Chapter 3: Private Investment: A single Equation Analysis

3.0.0: Introduction

Studies on private investment usually adopt a single equation approach on the assumption that all the relevant information is captured within the single equation framework. In the q theory, for example, the relevant variable is the marginal q but since it is not observable, empirical analysts use the average q. In empirical studies on investment based on q theory, the investment equation leaves a large unexplained residual, implying that not all relevant information is captured by q (Abel, 1990, Artus and Muet 1990, Ford and Poret, 1991). On the other hand, in the neoclassical theory, the relevant variables are expected output and rental cost of capital. In the literature other variables include profits and uncertainty and variables that relate to them.

Given the characteristics of investment environment in developing countries (as described above), it is possible that single equation analysis may not be able to capture all these characteristics and their policy implications. Consequently, most studies on developing countries include different variables in the investment function on the basis of the researchers hypothesis or desire to capture specific characteristics. The empirical application of the q theory is hampered by not only the underdeveloped nature of markets but also on account of data unavailability.

Over the period of 1975-1996, private investment as a ratio of GDP fell by 3.1 percent per annum. In our attempts at understanding what explains this observed weakness in investment and the policy implications, we adopt a two way strategy, one is an analysis of investment behavior on the basis of a single equation analysis and the other is to investigate investment in a macroeconomic framework. In the single equation analysis we begin by using neoclassical framework to investigate how well it explains the observed investment performance in Kenya. Later in the study we introduce other alternative explanations, among them the complementarity and crowding out effects of government expenditure decisions.

3.1.0 Neoclassical Explanations of Private Investment in Kenya

According to the neoclassical theory as discussed above in chapter 2, firms choose output and factor inputs so as to maximize profits. It is also assumed that various adjustment costs delay the process of movement from the actual capital to the desired level of capital stock. This adjustment mechanism can be expressed as;

$$I = \lambda(K^* - K_{t-1})$$

Where I is net investment and is identical to $K - K_{t-1}$. K^* is the desired capital stock and λ is the adjustment parameter. The determinants of desired capital stock are obtained from the profit maximization conditions. To recapitulate, assume that we have a Cob-Douglas production in the form:$Q = AL^{\alpha}K^{\beta}$ where A is an efficiency parameter, α and β are the shares of labor and capital in total output. Assume further that the firm maximizes profits, π, where $\pi = pQ - rk - wL$. p, r and w are prices of output, capital and labor inputs respectively. Then the firm maximizes profit subject to the constraints that inputs should satisfy the above production function.

From the marginal productivity conditions, the optimal or desired capital stock can be obtained. In these case;

$\partial Q/\partial K = r/p = \beta Q/K = \beta AL^{\alpha}K^{\beta-1}$. The optimal capital stock can then be obtained as;

$K^* = \beta\frac{pQ}{r}$. To arrive at the optimal capital stock it is assumed that Q is exogeneously determined..

In the neoclassical framework investment is expressed as;

$$I = \lambda(K^* - K_{t-1}) = \lambda(\beta\frac{pQ}{r} - K_{t-1}).$$

Accordingly in the neoclassical theory, investment is a positive function of current output and is negatively related to the cost of capital ,r. Empirical studies that have been carried out in the neoclassical tradition, relate investment to the variables in the above equation. Most of the studies as mentioned earlier have been carried out on industrial countries. A survey of early studies can be found in Jorgenson (1971) and recently in Ford and Poret (1991).

The first step in our single equation is to investigate how well this model explains investment behavior in Kenya. In the neoclassical interpretation, the determinants of investment can be viewed in two parts: the accelerator effects relating investment to output and the capital cost factor, relating investment to the cost of capital. As far as the accelerator effects are concerned, most studies on developing countries have confirmed its relevance. The output variable has a positive and statistically significant effect on investment in many studies carried out on developing countries (Rama, 1993). In measuring the cost of capital, such components of cost of investment as; the purchase price of investment goods, cost of financing the purchase of capital goods, depreciation rate, profit taxes and tax credits if any are supposed to be taken into account. Due to data unavailability on corporate income tax rate and tax rebates, our measure of cost of capital is rather simple comprising only three components; the depreciation rate, interest rate on borrowing and price of capital goods. Formally, the cost of capital has been calculated as;$r = p(i + d)$ where r is the cost of capital, p is the purchase price of capital goods (we use the deflator for investment as a proxy), i is the real commercial bank lending rate and d is the capital consumption allowance or depreciation rate.

In the empirical analysis, the change in capital stock (ΔK) is expressed as a function of output, lagged capital stock, and cost of capital. Different specifications and lag structures involving these variables are tested, a few regression results are reported below for discussion. Data is not available for private sector capital stock separately, therefore the equations with ΔK as the dependent variable refer total fixed net investment (public and private together). However since we are interested more in the behavior private investment behavior, we also run similar regressions on private investment. However, the data on private investment is gross terms while the neoclassical theory refers to investment in net terms. If we assume that private capital stock is proportional to total capital stock *(K)*, then, in the regression equations involving private investment, the coefficient of the capital stock variable in this case does not represent the adjustment parameter[30]. In another specification of the dependent variable we have used the investment ratio. The results based on this specification are not quite different from those of total net investment and gross private investment variable. That is, the cost variable is still insignificant and sometimes with a wrong sign whereas the output variable is statistically significant and with the right sign.

The results, thus support the accelerator effects. The output variable is positive and statistically significant in almost all the specifications. Another important issue that can be noted from the empirical results is that lagged output variable does not give statistically consistent results. This, perhaps supports the neoclassical view that output and factor inputs are decided on contemporaneously. We do not find statistical evidence that the cost variable plays an important role in explaining variations in the investment.

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[30]In the neoclassical investment function, net investment, $I = \lambda(K^* - K_{t-1})$. Since private investment is in gross terms, that is, including depreciation, we can add depreciation in the function ($I_P = I + \delta K_{t-1}$) , where δ is the rate of depreciation. Thus gross investment, $I_P = \lambda K^* - (\lambda - \delta)K_{t-1}$. There are also conceptual problems, since depreciation is supposed to handled as a cost within this neoclassical framework. However, equations using the investment goods deflator alone as the cost variable gave similar results as those reported in the table 9.

Table 3.1: Neoclassical Investment Regression Results: Determinants of Private Investment

Dependent Variable		Y	ΔY	ΔY_{t-1}	C	ΔC	ΔC_{t-1}	ΔK_{t-1}	ΔK_{t-2}	K_{t-1}	K_{t-2}	R^2; $\bar{R}^2$; F;
ΔK_t	1.	.32 (2.2)**			-.00 (-0.1)					-.17 (-2.8)**		.52; .42; 5.4
	2.	0.31 (2.9)**			0.01 (1.1)					0.41 (2.3)**	.56 (3.4)***	.79; .72; 12.0
	3.		-6.92 (-0.5)	32.41 (2.4)**		0.00 (.5)	-.01 (-.3)			-.03 (-1.4)		.61; .44; 3.8
	4.		21.60 (2.8)**			.00 (.3)		0.71 (4.6)***				.71; .64; 11.3
	5.		26.1 (2.9)**			.00 (.2)		.77 (3.3)	-.09 (-.4)			.53; .39; 3.7
I_P	1.	.18 (3.0)***			.00 (.46)					-.13 (-1.4)	.05 (.5)	.53; .38; 3.7
	2.	.19 (3.2)***				.00 (.77)				-.13 (-1.4)	.04 (.46)	.54; .40; 3.9
	3.		15.28 (2.2)**			.00 (.02)				.09 (.7)	-.08 (-.7)	.40; .22; 2.2
	4.		14.45 (2.8)**			.00 (.1)	-.04 (.3)					.46; .28; 2.6

Note: K is capital stock, I_P is private investment and C is cost of capital while Y is output. T-statistics in parathesis. *** indicates that the coefficient is significant at 1%, ** at 5% and * at 10% level of significance. The results reported above are selected from the various regression specification experiments carried out in the empirical analysis. These specifications provided better results on the basis of statistical test and are thus reported here for discussion.

