The Economic Journal of Nepal, Vol.11, No.1, Issue 41, January-March 1988

Investment and Income in Nepal

SRI RAM POUDYAL*

INTRODUCTION

The analysis of investment and its relation with growth has been one of the most strategic aspects of development planning. Ever since the time of classical economists to present day, it has received a good deal of theoretical and empirical attention. Consequently, there have been a number of studies on the relationship between investment and growth and on the determinants of investment. Since it has been a general practice to assume public investment as autonomous, econometric studies are mainly concerned with analysing the determinants of private sector investment. These studies reveal a number of methodological issues and the complexity of data problems one has to encounter in the context of developing countries. The purpose of this paper is to analyze the relationship between investment and income in Nepal in the perspectives gained from the evaluation and understanding of the theoretical and empirical literature. Section II presents a brief review of econometric literature on investment - growth relationship, capital-output ratio and the determinants of investment. Section III contains empirical estimates and the analysis of the results. Section IV provides a summary and conclusions.

REVIEW OF LITERATURE

Investment and Growth

It has been long emphasized that capital accumulation is a strategic factor of growth. The classical theories of growth - both the original and their modern versions all emphasize that high investment ratio or high rate of savings is an important factor of economic growth. For Smith, capital accumulation either through saving or parsimony was essential to promote division of labour and, therefore, to growth in productivity. For J.S. Mill, industrial development was constrained by capital accumulation. Similar expressions emphasizing the critical role of capital can be found in the works of other classical economists also. It was not, however, until the contributions of Harrod and Domar that the relationship between investment and growth was so explicitly established. In their models, investment has two distinctly different effects - the demand generating effect and the capacity creating effect. The demand generating effect refers to the greater demand for consumer goods due to increased income

*Dr. Poudyal is Reader in Economics, CEDA, Tribhuvan University. He is currently Adviser at Nepal Rastra Bank, Kathmandu, Nepal.

through the multiplier process, while the capacity creating effect refers to investment in new capital goods to increase output after a time lag. The condition for an equilibrium growth rate in the sense of equating planned saving and planned investment requires that output and income grow at a rate:

$$\frac{\Delta Y}{Y} = \frac{s}{c} \qquad (1)$$

or,
$$\frac{\Delta Y}{Y} \times \frac{\Delta K}{\Delta Y} = \frac{S}{Y}$$

or,
$$\frac{\Delta K}{Y} = \frac{S}{Y}$$

Since
$$\Delta K = I$$

$$\frac{I}{Y} = \frac{S}{Y}$$

where s = savings ratio $(\frac{S}{Y})$.

c = incremental capital output ratio $(\frac{\Delta K}{\Delta Y})$.

$\frac{\Delta Y}{Y}$ = growth rate of income.

Equation (1) also shows that the rate of growth of income in any period is the product of the rate of saving, expressed as a ratio of saving to income and the reciprocal of the capital-output ratio. It is this relationship which has been increasingly used as a conceptual framework for planning purposes in developing countries.

A number of models that have been developed later along the Harrod-Domar framework also stress on capital formation as the most significant factor of growth. Solow and few others have, however, advanced the technology led growth theory. But, it has been well argued that a large proportion of growth rate assigned to technical change must be ascribed to investment because it is only through investment, new technologies get embodied in the production process. Thus, investment not only adds to the productive capacity of the economy but also contributes to the transmission of technical progress.

With a view to test the theoretical presumption regarding the relationship between investment and growth many authors have resorted to empirical studies in the context of both the developed as well as developing countries. One of the earliest investigations was that of Simon Kuznets. He calculated Kendall's rank correlation co-efficient between capital formation and output for 10 countries for the period from the mid-19th century to World War I and for 12 countries from the end of 19th century through the mid-20th century, but none of the coefficients exceeded 0.33 nor any of them was statistically significant. The study made by the Secretariat of the Economic Commission for Europe of the United Nations also revealed a very low correlation coefficient (0.2) between capital and growth rate for 22 western countries in the 1950s. In contrast to these T. Hill finds that the growth rates of 5 developed countries (the US, France, Italy, the UK and West Germany) during the period 1954-62 have been quite strongly associated with the shares of national product devoted to investment.[1] In addition, different types of investment are found to have different impact on growth, the higher impact being exerted by investment in machinery and equipment.

A strong association between capital accumulation and growth is also found by Pesmazoglu in a sample of 43 countries over the period 1957-68.[2] In addition to investment ratio ($\frac{I}{Y}$) he includes the rate of growth of capital stock ($\frac{\Delta K}{K}$) as an explanatory variable in order to account for the technical progress carrying effects of investment. The regression is also run separately for 3 sub-samples of the countries classified according to the level of per capita income. While the variable $\frac{\Delta K}{K}$ is consistently significant in all groups, the responsiveness of output to capital accumulation is less in very poor countries (per capita income less than US \$ 300) than in countries at the intermediate stage of development (per capita income between US \$ 300 and 850). This can be explained in terms of differences in the quality of capital accumulated in the two groups of countries and differences in the quality of co-operating factors of production.

Modigliani's work based on a mixed sample of 36 countries also shows a strong relation between output growth and the proportion of a country's income invested.[3] A similar result is obtained by Sommers and Suits taking a sample of 100 countries for the year 1966 and regressing rate of growth of GNP on investment ratio and population growth. The results show that the growth rate of GNP is influenced positively by the fraction of GNP invested and negatively by population growth. The same pattern of result is evident even when the sample is divided into two sub-samples of rich and poor countries on the basis of per capita income level.

Robinson, taking 39 less developed countries for the period 1958-66, finds that growth rate is significantly influenced by the investment ratio. The coefficients of investment ratio take values ranging between 0.08 to 0.19 and are statistically significant. In his specification the rate of growth of labour force is also included as an additional explanatory variable, but it does not appear to be significant.

