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Convergence of Investment Leads by the Real Rate of Interest: An Empirical Evidence in the Indian Economy

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Abstract: This paper examines the impact of real rate of interest in the determination of investment. The policymaking to pave the way of growth is required to determine the effective rate of interest. Nominal interest rate does not depict the real phenomena of an economy. To capture the real phenomena of Indian economy, quarterly series of GDP deflator, the Nominal Rate of Interest, and Gross Fixed Capital Formation used as a proxy of investment have been used at the base year 2011-12. Real rate of interest is the subtraction of inflation from nominal rate of interest. The investment gap ratio is the difference between actual investment and the time trend value of the investment. The trend value of the investment is obtained by linear time. Standard methods have used to test the robustness of the Aggregate Supply equation by applying Augmented Dickey-Fuller and Phillips-Parron tests to avoid spurious regression. Granger Causality test is also employed to confirm the causal relationship between investment and inflation, and investment and the real rate of interest. The analysis concluded that the real rate of interest plays an important role to induce the investment to achieve desired growth of an economy.

Keywords: Inflation, Real rate of interest, Expectations, Market disequilibrium, Gap of growths of investment.

1. Introduction

General theory and Cambridge capital controversy demonstrate the contradictory relationship between the interest rate and investment. Keynes develops his theory of investment on the concept of supply and demand price of capital. The supply price of capital is defined as that price that induces a producer to produce an additional unit. Demand price is the prospective yield of a producer from a produced unit in a time at the current rate of interest. The equilibrium of investment occurs where the demand and supply prices are equal (Mckenna & Zannoni, 1990). Rises in price lower the real interest rate and reason of fall in investment rate (Sajedi & Thwaites, 2016). The available literature confirms the results from the different studies regarding the relation of inflation and the real rate of interest with investment. (Korala & Chandra, 1998) argued that the real rate of interest promotes both financial and total savings. Financial savings in turn promotes investment through the capital market. (Alshubiri, 2022) market forces has been worked to determine the real interest rate.It implies that the rate of interest positively impacts the cumulative investment. (Gillma & Kejak, 2009) argued that inflation decreases both the investment rate and output growth. (Negro, Giannone, Giannoni, & Tambalotti, 2019) also argued that lower real interest rate has been declining the global economic growth observed in decades. (Wuhan & Khurshid, 2015) investment and interest rate has negative relationship in long run and in contrast in short run. (Rachel & Smith, 2015) as per their discussion the slowing global growth hamper the demand and cause of inflation which lower the real rates. Interest rate uncertainty adversely impacts the investments (Bretscher, Schmid, & Vedolin, 2018). In contrast, (Shrivastava, et al., 2013) suggested that the lower real interest rate has been impacted on growth that may be achieved through higher inflation. (Fischer, 2013) found that the increased inflation uncertainty is associated with a reduction in total investment. (Hambur & Cava, 2018) fall in interest rate lower the cost of debt and increase the investment. In substance, it can be inferred that Keynes's prospective yield (induced from demand prices) leads a producer to invest, and investment in an economy is a function of inflation and the real rate of interest. Appendix A(a) (b) & (c), show that inflation, the real rate of interest, and investment growth have been declining during the study period in

India. (Acharya & Dogra, 2018) argued that higher inflation leads to more employment and high investment. On the other hand, (Madsen, 2003) estimated that the reduction in inflation increases the investment.

In India, the pandemic-induced lockdown that rigorously interrupted the economy, the declining trends of inflation concurred with the low growth of an investment. The lower nominal rate of interest and lower inflation deferred the prospective yields of producers. The focus of policymakers in India has been on dealing the nominal interest rate in total, irrelevance to inflation and real rate of interest. Therefore, our attempt in this research work is to examine the impact of such policy which work and incorporate the real rate of interest to determine investment to pave the way of growth of India's economy.