Generally, the equations leave out a large unexplained variation in investment. The analysis of investment behavior thus continues by trying to take into account specific developing country investment environment characteristics.

3.2.0: A Model for Private Investment

As discussed in Chapter 2, the alternative theories of investment behavior agree on the validity of the accelerator principle but the determinants of the desired private capital stock. The flexible accelerator model (equation 2.1, chapter 2) is a partial adjustment model, that is, the actual capital stock (K_t) adjusts to the desired level, (K_t^*) only partially and depends on λ, the adjustment coefficient. The direct application of this version of investment model on developing countries is sometimes limited on account of lack of data on private sector capital stock (Blejer and Khan, 1984). Theoretical issues that relate to the variables that should be considered as determinants of desired capital stock in the context of a developing country have been discussed above. Of the theories of investment, perhaps the most dominant is the neoclassical model (Dornbusch and Fischer, 1994). Attempts at empirical application of the neoclassical model on Kenya is discussed above together with the conceptual as well as data limitations: Apart from lack of separate data on private capital stock, difficulties were encountered in calculating the cost of capital related to the fact interest rates were controlled and sometimes turned negative in real terms. The determinants of the desired capital stock in the neoclassical model are obtained from the marginal productivity conditions, that determine the optimal use of inputs assuming perfect information and competitive markets. However, the discussion of the private investment environment in the developing countries in chapter 2 emphasizes constraints to increased investment such as basic infrastructure, macroeconomic instability and finance. Consequently it is of more interest to study investment behavior in terms of these constraints.

In the literature, there are already notable attempts in this direction. Tun Wai (1982) and Blejer and Khan (1984) have incorporated such constraints as lack of infrastructure and 'crowding out' in investment functions for abroad group of developing countries. Our model of private investment behavior is a variant of the accelerator model and draws from the approach by Tun Wai (1982) and Blejer and Khan (1984). The accelerator model is reformulated to take into account the data limitations and some of the developing country specific constraints.

We start by setting a partial adjustment model for gross private investment, which can be expressed formally as

$$\Delta I_t = \beta(I_t^* - I_{t-1}) \quad (3.1) \text{ or}$$

$$I_t - I_{t-1} = \beta(I_t^* - I_{t-1})$$

Where, I_t^*, is desired or optimal investment at time t, I_t is actual investment at time t and β is the partial adjustment coefficient reflecting the assumption that the rate at which firms move from actual level of investment to the desired or optimal level is gradual involving lags. Equation 3.1 above simply states that, the change in investment is a partial adjustment to the gap between the desired and actual investment. As to the question about the underlying production function, we assume a Domar type production function that relates output to the stock of capital[31].

[31]The above formulation is necessitated by the lack of data on private capital stock, see Blejer and Khan (1984) for a similar specification. Salimano (1989) begins from this premise in his formulation of investment function for Chile.

The desired capital stock, K^*, is assumed to be proportional to expected aggregate demand/output, Y_t

$K^* = \delta Y_t$......................................(3.1a) Where $\delta > 0$.

This specification assumes a fixed factor proportions production function. Fixed factor proportions production function may be justified on the grounds of existence of surplus labor and thus production is constrained by the size of capital stock. An alternative production function that allow factor substitution, would require introduction of the ratio of rental cost of capital to wage rate. Data unavailability makes it difficulty to calculate these variables.

Actual private capital stock in period t can be formally expressed as;

$K_t = K_{t-1} + I_t - aK_{t-1} = I_t + (1-a)K_{t-1}$.

Where a is the depreciation rate. Thus gross investment at time t is equivalent to:

$I_t = K_t - K_{t-1} + aK_{t-1} = K_t - (1-a)K_{t-1}$....................(3.2)

Introducing the lag operator, that is, $LK_t = K_{t-1}$, then equation (3.2) above can be written as:

$I_t = [1-(1-a)L]K_t$.

In a steady state then;

$I_t^* = [1-(1-a)L]K_t^*$.................................(3.2a).

Where I_t^* is the desired investment at time t. By combining equation (3.1a) and (3.2a) above, we obtain;

$I_t^* = [1-(1-a)L]\delta Y_t$ ....(3.3)

This relationships require that $K_{t-1}^* = K_{t-1}$. This would generally hold under a steady state condition. By substituting equation (3.3) in to (3.1) we obtain a dynamic flexible accelerator model:

$\Delta I_t = \beta([1-(1-a)L]\delta Y_t - I_{t-1})$.................................(3.3a)

We adopt the approach used by Tunwai and Wong (1982) and Blejer and Khan (1984) to allow private investment to vary with economic conditions. We thus hypothesis that β depends on: (1) public investment on infrastructure, *(pu)* (2) availability of finance in terms of profits (π) (3) credit and (4) uncertainty or risk (ξ) in relation to the gap between desired and actual investment.

Formally β can be expressed as;

$$\beta = f(\frac{pu}{I_t^* - I_{t-1}}, \frac{\pi}{I_t^* - I_{t-1}}, \frac{\zeta}{I_t^* - I_{t-1}}, \frac{f}{I_t^* - I_{t-1}}) \qquad (3.4)$$

Note that each variable is expressed in relation to the size of the discrepancy between actual investment and the desired level of investment. In this specification, the above hypothesized factors affect investment through the process of adjustment from actual investment towards desired levels. In a linear form, equation (3.4) above can be represented as;

$$\beta = \mu_0 + \frac{1}{(I_t^* - I_{t-1})}(\mu_1 pu + \mu_2 \pi + \mu_3 \zeta + \mu_4 f) + \varepsilon \qquad (3.5)$$

By substituting equation (3.5) into (3.1) and solving for I_t, we obtain;

$$I_t = \mu_0(I_t^* - I_{t-1}) + \mu_1 pu + \mu_2 \pi + \mu_3 \zeta + \mu 4 f + I_{t-1}$$

$$I_t = \mu_0 I_t^* + \mu_1 pu + \mu_2 \pi + \mu_3 \zeta + \mu_4 f + (1 - \mu_0) I_{t-1} + \Phi \qquad (3.6)$$

Where Φ is a disturbance term

In equation (3.6) , I^*_t, the desired investment is not observable , by substitution of (3.3) in to (3.6) we obtain.

$$I_t = \mu_0[(1 - (1 - a)L]\delta Y_t + \mu_1 pu + \mu_2 \pi + \mu_3 \zeta + \mu_4 f + (1 - \mu_0) I_{t-1} + \Phi \qquad (3.6a)$$

Equation 3.6a above represents our model for private investment in Kenya. Using this model an attempt is made to explain the actual observed investment performance. Although the discussion in chapter 1 and chapter 2 suggest that more variables need to considered in the investment function, its is a normal practice in empirical analysis to concentrate on a few variables considered more important and test the validity. Moreover, given the sample size, the more and more variables you include the less the degrees of freedom *(df)* and so is the reliability of such inferences made from the empirical results. Each of the explanatory variables in equation 3.6a is discussed below in relation to private investment.