Thirlwall also finds a significant positive relation between the growth of income and investment ratio in a sample of 68 developed and developing countries for the period 1958-68. He also works with two sub-samples and finds that the impact of investment on growth is higher in the developed countries group than in the developing countries group.[4] In alternative specification he replaces investment ratio by the savings ratio, but the relation does not turn out to be significant.

From the above review of empirical studies it thus seems that there is a significant positive relationship between growth and investment. Moreover, it is also brought to the foreground that composition of investment is as important as its magnitude. It remains, however, debatable whether the findings emerging from the cross-country studies can be generalized for individual countries as the nature of one underdeveloped country may be totally different from another. We feel that while the cross-section studies are certainly useful for deriving a broad picture and examining whether the countries which are growing at higher rates are the ones which are having higher investment shares, they cannot provide useful generalizations for other individual countries.

The empirical studies reviewed above assume that the effect of investment on growth is instantaneous. Actually, however, general intuition as well as casual observation suggest that output responds to investment only after a time-lag. Because of gestation lags and other associated problems, investments undertaken now may start yielding benefits after a lapse of some years. For example, investments in physical infrastructures such as, irrigation, roads, electricity, etc., and in social overheads such as, health and education which constitute the bulk of investment in underdeveloped countries, have relatively longer gestation periods and hence contribute to output after a reasonable time lag. Even in the case of equipments and machinery, the initial problems in manning them owing to shortage of skilled manpower and inadequate supply of raw materials and complementary inputs due to structural rigidities may make it quite difficult to operate them at full capacity. As such, the effect of investment on output would increase gradually with the lapse of time as complementary sectors and activities also get developed. The output in any particular year may have, thus, very little relation with the investment undertaken in that year, rather it may be the result of investments made over the years in the past. Given this reality, ignoring time lags between investment and growth may seem quite unrealistic.

It may also be pointed out that these studies are concerned mainly with examining the effect of investment on growth while, in reality, capital accumulation may also depend on growth. The reasoning is that investment leads to increase in output which, in turn, may cause savings to increase, resulting in higher investment. To take this simultaneity into account, studies have to be conducted in the framework of simultaneous equation system.

Capital Output Ratio

The capital output ratio is the most important parameter of planning. It is the capital output ratio along with the amount of capital outlay that determines the rate of growth of an economy. As indicated earlier, the Harrod-Domar model gives the production function of the type:

$$Q = \frac{1}{k} K$$

which means that aggregate output is given by the product of output capital ratio and the total capital stock. The constant k may be estimated in a number of ways, the most straightforward of which is a regression of ΔQ_t on I_{t-1}

$$\Delta Q_t = \frac{1}{k} I_{t-1}$$

where I_{t-1} is the gross domestic capital formation in the previous period. A similar approach suggested by United Nations Group specifies :

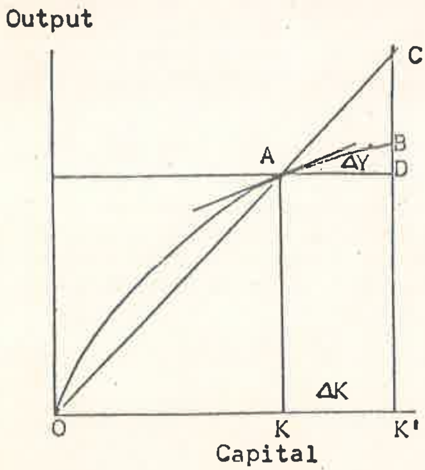
$$Q_t = \alpha + \frac{1}{k} \sum_{t=0}^{N} I_t$$

where I_t refers to gross capital formation.

Though the concept of capital output ratio appears as a very useful and convenient tool for planning purpose, its subtlety goes far beyond its apparent simplicity. The major issues involved are the definition of the concept itself, the validity or otherwise of the assumptions underlying the concept and computational complexities. These will be briefly discussed in the following.

There are in general, two concepts of capital output ratios, namely, average capital output ratio (ACOR) and the marginal or incremental capital output ratio (ICOR). The ACOR refers to the ratio of aggregate stock of capital to total domestic product ($\frac{K}{Y}$), whereas the ICOR refers to the ratio of change in the capital stock to change in the domestic product from one period to the other ($\frac{K_t - K_{t-1}}{Y_t - Y_{t-1}} = \frac{\Delta K}{\Delta Y}$). The difference may be further clarified with the help of a simple diagram:

Graph 1
Average and Marginal Capital - Output Ratios



Given that OAB is the function relating capital to output, the ACOR is $\frac{OK}{KA}$ (= $\frac{AD}{CD}$) and the ICOR is $\frac{AD}{DB}$.

Since the basic object of planning is to raise income (output) from a certain existing level to a specified higher level, it may be more pertinent to know how much additional investment is required to achieve the stipulated increase in output. This can be known only with reference to ICOR.

The distinction between ACOR and ICOR, however, does not crop up in the Harrod-Domar model and its variants because these models take for granted that the productivity of investment is immutably fixed. This implied that the ACOR and the ICOR are identical and hence the capital output ratio estimated on the basis of historical data is also the ICOR and can be used for estimating the additional investment requirement of a target increase in income. This is a rather restrictive assumption, and if, as is more likely, capital output ratio varies at different levels of development, the historical performance is of limited relevance in the development context. Quite reasonably, the question early was asked as to why the constancy of capital output ratio is not likely to be the case in reality.

