ROLES OF PUBLIC CAPITAL IN PAKISTAN’S ECONOMY: PRODUCTIVITY, INVESTMENT AND GROWTH ANALYSIS

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This study analyzes the role of public capital in Pakistan’s economy, tracing the relationship between productivity of public capital and economic growth. We estimate a production function, with public capital as an input. The results indicate that the productivity (output elasticity) of aggregate as well as different components of public capital are sufficiently high. We also analyze substitutability and complementarity between public and private capital by estimating investment functions, revealing that public capital has worked as a substitute for private investment. The net effect of public capital on the national economy is analyzed by estimating reduced forms, with the result that public capital has a positive net effect on national product. The growth analysis shows that the contribution of public capital is declining over time.

1. Introduction

Pakistan’s many economic crises have hampered the country’s attainment of sustainable growth. A severe fiscal imbalance, that is, budget deficit, continues to persist despite the efforts made by several governments to contain it. Its economic system does not operate independently of political influence. The economy also faces the burden of an underdeveloped financial and banking system, growing external and internal debt, low rate of investment and deteriorating physical infrastructure, large regional income disparity and poverty.¹

The growth pattern of Pakistan’s economy (Table 1) indicates that during the 1960s the economy experienced impressive performance, growing at an annual rate of 6.7%. During the 1970s and 1980s, however, the growth rate remained 4.3 and 5.8% per annum, respectively, and during 1990-97, was at 4.6%. The decline in the growth rate may be attributed to insufficient supply of physical infrastructure to cope with expanding requirements of the economy (Faiz, 1992). The decline is believed to adversely affect the country’s regional imbalances and further aggravates regional income disparity.

¹ We measured the extent and trend of regional disparity of per capita income, where Pakistan is divided into four regions. The results indicate that there exists considerable regional income disparity, and that its magnitude is increasing. We also measured the disparity for two-region case by grouping regions as relatively “advanced” or “backward.” Results of this analysis also confirm the existence of disparity between regions, though the magnitude is smaller than the four-region case. For example, in the case of four regions, the coefficient of variation of per capita income during 1990-97 is 0.28. During the same period, in the two-region case the coefficient is 0.16.
Table 1. Average GDP Growth Rate in Pakistan

<table>
<thead>
<tr>
<th>Year</th>
<th>Growth Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-70</td>
<td>6.7</td>
</tr>
<tr>
<td>1970-80</td>
<td>4.3</td>
</tr>
<tr>
<td>1980-90</td>
<td>5.8</td>
</tr>
<tr>
<td>1990-97</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Papanek (1996) observes that one factor often overlooked in the continued rapid growth of Southeast Asia is the self-perpetuating nature of the process. Once a country starts to grow rapidly, it is often easier to continue to grow at a higher rate. Rapid growth tends to increase the rate of saving and investment, provides incentives for foreign and domestic investment, augments the resources available for government investment in infrastructure and other social sector by generating more tax revenues, reduces poverty and increases the resources available to pacify important segments of society. It can thus contribute to economic and political stability, further enhancing the environment for investors.

A slowly growing economy finds it difficult to radically accelerate that growth. Pakistan had periods of rapid growth that did not lead to further growth due to political problems and sometimes due to economic mismanagement. One reason for the vicious cycles of growth is that imbalances and problems are interrelated. For example, an inadequate savings rate in Pakistan is in substantial part due to political uncertainty and low or negative government savings. Low savings result in low investment and low growth, which in turn discourage foreign private investment. Slow growth makes it difficult to finance the needed human capital investment and social sector operating costs. It also means that the economy has a great deal of old and outdated machinery, which makes it more difficult to export and to compete on the world market. Moreover, slow growth makes the economy unattractive and causes both capital flight and brain drain.

In Pakistan, like in other developing countries, public investment plays an important role for economic growth and development (Khan, 1996). Table 2 shows the average investment rate in Pakistan economy during different time periods. The table indicates that the total investment in the economy as a percentage of GDP is relatively low, ranging around 16.3%, but that the share of public investment in total investment is sufficiently large, reaching more than half during 1970-80, and afterward decreasing. By comparison, Table 3 shows that the average investment rate is more than 20% of GDP in Asia and all developing countries, around 25% of GDP in Europe and the Middle East. Public investment is supposed to promote the productivity (of private inputs) in most industrial sectors. On the other hand, it is sometimes hypothesized that public investment crowds-out private investment, so the effect or contribution of public investment should be discounted. The issue of whether public investment encourages or discourages private investment has to be analyzed empirically.