3.2.1: Profits

The neoclassical theory refers to profits implicitly by explaining investment in terms of the factors that determine its profitability. In the literature, some studies in 1960's and 1970's have accorded profits a direct causal effect on investment. These studies are among those surveyed by Jorgenson (1971). In recent literature, profit is receiving renewed interest as a direct determinant of investment. (See for example, Catinat et al, 1987 and European Economy No. 50 (EE), December, 1991). In EE, (1991) it is noted that about three quarters of variability in capital stock in OECD could be explained by variations in profitability.

In developing countries with underdeveloped capital markets one would expect profits to play a more direct causal effect. Even in a developed capital markets system, profits may be viewed as a way of financing capital expansion without resorting to external borrowing thus limiting indebtedness of the firm and outside control.

At a macroeconomic level, the measurement of profits is more difficulty and as a result, round about techniques have to be adopted. Two roundabout techniques are available at the macroeconomic level (Dornbusch and Fischer, 1994). One is based on the operating surplus component of incomes in total incomes (EE, December, 1991) and the other is based on marginal productivity principles.

3.2.1.1: Profitability in a Macroeconomic Framework. Operating Surplus Approach

As discussed in chapter 1, from the national accounting perspective, total incomes earned can be divided between wages (incomes to labor) and non wage incomes. From these then a measure of profitability can be computed[32]. Measures of profitability for OECD countries based on this concept, can be found in (EE) No. 50 (1991). The study observes a strong correlation between 'a strong and sustainable' catching up process, and high investment supported with high returns to capital. It is observed that Japan achieved these catch up process in the 1960's, with the profitability index rising from 69.5 in 1960 to 139.2 in 1970. In the European Community countries, a similar trend is noted in the case of Greece, Spain and Portugal during their catching up period in the 1960's. We have used data from the UN National Account Statistics to compute a rough measure of profitability of capital[33] for South Korea (South Korea is one of the new industrialized countries on which data is available). It shows that profitability of capital increased from about 43 percent in 1960 to 53 percent in 1977. Using data from (EE) No. 50 (1991) Dornbusch and Fischer, (1994) observes that recessions in the US have been associated with low profitability. On the issue of causality between profits and investment, Ford and Poret (1991) find statistical evidence that profits cause investment in France, Italy and UK but investment cause profitability in US, Japan and Germany[34].

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[32]Assuming that W is wage incomes and P is nonwage incomes, then $W + P = Y - T$, where Y is income and T is indirect taxes. In turn $W = w.L$, where w is wage rate, and L labor input (employment). Similarly $P = r.K$ where K is capital stock and r is the rate of return on capital. Thus P/K gives a rough indicator of profitability.

[33]The measure used is the operating surplus (deflated by the investment deflator) as a ratio of real GDP

[34]These results may also be a reflection of the extent to which investment in the respective countries is financed from internally generated funds. We have not found any study on this aspect in the context of developing countries.

This measure of profitability should be taken only as a proxy since at the macroeconomic level, gross income of capital can not be calculated accurately. We have estimated a similar measure of return to capital in Kenya. This is shown in chart 3.1. We obtained gross operating surplus in the economy by subtracting from GDP at factor cost total wage cost of employees and non monetary output[35]. Data on traditional output is available from the official statistics. It is obtained by 'interpolating annual estimates of population connected with traditional production to estimates of aggregates such as consumption of firewood, number of dwelling etc., in base years for which information has been directly obtained' Republic of Kenya, Statistical Abstract, 1995 page 55. Using GDP at factor cost ensures that subsidies are included in incomes of firms. There is a conceptual problem however, profit at the firm level is equivalent to total revenue minus total variable costs including costs of intermediate inputs. Our measure does not take in to account this aspect of cost, consequently, we have deflated the operating surplus by the deflator for investment goods. This ensures that, the incomes are viewed in terms of the amount of capital goods that they can command. There is another problem with the measure, it needs to be corrected for incomes of the self employed and capital consumption allowance or depreciation. In adjusting operating surplus for depreciation, there is a problem of heterogeneity of capital, different kinds of capital have different lifetimes and so is their depreciation rates. In view of what is practicable, for this study we have adjusted real non wage incomes for depreciation (depreciation on overall capital stock - there is no data on depreciation for private capital stock separately, moreover data on private capital separately is not available) to obtain net operating surplus without taking into account the heterogeneity of capital. We do not have

[35]As defined in the United Nations System of Accounts (SNA), this is the sum of wages and salaries, contributions by employers to social security schemes for employees and contributions, paid or imputed made by employers to employees for pension, insurance, and family allowances. For definitions see. United Nations National Accounts Statistics, Years Book, for definitions.

data on self employed incomes, thus the final measure is not adjusted for these kind of incomes. Our proxy measure of return to capital is thus net operating surplus as a ratio of capital stock both at constant 1982 prices (or GDP at factor cost less traditional output less depreciation as a ratio of capital stock in real terms). Chart 3.1. shows movements in this variable.

3.2.1.2: Profitability: A Marginal Productivity Approach

As indicated above another proxy measure of returns to capital can be obtained from the marginal productivity conditions. Assuming a Cob-Douglas production, the marginal productivity for capital is equal to the share of capital in total output multiplied by output capital ratio($\partial Q/\partial K = \gamma(Q/K)$. The share of capital in total output in current prices has averaged around 60 per cent over the period of 1975-1994. It is thus possible to obtain a rough measure of marginal productivity of capital since data on output capital ratio is also available. To obtain a measure for return to capital that takes into account cost of investment, the value of marginal productivity of capital was deflated by the investment deflator[36].

Another indicator of profitability that was tried is the ratio of net operating surplus to total value added. There is a close correlation between this variable and net operating surplus as a ratio of capital stock. They may be linked due to the fact that there is a strong correlation between capital stock and total value added. Our two measures of profitability are presented in chart 3.1. They are highly correlated, with a correlation coefficient of about is .94.