According to Sen, the assumption of constancy of capital output ratio requires that: (i) the allocation of investment between sectors is unchanged, (ii) there is a fixed rate of capacity utilization, (iii) innovations are absent or neutral, (iv) real wages rise as much as labour productivity, (v) the rate of interest, which is the same as the rate of profit, is stable, (vi) the number of work shift does not change, (vii) there are constant returns to scale, and (viii) foreign prices are constant. Evidently all these are next to impossible in reality and hence to assume that the capital output ratio is constant over time is quite unrealistic. Myrdal also critically evaluates the various assumptions underlying the concept and concludes that "far from being constant, the capital output ratio will depend on the size of additional output, on income and price elasticities of demand and supply of products and factors, and on political choices." The UN also suggests that the experience of many developing countries, especially during the 70s does not lend support to the assumption of constancy of capital output ratio. The study by Dholakia in the context of Indian economy shows that neither the aggregate nor the sectoral capital output ratios remained constant during 1949-82, rather they exhibited a significant tendency to rise. In view of these considerations and findings, the assumption of constant capital output ratio appears to be of doubtful relevance to development planning.

Capital output ratios could be defined in different ways depending on how capital and output are measured. Sen distinguishes between three types of capital output ratio on the basis of 3 alternative measures of output: (i) capital to gross output ratio, (ii) capital to gross value added ratio, and (iii) capital to net value added ratio. The first measure of output is self-explanatory, the second measure is net of raw materials cost and the third measure is net of raw materials cost and depreciation. Dholakia also categorises capital output ratio into 3 types but on the basis of 3 alternative measures of capital. They are

(i) net capital stock at purchase prices indicating the book value of capital assets, (ii) the net capital stock at constant prices indicating the depreciated value of capital assets at given base period prices, and (iii) the gross capital stock at constant prices indicating the undepreciated value of capital assets at given base period prices. However, the common practice is to derive the capital output ratios either in gross or in net terms. In gross terms the ICOR refers to the ratio of gross capital formation of a year to change in gross product associated with it, and in net terms it refers to the ratio of net capital formation of a year to change in net domestic product. Thus the basic difference between the gross and the net is obviously made up of whether the component of depreciation is allowed on capital and output. The relevance and the usefulness of gross and net capital output ratios would differ significantly by the purpose we want to serve. In this connection Panchamukhi suggests that if the purpose is to analyze productivity of capital, the concept of net capital output ratio should be used, but if the purpose is to derive the estimate of gross investment that is required for bringing about a desired change in gross output, gross capital output ratio would be the relevant parameter. He, however, mostly uses the gross values of capital formation and domestic product in his analysis of capital output ratio for India, justifying this on the ground that gross values of capital formation are more reliable than net values.

There remain a fairly large number of complex measurement problems that must be solved before the capital output ratio can be estimated. The most difficult thing to measure is, of course, capital and a great deal of theoretical controversy has raged around it. Joan Robinson argues that since capital consists of heterogenous equipments at various stages of their life cycles and at various degrees of obsolescene which can in no way be easily aggregated, the idea of a composite capital total is not at all operational. It is not also easy to provide a price measure because, as Robinson points out, the unit of measurement varies with the rate of profit and the relative prices of equipment is determined by the future profit expectations. These difficulties are, indeed, formidable but some aggregation is necessary for empirical work. But, even if we accept the idea of homogenous capital, there is no easy way to estimate the time series of capital stock. One technique that is usually employed for deriving the time series of capital stock is the perpetual inventory method. The basic methodology involved in this technique is that an inventory is maintained of the capital stock at the base year prices by adding gross investment to an initial stock of capital and by deducting capital consumption annually. However, the data requirements of this method are too large to be available in many of the developing countries. For example, data on capital stock at given base year prices, price indices, depreciation and annual additions to capital stock by type of assets in different industry groups may not be available at all. In such circumstances one has to be satisfied with some crude measures or approximations.

Another method which is often used in the absence of data on initial stock of capital is the approach of stock-flow conversion factor. The methodology of this approach has been well explained by Panchamukhi. What is involved in this approach is that the investment level in the terminal year of the plan, viz., period T, is derived in relation to the stock of capital accumulated over all the previous years of the plan. If investment grows in an exponential form with growth rate r, then in any period T, $I_T = I_o e^{rt}$. The capital stock accumulated over the period 0 to T is given by:

$$K_{OT} = \int_0^T (I_o e^{rt}) dt$$

$$= \frac{I_o}{r} (e^{rt} - 1).$$

Hence the ratio of investment flow in the terminal year T to the capital stock of the plan period is given by:

$$\lambda = \frac{I_T}{K_{OT}} = \frac{I_o e^{rt}}{\frac{I_o}{r} (e^{rt} - 1)} = \frac{r e^{rt}}{(e^{rt} - 1)} .$$

Panchamukhi suggests that this ratio can be worked out for different values of r and that ratio which corresponds to a feasible estimate of the growth rate of investment r, could be used to derive the investment for the terminal year from the estimated capital stock of the plan period. The latter can be derived by using the targetted growth rate of income and the overall capital output ratio. Thus,

$$K_{OT} = \beta(Y_T - Y_o), \text{ and}$$

$$I_{OT} = \lambda K_{OT} .$$

The derivation of the stock-flow conversion factor is not also without difficulty. It puts one in a circularity of reasoning. To obtain sectoral investments for period T and hence growth rates of investment, we have to derive output of period T. But for deriving output levels of period T, the vector I_T should be derived.

In the analysis of the relationship between output and factors determining it, the approach of production function assumes special significance. The production functions of the Cobb-Douglas and the Consultant Elasticity of Substitution types provide a useful framework for examining the nature of the relationships between output and the inputs used in the production activity. The estimates of different parameters can also be analyzed to bring out the nature of returns to scale and production efficiency for the industry or the sector taken for analysis. However, for Nepal's economy it has not been possible to estimate these production functions for obvious reasons of unavailability of time series on capital stock and labour force at the aggregate and sectoral levels.

Determinants of Investment

Studies on the determinants of investment are exclusively concerned with private investment as it is a common practice to regard public investment to be autonomous. As most of the developing countries are pursuing planned process of development involving active participation of private sector, private investment is expected to play an important role in the realization of planned targets and programmes. The programmes for the private sector is broadly sketched in the plan and various policies are designed to promote, channelize and regulate private investment in the desired direction. However, these policies may not be effective in motivating the private sector to the extent warranted unless they have a good grip of the factors that determine private investment behaviour. It is, therefore, desirable to see what light the theories and empirical works shed in this regard.