Few attempts have been made to quantify the real productivity contribution of public capital in Pakistan. This study intends to analyze the role of public capital in its economy, specifically to trace the relationship between productivity of public capital and economic growth, to investigate the issue of substitutability and complementarity between public and private capital and the net effect or contribution of public capital in national economy, and to
assess the contribution of public capital to economic growth over the time. Based on this analysis we can assess the government’s different expenditure policies, the country’s growth mechanism and private investment behavior.

The paper is organized as follows. In Section 2 we present a brief review regarding the role of public capital in production and investment, with reference to Pakistan. Section 3 then analyzes the role of public capital in production. Section 4 investigates the investment behavior of the private sector and its relation to public investment. Section 5 examines the net effect of public capital on national product. Section 6 evaluates the average contribution of each input in total economic growth. Finally, Section 7 states concluding remarks.

2. Review of the Literature

For the last few decades, in both developed and developing countries, increasing attention has been given to analysis of productivity of public capital stock and its relation to economic growth and regional income differences. Mera (1975) thoroughly analyzed the effects of social capital on the national economy. A comprehensive discussion on the method of evaluating the effects of infrastructure investment is found in Reitveld (1989). Aschauer (1989a, 1989b) estimated the productivity of public capital in aggregate production function, finding significant positive contribution of public stock in the United States. Furthermore, his findings suggest that public capital is a significant determinant of output growth and that the fluctuations in public stocks could have marked effects on the private sector. Munnell (1990) estimated the
productivity of public capital at aggregate and regional levels for the United States; his study also supports that public capital has a significant positive role in the production process. García-Mila and McGuire (1992) used highways and education components of public capital at the state level for the United States. Their results support that these inputs have a significant and positive effect on output. In a cross-country analysis for OECD countries, Robert and Poret (1991) found that infrastructure investment in general plays a positive role and that the estimates vary from country to country depending on production structure. Sturn and De Haan (1996) presented a detailed survey of empirical studies on the issue and outlined various methods to analyze the impact of public capital on output and economic growth, concluding that public capital enhances economic growth, although the magnitude of the effect of public capital varies among studies.

Seitz et al. (1993) focused on the effects of a specific type of social capital stock—road capacity—on the national economy, that is, the extent to which the expansion of road networks increases the efficiency of national production. Their results suggest significant contributions of public road infrastructure to the economic performance of the private industry in Germany. Sasaki et al. (1995) analyzed quantitatively the economic effects of road capacity and its spatial allocation across regions of Japan. They emphasized that the effect of road stock seems to depend on the spatial distribution of a road network, since the industrial structure, agglomeration of economic activities, density of population and so on vary over space. Thus, it might be hypothesized that road capacity increases production efficiency more in regions where non-agricultural activities are dominant and the population density is higher.

In the context of Pakistan, only a few studies have analyzed the role of infrastructure investment in socio-economic development and regional issues. Looney (1997) analyzed the country’s long run growth pattern and its relation to infrastructure investment, finding that the growth pattern since 1973 can be characterized by the balance achieved between GDP, infrastructure investment and private investment in large-scale manufacturing. These variables are in equilibrium in the long run and clearly complement each other with expanded GDP growth, stimulating private investment in manufacturing, which in turn creates effective demand for additional infrastructure facilities. In other studies, Ahmed (1994), and Looney (1995a) have shown that GDP growth can be explained by a conventional growth model stressing direct factor inputs. In Looney’s study (1997), the role of infrastructure is not as straightforward. On one hand it appears that in the case of Pakistan the expansion of public infrastructure has played a rather passive role in the country’s development; that is, public facilities have largely expanded in response to the needs created by private sector investment in manufacturing, rather than initiating private capital formation. On the other hand, because infrastructure has responded to tangible needs created by private sector expansion, it has been very effective in alleviating real bottlenecks. This phenomenon would be consistent with the common view that the country suffers from a lack of infrastructure in many key areas. In any case, the overall effect of this pattern of linkages implies that the rate of return on infrastructure investment is very high in Pakistan and, as such, the country has been able to sustain relatively high rates of growth in the past, despite lower levels of investment. Looney (1995) assessed whether the public sector’s crowding-out of investment in manufacturing has been a major factor affecting the pattern of private capital formation in that sector. His analysis suggests that expanded public investment in manufacturing has not played an important role in stimulating private investment in industry, and that the investment has stimulated a follow-on expansion in infrastructure. Instead of crowding-in (that is, a positive feedback effect) additional private invest-
ment, infrastructure investment appears to have led to larger deficits and domestic borrowing. In turn, these financial developments have dampened the flows of private capital into the important large-scale manufacturing sector. Most of the studies on the role of public capital in the context of Pakistan relied on approaches such as factor analysis or Vector Auto Regression (VAR) models.