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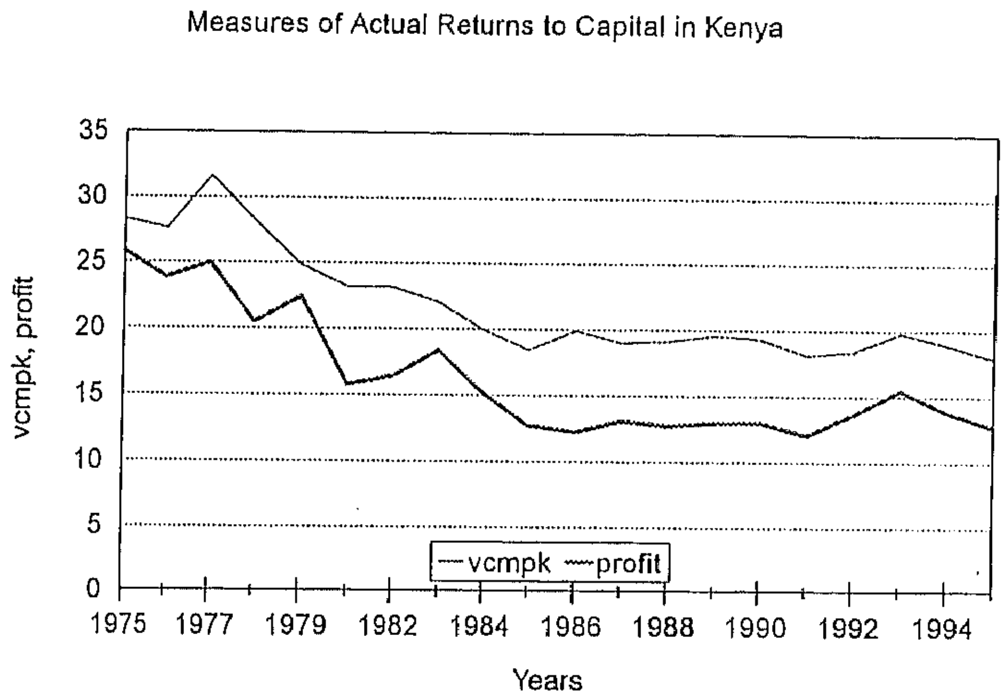
[36]According to the neoclassical theory, it is profitable for a firm to invest whenever, the value of marginal product of capital exceed the user cost of capital. The user cost of capital may be defined as $P(r+d)$. Where P is the price of capital goods, r is the rate of interest and d is depreciation. Interest were controlled in Kenya up to 1991 and occasionally turned out negative in real terms. Thus using a measure of cost of capital that includes negative interest rates renders the cost of capital negative in some years. Consequently, we have used P in relation to value of marginal productivity of capital to provide a measure for attractiveness to invest.

Chart 3.1 :Measures of Actual Returns to Capital in Kenya



vcmpk is the marginal productivity of capital (the share of capital in total output times the output capital ratio) multiplied by the relative cost of capital. Profit on the other hand is the ratio of net operating surplus to capital stock

The measures of profitability of capital shown in chart 3.1 reveal that profitability of capital fell drastically between 1975 and 1985. Although profitability remained somewhat stable over the period 1985-1994, these levels were much lower than those of the first decade up to 1985. These may be explained in terms of strong import substitution measures of the 1970's and early 1980's and falling efficiency in use of capital resources - see trends in ICOR's discussed in chapter 1. Chart 3.1 may lead us to tentatively conclude that the declining trend in profitability help explain the observed performance in investment.

3.2.2: Public Policy and Private Investment

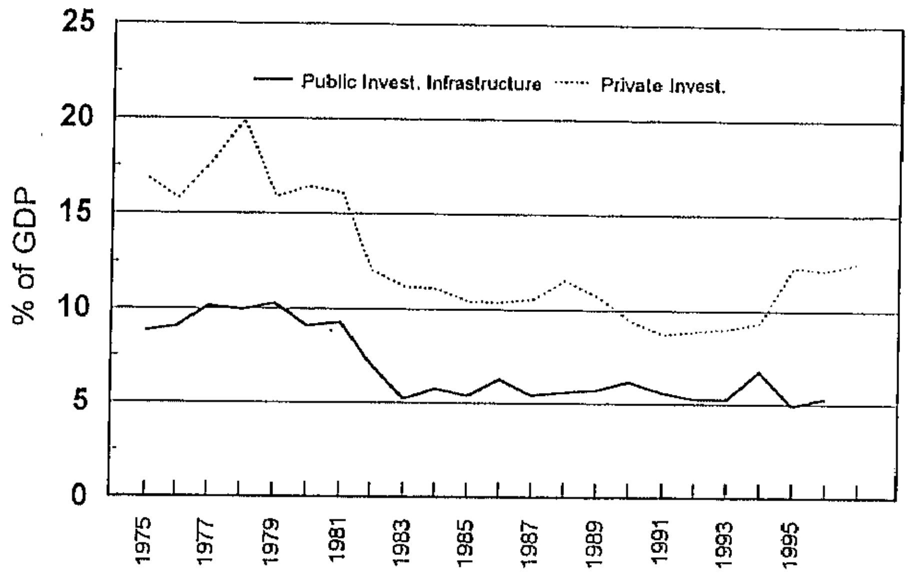
In studying the effect of public sector expenditure-revenue decisions on private investment in developing countries, two hypothesis are usually investigated: the complementarity and 'crowding out' hypothesis. The complementarity hypothesis emphasizes the positive effects of government expenditure on private investment, especially infrastructure investment by the government. Investment on basic infrastructure such as roads, ports, railways is supportive of private investment and thus should be encouraged. The crowding-out or substitutability hypothesis, on the other hand postulates that increases in public expenditure may lead to a reduction in private investment especially if the public sector invests in competing activities. On the financing side, the crowding out hypothesis presupposes that financing of public investment whether through taxes, issuance of debt or direct borrowing reduces the resources available for the private sector for investment and therefore has an adverse impact on private investment activity (Gregori (1992); Blejer and Khan (1984); and Rama (1993)).

Data on composition of public investment in Kenya is available in 7 categories: residential buildings, nonresidential buildings, construction and works, land improvement and plantation development, transport equipment, machinery and other equipment, breeding of stock and dairy cattle. To distinguish between public investment on basic infrastructure and other types of investment, we assume that investment on infrastructure constitute: public investment in construction and works, transport equipment, and machinery and equipment[37]. The chart below shows evolution of investment on the basis of this classification. The sharp

[37]The various categories of public investment may be overlapping. However, it is believed that investment under these three categories better represents investment in infrastructure. Investment in machinery is included since construction of basic infrastructure (say) roads and/or bridges, ports, electricity etc. involves machinery.

increase in infrastructure investment in 1994, reflects the increase in investment due to the construction of oil pipeline to Western Kenya. However, a general downward trend in investment on infrastructure can be observed.

Chart 3.2: Public Investment on Infrastructure as a ratio of GDP



Source: Statistical Abstracts, Various Issues, Republic of Kenya

The importance of infrastructure for investment has been also confirmed in survey on the private sector constraints carried out by GTZ[38] in 1992 that found that among the major investment constraints were infrastructure related, especially the quality of roads, telephone services, waste water and garbage disposal among other problems.