In the past three decades several alternative theories have been formulated in the analysis of investment behaviour at the mocro level. They can be conveniently grouped into (i) the profit theories, and (ii) the acceleration models. However, over the years the exclusiveness of these two theories have been somewhat blurred because some variant of profits is also brought into the context of accelerator model.

Profit theories contend that investment level is determined by the present profits while the accelerator theory postulates that the rate of investment is a linear function of the rate of change of output. The accelerator theory has been modified in a number of ways so as to take account of excess capacity, expectations and lags. One important modification consists in introducing the concept of desired capital stock and the adjustment of actual to the desired level with a certain speed of adjustment. These types of models are formulated by Koyck and others as distributed lag models. Second modification is towards making investment a function of excess capacity. Chenery argues that if firms seek to minimize the cost of production over time, they will on the average build ahead of time and there remains unexploited scale economies. To allow for this Chenery introduces the 'capacity factor' as an additional factor in the accelerator model.

Empirical studies of investment behaviour have largely been set in the framework of acceleration model with financial variables and capacity utilization factor as other determinants. The survey of econometric studies of investment behaviour in USA by Jorgenson shows that accelerator model has long been the standard framework in the study of investment behaviour. Within this framework a variety of other variables such as, profit sales, capacity utilization cost of external finance, etc., are incorporated as additional explanatory variables. Studies relating to investment behaviour in India also adopt a similar approach. These studies bring out that accelerator, profit, capacity utilization, internal funds, external finance, etc., are the important determinants of investment.

In the context of an underdeveloped economy of Nepal's type it is also imperative to take into account physical infrastructure and institutional or policy factors. While one may be justified in omitting these factors in the case of developed countries as they generally have well developed physical infrastructure and institutional set up, the situation in underdeveloped countries is quite different. In the latter countries the low level of physical infrastructure and formative stage of institutional set up may work as severe constraints to private investment. Likewise, scarcity of foreign exchange and capital goods may also restrain the pace of investment. It is, therefore, desirable to incorporate some indicators of these constraints in the function.

In the case of Nepal, in addition to the above, we must also consider the constraints imposed by landlocked geography. Firstly, there is always a cloud of uncertainty regarding the availability of transit facilities and the related infrastructures, and hence the timely procurement of imported items. Any delay in transit, apart from increasing the costs such as insurance, storage, interest on loans, penalties etc., and the risk of loss due to theft, damage or deterioration, may severely hamper the process of investment by stopping or halting the construction or installation works. Secondly, the absence of sea coast means higher transportation costs which, in turn, raises the cost of imported goods and makes exportable products less competitive in the international markets. The effects of higher cost of imported capital goods and a reduction in export receipts are naturally quite harmful to the growth of investment. These limitations are, therefore, to be borne in mind while analysing the behaviour of investment in Nepal.

EMPIRICAL ESTIMATES

The empirical results which we present below are estimated by using annual data for the period 1964/65 - 1981/82. Because of the non-availability of important price indices such as, investment deflator and import price indices, it has not been possible to estimate the specified relations in constant prices. However, as an alternative, though not a satisfactory way to do, values of the variables have been converted to constant prices by means of GDP deflator and then regressions run. The results obtained from this exercise are reported and compared with those obtained by using current prices data, at the end of the section. In some cases, the use of GDP deflator is found to yield consistent results.

Investment and GDP

Unlike in the case of cross-country studies, there is no correspondence between investment share and growth rate of GDP in Nepal. The value of R^2 is very low and the regression co-efficient of investment share is statistically insignificant.[5]

This may be because of roughly constant investment share over the years. It could also be due to the fact that a certain stage has to be reached before the investment rates play an important part in the growth of output. However, the regression of GDP on investment shows that the level of GDP is significantly influenced by investment.

$$Y = 2544.3 + 5.28\ I$$
$$(4.87)^{*} \quad (27.25)^{*}$$
$$\bar{R}^2 = 0.98;\ DW = 1.49;\ F = 742.59$$

In this case the $\bar{R}^2$ is high and there is no evidence of serial correlation. In the preceding section we argued that for several reasons we expect investment to contribute to GDP in a lagged pattern. We now perform the Almon lag scheme to test the lag structure of the effects of investment on GDP. The results come out as follows:

$$Y_t = \underset{\substack{(1002.42)\\(3.27)^{*}}}{3277.9238} + \underset{\substack{(1.7329)\\(2.04)^{*}}}{3.5381}I_t + \underset{\substack{(1.1403)\\(0.67)}}{0.7681}\ I_{t-1} + \underset{\substack{(0.9601)\\(0.05)}}{0.0526}\ I_{t-2}$$

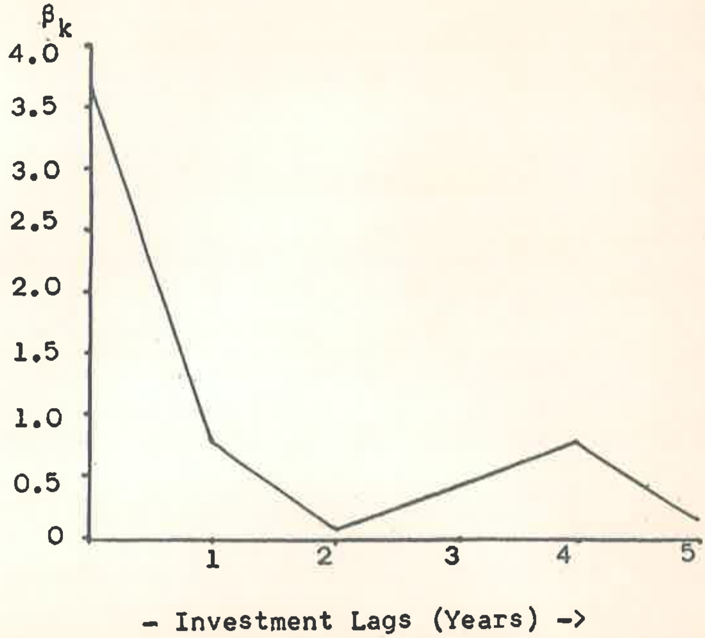
$$+ \underset{\substack{(1.0605)\\(0.36)}}{0.3832}\ I_{t-3} + \underset{\substack{(1.3243)\\(0.57)}}{0.7515}\ I_{t-4} + \underset{\substack{(2.1299)\\(0.07)}}{0.1493}\ I_{t-5}$$

