review

Keynes (1936, p.199) defined the marginal efficiency of capital as "equal to the discount rate that would determine that the present value of a series of annuities given by the expected benefits brought by the capital asset over its lifetime to be equal to its price offer".

Starting from this point, Keynes (1936, p.199) defined the function of investment demand as a function meant to link the rate of aggregate investment with the marginal efficiency of the capital determined that the level of the aggregate investment rate.

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The size of the investment depends on the relationship between the interest rate and the correlation between the marginal efficiency of capital and the various dimensions of current investments , while the marginal efficiency of capital depends on the relationship between the offer price of a capital good and the future benefits it will bring (Keynes, 1936, p.211) If the marginal efficiency of capital is higher than the interest rate, investment will grow, if it is lower, the investment will decrease. Keynes argued that “the investment rate will increase to the point at which the marginal efficiency of capital is approximately equal, in general lines, to interest rate” (Keynes,1936 p. 314). Given the “propensity to consume” and “incentive to invest” (determined jointly by the marginal efficiency of capital and the market interest rate), the employment rate is uniquely determined.

Classical economists assumed that aggregate demand - production cost in monetary units - adjust quickly and flexibly to changes in expectations of sales profitability, keeping the economy at full employment rate. Keynes’s denial that this must happen , is the crux of his denial of Say’s Law - that supply always creates its own demand. Assuming that an employer’s expected sales arise from N workers hiring, employment falls below the cost of employing that number; in Keynes’s model, employers reduce their production costs through layoffs of workers. This reduces total demand in the economy. It is not wage cuts, but the decrease in employment rate that removes excess supply of output. This would be equivalent to the statement that the excess of savings over investment is eliminated by the fall in income (Skidelsky, 2010, pp.154-155).

The amount of work that entrepreneurs decide to employ depends on effective demand, i.e. the sum regarding what the company expects to spend on consumption and what the company expects to be devoted to new investments (Keynes, 2009, p.88). From the definitions of income and consumption provided by Keynes (1936, pp.123), it follows that savings are equal to $A_1 - U$, while net savings are expressed as a surplus of income over consumption equal to $A_1 - U - V$.

Starting from the definition of income, the current investment can defined as “current addition to the value of the technical capital resulting from the productive activity of the period under consideration ... this addition is equal to what we have just defined as savings, because it is that part of the income that has not passed into consumption”(Keynes, 1936, pp.123-124).

In other line of ideas, the excess income, expressed as $A - U$, over the part of income already in consumption, with the value of $A - A_1$, namely $A_1 - U$, is the addition to the technical capital as a result of the productive activity in the timeframe and represents the investment of that period.

Regarding the net investment, this equals $A_1 - U - V$, representing the net addition to technical capital after the normal depreciation of its normal value.

The study of the relationship between investment and interest rate has also been achieved in 2010 and the current research subject of this study is a continuation of that research (Opreana, 2010, pp.227-237). Thus, the research from 2010 has been disproved hypothesis that “investments are expressed by a function dependent on interest rates” and proposed a different function to identify factors that influence investments. These limits of that particular research consisted of the invalidation of the hypothses of homoskedasticity, normality and independence of values.

In this framework, the current research aims precisely to eliminate these limitations and to identify new investment functions to highlight the factors influencing investment in the U.S. economy.

3. Research Methodology

The next step implies the testing of the research assumptions in relation to this study’s objectives to verify the validity of Keynes’s model equations. In this research I will use a multiple linear regression model to test and determine the impact that different independent variables have on the dependent variables.

The general form of the multiple linear regression equation is:

$$Y_t = \beta_t^{X_1} X_{i1} + \beta_t^{X_2} X_{i2} + \cdots + \beta_t^{X_n} X_{in} + \beta_0 + \varepsilon$$

For simple linear models, regression coefficients measure the marginal contribution of the independent variable to the dependent variable, holding all the other variables fixed. If there is a constant (β), it represents the basic level of the prediction when all the other independent variables are zero. The other coefficients are interpreted as the slope of the relationship between the independent variable and the corresponding dependent variable, assuming all other variables do not change (Quantitative Micro Software, 2007, p.12).