3. The Role of Public Capital in Production

To evaluate the productivity of public capital, we specified a production function with three inputs, including public capital stock as an additional input, both at aggregate and sectoral levels of the Pakistan economy. Assuming Hicks-neutral technology, the production function is represented in the following way:

\[ Y_t = A_t F(L_t, K_t, G_t) \]  

and

\[ Y_{it} = A_{it} F(L_{it}, K_{it}, G_t) \quad i = 1, 2, \ldots, 7, \]  

where

- \( Y_t, Y_{it} \) = real value added at aggregate level and in sector \( i \) at time \( t \), respectively.
- \( A_t, A_{it} \) = Hicks-neutral technological coefficient, at aggregate and sectoral levels, respectively.
- \( L_t, L_{it} \) = amount of labor employed at aggregate and sectoral levels, respectively.
- \( K_t, K_{it} \) = private capital stocks at aggregate and sectoral levels, respectively.
- \( G_t \) = aggregate stock of public capital at time \( t \).

Regarding the specification of the statistical model, we tried to estimate Cobb-Douglas and Translog production functions under linear-homogeneity restriction on three inputs including public capital. However, the estimated results were not satisfactory in most of the cases; either the sign condition was not met or the coefficients were not statistically significant. Thus, the production function finally adopted is a type of variable elasticity of substitution, which is shown in (3) and (4).

The aggregate production function is:

\[ Y_t = B e^{A_t L_t^{\alpha} K_t^{\gamma}} \]  

or

\[ \ln Y_t = \ln B + A_t + \alpha \ln L_t + \beta \left[ \ln G_t - \ln L_t \right] + \gamma \ln K_t \]  

2 Details about sectors are cited in the data section of the Appendix.

3 Variable elasticity form of production function is more general than constant elasticity of substitution; for example Sasaki, et. al. (1995) also used variable elasticity form of production function in the context of evaluation of road capacity for the regions of Japan.
\[ \beta > 0, \gamma > 0, \alpha < 0. \]

The sectoral aggregate production function is:

\[ Y_{it} = Be^{A_x} L_{it}^{\alpha_i} K_{it}^{\gamma_i}, \]

or

\[
\ln Y_{it} = \ln B + A_x + \alpha_i \ln L_{it} + \beta_i \ln (G_t - \ln L_{it}) + \gamma_i \ln K_{it}\]

\[ \beta_i > 0, \gamma_i > 0, \alpha_i < 0. \]

Under the specification of variable elasticity in (3) and (4), it is hypothesized that the efficiency of labor input depends on per-labor public capital stock \((G/L)\). That is, the efficiency of labor is increased by public capital stock, but congestion in the use of publicly provided facilities is taken into consideration. In other words, the positive effect of public capital on labor input efficiency decreases with the number of users of public capital. For example, the greater the number of users of road, the greater will be congestion and less will be the positive effect of road use.\(^4\)

For the subsequent empirical analyses a time series data for the period 1964-97 is used. (See Appendix for data.) In this study, public capital is defined rather broadly as the services from publicly provided facilities. Besides total public capital \((G)\), its three different components (agriculture related \(G_1\), transport and communication \(G_2\) and financial-social and welfare related \(G_3\)) are also used in separate estimations. A time trend is introduced as a proxy for a technology indicator. Equations (3) and (4) are estimated both at aggregate and sectoral levels.

Results of the estimation of equation (3) are reported in Table 4. Equation (3-1) shows the estimate with total public capital stock and time trend. The estimated coefficients indicate a strong positive relationship between public capital-labor ratio and output. The coefficients \((\beta)\) of the public capital-labor ratio and private capital \((\gamma)\) are positive and significant at the 5% and 1% levels, respectively. The coefficient of determination adjusted for degree of freedom \((\overline{R}^2)\) is high.\(^5\) The coefficient \(\beta\) indicates that a 1% increase in the public capital-labor ratio increases the efficiency of labor input by .039%. In equation (3-2) without time trend, the coefficients \(\beta\) and \(\gamma\) show a positive relationship to output and are significant at 1%. Similarly, equations (3-4) through (3-8), show the estimates with different components of public stock. In all of them the coefficient \(\beta\) and \(\gamma\) are positive and significant in most cases at a 1% level, indicating strong positive effects on output of public stock-labor ratio and private capital stock.

\(^4\) As a referee pointed out, a more general or more symmetric form of variable elasticity of substitution is to add the term of \(\delta (\ln G_t - \ln K_t) \ln K_t\) in (13). This model was also estimated, but satisfactory results could not be obtained.