2. Methodology

In this study, we have investigated a relation between real rate of interest and investment. For the empirical work, the framework of equations has been developed and given in appendix A (from eq. A-1 to A-15). The modified supply equations (in appendix) are reproduced as under:

$$RRI= \beta_0+\beta_1(RRI)_{-1}+ \beta_2((NI-NI^*/NI^*)+\beta_3(Ng- Ng^*)+ u$$

The stochastic equation represents expectations augmented Phillips equation which has been used by various researchers to empirically estimate the relationship between inflation and unemployment rate. Similarly, instead of output or GDP, gross fixed capital formation or investment has been used to estimate the empirical relation between inflation, and ratio of investment gap and gap of growth of investment rates. In equation A-15, the relation of real rate of interest, and investment gap ratio and gap of investment growth rates has been estimated. In the equation number 15, the β_i are parameters, NI is investment or proxy of gross fixed capital formation, NI* is time trended value of investment, u is stochastic term, Ng is used for actual growth of investment, Ng* is time trend growth rate of investment, RRI is real rate of interest, $(RRI)_{-1}$ is lagged real rate of interest, {(NI – NI*)/NI*}represent the investment gap ratio from its time trend, and (Ng-Ng*) stand for gap of investment growth rate from its time trend growth rate.

For the equations, quarterly data of GDP and gross fixed capital formation from Central Statistical Office, nominal interest rate from RBI's website for the period 1996-2019 for India has been taken and used.

The quarterly series of investment as proxy of Gross Fixed Capital Formation at 2011-12 bases have been used and presented in a table of appendix B. The investment gap ratio measured by the difference of actual investment (NI) and time trend value of investment (NI*), NI* by fitting the linear time trend of the investment at (2011-2012) prices for different studied time periods. GDP deflator has been used as a proxy of inflation rate as Inf l(GDPD). Other variables representing, lagged inflation rate $(Infl (GDPD))_{-1}$, investment gap ratio {(NI-NI*)/NI*} and gap of investment growth rates (Ng-Ng*) are derived from data table in appendix B. For estimation of the equations, Augmented Dickey-Fuller and Phillips-Parron tests has been applied to avoid spurious regression. Granger Causality test is also employed to confirm the functional relationship between investment-inflation and investment-real rate of interest.

i. Augmented Dicky-Fuller Test

As mentioned, the Augmented Dicky-Fuller test is used to examine the stationarity of namely, Real rate of interest(RRI), Lagged RRI, Infl(GDPD), $Infl (GDPD)_{-1}$, {(NI-NI*/NI*}and (Ng–Ng*).

All the six series appear to be stationary in the level or on first difference form (appendix C (a & b). However, we further decided to carry out a rigorous test of ADF to these series by estimating the following two models i.e. Intercept no-trend model and Intercept & trend model.

The studied variables are stationary on the basis of ADF test except investment gap ratio {(NI-NI*/NI*} which is integrated at order one, and all the variables are stationary at first difference as shown in figure and table in appendix C.

ii. Phillips-Parron Test

To test regression for Phillips-Parron(PP) test in the AR(1) process, the PP-test is performed by testing the hypothesis of no stationarity (H_0:β=0) against the hypothesis that the series is integrated of the order zero I(0) hence stationary. The computed PP statistics and corresponding critical values are given in the table of Appendix C (b). If the computed values of PP-statistics are less than the corresponding critical values, then the null hypothesis of no stationarity is rejected and hence the series is stationary. The series were tested both at level and at first difference and the summary of the results is given below Appendix C (b).

Thus, all the six time series are stationary except investment gap ratio {(NI-NI*/NI*} on the basis of PP test for both the specifications namely intercept model as well as trend and intercept model, this can be the cause of spurious result of regression only for investment gap ratio to inflation and real rate of interest. Remaining series is giving robust values of causal relation. The graphs of the variables in their level as well as first difference is given in appendix C (c).

iii. Granger Causality Tests

According to Granger (1969), the null hypothesis that one variable does not cause another variables is rejected if the computed value of F-statistic exceeds the tabulated value at a specified level of significance. This tests performed by E-views application and result summarized are given the appendix E table.