By concentrating on the positive effects of government expenditure on private investment one might overlook the negative impact through crowding out. If the government finances its investment expenditure through borrowing this may reduce the available resources

[38]The results are summarized in "Industrial Development Strategy Study", Republic of Kenya (1993) carried out by Engineering Consulting Firms Association, Japan (ECFA)

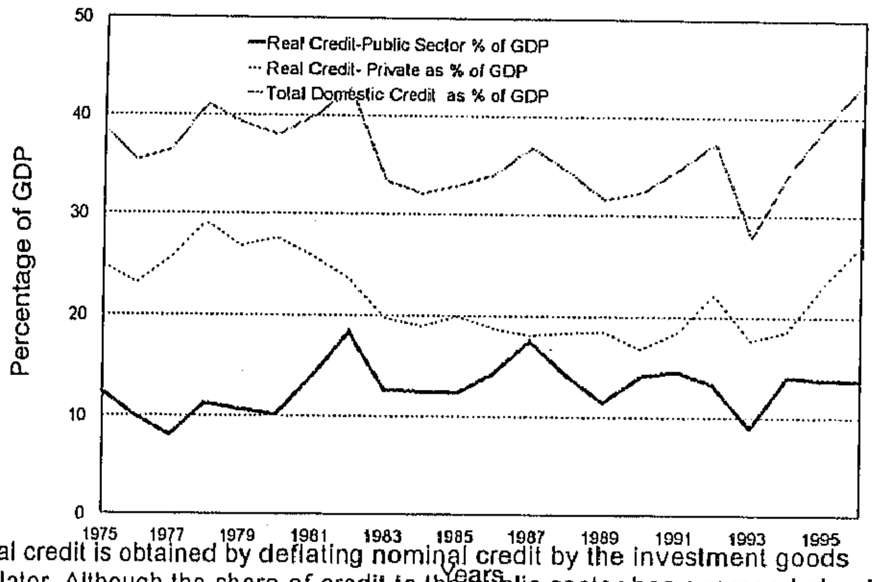
for private sector investment. In Kenya, the share of credit to the government has been on average about 35 percent of total credit. If we assume that the amount of funds available is fixed[39], then as the government obtains more funds, firms will get less. The chart below shows the distribution and trend in real credit.

A general slow down in growth of overall credit over the period 1983-1995 can be seen from the chart. In relation to credit to the public sector, it seems clear that the fall in overall credit fell heavily on the private sector. In 1992, there was a sharp increase in credit levels. This is probably due to excessive expansionary policies adopted by the government during the first multiparty elections in 1992. This was followed by a restrictive policy to bring down inflation, this accounts for the drastic fall in credit levels in 1993. In the empirical analysis, attempts are made to asses whether public borrowing from the banking system has actually lead to crowding out of private investment. We implement this by including the total bank credit less government borrowing as a ratio of real GDP in the investment function. Chart 3.3 shows movements in the shares of credit to the private sector, public sector and total credit.

[39]Total credit expansion may be a policy variable. For example under stabilization credit ceilings have been widely used, which implies that, the higher the share of credit to the public sector in total credit, the lower the share of credit to the private sector.

Chart 3.3: Composition and Trend in Credit 1975-1996

Composition and Trends in Bank Credit (1975-1996



Real credit is obtained by deflating nominal credit by the investment goods deflator. Although the share of credit to the public sector has averaged about 35 percent in nominal terms, in real terms the share is about 13 percent. Total bank credit stood at about 35 percent (in real terms) on average over the period 1975-1996.

Source: International financial Statistics, IFS, IMF, Various Issues

Fiscal policy reform under adjustment has required that adjusting governments maintain a balanced budget or cut down budget deficits. For example, in classifying countries on the basis of their fiscal stance, World Bank (1994) groups Sub-Saharan countries as having a 'good' or 'adequate' rating if they had a budget surplus or a deficit of less than 1.5 percent of GDP over the period 1990-91. Only five countries meet this criterion: The Gambia, Ghana, Mauritania, Senegal and Tanzania. Kenya was rated among the 'poor' group with a deficit of 3.6 -7.0 percent of GDP.

Keynes long viewed the idea of a balanced budget as misguided and argued that the government had an important instrument (government expenditure) to stimulate the economy when the resources of the economy were underemployed. Budget deficits require that the country borrow what it does not raise through taxation. Since government expenditure is not offset by increased taxes, the multiplier effect of increased government expenditure is higher than the case of a balanced budget. Consequently budget deficit financing may have a much stronger impact on investment than a balanced budget. The idea of financing government expenditure through budget deficits, run into problems in early 1980's when developing countries that had borrowed heavily from abroad found themselves unable to pay their debts. Since then most economists now hold idea that responsible governments should maintain balanced budgets. On Africa, the World Bank notes that '*African countries had to establish a balance between income and expenditure to improve balance of payments. This required tightening of fiscal and credit policies..........*" (World Bank (1994) Page 43.

The overall government budget deficit improved from above about 5.6 per cent of GDP in 1993/94 to 3.6 per cent in 1994/95 and further to 0.9 percent of GDP in 1995/96[40]. A reduction in budget deficit may be achieved by either increasing revenue or cutting expenditure, while efforts to raise revenue have achieved some success, it has been difficulty to reduce overall public expenditure. For example while current revenue as a percentage of GDP increased from about 24.5 percent in 1990 to about 30 percent in 1996, total public expenditure increased from about 40 percent of GDP in 1990 and 45 percent in 1996.

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[40]See Economic Survey, Republic of Kenya, 1997. This overall deficit includes external grants which has been on average about 7 percent of total expenditure or about 2.6 percent of GDP in recent years.

3.2.3: Risk or Uncertainty

There are a number of reasons why risk enters a firm's investment decision. Investment once undertaken can not be wholly reversed. Some firms may operate on thin margins such that a slight change in economic conditions (say an increase in costs) entail serious losses to the firm. As a result, under uncertain conditions a firm may choose to 'wait and see' or postpone its investment. Firms usually make forecasts of costs and sales to determine profits. Due to information imperfections such future projections may not be certain. Thus investment expenditure is associated with some risk.

In recent macroeconomic literature, uncertainty or risk has received increased attention as a determinant of investment. See for example discussion by Pindyck (1993), and Dixit and Pindyck (1994). In empirical work, several proxies are employed to reflect uncertainty in the economy or an uncertainty index based on the above measures of uncertainty (Serven and Salimano (1998)). Although the emphasis here is on uncertainty based on economic variables, this risk or uncertainty may also arise out of political and social instability. For the purpose of this paper, various proxies have been tried. These include; variability in output, profits, exchange rate and external debt.

3.3.0 Non-Neoclassical Determinants of Private Investment Empirical Analysis

The task in this section is to analyze to what extent the factors discussed above explain the observed performance in investment behavior[41]. To implement complementarity and substitutability hypothesis discussed above, we include the share of credit to the private sector ($TCR - PRC$) as well as public investment in the investment function[42]. The empirical regression results are based on equation 3.6a above. In our model, expected output is not observable. For empirical analysis, our measure of expected output relates potential output to actual incomes. Potential output is estimated on the basis of the Domar growth model. Accordingly, capital stock is related to potential output by the following two equations:

$$ß\frac{\partial K}{\partial t} = \frac{\partial c}{\partial t} \text{ and therefore } \int ß\frac{\partial k}{\partial t}\partial t = \int \frac{\partial c}{\partial t}\partial t$$

Therefore, $C_{(t)} = ßK_{(t)}$ is the production function, implying that with a given capital stock, K, the economy is effectively capable of producing $C = ßK$ output. Where C is capacity or potential output, ß is capacity-capital ratio and K is capital stock. Our measure of expected incomes relates potential output to actual total expenditure in the form: $\frac{Y}{C} = UTR$ where Y is total expenditure (GDP) and C is capacity output.