\(^5\) The Durbin-Watson ratio is generally low indicating positive serial correlation in the residuals of the estimated equations.
Table 4. Results of Estimation at Aggregate Level

<table>
<thead>
<tr>
<th>Equation</th>
<th>Constant</th>
<th>Time</th>
<th>$\ln L$ (α)</th>
<th>$\ln G/l L$ (β)</th>
<th>$\ln K$ (γ)</th>
<th>$\mathbf{R}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1. (G)</td>
<td>14.129</td>
<td>0.044</td>
<td>-0.509</td>
<td>0.040</td>
<td>0.164</td>
<td>0.997</td>
</tr>
<tr>
<td></td>
<td>(4.809)</td>
<td>(5.713)</td>
<td>(-1.685)</td>
<td>(2.708)</td>
<td>(3.659)</td>
<td></td>
</tr>
<tr>
<td>3-2. (G)</td>
<td>1.564</td>
<td>0.0565</td>
<td>0.536</td>
<td>0.064</td>
<td>0.343</td>
<td>0.994</td>
</tr>
<tr>
<td></td>
<td>(0.565)</td>
<td></td>
<td>(1.563)</td>
<td>(3.178)</td>
<td>(7.479)</td>
<td></td>
</tr>
<tr>
<td>3-3. (G₁)</td>
<td>7.821</td>
<td>0.191</td>
<td>0.189</td>
<td>0.003</td>
<td>0.177</td>
<td>0.9967</td>
</tr>
<tr>
<td></td>
<td>(1.396)</td>
<td>(2.476)</td>
<td>(0.405)</td>
<td>(0.630)</td>
<td>(1.694)</td>
<td></td>
</tr>
<tr>
<td>3-4. (G₁)</td>
<td>-6.020</td>
<td>-15.369</td>
<td>1.328</td>
<td>0.013</td>
<td>0.417</td>
<td>0.996</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(15.079)</td>
<td>(5.188)</td>
<td>(9.704)</td>
<td></td>
</tr>
<tr>
<td>3-5. (G₂)</td>
<td>17.696</td>
<td>0.063</td>
<td>-0.713</td>
<td>0.014</td>
<td>0.044</td>
<td>0.997</td>
</tr>
<tr>
<td></td>
<td>(3.633)</td>
<td>(5.806)</td>
<td>(-1.563)</td>
<td>(1.788)</td>
<td>(0.725)</td>
<td></td>
</tr>
<tr>
<td>3-6. (G₂)</td>
<td>-9.966</td>
<td>-7.575</td>
<td>1.863</td>
<td>0.018</td>
<td>0.334</td>
<td>0.993</td>
</tr>
<tr>
<td></td>
<td>(12.192)</td>
<td></td>
<td>(2.211)</td>
<td>(6.786)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-7. (G₃)</td>
<td>19.375</td>
<td>0.055</td>
<td>-0.984</td>
<td>0.035</td>
<td>0.198</td>
<td>0.998</td>
</tr>
<tr>
<td></td>
<td>(7.002)</td>
<td>(9.091)</td>
<td>(-3.567)</td>
<td>(5.032)</td>
<td>(5.289)</td>
<td></td>
</tr>
<tr>
<td>3-8. (G₃)</td>
<td>-2.909</td>
<td>-1.185</td>
<td>1.099</td>
<td>0.023</td>
<td>0.373</td>
<td>0.993</td>
</tr>
<tr>
<td></td>
<td>(3.721)</td>
<td></td>
<td>(1.768)</td>
<td>(6.015)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Denotes significant at the 5% level. ** Denotes significant at the 1% level.

It should be noted that we adopted specific functional form of the production functions, with variable elasticity of substitution, so the parameters (α, β) can not directly be referred to as output elasticities for labor and public capital stocks. We thus calculated output elasticity of labor and public capital for the equations (3-2), (3-4), (3-6) and (3-8) at the average values of each variable. Table 5 shows the output elasticities of total, and components of public capital stocks, labor and private capital inputs. Elasticity estimates in the table indicate that output elasticity of total public capital stock is 0.648. A 1% increase in total public capital stocks increases 0.64% output. Similarly, output elasticity of labor, when aggregate public capital stock is used, indicates that labor input contributes 0.034% to output. Low output elasticity of labor indicates that the congestion phenomena is severe. Output elasticity of private capital stock is 0.34 when aggregate public capital is used, and 0.42, 0.33 and 0.37

$\varepsilon_G = \frac{\partial \ln Y}{\partial \ln G} = \beta \ln \bar{L}$,

$\varepsilon_L = \frac{\partial \ln Y}{\partial \ln L} = \left[ \alpha + \beta \ln \left( \frac{G}{L^2} \right) \right]$,

where $\bar{L}$ and $\bar{G}$ are average labor and public capital stock respectively. The term $\ln \left( \frac{G}{L^2} \right)$ in the above expression indicates the congestion effect in the use of public capital. If the number of labor is too large relative to public capital, this term will be negative. If the $\varepsilon_L$ is negative, indicates that negative congestion effect is stronger or the congestion phenomena is revealed.
respectively, when different components of public capital are used in the estimation. These values are rather robust regardless of differing $G$. Estimates of elasticity for equations (3-4), (3-6) and (3-8) indicate the contribution of different components of public capital to output. Estimates also indicate that the $G_3$ component has higher output elasticity than the other two. The estimates of output elasticities in the table indicate that on an aggregate level public capital plays a very strong and positive role in the production process in the economy of Pakistan. Among alternative components, $G_3$ and $G_2$ have higher productivity than $G_1$.