3. Results of Estimated Equations

For the modelled equations (15), quarterly data for the period 1996-2019, 2000-19, 2004-19, 2008-19 and 2012-19 for India has been used. The purpose of using different time periods is to evaluate the real rate of interest (RRI) and aggregate behaviour of economy in term of investment disequilibrium, and gap of growth of investment from its time trended growth. The diagram in appendix B (e) shows that RRI is 7.99% in the year 2004-05 and investment is highest, thereafter has been declining steadily. The time period between 2012 and 2019 also captures the phenomenon.

The result reported in Appendix D (a), estimated coefficient of β_0 (Intercept) represents the inertia in the RRI which is independent from expected rate of inflation. The value of β_i (beta) parameter reflects the relation of RRI on aggregate supply curve of Indian economy in terms of investment. The value of coefficient β_1 shows adaptive expectations[1] which are used for real rate of interest and expected real rate of interest. In the long run, when, the actual real rate of interest is equal to the expected real rate of interest the value of β_1 is one. Stickiness of real rate of interest is also estimated by β_1. The coefficient β_2 represents the sensitivity of real rate of interest to the investment disequilibrium from its trended. It also represents the degree of responsiveness of real rate of interest to the disequilibrium in the investment market; it determines the slope of simple aggregate supply curve for investment. The coefficient β_3 reflects the sensitivity of the real rate of interest on the rate of recovery as well as the gap of growth of investment from its trended (actual growth of investment minus trended growth of investment).

Figure for β_2 shows that the value of disequilibrium decreases from e to e1, the RRI increased from a to a1, inversely disequilibrium from e to e2, RRI decreases from a to a2 and ratio of disequilibrium increases from b to b2. Real rate of interest has been calculated by the difference of nominal rate of interest and inflation. Given the nominal rate of interest, lowering of inflation will make the real rate of interest high that will reduce the prospective yields to the producers, and contraction in supply. This will create disequilibrium in an economy from its trended equilibrium.

Only the significant value of the OLS has been reported here. The coefficient β_2 represents the sensitivity of RRI to the disequilibrium from its time trended investment. The value of the coefficient is negative (-0.0483) and significantly different from zero. It indicates that 1% increase in investment disequilibrium results in 4% decrease in real rate of interest. The coefficient β_2 for the years 1996-2019, 2000-19, 2004-19, 2008-19 is depicted in figure for β_2 (Fig. 1).

[1] According to adaptive expectation scheme $Infl(GDPD)^e - Infl(GDPD)^e_{-1} = \lambda[Infl(GDPD)^e - Infl(GDPD)^e_{-1}]$, where λ is speed of adjustment, $0<\lambda\geq 1$ when $\lambda = 1$, $Infl(GDPD)^e = Infl(GDPD)_{-1}$; Similarly according to adaptive expectation scheme $RRI^e - RRI^e_{-1} = \lambda[(RRI)^e - (RRI)^e_{-1}]$, where λ is speed of adjustment, $0<\lambda\geq 1$ when $\lambda = 1$, $(RRI)^e = (RRI)_{-1}$

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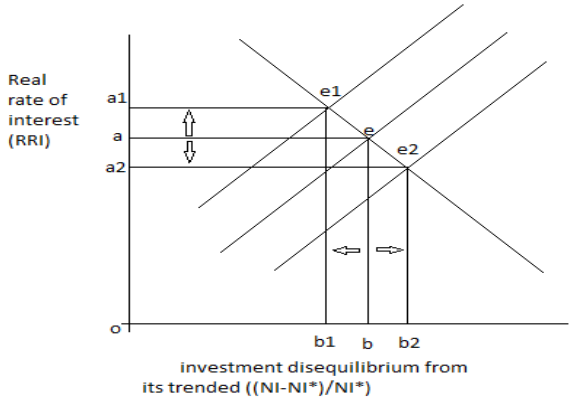

Figure 1 for β_2 (1996-2019, 2000-19, 2004-19, 2008-19)

The coefficient B_3 represents the sensitivity of real rate of interest to the rate of recovery. The value of β_3 is (0.1976). It is positive and statistically significant. It means that 1% rate of recovery or gap of growth of investment leads to 19% increase in real rate of interest. Similar results have been reported in Appendix D (a) for different periods. Primarily, the result of 92, 76, 60 and 44 observations spread over 23, 19, 15 and 11 years respectively reflects long and short term trend in case of disequilibrium in investment from its trend, gap of growth of investment, and real rate of interest.