Regression estimated by the method of least squares are determined by the following formula (Quantitative Micro Software, 2007, p.11):

$$\beta = (X'X)^{-1} X'y \tag{2.47}$$

For the inference based on the results of the multiple linear regression to be valid, I will use the following set of tests:

(i) The *F-Test* for testing the validity of the model. This test measures how well the independent variables explain the evolution of the dependent variable. Under the null hypothesis of normally distributed errors, this test has an *F* distribution with *k-1* degrees of freedom for the numerator and *T-k* degrees of freedom for the denominator. If the *p* value is less than the relevant level that is considered for the research, then at least one of the coefficients of the regression is statistically significant. But if the p-value is higher than the relevant level of the research, then all the regression coefficients are considered statistically insignificant (equal to zero) (Quantitative Micro Software, 2007, p.15).

(ii) The *coefficient of determination* R^2 and *adjusted coefficient of determination* $\bar{R}^2$ are used to determine the intensity link between values and measure the quality of the adjustment

(iii) *t-statistic* is used for testing the validity of the coefficients - t-statistic, calculated as the ratio between the estimated coefficient and its standard error, is used to test the hypothesis that a coefficient is equal to zero (Quantitative Micro Software, 2007, p.12).

(iv) *White test* for testing the hypothesis of homoskedasticity of the residual variable. The White test is a statistical test that determines whether the residual variance of a variable in a regression model is constant (homoskedasticity assumption).

(v) *Jarque-Bera test* for normality testing of the random variable distribution. Jarque-Bera tests whether a distribution is normally distributed. The test measures the difference between the asymmetry coefficient (skewness) and vaulting coefficient (kurtosis) of the analyzed distribution with that of a normal distribution. The test has the following null hypothesis: the series is normally distributed. If the probability associated with the test is higher than the relevancy level chosen, the test indicates the acceptance of the normality assumption and the fact that the series is normally distributed; otherwise, it indicates the rejection of the hypothesis of normality.

(vi) *Durbin-Watson test* and *Breusch-Godfrey test* for testing the hypothesis of independence of the residual variable values. The Durbin Watson test (DW) is a statistical test that examines the serial correlation of errors. If errors are not correlated, then the value of DW is about 2, in the same way, if the DW is less than 2, there is evidence of a positive correlation series. If there is a negative correlation, statistical test will show a value between 2 and 4 (Quantitative Micro Software, 2007, p.14). The existence of serial correlation, shown by correlogram errors, is confirmed by the Serial Correlation LM test. To obtain certain results, the *F-Statistic*, R^2 and their associated probabilities are analyzed. If the probability associated with the two tests is below the level of relevance chosen for the analysis, then there is a serial correlation of the residuals; otherwise there is no serial correlation (Codîrlașiu, 2007, p.47).

This methodology will be applied using Eviews 6 software on empirical data, in order to attain the research objectives. In the process of the research, the methodology will be applied on time series of the U.S. economy, obtained from the Federal Reserve of St. Louis in the timeframe of 1959-2011.

4. Analysis and Results

The Identification of the Linear Regression Theoretical Model and the Verification of the Model's Validity

In the following section the investment equation is presented, based on the equation offered by the model:

$$LI = I_0 + i * LR$$

where I– Investment, I_0 – Autonomous Investment, i – Investment Sensitivity to Interest Rate Change, r – Interest Rate, LI – Logarithm of Investment and LR – Logarithm of Interest Rate

After applying the linear regression model of the historical data, the following investment equation is obtained:

$$LI = 7.069075 - 0.366704 * \mathrm{LR}$$

Table 1. *The Investment Regression Equation*

Dependent Variable: LI
Method: Least Squares
Date: 10/15/12 Time: 22:16
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LR	-0.366704	0.380933	-0.962648	0.3405
C	7.069075	0.714306	9.896421	0.0000

R-squared	0.018940	Mean dependent var	6.395430
Adjusted R-squared	-0.001498	S.D. dependent var	1.012555
S.E. of regression	1.013313	Akaike info criterion	2.903505
Sum squared resid	49.28656	Schwarz criterion	2.979986
Log likelihood	-70.58764	Hannan-Quinn criter.	2.932630
F-statistic	0.926692	Durbin-Watson stat	0.017955
Prob(F-statistic)	0.340549		

After analyzing the equation obtained, the following g conclusions arise:

(i) Prob (F-statistic) = 0.3405 > 0.05, indicates that the model is not statistically significant.