[41]Most empirical studies on investment on developing countries employ an eclectic approach and thus the list of endogenous variables may vary depending on the statement of the problem.

[42]The share of credit to the private sector is expressed as $TCR - PRC$, where TCR is total bank credit as a percentage of GDP in real terms and PRC is the share of bank credit to the public sector as a percentage of real GDP. This specification is important in analyzing the impact of financial 'crowding out' within a macro framework in the next chapter. To test for complementarity/substitutability in real terms both public investment on infrastructure as well as other public investment is tested in the econometric analysis.

3.3.1 Empirical Regression Results

The regression results of the model 3.6a are reported in table 3.2 below. Real private investment is expressed as a function of actual profits, expected output or incomes, credit to the private sector, variability in profits, public investment on infrastructure and lagged private investment. The results suggests that government borrowing from the banking system may 'crowd out' private investment. In almost all the experiments (some not reported here), the credit variable cane out statistically significant and with the expected sign. In some specifications, public investment came out with negative sign but insignificant - see for example equation 1 and 2 reported below for discussion. As for the proxy measures for uncertainty, the sign was as expected except for equation 4, however, this is also insignificant. Our proxy variable for expected incomes/output was consistently statistically significant and with the expected sign.

There are two possible explanations for the results for the public investment variable. One explanation may be in relation to the inefficiency of public investment. There have been problems in the composition of public investment in Kenya. This problem has been highlighted in the Sessional Paper No. 1 of 1986 on *Economic Management for Renewed Growth* (Republic of Kenya, 1986) and the National Development Plan (NDP) 1994-1996, (Republic of Kenya, Dec., 1993). For example, NDP 1994-1996, page 5 notes that '*investment resources were spread over a large number of unproductive investments especially among public corporations*'. To redress this problem, the government embarked on a Budget Rationalization Program (BRP), aimed at concentrating resources on high yielding projects. As is discussed later in chapter 5, apart from most public investments going to parastatals, capital expenditure by the state has been falling. Instead more resources went to loan repayments and labor costs (see table 5.1). The second possible explanation is that public investment affects private investment through profitability. In most equations that exclude profitability variable in the specification, the public investment variable came out with the expected sign and statistically significant. In equations 3 and 4 that exclude profitability, the standard error for the public investment variable fall drastically which is reflected in the t statistic. Generally speaking, the regression results do not reject the complementarity hypothesis. For the purpose of further analysis of econometric analysis of the time series data characteristics, equation 5 has been selected on the basis of its better statistical performance. .

Table 3.2: Non-neoclassical Regression Results: Determinants of Private Investment

Dependent Variable		ΔUTR	ACRP	PUI	PUINF	VAR	I_{Pt-1}	ΔI_{Pt-1}	$(\frac{\pi+\pi_{t-1}}{2})_{t-1}$	R^2; $\bar{R}^2$; F; DW
I_P	1.	1946.19 (4.0)***	.28 (2.9)**		-7.47 (-.6)	-.25 (-1.3)	.61 (3.5)***		13.03 (2.83)***	.74; .60; 5.33 ;
	2.	1914.12 (3.6)***	.28 (2.5)**	-.79 (-.09)		-0.21 (-1.1)	.59 (2.5)**		11.22 (1.9)**	.74; .59; 5.1; 2.09
	3.	1390.57 (3.3)***	.16 (2.0)*	12.83 (3.1)***		-.06 (-.31)	.33 (1.8)*			.68; .57; 5.1; 2.09
	4.	1378.44 (5.2)***	.17 (1.8)*		18.49 (2.2)**	.14 (.77)	.49 (2.5)			.60; .45; 3.9; 2.20
	5.	1049.17 (2.4)**	.27 (3.1)***			-.59 (-2.7)**		275.10 (3.6)***	11.65 (4.2)***	.74; .63; 6.86; 1.9

I_p is real private investment, CRP is equivalent to *TCR-PCR* as defined above, *PUI* is total public investment, PUINF is public investment on infrastructure. Note that equations 6 and 7 do not include any measure of profitability of Capital. π is a measure of actual profitability

The sample period generally covers 1976-1995

*** significant at 1 percent level of significance

** significant at 5 percent level of significance

* significant at 10 percent level of significance

T- Statistics in parenthesis

The intercept coefficients are not reported in the table above.

3.3.2: Profits, Investment and Causality

The discussion in the previous sections, has presumed that profits determine investment. However, Ford and Perot (1991) have found statistical evidence on the contrary in some countries. They report statistical evidence that profits causes investment in Italy, U.K and France whereas in U.S, Japan and Germany, investment cause profits. Although the results can also be interpreted in terms of the importance of internal finance in financing investment in the respective countries, it also implies that profit-investment relationship may be country specific. Against this background it is of interest to attempt to establish the direction of causality between these two variables in the Kenyan case.

To establish the direction of causality between profits and investment we employ Granger Causality Test. Granger (1969) has proposed a concept of causality based on the prediction error. A variable X is said to 'Granger Cause' Y if Y can be forecast better using the past values of Y and past values of X. The conventional Granger causality test involves specifying a bivariate vector auto regressive model as;

$$X_t = b_0 + b_1(L)X_t + b_2(L)Y_t + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

$$Yt = a_0 + a_1(L)Y_t + a_2(L)X_t + \zeta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.8)$$

Where (L) is a distributed lag function that can be expressed in a general form by polynomials of the lag operator L defined for example as $LX_t = X_{t-i}$. ε and ζ are random terms. The null hypothesis that X does not 'Granger cause' Y requires that the coefficients of a_2 (equation 3.8) in lag structure equal to zero. This can be tested using the standard F test. Likewise the null hypothesis that Y does not cause X requires that b_2 in the distributed lag is equal zero.

The testing of (3.7) and (3.8) becomes a little complicated if the time series data is not stationary[43]. If the variables become stationary after first differencing then equations (3.7) and (3.8) are conducted in the first difference of the variables. The first step in our investigation to establish whether profits cause investment or vice versa is then to establish whether the series are stationary or require to be differenced to achieve stationarity.

3.3.2.1: Tests for Stationarity (Unit Roots)

The standard procedure for testing for stationarity is to fit the relevant time series data to an appropriate autoregressive (AR) process and test whether the roots imply stationarity or not[44]. The Dickey-Fuller (DF) test and Augmented Dickey-Fuller (ADF)[45] test for stationarity or unit roots are usually implemented by estimating the following regression.

$$\Delta x_t = \theta + \beta T + \rho x_{t-1} + \sum_{i=1}^{n} d_i \Delta x_{t-i} + e_t \quad \text{.................................(3.9)}$$

Where x_t is the relevant time series variable, T is time trend and e_t is the disturbance term. d -coefficients are the second order corrections. Since we do not know beforehand what order of AR fits the given series, it is a normal practice to estimate the above equation adding many terms of differenced variables necessary to achieve residuals that are non-auto correlated. Equation (3.9) encompasses two different types of trends: a stochastic trend and a

[43]Standard regression techniques require data to be stationary in the sense that the mean, the variance and covariance remain constant. If the series are trending (as is common in macroeconomic time series data), then the traditional measures of goodness of fit (say R^2 or t-ratios) may consist of spurious correlation.