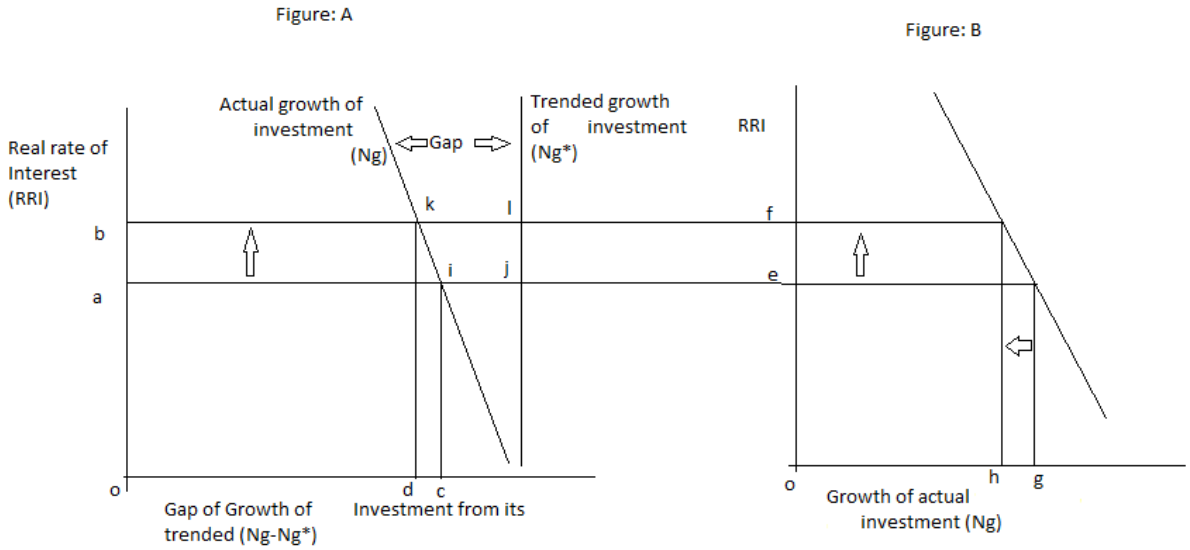

Figure 2 for β3 (1996-2019, 2000-19, 2004-19, and 2008-19)

Given the prospective yields, higher inflation lowers the real rate of interest thereby increasing level of investment. As RRI increases from point 'a' to 'b', the gap of growth of investment also increases from 'ij' to 'kl'. Similarly, lower real rate of interest reduces the gap of growth of investment as depicted in the Figure A. Figure B, confirms the inverse relation of real rate of interest and actual growth of investment (Fig. 2).

The variation in RRI is explained 28 percent, 31 percent, 23 percent, and 21 percent in the period 1996-2019, 2000-2019, 2004-2019, and 2008-2019 respectively. The real rate of interest is also explained by the exogenous variables in the model. The implication is that in the long run as well as in short run, monitoring the real rate of interest is critical for the growth of the economy of India. Therefore, the policy makers should focus on the factors impacting the level of investment for paving the way of growth of Indian economy.

i. Causality test for real rate of interest and investment in India

The result of the Granger Causality Test has been given in Appendix E(a). The first row of Appendix E(a) table shows that the null hypothesis, {(NI-NI*)/NI*} does not Granger Cause real rate of interest (RRI) and therefore rejected at 1 percent level of significance, and that investment gap ratio {(NI-NI*)/NI*}causes RRI in 1996-2019

and 2000-2019. The null hypothesis, RRI does not Granger Cause {(NI-NI*)/NI*} is also significantly rejected in case of first row directly, and in case of second row inversely. Thus, we find that there is bidirectional causal relationship between investment gap ratio {(NI–NI*)/ NI*} and RRI in 2004-19, 2008-19 and 2012-19. We also find that disequilibrium in investment from its trend impact the real rate of interest.