(ii) R-squared = 0.0189 and Adjusted R-squared = -0.0015 show a reduced intensity of the connection between interest rate (LR) and investment (LI).

(iii) t-Statistic for the LR parameter has Prob = 0.3405>0.05, illustrating the fact that the parameter is not significant.

Table 2. *White test for homoskedasticiy*

Heteroskedasticity Test: White

F-statistic	11.60237	Prob. F(2,47)	0.0001
Obs*R-squared	16.52648	Prob. Chi-Square(2)	0.0003
Scaled explained SS	8.816072	Prob. Chi-Square(2)	0.0122

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/29/13 Time: 19:42
Sample: 1962 2011
Included observations: 50

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.658087	2.501907	0.662729	0.5107
LR	0.952836	2.758052	0.345474	0.7313
LR^2	-0.689024	0.741635	-0.929062	0.3576

R-squared	0.330530	Mean dependent var	0.985731
Adjusted R-squared	0.302041	S.D. dependent var	1.071363
S.E. of regression	0.895059	Akaike info criterion	2.674269
Sum squared resid	37.65310	Schwarz criterion	2.788991
Log likelihood	-63.85673	Hannan-Quinn criter.	2.717956
F-statistic	11.60237	Durbin-Watson stat	0.149490
Prob(F-statistic)	0.000080		

(iv) Prob. F(2,47) = 0.001 < 0.05 indicates that after applying the White test, the hypothesis of homoskedasticity is verified in the regression function.

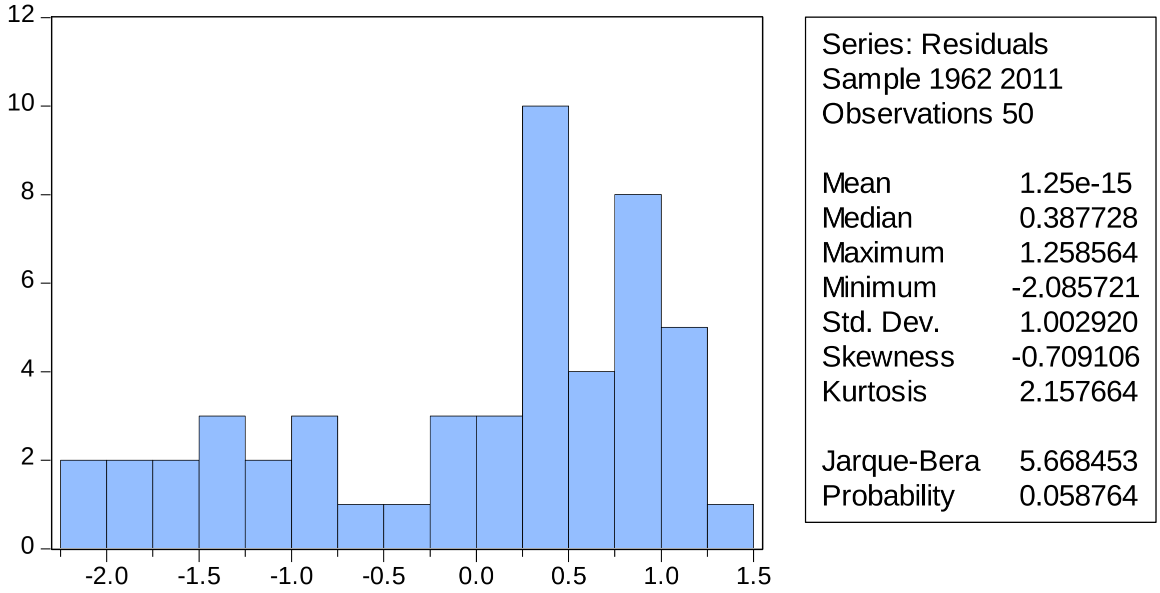

Figure 1. *Jarque Berra test for normality testing*

(v) Prob(Jarque-Berra Test) = 0.0588 > 0.05 indicates that the assumption of normality, checked through the the Jarque-Berra test, is accepted.