$$\bar{R}^2 = 0.97\ ;\ DW = 1.56\ ;\ F = 98.0.$$

Note: Figures in the first parentheses are standard errors while those in the second parentheses are t-values.

We find that the $\bar{R}^2$ is quite high. We could not, however, apply the DW test for the detection of autocorrelation because this test is possible only if the number of observations is at least 15. In this case it is only 13. The co-efficients of investment are all positive which means that GDP is influenced not only by the current values of investment but also by past values. However, it is the investment in current year which has the highest and significant impact on GDP. Looking at Graph 2, it appears that the beta co-efficients follow a fluctuating pattern, decreasing upto 2 period lag, increasing thereafter upto 4 period lag and again declining. The highest initial impact of investment may be because of the boost up that the existing infrastructures and production lines receive from new investment. But because the stimulating effect is short-lived and investments allotted to new projects take time to fructify, the impact subsides for a couple of years before rising up again.

Graph 2
Relative Effectiveness of Different Investment Lags on GDP



The short run investment multiplier is 3.54, whereas the total or the distributed lag multiplier is 5.64. It is interesting to note that the total investment multiplier is nearly identical to that obtained by regressing GDP on current investment without considering any lag. The $\bar{R}^2$ and the DW are not also very different from the unlagged case.

Capital Output Ratio

The statistics available for Nepal's economy mainly deal with annual flow variables such as domestic product, savings, capital formation, etc., rather than with the stock variables such as the stock of capital. And no estimate, whatsoever, of the capital stock is available from any other source. This makes the task of estimating the capital output ratios extremely difficult. Hence, the estimates of capital output ratios derived here are based on gross values of GDP and investment in current prices. The estimation in constant prices has not been possible because of non-availability of investment price index. One possible way to obtain investment series in constant prices would be to deflate current price series by the GDP deflator.

Capital output ratio in current prices may not necessarily give a true picture of the real productivity of investment. However, it may provide a broad indication of the current turn-over rates which may be useful in the process of financial management and decision making. Table 1 presents the estimates of capital output ratios with no lag, with one year lag and as five year average lag on year to year basis. These computations are based on a three year moving average of GDP and investment. The moving average transformation tends to make the data series more campatible by smoothening the abrupt annual changes in the figures. Two broad observations are pertinent on the estimates of capital output ratios given in Table 1. Firstly, the estimates, show wide

Table 1
Capital Output Ratios

(in current prices)

Year	No lag $k = \frac{I_t}{Y_t - Y_{t-1}}$	One Year lag $k = \frac{I_t}{Y_{t+1} - Y_t}$	Five Year Average $k = \frac{\Sigma I_t}{Y_{t+5} - Y_t}$
1967-68	1.80	-	-
1968-69	2.63	2.63	-
1969-70	1.42	1.20	-
1970-71	2.12	1.90	-
1971-72	1.66	1.57	-
1972-73	3.36	3.30	2.04
1973-74	1.14	1.04	1.68
1974-75	1.19	1.00	1.57
1975-76	1.12	0.95	1.37
1976-77	2.65	2.37	1.52
1977-78	2.82	2.47	1.60
1978-79	2.03	1.85	1.78
1979-80	1.86	1.61	1.93
1980-81	1.66	1.49	2.05
1981-82	1.70	1.56	1.91

year-to-year fluctuations, the range being 1.12 to 3.36 in the case without lags, 0.95 to 3.30 in the case of one year lag and 1.37 to 2.05 in the case of five year averages. These fluctuations may have been caused by the leads and lags that operate in the economy. The estimates of capital output ratios for India by Panchamukhi also reveal wide year to year fluctuations. He attributes these fluctuations to the uncertainties that operate in the system in realizing output from the investments that are made in the different years. Secondly, the estimates of capital output ratios obtained by us appear to be very low compared to the figure assumed in the Seventh Plan of Nepal (1985-1990) and the estimates used in the

Plans of India. In the Seventh Plan of Nepal an ICOR of 4.5 is used to estimate the amount of investment needed to achieve a 4.5 percent rate of growth and in India the ICOR in the Fifth (1974-75 - 1978-79) and Sixth (1979-80 - 1984-85) Plans is estimated at 4.2.[6] The low estimates obtained by us for Nepal may be due to the use of data in current prices. There is some empirical support for the view that capital output ratios in current prices tend to be much smaller as compared to those in constant prices. Estimates by Panchamukhi of the capital output ratios in current and constant prices for the Indian economy are presented in Table 2.

Table 2

Estimates of Incremental Gross Capital Output Ratios for Indian Economy (Based on the Data of Three Year Moving Average), Zero Gestation Lag

Year	Total Economy	
	Current Price	Constant Price
1962	2.145	4.929
1963	1.559	3.703
1964	1.839	8.332
1965	1.835	19.877
1966	1.761	15.175
1967	1.865	5.017
1968	2.013	3.380
1969	2.705	4.665
1970	2.460	4.665
1971	2.457	10.341
1972	1.633	12.405
1973	1.382	14.617
1974	1.722	4.468
1975	2.463	5.953
1976	2.729	3.506
1977	2.828	4.584
1978	2.976	8.228

Source: V.R. Panchamukhi /1986/, Table 12B.