The estimation results of sectoral production functions show that in all the cases, the coefficient $\beta$ and $\gamma$ are positive and significant at 1% or 5% level of significance, respectively, indicating positive effect on output of public stocks-labor ratio and private capital stocks. (The estimation results are available from the authors upon request.) Table 6 shows the output elasticities of aggregate as well as components of public capital stock in each sector. In the agriculture sector, elasticities of aggregate and primary public stock in each sector. In the agriculture sector, elasticities of aggregate and primary public stock are 0.311, and 0.124, respectively. Elasticity of labor is negative due to strong negative congestion effect. In the manufacturing sector, productivity contribution of aggregate as well as components of public capital is sufficiently large; congestion phenomena is not revealed. Similarly, in the construction and trade sectors the contribution of public capital is strong: again congestion is not revealed. In the energy, transport and services sector, though the contribution of public capital is sufficiently large, the negative effect of the congestion phenomena in its use is large to the extent that the elasticity estimates of labor input become negative.

### Table 5. Output Elasticity at Aggregate Level

<table>
<thead>
<tr>
<th>Equation</th>
<th>$\varepsilon_G$</th>
<th>$\varepsilon_L$</th>
<th>$\varepsilon_K$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3-2) $G$</td>
<td>0.648</td>
<td>0.034</td>
<td>0.343</td>
</tr>
<tr>
<td>(3-4) $G_1$</td>
<td>0.132</td>
<td>1.204</td>
<td>0.416</td>
</tr>
<tr>
<td>(3-6) $G_2$</td>
<td>0.180</td>
<td>1.715</td>
<td>0.334</td>
</tr>
<tr>
<td>(3-8) $G_3$</td>
<td>0.236</td>
<td>0.840</td>
<td>0.372</td>
</tr>
</tbody>
</table>

### Table 6. Output Elasticity of Public Capital and Labor in Each Industrial Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Total Public Capital ($G$)</th>
<th>Infrastructure ($G_2$)</th>
<th>Services ($G_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture</td>
<td>$\varepsilon_G$</td>
<td>$\varepsilon_L$</td>
<td>$\varepsilon_G$</td>
</tr>
<tr>
<td>2. Manufacturing</td>
<td>0.648</td>
<td>0.432</td>
<td>0.194</td>
</tr>
<tr>
<td>3. Construction</td>
<td>0.543</td>
<td>0.095</td>
<td>0.337</td>
</tr>
<tr>
<td>4. Energy</td>
<td>1.844</td>
<td>-0.169</td>
<td>1.308</td>
</tr>
<tr>
<td>5. Transport &amp; Com</td>
<td>0.999</td>
<td>-0.058</td>
<td>0.702</td>
</tr>
<tr>
<td>6. Trade</td>
<td>0.524</td>
<td>0.448</td>
<td>0.209</td>
</tr>
<tr>
<td>7. Services</td>
<td>0.821</td>
<td>-0.102</td>
<td>0.694</td>
</tr>
</tbody>
</table>

*Denotes that the component $G_1$ is used instead of $G_2$. 

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4. Investment Behavior of the Private Sector

For explaining the investment behavior of private firms, a capacity-acceleration type investment model is specified both at national and sectoral levels by incorporating public capital. That is,

$$I_t = \psi (K_t^* - \lambda K_{t-1}) + \delta K_{t-1} + \bar{I}, \quad (5)$$

where $I_t$ is the gross private investment during the time period $t$, $K_t^*$ and $K_{t-1}$ are desired and actual capital stocks at the end of time $t$ respectively, parameter $\lambda$ is the capacity utilization rate and $\psi$ is the adjustment speed coefficient such that $0 \leq \psi \leq 1$. The replacement investment is assumed to equal to $\delta K_{t-1} + \bar{I}$, where $\delta$ is the “average” depreciation rate of capital stock and $\bar{I}$ is constant. The desired capital stock is assumed to be proportional to expected output. That is,

$$K_t^* = c Y_t^e, \quad (6)$$

where $c$ is the capital-output ratio and $Y_t^e$ is the expected output in time period $t$.