[44]Assume we have stochastic variable, Y. In the simplest first-order AR process, it can be expressed as: $Y = \varphi Y_{t-1} + \varepsilon_t$. Where ε_t is the random disturbance term. In terms of the lag operator notation, this can be expressed as: $(1 - \varphi L)Y_t = \varepsilon_t$. Where $LY_t = Y_{t-1}$.This AR process can only be stationary if the root $1 - \varphi L = 0$. Which implies that the process is stationary if $-1 < \varphi < 1$. For economic variables, we rule out negatives, thus $0 < \varphi < 1$.The above AR process can be rewritten as $\Delta Y = \varphi^* Y_{t-1} - \varepsilon_t$. Where $\varphi^* = \varphi - 1$. Testing the null hypothesis that $\varphi = 1$against the alternative that $0 < \varphi < 1$, is equivalent to testing the so-called *unit root*, that is, $\varphi^* = 0$. Thus in testing for stationarity the relevant variable is usually expressed in the form$\Delta Y = \varphi^* Y_{t-1} - \varepsilon_t$ together with a time trend and a constant.

[45]The main difference between DF and ADF test is that the latter based on a general AR process as in equation (3.9), while DF test is based on first order AR process, that is, equation (3.9) without the second order corrections

deterministic time trend. T is included because the alternative hypothesis is that the series is stationary around a time trend. If the series has a unit root (non-stationary) and no time trend, then the estimated coefficient for β and ρ in (3.9) above should be zero. Usually this is done a joint hypothesis test $\beta = \rho = 0$, failure to reject this null hypothesis implies that the series is subject to stochastic trend and not a deterministic trend. Under this conditions stationarity can be achieved by differencing. Nelson and Plosser (1982) provide statistical evidence that economic time series data does not comprise both a stochastic and deterministic trend. That is, it is highly unlikely that β will be significant when $\rho = 0$. If the joint hypothesis ,(Θ), $\beta = \rho = 0$ is rejected the series is stationary and the process of investigating its unit root ends. Otherwise other restrictions are tried, for example, a stationary series with no time trend, that is (3.9) without the second term. The t test statistic for $\rho = 0$, tests for null hypothesis of a unit root, if it exceeds the critical value the series is considered to be stationary. The results obtained by estimating (3.9) and its first order AR both in levels and differences are reported below:

3.3.2.2 Results: Unit Root Tests for Profit Rate (π)and Real Investment (I_p)

To test profit rate variable for stationarity, the ADF and DF regression processes reported above has been implemented and the results are reported below for discussion.

$$\Delta\pi = -2.97 + 0.03T - 0.16\pi_{t-1} - 0.71\Delta\pi_{t-1} - 0.58\Delta\pi_{t-2} - 0.34\Delta\pi_{t-3} \ldots\ldots (3.10a)$$

(-.38) (1.1) (-.5) (-1.8) (-1.4) (-1.1

R^2=.47; Q(4-0) = 4.3; F(2,10)= 3.28; Sample 1979-1994

and

$$\Delta\pi = 6.67 - 0.14T - .39\pi_{t-1} \ldots\ldots (3.10b)$$

(1.5) (-.94) (-2.1)

R^2 = .25; Q(4-0) = 1.4; F(2,16)= 2.79; Sample 1976-1994

In both 3.10a and 3.11b above, the Q statistic shows that there does not appear to be higher order serial correlation. To test for stationarity of the π series, the t ratios on the coefficient of π_{t-1} in 3.10a and 3.11b have to be examined. They take the values of -.5 and -2.1. They have to be compared with critical values from table 8.5.2 in Fuller (1976)[46]. At five percent level of significance the critical value is -3.6. We can not reject that the coefficient of π_{t-1} is zero. The reported F statistic in both 3.10a and 3.10b correspond to the joint hypothesis Θ, that is, the coefficient of π_{t-1} and the time trend are both zero. The relevant critical value is 7.24 in table 6; Dickey and Fuller (1981). Both are statistically insignificant. The series does not appear to have a deterministic trend, the coefficient of T is highly insignificant in both cases.

To determine whether $\Delta\pi$ is stationary we estimate DF regressions for $\Delta^2\pi$, the second difference of the profit rate. This gives:

$$\Delta^2\pi = -2.69 + 0.16T - 1.49\Delta\pi_{t-1} \qquad (3.11a)$$
$$\quad (-2.1) \quad (1.6) \quad (-6.6)$$

R^2=.74; Q(4-0) = 4.13; F(2,15)= 21.78; Sample 1977-1994

and

$$\Delta^2\pi = 1.31\Delta\pi_{t-1} \qquad (3.11b)$$
$$(5.75)$$
R^2=.66; Q(4-0) = .6; Sample 1977-1994

The test now suggest that we can reject the hypothesis that change in profit rate is non-stationary. It indicates that the profit rate is non-stationary but becomes stationary after the first difference. The series is integrated of order 1 or $I(1)$[47].

To investigate the unit root characteristics of the private investment series, we follow a similar procedure. The following regressions have been estimated.

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[46]Under conditions of non-stationarity, the OLS estimators are biased downwards. Dickey and Fuller have tackled the above problem by tabulating the asymptotic distribution of t statistic under these conditions.
[47]A series is said to integrated of the order d, denoted as I(d), if it has to be differenced d times before it becomes stationary.

$$\Delta I_P = 597.03 - 0.72T - 1.44I_{t-1} + 1.8\Delta I_{t-1} + 0.61\Delta I_{t-2} + 0.68\Delta I_{t-3} + 0.23\Delta I_{t-4} \ldots\ldots (3.12a)$$
(3.5) (-0.4) (-3.4) (3.2) (2.4) (3.6) (1.1)

R^2=.75; Q(3-0) = 5.1; F(2,8)= 6.3; Sample 1980-1994

and

$$\Delta I_P = 228.96 - 0.95T - 0.6I_{t-1} \ldots\ldots\ldots\ldots (3.12b)$$
(1.03) (-.58) (-1.3)

R^2=.13; Q(4-0) = 6.10; F(2,16)= 3.3; Sample 1976-1994

The reported F statistics in 3.12a and 3.12b lead to the acceptance of the null hypothesis that the coefficient of the time trend and investment (I) lagged one year are not statistically different from zero. The individual t statistics are also statistically insignificant in relation to their critical value of -3.6. This indicates that the private investment series is non-stationary in levels. We test the unit roots by using the second difference of the investment series. The following regressions are estimated.

$$\Delta^2 I = -16.05 - 1.04T - 1.03\Delta I_{t-1} \ldots\ldots\ldots\ldots (3.13a)$$
(-0.54) (0.44) (-3.9)

R^2=.51; Q(4-0) = 4.1; F(2,15)= 7.8; Sample 1977-1994

and

$$\Delta^2 I = -1.01\Delta I_{t-1} \ldots\ldots\ldots\ldots (3.13b)$$
(4.2)

R^2=.51; Q(4-0) = 4.3; Sample 1977-1994

The F statistic in 3.13a indicate that the joint hypothesis(Θ) $\beta = \rho = 0$ can not be accepted. The coefficient of ΔI_{t-1} in 3.13b is greater its critical value of -1.95 at 5 percent level of significance. The results now suggest that the investment is stationary. We thus conclude that investment series as the profit rate series is non-stationary in the levels but becomes stationary after the first difference. Both series are integrated to the order of 1 or I(1). Unit root tests on credit and output suggest that they are I(1).