Table 3. *Breusch-Godfrey Serial Correlation LM Test*

F-statistic	212.7050	Prob. F(2,46)	0.0000
Obs*R-squared	45.12102	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/29/13 Time: 19:43
Sample: 1962 2011
Included observations: 50
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LR	0.213376	0.127841	1.669080	0.1019
C	-0.375669	0.238433	-1.575572	0.1220
RESID(-1)	0.941917	0.148031	6.362954	0.0000
RESID(-2)	0.019544	0.150952	0.129469	0.8976

R-squared	0.902420	Mean dependent var	1.25E-15
Adjusted R-squared	0.896056	S.D. dependent var	1.002920
S.E. of regression	0.323344	Akaike info criterion	0.656419
Sum squared resid	4.809363	Schwarz criterion	0.809381
Log likelihood	-12.41047	Hannan-Quinn criter.	0.714667
F-statistic	141.8033	Durbin-Watson stat	1.070316
Prob(F-statistic)	0.000000		

(vi) The results of the Durbin-Watson test (0.14) and Prob. F (Breusch-Godfrey) = 0.00 <0.05 show that the assumption of independence of the residual variable values is rejected, meaning that the errors of the models have positive autocorrelation, and are not independent.

Thus, after verifying the validity of the model, it can be stated that it is not valid, and that the investment is not a linear function of the interest rate.

Next, in this paper, the investments' function will be achieved, and also factors determining the investments will be identified.

Following the re-estimation model, it results in a new form of the equation according to the type of economy and the influence of external factors. The results yielded the following equation:

$$LI = LI(-1) + \Delta(LD) + LT(-1) + I_0$$

where LI – Logarithm of Investment, $LI(-1)$ – Logarithm of investment in the previous period, LD – Logarithm of Discount Rate, $LT(-1)$ – Logarithm of taxes of the previous period, I_0 – Autonomous Investment

Table 4. *The New Investment Regression Equation*

Dependent Variable: LI
Method: Least Squares
Date: 10/26/12 Time: 21:46
Sample (adjusted): 1960 2011
Included observations: 52 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LI(-1)	0.693979	0.115135	6.027511	0.0000
Δ(LD)	0.150015	0.021536	6.965871	0.0000
LT(-1)	0.287056	0.110573	2.596072	0.0125
C	0.330209	0.099269	3.326397	0.0017

R-squared	0.996112	Mean dependent var	6.317287
Adjusted R-squared	0.995869	S.D. dependent var	1.068041
S.E. of regression	0.068645	Akaike info criterion	-2.445939
Sum squared resid	0.226181	Schwarz criterion	-2.295843
Log likelihood	67.59441	Hannan-Quinn criter.	-2.388396
F-statistic	4099.371	Durbin-Watson stat	1.639700
Prob(F-statistic)	0.000000		

The Verification of the Proposed Model's Validity

After testing the validity, through the F test, the following two conclusions arise:

(i) Prob (F-statistic) = 0.0000 < 0.05, indicates that the model is statistically significant (valid).

(ii) Giving the R-squared of 0.6413 and the Adjusted R-squared of 0.6384, leads to the conclusion that there is a strong intensity of the relationship between the endogenous variables and the exogenous variable.

(iii) t-Statistic for the parameters of the analysis show that these are statistically significant.