In our model, public capital is hypothesized to affect the capital-output ratio $c$. If an increase in public capital promotes private capital, then capital-output ratio $c$ will increase so that public and private capitals are complementary to each other. On the other hand, if an increase in public capital decreases private capital, then capital-output ratio $c$ will decrease so that public capital works as a substitute to private capital. On the basis of this hypothesis, we specified capital-output ratio $c$ as function of growth in public capital stock, That is,

$$c = \left( c_1 + c_2 \frac{G_{t-1}}{G_{t-2}} \right). \quad (7)$$

Expected output in current period is assumed to be a function of the last period’s output:

$$Y_t^e = b Y_{t-1}. \quad (8)$$

In this study, it is hypothesized that the adjustment speed ($\psi$) depends positively on the ratio of change in bank credit to private sector to the total desired investment: the more the increase in bank credit, the more rapidly the desired investment is realized. That is,

$$\psi = f\left( \frac{\Delta BC}{K_t^* - \lambda K_t} \right), \quad f' > 0. \quad (9)$$

The justification of this hypothesis is based on a vast body of literature on “financial repression.” McKinnon (1973), Shaw (1973), Fry (1980, 1982) and Galbis (1979) have argued that low nominal interest rates, interest rate ceilings combined with high and variable rates of inflation, have retarded the process of financial deepening in many developing countries. In the case of Pakistan, financial repression has been prevalent since its inception. The government, for a variety of reasons, keeps the real interest rate low, which impedes financial deepening,
capital formation and growth. The money or capital market remains relatively less developed. The interest rate is not determined freely by market forces but rather administered by the monetary authorities.\(^7\) Therefore, it does not reflect the true cost of financing investment.\(^8\)

Second, in the traditional Keynesian model, the link between the real and monetary sectors is provided by the rate of interest via its effect on investment. This has been the standard approach in the model for developed countries because of the nature of the well-organized capital market. This link seems to be inapplicable in the model for developing economies. Thus, bank credit in the investment function actually provides a link between the real and monetary sectors (Khan; 1988).

Under the assumption of linear form of \( f \) in (9),

\[
\psi = \alpha_o + \frac{1}{(K^*_t - \lambda K_{t-1})}(\alpha_1 \Delta BC) \tag{10}
\]

or

\[
\psi(K^*_t - \lambda K_{t-1}) = \alpha_o(K^*_t - \lambda K_{t-1}) + \alpha_1 \Delta BC. \tag{11}
\]

By substituting (7) and (8) in (6), we get

\[
K^*_t = \left\{ c_1 + c_2 \frac{G_{t-1}}{G_{t-2}} \right\} \left\{ b Y_{t-1} \right\}. \tag{12}
\]

Substituting equations (11) and (12) into equation (5), we derive equation (13), which will be used in the estimation:

\[
I_t = \alpha_o(K^*_t - \lambda K_{t-1}) + \alpha_1 \Delta BC + \delta K_{t-1} + \tilde{I}
\]

\[
= \tilde{I} + \left( \alpha_0 c_1 b + \alpha_0 c_2 b \frac{G_{t-1}}{G_{t-2}} \right) Y_{t-1} + \alpha_1 \Delta BC + (\delta - \alpha_0 \lambda) K_{t-1}
\]

\[
= \beta_0 + \left\{ \beta_1 + \beta_2 \frac{G_{t-1}}{G_{t-2}} \right\} Y_{t-1} + \beta_3 \Delta BC + \beta_4 K_{t-1}, \tag{13}
\]

where

\[
\beta_0 = \tilde{I}, \quad \beta_1 = \alpha_0 c_1 b, \quad \beta_2 = \alpha_0 c_2 b, \quad \beta_3 = \alpha_1, \quad \beta_4 = (\delta - \alpha_0 \lambda)
\]

\[
\beta_1 > 0, \quad \beta_2 < 0, \quad \beta_3 > 0, \quad \beta_4 < 0.
\]

\(^7\) For more detailed discussion on the importance of interest rates in developing countries, see Lanyi and Saracoglu (1983). Furthermore Edwards and Khan (1985) analyzed the positive association between the degree of development of financial sector and general economic performance.

\(^8\) We also tried to estimate investment functions which include interest rate, but interest rate coefficient was insignificant both at aggregate as well as sector level.
As described above, if public capital is a complement to private capital, the capital-output ratio will increase, i.e., $\beta_2 > 0$. For example, construction of new roads and highways will compel the truck industry to invest more in new vehicles. Likewise, public investment in irrigation and water management facilities will encourage the agriculture sector to invest more to cultivate more land. On the other hand, if the public capital turns out to be a substitute for private capital, the capital-output ratio $c$ will decrease. For example, investments in communication by the public sector will make the facilities available to private business firms so that they need not invest their resources in this, i.e., $\beta_2 < 0$.