After establishing the order of integration we can now carry out the standard granger causality tests. Our analysis above shows that the Granger causality tests have to be carried out in the first difference of the variables. The estimated regressions are in the form;

$$\Delta\pi_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\Delta\pi_{t-i} + \sum_{i=1}^{n} \beta_{2i}\Delta I_{t-i}$$

and

$$\Delta I_t = a_0 + \sum_{i=1}^{n} a_{1i}\Delta\pi_{t-i} + \sum_{i=1}^{n} a_{2i}\Delta I_{t-i}$$

The results are shown in the table below;

Table 3.3a: F statistics For Granger Causality (Profit Rate and Real Investment)

Lag Lengths $(\Delta\pi, \Delta I_P)$	*Profit Equation* F1	*df*	*Investment Equation* F2	*df*	*Lag lengths* (π, I_P)	*Profit Equation* F1	*df*	*Investment Equation* F2	*df*
(4,4)	3.4*	(4,6)	.24	(4,6)	(4,4)	4.9**	(4,7)	.25	(4,7)
(3,3)	3.9*	(3,9)	.18	(3,9)	(3,3)	2.2	(3,10)	.86	(3,10)
(2,2)	0.6	(2,12)	.94	(2,12)	(2,2)	.94	(2,13)	1.9	(2,13)
(1,1)	1.3	(1,15)	.27	(1,15)	(1,1)	.90	(1,16)	.9	(1,16)

Table 3.3b: F statistics For Granger Causality (Profit Rate and Rate of Investment)

Lag Lengths $(\Delta\pi, \Delta\frac{I_P}{Y})$	*Profit Equation* F1	*df*	*Investment Equation* F2	*df*	*Lag lengths* $(\pi, \frac{I_P}{Y})$	*Profit Equation* F1	*df*	*Investment Equation* F2	*df*
(4,4)	4.1*	(4,6)	.47	(4,6)	(4,4)	2.2	(4,7)	1.2	(4,7)
(3,3)	4.7**	(3,9)	.76	(3,9)	(3,3)	2.0	(3,10)	1.9	(3,10)
(2,2)	0.9	(2,12)	2.0	(2,12)	(2,2)	1.1	(2,13)	4.9**	(2,13)
(1,1)	1.9	(1,15)	.56	(1,15)	(1,1)	3.0*	(1,16)	6.6**	(1,16)

F1 tests the null hypothesis that all $\beta_{2i} = 0$ and F2 tests that all $\alpha_{1i} = 0$

*** *significant at 1% level*

** *significant at 5 % level*

* *significant at 10 % level*

Note: Tables 3.3a and 3.3b above provide causality results both for the variables in first differences and levels. Table 3.3b provides the results for tests for causality between the rate of investment and rate of profit.

The Granger causality tests carried out above suggest that profits occur after investment or rather investment 'Granger' cause profits. The tests are provided for causality between profits and rate of investment as well as real investment in levels. The results in Table 3.3a, both in first differences and levels suggest that investment 'granger cause' profits. The results for the rate of profits are mixed. In first differences, the rate of investment 'granger cause' profit. However, in levels the rate of investment (investment as a ratio of output) is 'granger caused' by the rate of profit. Although the above results provide an indication as to the direction of causality, they need to be interpreted with caution given the short sample period.

3.4.0: Cointegration Analysis

The Dickey-Fuller procedure for testing for stationarity or unit roots discussed above provides a technique for testing whether equilibrium relationships exist between relevant variables. To illustrate the idea behind the tests for equilibrium relationships, assume that we have two variables x and y, whose long run relationship is given by $y = a + a_1 x + \varepsilon$. Where ε is the random disturbance term, which represents the deviations away from the equilibrium path. Then for an equilibrium relationship to exist, as Engle and Granger (1987) have observed, these disequilibrium errors $\varepsilon = y - a - a_1 x$, should fluctuate fairly around zero, which means that the errors must be stationary of order 0, (I(0))[48]. Or in other words, a linear combination of the series should be I(0). The statistical concept of this behavior is called *cointegration*.

To test for cointegration, we use the so-called Engle-Granger two step procedure. The procedure involves, estimating the hypothesized equilibrium relationship (sometimes referred

[48] If a series is stationary without differencing it is said to be I(0).

to as *co-integrating regression* or *static regression* and obtain the residuals then apply ADF test for stationarity (unit roots) as discussed above.

Using the Dickey-Fuller tests already discussed above, the residuals are tested for unit roots by estimating:[49]

$$\Delta\varepsilon = \varphi\varepsilon_{t-1} + \sum_{i=1} \varphi_i \Delta\varepsilon_{t-i} + \varrho \qquad (3.14)$$

The null hypothesis is $\varphi = 0$, or has a unit root. The relevant critical values for the cointegration ADF test are given in Engel and Yoo (1987), Table 3.

We have obtained the residuals from the investment function over the period 1975-1996. Results are reported in the table below.

Table 3.4: Cointegration Test Results

Dependent Variable: $\Delta\varepsilon$

Independent Variable	Equation 1	Equation 2	Equation 3	Equation 4
ε_{t-1}	-2.2	-2.47	-2.5	-4.1
$\Delta\varepsilon_{t-1}$	0.55	0.52	-0.04	
$\Delta\varepsilon_{t-2}$	0.73	0.97		
$\Delta\varepsilon_{t-3}$	0.46			
	Q(4-0) = .57 LM(1-4)= 6.27	Q(4-0) = .81 LM (1 - 4) = 6.59	Q(5-0) = .40 LM (1-4) = 8.7	Q(4-0) = .8 LM(1-4) = 4.6
	LM (1-3) = 5.82	LM (1- 3) = 5.82	LM (1-3) = 4.55	LM(1-3) = 1.35

* significant at 10 percent level of significance. The critical value for the coefficient of ε_{t-1} is 4.61, 3.98, 3.67 at significance level 0.01, 0.05 and 0.10 respectively. Source: Engle and Yoo (1987), Table 3.

[49] ε is the series of residuals obtained from the *static regression*. Note that unlike (3.9), the trend and the intercept are not included, since the residuals should have a zero mean and we do not expect a deterministic trend.

The LM test is a generalization of the Durbin *h* test and tests against the alternative hypothesis of serial correlation of higher order. In all the equations the LM statistics rejects the existence of higher order serial correlation of the fourth order to eight order. The Q test also confirms lack of higher order serial correlation.

The results reported above are mixed in the sense that there is no clear support nor rejection of cointegration. Equations 1, 2 and 3 reject cointegration yet equation 4 suggests that the variables are cointegrated. This may be explained in terms of our small sample size. Long run relationships may exist but it is only that we could not establish it. Maddala (1998) has noted that Monte-Carlo studies on the power of unit root tests suggest that in general they are weak, thus the results need to be considered with caution especially in this case the sample size is small (1978-1994).