It can be clearly observed that the estimates of capital output ratios in current prices for the Indian economy are similar to those obtained by us for Nepal. Therefore, in constant prices, the ICORs for Nepal's economy should be much larger, mostly double, than those in current prices. Commenting on the divergence between ICORs in current and constant prices, Panchamukhi argues, "If one should interpret ICOR in current prices as the rate of turn-over per unit of capital and the ICOR in constant prices as an index of efficiency in the resource use, one can interpret the difference between the two as measuring the 'efficiency illusion' that is caused by the relative prices in the economy."

In estimating the capital output ratio, the approach suggested by the UN Group is quite useful as it makes the GDP of each year a function of cumulative sum of current and past investments. The specification is as follows:

$$Y_t = \alpha + \beta K_t$$

or,

$$Y_t = \alpha + \beta(K_o + \sum_o^t I_t)$$

where K_o is the capital stock at the beginning of the year.

$$Y_t = \alpha + \beta K_o + \beta \sum_o^t I_t$$

or,

$$Y_t = A_o + \beta \sum_o^t I_t$$

where $A_o = \alpha + \beta K_o$

The estimation of the above equation with Nepal's data yields the following results:

$$Y = \underset{(20.27)^*}{5874.03} + \underset{(39.61)^*}{0.57\ \Sigma I}$$

$$\bar{R}^2 = 0.99 \ ; \ DW = 1.84 \ ; \ F = 1569.28$$

As can be seen, all the statistical tests, namely, the t value of the regression co-efficient, the $\bar{R}^2$, the F value and the DW statistic highly validate the estimated functional relation between GDP and investment. The reciprocal of the value of the regression co-efficient associated with ΣI gives the incremental capital output ratio. The estimate of ICOR is thus 1.75, which is still very low. This may be again due to the use of data in current prices.

Determinants of Investment

Lack of data has prevented an analysis of the determinants of private sector investment in Nepal in the framework of various models reviewed earlier. No estimate of private investment expenditure or of industrial profit or output is available. However, as we have already explained, private investment is not of much significance in the context of Nepal. As such, the omission of the analysis of private investment behaviour may not be altogether unreasonable. With the data available, it is possible to examine the determinants of investment at the aggregate level only, and this may indeed be justified because of its significant influence on GDP.

On a priori grounds, it seems that the acceleration hypothesis may well be valid in the context of total investment. We attempt to see if the Nepalese data support this hypothesis and ascertain what the other determinants of investment are. It might also be reasonably argued that in a developing economy of the Nepalese type, investment is likely to be heavily influenced by foreign aid. Because domestic investible funds are so limited, total investment, or at least its public sector component, is largely determined by the inflow of foreign aid. The availability of foreign aid appears to have made it feasible to finance increased imports of capital goods which are not producible at home and in the absence of which investment plans may not be realized. As we find in our statistical analysis of imports later, imports of capital goods are significantly determined by foreign aid. Since exports have been roughly stagnant over the years, imports of foreign capital goods would not have been possible to the extent realized in the absence of foreign aid. Apart from foreign aid, investment in the previous year may also exert some influence on current investment. The lag effect may be due to the requirement of maintaining last year investment level or the adjustment of actual investment to the desired level in the framework of distributed lag hypothesis.

In view of the considerations above, we take change in output, foreign aid and investment lagged one year as the main explanatory variables to explain the variations in total investment. We also try to ascertain the link between capital goods imports and investment. So, in alternative specifications the variable capital goods imports is used in lieu of foreign aid. The regression results are as follows:

I $$I = \underset{(5.77)^*}{783.55} + \underset{(1.02)}{0.08}\ \Delta Y + \underset{(12.28)^*}{2.72\ F}$$

$$\bar{R}^2 = 0.94\ ;\ DW = 1.16\ ;\ F = 125.82$$

II. $$I = \underset{(1.60)^{***}}{230.54} + \underset{(1.42)^{***}}{0.07}\ \Delta Y + \underset{(2.36)^{**}}{0.94\ F} + \underset{(4.76)^*}{0.72}\ I_{-1}$$

$$\bar{R}^2 = 0.98\ ;\ DW = 2.29\ ;\ h = 0.146\ ;\ F = 221.09$$

III. $$I = \underset{(15.27)^*}{992.43} + \underset{(2.41)^{**}}{0.09}\ \Delta Y + \underset{(25.17)^*}{4.31}\ M_I$$

$$\bar{R}^2 = 0.98\ ;\ DW = 1.64\ ;\ F = 514.96$$

IV. $$I = \underset{(3.67)^*}{775.44} + \underset{(2.28)^{**}}{0.09}\ \Delta Y + \underset{(3.99)^*}{3.41}\ M_I + \underset{(1.08)}{0.23}\ I_{-1}$$

$$\bar{R}^2 = 0.98\ ;\ DW = 2.03\ ;\ h = -0.036\ ;\ F = 347.72$$

Comparing the first two equations, we find that the lagged version is marginally better than the unlagged one. The introduction of lag not only results in higher $\bar{R}^2$ but also tends to support (though modestly) the acceleration hypothesis as being relevant to total investment. Other variables also perform well; the lag co-efficient is statistically significant and meaningful and the same holds good for foreign aid. Even when imports of capital goods is used in lieu of foreign aid, the equation performs equally well. The results also reveal the importance of acceleration hypothesis in the determination of total investment. It is interesting to note that the co-efficient of ΔY is roughly the same as in the case with foreign aid. But the lagged variable, though of the expected sign, comes out to be insignificant.