Table 7 reports the estimation results of investment equation (13) at the national aggregate level using three different categories of public capital. The sign conditions for coefficients of output ($\beta_1$) and bank credit ($\beta_3$) are as expected in all three cases. The coefficient of output $\beta_1$ bears positive sign in equation (13-1), but not significant even at 10%, indicating that the previous year’s output or sales did not have significant impact on the current year’s investment when aggregate public capital is used in the estimation. The coefficient of bank credit $\beta_3$, is positive and significant at 1% level in all three cases. This result indicates that the speed of adjustment in relation to discrepancy between desired and actual private capital stock is explained well by the amount of bank credit in the private sector. It also implies that private investment in Pakistan is constrained by the availability of funds; therefore, the government or monetary authorities can use bank credit as a policy instrument for influencing private investment behavior through the proper use of bank credit. The coefficient of private capital stock ($\beta_4$) is negative and significant at the 1% level, indicating that accumulation of the previous period’s capital stock works as a restrain to investment in the current period. In other words, higher accumulation of capital stocks in the last period already reduced the discrepancy between desired and actual stock to a great extent; in the next period firms need not invest more. The coefficient of growth rate of public capital ratio ($\beta_2$) is negative, and not significant. The negative sign indicate public capital works as substitute for private capital, but the coefficient is insignificant, so we can interpret it as a weak substitute or neutral effect of aggregate public capital on private investment. In the case of equation (13-2), when the $G_2$ component of public capital is used in the estimation, the coefficient of output is positive and significant at the 5% level. The coefficient of bank credit bears the expected sign and is significant at 1%, while that of private capital is negative and significant at 5%. The coefficient of growth rate of public capital ratio is negative and significant at 10%, indicating that public capital is a substitute for private capital.

<table>
<thead>
<tr>
<th>Equation/Public Capital</th>
<th>$\beta_0$</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_3$</th>
<th>$\beta_4$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-1 (G)</td>
<td>(-9.319) ** ((-4.662))**</td>
<td>0.166 ((1.141))</td>
<td>(-0.091) ((-0.691))</td>
<td>0.303 ((2.615))**</td>
<td>(-0.065) ((-2.641))**</td>
<td>0.970</td>
</tr>
<tr>
<td>13-2 (G_2)</td>
<td>(-9.397) ** ((-5.744))** **</td>
<td>0.216 ((2.321))*</td>
<td>(-0.126) ((-1.644))</td>
<td>0.291 ((2.594))**</td>
<td>(-0.050) ((-1.949))*</td>
<td>0.972</td>
</tr>
<tr>
<td>13-3 (G_3)</td>
<td>(-6.621) ** ((-3.135))** **</td>
<td>0.276 ((3.042))** **</td>
<td>(-0.179) ((-2.361))**</td>
<td>0.295 ((2.759))**</td>
<td>(-0.034) ((-1.311))</td>
<td>0.975</td>
</tr>
</tbody>
</table>

** denotes significant at the 1% level * denotes significant at the 5% level
capital works as a substitute to private capital. In the case of equation (13-3), the coefficient of public capital turns out to be negative and significant at 5%, while that of private capital is negative and significant only at a 10%. Thus, it can be concluded that the aggregate public capital works as a weak substitute to private capital or has a neutral effect on private investment, and that each component of public capital is a substitute to private capital. Another important finding is that the private investment in Pakistan is constrained by the availability of funds, and that bank credit variable plays a significant role in the decisions on private investment.

Sectoral investment functions were also estimated (and are available from the authors upon request). In the agriculture sector, the coefficient of output ($\beta_1$) is positive and statistically insignificant, while that of public capital ($\beta_2$) is negative and significant at the 1% level, suggesting that public capital ($G_1$) works as a strong substitute for private capital in this sector. The coefficient of bank credit ($\beta_3$) bears a positive sign and is significant at 1%, indicating that this sector is facing resource constraints. In Pakistan, credits to private sectors are allocated and disbursed via credit rationing policy. The agriculture sector is the largest of the economy (contributing around 27% of GDP), although the average share of credit allocated to it is around 19% of the total credit for the private sector. Thus, there is a scarcity of funds in this sector. The coefficient of private capital ($\beta_4$) is negative and significant at 1%.