Table 5. *White test for homoskedasticiy*

Heteroskedasticity Test: White

F-statistic	1.739522	Prob. F(9,42)	0.1100
Obs*R-squared	14.11996	Prob. Chi-Square(9)	0.1181
Scaled explained SS	12.56367	Prob. Chi-Square(9)	0.1834

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/29/13 Time: 19:37
Sample: 1960 2011
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.088833	0.083703	-1.061294	0.2946
LI(-1)	0.138502	0.189585	0.730555	0.4691
LI(-1)^2	-0.137750	0.119273	-1.154918	0.2547
LI(-1)*(D(LD))	0.039933	0.033204	1.202678	0.2358
LI(-1)*LT(-1)	0.274421	0.228206	1.202516	0.2359
D(LD)	-0.031842	0.026327	-1.209476	0.2332
(D(LD))^2	-0.002228	0.002250	-0.990497	0.3276
(D(LD))*LT(-1)	-0.038411	0.032379	-1.186286	0.2422
LT(-1)	-0.113906	0.179483	-0.634635	0.5291
LT(-1)^2	-0.138967	0.109365	-1.270674	0.2108

R-squared	0.271538	Mean dependent var	0.004350
Adjusted R-squared	0.115439	S.D. dependent var	0.006347
S.E. of regression	0.005970	Akaike info criterion	-7.233199
Sum squared resid	0.001497	Schwarz criterion	-6.857960
Log likelihood	198.0632	Hannan-Quinn criter.	-7.089341
F-statistic	1.739522	Durbin-Watson stat	2.130446
Prob(F-statistic)	0.109964		

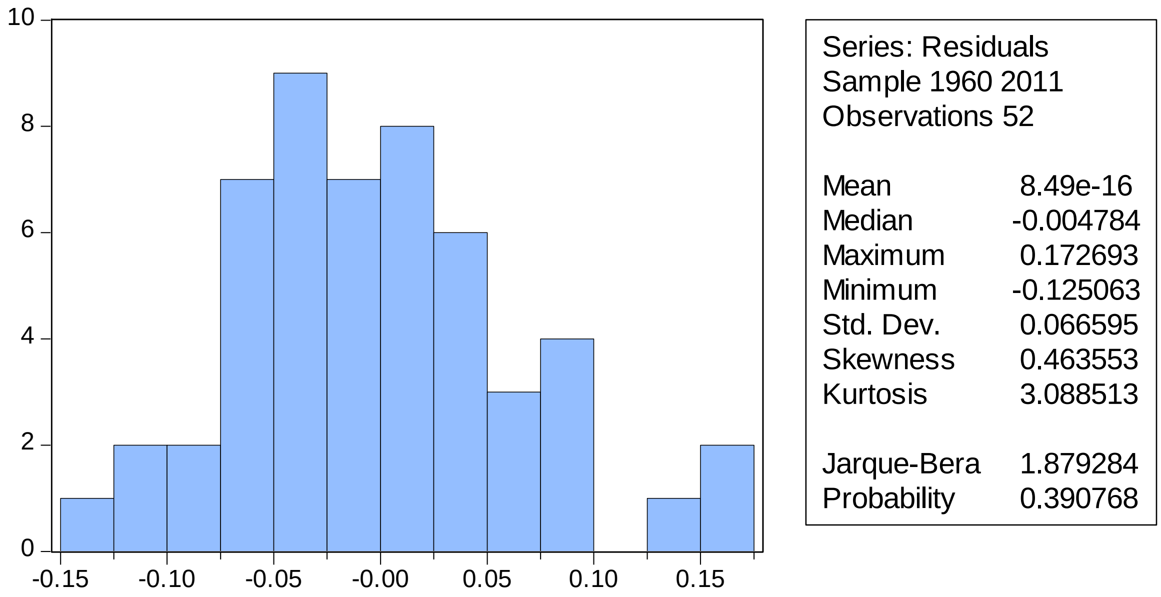

Figure 2. *Jarque Berra test for normality testing*

(iv) Prob(Jarque-Berra Test) = 0.3908 > 0.05 indicates that the assumption of normality, verified through the Jarque-Berra test, is accepted.