The results in third and fourth rows shows that the null hypothesis, (Ng-Ng*) does not Granger Cause RRI, is rejected significantly in the period 1996-2019, 2000-2019 and 2004-2019. Further, (Ng-Ng*) Granger Cause RRI. Similarly, it can be seen that the null hypothesis, RRI does not Granger Cause (Ng-Ng*) and confirm the bidirectional relationship for the period 2012-2019. Therefore, gap of growth in investment impacts the level of real rate of interest.

The fifth and sixth row show that the null hypothesis, {(NI-NI*)/NI*} does not Granger Cause lagged RRI, and its inverse i.e. lagged RRI does not Granger Cause {(NI-NI*)/NI*}is significantly rejected. Thus, there is a bidirectional causal relationship between investment gap ratio {(NI-NI*)/NI*} and lagged RRI for the period 1996-2019, 2000-2019, 2004-2019 and 2008-2019. Fifth row in 2012-19, investment gap ratio causes lagged RRI. Overall, we can say that the investment gap ratio and adaptive expectations of real rate of interest causes each other.

The seventh and eighth row shows that the null hypothesis that the (Ng-Ng*) does not Granger cause lagged RRI, and similarly, null hypothesis that lagged RRI does not Granger cause(Ng-Ng*) is also rejected significantly for the period 1996-2019, 2000-2019, 2004-2019 and 2008-2019. This confirms the bidirectional relationship between (Ng-Ng*) and lagged RRI all the cases in our model except for the period 2012-2019 where relation is unidirectional i.e. (Ng-Ng*) causes lagged RRI. It means that the gap of growth of investment also affects that level of lagged real rate of interest.

4. Conclusion and Suggestions

This result of the study indicates that the statistically significant coefficients namely β2 & β3. The findings of the study also confirm that the 1% increase in investment disequilibrium results in 4% decrease in the real rate of interest. It means, that lower inflation leads to a high real rate of interest which reduces the prospective yields of producers thereby contracting the supply. This causes the disequilibrium in an economy from its trended equilibrium. It also shows that the 1% rate of recovery or gap of growth of investment leads to 19% increase in the real rate of interest. Higher inflation lowers the real rate of interest which induces the producer to increase investment. Disequilibrium in investment from its trend impacts the real rate of interest. In other words, the gap of growth in investment impacts the level of the real rate of interest. Similarly, adaptive expectations of the real rate of interest are influences the investment.

In substance, we can conclude that standard economic theories are applicable in the Indian scenario in the case of investment determination. Consequently, policy formation is a key driver to achieve the desired growth. The results also suggest that in the long run as well as in the short run, policy-induced modulation of the real rate of interest is an effective mechanism in influencing the growth of the economy in India. Interestingly, in this scheme of things, the nominal rate of interest is not an important variable. Thus, our findings do not support the policy stance of the policymakers of India, who put focus on the nominal rate of interest. (Hussain & Nahar, 2016) interest rate pass-thourgh money market rates to retail rates, it means that the timely actions by monetary policy helpful for an economy.

Therefore, it is recommended that in India, the major emphasis of policymakers should be to manage the real rate of interest to achieve the desired level of growth.

Appendix A

(Derivation of Aggregate supply equation for inflation and real rate of interest from Phillips Curve)

(A.W.Phillips, 1958)

$$\text{Infl}(w)+a = bU^{r} \qquad 1$$

Infl (w): rate of change of wage rate, U: percent unemployment, a, b and ϒ are parameters

(Lipsey, 1960)

$$\text{Infl}(w)=a+bU^{-1}+cU^{-2} \quad (2)$$

(Dornbusch, Fischer, & Richard, 2003)

$$\text{Infl}(GDPD)=\text{Infl}(GDPD)^{e}-\beta\,(U-U^{*}) \quad (3)$$

Infl (GDPD): Actual inflation rate,

Infl $(GDPD)^{e}$: Expected inflation rate,

U: Actual unemployment rate,

U*: Natural unemployment rate,

β(U-U*): β: is a positive constant which represents the response of price inflation rate to a change in the deviation of actual unemployment rate from natural rate of unemployment.