In this case (and also in equation 2) the DW test is not appropriate to detect the presence of autocorrelation because of the appearance of lagged dependent variable among explanatory variables. The DW value in such cases will often be around 2, which is the value of DW expected in the absence of autocorrelation. Hence, if this statistic is applied, there is a bias against detecting the presence of autocorrelation. It can be seen that in equations 2 and 4, where the lagged value of the dependent variable (I) is also included in the set of explanatory variables, the DW statistic are 2.29 and 2.03 respectively. To overcome this problem Durbin has developed the so-called h statistic.[7] But this is a large sample test (N > 30) and nothing is known about its small-sample properties.

Thus from the analysis of our results, we come to the conclusion that acceleration hypothesis, foreign aid or imports of capital goods and lagged investment are the important variables influencing total investment in Nepal.

Estimates in Constant Prices

The constant price estimate of the equation relating GDP to investment is as follows:

$$Y = \underset{(8.68)^*}{75.43} + \underset{(10.56)^*}{3.54\ I}$$

$$\bar{R}^2 = 0.87 \ ; \ DW = 1.41 \ ; \ F = 111.58$$

The co-efficient of investment is as before positive and statistically significant but its magnitude is lower - 3.54 as compared to 5.28. The $\bar{R}^2$ is also slightly lower - 0.87 as against 0.97 whereas the DW statistic is about the same, showing no evidence of autocorrelation.

Estimating the U.N. specification using deflated data, we obtain:

$$Y = \underset{(77.50)^*}{129.28} + \underset{(25.03)^*}{0.17\ \Sigma I}$$

$$\bar{R}^2 = 0.97 \ ; \ DW = 1.77 \ ; \ F = 626.43$$

The equation is as before highly satisfactory from all points of view including serial correlation. The co-efficient of ΣI gives an estimate of the ICOR of order 5.88 which is much larger than that estimated in current prices. This tends to support the contention that the ICORs in current prices are likely to be much Lower than those at constant prices.

The constant price estimates of the determinants of aggregate investment are as follows:

I. $$I = \underset{(6.05)^*}{11.16} + \underset{(0.94)}{0.18\,\Delta Y} + \underset{(7.07)^*}{2.32\,F}$$

$$\bar{R}^2 = 0.81 \; ; \; DW = 0.52 \; ; \; F = 29.67$$

II. $$I = \underset{(1.01)}{2.29} + \underset{(0.64)}{0.08\,\Delta Y} + \underset{(1.79)^{**}}{0.73\,F} + \underset{(4.62)^*}{0.76\,I_{-1}}$$

$$\bar{R}^2 = 0.91 \; ; \; DW = 2.51 \; ; \; F = 55.62$$

III $$I = \underset{(7.97)^*}{14.65} + \underset{(0.83)}{0.19\,\Delta Y} + \underset{(5.55)^*}{3.32\,M_I}$$

$$\bar{R}^2 = 0.69 \; ; \; DW = 0.88 \; ; \; F = 18.69$$

IV. $$I = \underset{(1.17)}{2.50} + \underset{(0.53)}{0.06\,\Delta Y} + \underset{(2.17)^{**}}{1.02\,M_I} + \underset{(6.36)^*}{0.80\,I_{-1}}$$

$$\bar{R}^2 = 0.92 \; ; \; DW = 2.58 \; ; \; F = 61.07$$

In contrast to estimates in current prices, the regression coefficient of ΔY comes out to be statistically insignificant in all equations. This would suggest that accelerator has no influence on aggregate investment. The importance of other variables like foreign aid or import of investment goods and lagged investment is, however, significant as before. The values of $\bar{R}^2$ in equations with lagged investment as one of the explanatory variables are only marginally lower compared to results in current prices. There is, however, a difference between the constant and current price results in respect of the significance of lagged investment in equation IV. In current prices, lagged investment is not found to be significant, whereas in constant prices it is significant.

SUMMARY AND CONCLUSIONS

In the empirical literature considerable attention has been paid to analyze the relationship between growth rate and investment, and identify the various determinants of investment, especially private investment. The findings in general reveal a strong positive association between the rate of growth and the investment share $(\frac{I}{Y})$. But this does not seem to be valid for Nepal, possibly due to constant share of investment in GDP.

This may be also indicative of the fact that a certain stage has to be reached before the investment rates play an important role in the growth of output. However, when we regress GDP on investment, a significant positive relationship is found between the two. The lagged values of investment are also found to be important in determining GDP, but it is the current value which has the largest impact. This would imply that fresh investments activise the on-going projects which directly or indirectly contribute to raise the level of GDP.

The quantitative relationship between capital and output is provided by the average capital output ratio and its variant, incremental capital output ratio. Even though the assumptions underlying the concept are quite restrictive and computational difficulties quite serious, it is being extensively used in the formulation of development plans, especially to arrive at an overall estimate of investment requirements of a specified targetted rate of growth. Evidently, Nepal's development plans have also made use of aggregate capital output ratio for this specific purpose. However, there is scope for empirical verification of the relationship between investment and output in a systematic manner. There are, indeed, serious data problems in its estimation and it has not been possible to overcome them in this study. Our attempt in this paper must therefore be regarded as an exploration in alternative methodologies and their empirical implications rather than drawing a single set of parameters.

The estimates of capital output ratios obtained by us seem to be rather low possibly because the estimates are derived in current prices. We, therefore, think that in real terms the values of capital output ratios should be considerably higher than those obtained by us. The estimate of ICOR based upon the data deflated by GDP deflator does, indeed, provide support to our belief.

Our analysis of the determinants of investment brings out the importance of accelerator in the explanation of aggregate investment. Foreign aid or imports of capital goods and lagged investment are also found to be important in determining total investment. The importance of accelerator, however, does not turn out to be significant in the constant price estimates. Apart from this difference, the broad nature of the results do not differ much as between the two estimates with regard to the importance of foreign aid or import of investment goods and lagged investment in determining aggregate investment.