Table 6. *Breusch-Godfrey Serial Correlation LM Test*

F-statistic	1.736657	Prob. F(2,46)	0.1875
Obs*R-squared	3.650702	Prob. Chi-Square(2)	0.1612

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/29/13 Time: 19:41
Sample: 1960 2011
Included observations: 52
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LI(-1)	-0.030592	0.148090	-0.206579	0.8373
D(LD)	0.000995	0.021832	0.045574	0.9638
LT(-1)	0.029510	0.141223	0.208963	0.8354
C	0.021349	0.124748	0.171137	0.8649
RESID(-1)	0.219687	0.182384	1.204533	0.2345
RESID(-2)	-0.199533	0.166376	-1.199291	0.2366

R-squared	0.070206	Mean dependent var	8.49E-16
Adjusted R-squared	-0.030859	S.D. dependent var	0.066595
S.E. of regression	0.067615	Akaike info criterion	-2.441808
Sum squared resid	0.210302	Schwarz criterion	-2.216664
Log likelihood	69.48701	Hannan-Quinn criter.	-2.355493
F-statistic	0.694663	Durbin-Watson stat	2.019578
Prob(F-statistic)	0.630114		

(iv) The results of the Durbin-Watson test (1.64) and Prob. F (Breusch-Godfrey) = 0.1875> 0.05 show that the assumption of independence of the residual variable values are accepted, meaning that the errors of the models are not positively auto-correlated, as the patterns are independent.

By reformulating the equation, we get the following situation:

$$LI = 0.6940 * LI_{n-1} + 0.15 * LD - 0.15 * LD_{n-1} + 0.2871 * LT_{n-1} + I_0$$

An important aspect in the analysis process is to analyze the residual variable, i.e. the differences between the values obtained by applying the model and the observed values are shown in Figure 3.

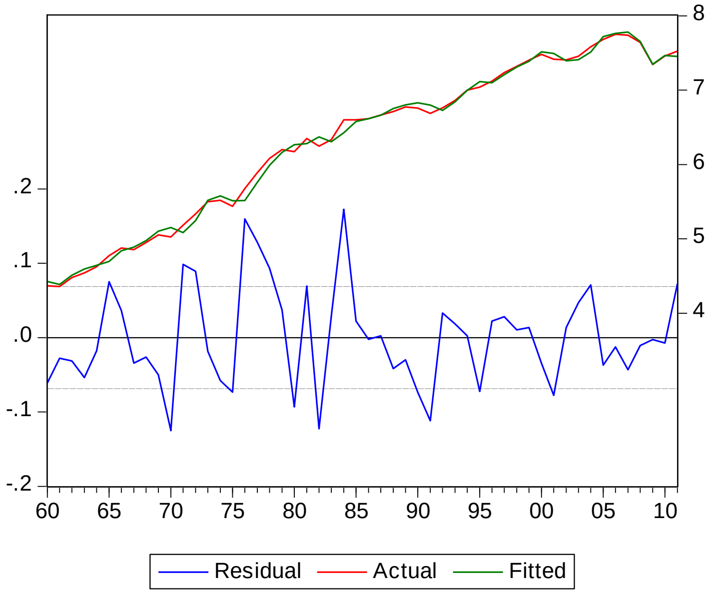

Figure 3. *Residual variables in the investment functions*

5. Conclusion

The short-term model proposed by Mundell and Fleming, in terms of investment as a linear function dependent on the interest rate, is not a valid model in the long term. Long-term investments are expressed with the following equation:

$$LI = 0.6940 * LI_{n-1} + 0.15 * LD - 0.15 * LD_{n-1} + 0.2871 * LT_{n-1} + I_0$$

Thus, we see that the economic developments of the past 50 years have led to major changes in terms of the structure and influencing factors underlying investments. Regarding the U.S. economy, investments are positively influenced by the volume of investments in the previous period, the interest rate (discount rate) of the monetary policy of the current timeframe, and the amount of taxes in the current period, and are negatively influenced by the interest rate of the monetary policy of the previous year.

This change of the investment structure also determined a change in terms of the equilibrium models that rely on the classical investment function. Thus, this new approach to investments directly influences the IS-LM model, and the Mundell-Fleming model.

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