(Gujrati, 2004) The relation in expected inflation and lagged inflation is taken from adaptive expectation scheme i.e. Infl $(GDPD)^{e}$ – Infl $(GDPD)^{e}_{-1}$ = λ[Infl $(GDPD)^{e}$ – Infl$(GDPD)^{e}_{-1}$],

where λ is speed of adjustment, $0<\lambda\geq 1$ when λ =1,

$$\text{Infl}(GDPD)^{e}=\text{Infl}(GDPD)_{-1} \quad (4)$$

Equation 4 has been incorporated in equation 3 and becomes

$$\text{Infl}(GDPD)=\text{Infl}(GDPD)_{-1}+(U-U^{*}) \quad (5)$$

Cycle effect of output on unemployment has been added in equation 5

$$\text{Infl}(GDPD)=\text{Infl}(GDPD)_{-1}+(U-U^{*})-(U-U_{-1}) \quad (6)$$

Data unemployment is not uniform and reliable and its constraint in number of countries. In the absence of authentic data on employment, (Okun, 1962) Okun's law help us estimating the relevant variables. Accordingly,i.e.

$$\alpha(U-U^{*})=\alpha((y-y^{*})/y^{*}) \quad (7)$$

Disequilibrium in labour market from its natural; U*: natural rate of unemployment;

U: rate of unemployment; α=1-U*

$$\beta(U-U_{-1})=\beta(G_{y}-G_{y^{*}}) \quad (8)$$

Cyclical unemployment = gap of growth rate of recovery;

β_{3}=(h.1/q)(sensitivity of the/rate of inflation to the rate of recovery(h)/Okun's parameters(q)); U_{-1} : lagged unemployment

Equation 7 and 8 incorporated in equation (6). (Bishnoi & Kumar, 2019; Kumar, 2013)

$$\text{Infl}(GDPD)=\text{Infl}(GDPD)_{-1}+((y-y^{*})/y^{*})+(G_{y}-G_{y^{*}}) \quad (9)$$

(Hayek, 1934) Contributed the relation of investment and output and in different theories of growth also given the positive relationship between the two. Gross fixed capital formation (investment) has been used as proxy of output due to verified positive relationship between investment and output. Number of theories proved that the investment or asset creation in an economy counted in growth of output. The behaviour of equation 9 modified for investment.

$$\text{Infl}(GDPD)=\text{Infl}(GDPD)_{-1}+((NI-NI^{*})/NI^{*})+(Ng-Ng^{*}) \quad (10)$$

NI is investment, NI* is time trend investment, Ng is actual growth of investment and Ng* is growth of time trend investment. Impact of the investment on real rate of interest also has been estimated in this paper as well as the procedure of adaptive expectation adopted.

$$\text{Real Rate of Interest (RRI)}=\text{Nominal Rate of Interest}-\text{Infl}(GDPD) \quad (11)$$

The relation in expected RRI and lagged RRI is taken from adaptive expectation scheme in equation 4 i.e. $(RRI)^e - (RRI)^e_{-1} = \lambda[(RRI)^e - (RRI)^e_{-1}]$,

where λ is speed of adjustment, $0<\lambda\geq 1$ when $\lambda = 1$,

$$(RRI)^e = (RRI)_{-1} \quad 12$$

Concept of equation 11 and 12 has been incorporated in equation 10.

$$RRI = (RRI)_{-1} + ((NI - NI^*)/NI^*) + (Ng - Ng^*) \quad 13$$

Estimation of equation 10 and 13 is written as stochastic equation to apply econometrics techniques

$$Infl\ (GDPD) = \beta_0 + \beta_1 Infl\ (GDPD)_{-1} + \beta_2\ ((NI\text{-}NI^*/NI^*) + \beta_3\ (Ng\text{-}Ng^*) + u \quad 14$$

$$RRI = \beta_0 + \beta_1 (RRI)_{-1} + \beta_2((NI\text{-}NI^*/NI^*) + \beta_3(Ng\text{-}Ng^*) + u \quad 15$$

Econometrics techniques have been employed on equation 14 and 15 in separate sections.

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