FOOTNOTES

1. The regression equation obtained is:

$$\frac{\Delta Y}{Y} = 6.11 + 0.58 \frac{I}{Y} \; ; \; R^2 = 0.96.$$

2. Pesmazoglu's estimated function is:

$$\frac{\Delta Y}{Y} = 2.42 + 0.28 \left(\frac{\Delta K}{K}\right) + 0.05 \frac{I}{Y} \; ; \; R^2 = 0.50. \; \text{s.e.} = (0.05) \; (0.04)$$

3. The regression result is:

$$\frac{\Delta Y}{Y} = 0.52 + 0.265\,\frac{I}{Y}\ ;\ R^2 = 0.73$$

$$\text{s.e.} = (0.042)$$

4. The results are:

All observations (68): $\frac{\Delta Y}{Y} = 2.221 + \underset{(0.0351)}{0.1405}\,\frac{I}{Y}\ ;\ R^2 = 0.195$

Developed countries (20): $\frac{\Delta Y}{Y} = -0.680 + \underset{(0.072)}{0.240}\,\frac{I}{Y} = R^2 = 0.377$

Developing countries (48): $\frac{\Delta Y}{Y} = 1.903 + \underset{(0.0496)}{0.1698}\,\frac{I}{Y} = R^2 = 0.203$

where the figures in the parentheses are standard errors.

5. $Y' = -1.55 + 0.28\ I/Y$
(-0.23) (0.64)
$R^2 = 0.026$; DW = 2.82

Note: Figures in parentheses ~~are~~ t-statistics. The asterik*, ** and *** wherever shown indicates that the co-efficient is significant at 1 percent, 5 percent and 10 percent level, respectively.

6. The estimate of capital output ratio for India is taken from, A Technical Note on the Sixth Plan of India, Perspective Planning Division, Planning Commission, Government of India, July, 1981.

7. The Durbin h statistic is given by:

$$h = \hat{\rho}\sqrt{\frac{N}{1-N[\text{var}(\hat{b}_3)]}}$$

where $\hat{\rho}$ is the estimate of first order serial correlation (ρ), var ($\hat{b}_3$) is the variance of the co-efficient of the lagged dependent variable, and N is the sample size.

SELECTED REFERENCES

Chenery, H.B. (1952), "Overcapacity and the Acceleration Principle", Econometrica, January.

Dholakia, B.H. (1983), Behaviour of Capital Output Ratios in the Indian Economy (Mimeo), Ahmedabad: Indian Institute of Management.

Domar, E.V. (1946), "Capital Expansion, Rate of Growth and Employment", Econometrica, April.

---- (1947), "Expansion and Employment", American Economic Review, March.

---- (1957), Essays in the Theory of Economic Growth, New York: Oxford University Press.

Harrod, R.F. (1939), "An Essay in Dynamic Theory", Economic Journal, March.

---- (1948), Towards a Dynamic Economics, London: Macmillan.

Hill, T. (1964), "Growth and Investment According to International Comparisons", Economic Journal, June.

Jorgenson, D.W. (1971), "Econometric Studies of Investment Behaviour: A Survey", Journal of Economic Literature.

Krishnamurty, K. and D.U. Sastry (1975), Investment and Financing in the Corporate Sector in India, Delhi: Institute of Economic Growth.

Kuznets, S. (1961), "Quantitative Aspects of the Economic Growth of Nations, VI. Long Term Trend in Capital Formation Proportions", Economic Development and Cultural Change, July.

Leamer, E.E. and R.M. Stern (1970), Quantitative International Economics, Chicago: Aldine Publishing Company.

Modigliani, F. (1970), "The Life Cycle Hypothesis of Saving and Inter-country Differences in the Savings Ratio", in W.A. Eltis, M.F.G. Scott and N.J. Wolfe (edi.) Induction, Trade and Growth: Essay in Honour of Sir Roy Harrod, Oxford University Press.

Myrdal, G. (1968), Asian Drama, An Inquiry into the Poverty of Nations, Vol. III, New York: Pantheon.

National Planning Commission, HMG/Nepal: The Fifth Plan (1975), Draft Seventh Five Year Plan (1985).

Panchamukhi, V.R. (1978), "A Survey of Econometric Studies in the Fields of Production, International Trade and Banking", in N.S. Iyenger and N. Bhattacharya (ed.), A Survey of Research in Econometrics, Vol. VII, New Delhi: ICCR.

---- (1988), Production and Planning, Dharwad: Centre for Multi-Disciplinary Research.

---- (1986), Capital Formation and the Output in the Third World, New Delhi: Research and Information System for the Non-Aligned and Other Developing Countries.

Pesmazoglu, J. (1972), "Growth, Investment and Saving Ratios", Some Long and Medium Term Associations by Groups of Countries", _Bulletin of the Oxford Institute of Economics and Statistics_, November.

Poudyal, S.R. (1988), _Foreign Trade, Aid and Development in Nepal_ (forthcoming), New Delhi: Commonwealth Publishers.

Robinson, J. (1953-54), "The Production Function and the Theory of Capital", _Review of Economic Studies_, Vol. XXI.

Robinson, S. (1971), "Sources of Growth in Less Developed Countries: A Cross-section Study", _Quarterly Journal of Economics_, August.

Sen, P.K. (1966), "Use of the Capital-Output Ratio in Economic Planning", _Indian Economic Review_, February.

Solow, R.M. (1962), "Technical Progress, Capital Formation and Economic Growth", _American Economic Review_, March.

Sommers, P.M. and D.B. Suits (1971), "A Cross-Section Model of Economic Growth", _Review of Economics and Statistics_, May.

Thirlwall, A.P. (1974), _Inflation, Saving and Growth in Developing Economies_, London: Macmillan.

United Nations (1964a), _Some Factors in Economic Growth in Europe During the 1950s_, Geneva.

---- (1964b), _Studies in Long Term Economic Projections for the World Economy_, New York.

---- _Year Book of National Accounts_, Various Years, New York.