In the manufacturing sector, the sign conditions for the coefficients of output ($\beta_1$) and bank credit ($\beta_3$) are satisfied in all three cases. The coefficient of output is significant at the 5% level only when the $G_3$ component of public capital is used in the estimation. The coefficient of bank credit bears a positive sign but is insignificant in all three cases. This is an indication that the manufacturing sector is not facing severe resource/funds availability constraints. The coefficient of private capital is negative and not significant in any of the three cases, while that of public capital ($\beta_2$) is negative in all three cases. In equations (13-1) and (13-2) public capital works as a weak substitute — a neutral effect on private investment — while in the case of equation (13-3) it works as a substitute. Further, for this sector political stability and general market conditions might be important factors for private investment.

In the construction sector, the coefficient of output is positive in all three cases, but significant only when the $G_3$ component of public capital is used (i.e., equation 13-3). The coefficient of private capital ($\beta_4$) is negative in all cases and significant at the 5% level only in the case of equation (13-3), indicating that aggregate and $G_2$ components of public capital have a relatively weaker substitution effect than $G_3$ on private capital. Further bank credit ($\beta_3$) is insignificant in this sector. The private capital coefficient ($\beta_4$) is negative and significant at the 1% level in all three cases.

In the energy sector, the coefficient of output is positive and significant at the 1% level, with the bank credit coefficient positive but insignificant. The coefficient of aggregate public capital is negative and significant at 1%, indicating that public capital is a strong substitute to private capital. The coefficient of private capital stock is negatively related to private investment and it is significant at the 1% level. This sector has been predominantly controlled by the government. Since the 1990s, the private sector has been given incentives and permission to invest in some specified areas; therefore a stronger substitution effect of public capital on private capital is natural.

In the transportation and communication sectors, the output coefficients are positive, with significance at 1% and 5%, respectively, in the cases of equations (13-1) and (13-2). The aggregate and $G_2$ components of public capital are negative and significant at 1% and 5%,
respectively, suggesting that they work as a substitute to private capital. The coefficients of private capital in both cases are negative and significant at the 5% level. The coefficient of bank credit is significant at 10% only when aggregate public capital is used in the estimation. In other words, this sector is not constrained by funds availability, and is also dominated by public enterprises like railways, airlines, shipping, telecommunications, etc.

In the services sector, the output coefficient is positive and significant in all three cases. Public capital appears to be negative in all cases and is significant at 5% only when the \( G_3 \) component is used in the estimation. An interpretation of these results is that the aggregate and \((G_2)\) component of public capital work as a weak substitute and that the \((G_3)\) component works as a relatively strong substitute to private capital. The coefficient of change in bank credit could not satisfy the sign condition, suggesting that this variable is not relevant to the services sector. In the retail trade sector, since the sign conditions were not satisfied, it seems that the capacity hypothesis does not hold, and that private investment decisions in this sector are governed by other factors.

5. Net Effect of Public Capital on National Product

The results of the production analysis indicate that public capital significantly increases output, and that the output elasticity of public capital is sufficiently large. On the other hand, the investment analysis reveals that in many cases aggregate public capital has a negative effect on private investment, though in some cases that effect is statistically insignificant. These opposing effects necessitate investigation of the net effect of public capital on the national economy of Pakistan. The following three equations for determining national output, private investment, and private capital stock are the recursive system:

\[
I_t = I(Y_{t-1}, K_{t-1}, G_{t-1} - G_{t-2}, \Delta BC_t) ; \quad (14)
\]

\[
K_t = I_t + (1 - \delta) K_{t-1} ; \quad \text{and} \quad (15)
\]

\[
Y_t = Y(L_t, K_t, G_t) . \quad (16)
\]

A reduced form for national output is represented as

\[
Y_t = F(G_t, G_{t-1}, G_{t-2}, Y_{t-1}, K_{t-1}, L_t, \Delta BC_t) . \quad (17)
\]

We next specify (17) in a linear form:

\[
Y_t = a_0 + a_1 G_t + a_2 G_{t-1} + a_3 G_{t-2} + a_4 L_t + a_5 Y_{t-1} + a_6 K_{t-1} + a_7 \Delta BC_t . \quad (18)
\]

Four alternative variations of (18) were estimated, with results reported in Table 8.9

9 Since Equation (16) (Equation (3)) is non-linear and in Equation (14) the term of \( \frac{G_{t-1}}{G_{t-2}} \) is incorporated, a reduced form (17) should be non-linear function of predetermined variables. Thus, Equation (18) is a linear
Table 8. Estimation Results of Reduced Form with G

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(18-1) Dependent variable (Y)</th>
<th>(18-2) Dependent variable (Y)</th>
<th>(18-3) Dependent variable (Y)</th>
<th>(18-4) Dependent variable Y/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>C (constant)</td>
<td>26786</td>
<td>5024</td>
<td>51648</td>
<td>0.386</td>
</tr>
<tr>
<td></td>
<td>(0.573)</td>
<td>(1.567)</td>
<td>(1.416)</td>
<td>(1.806)</td>
</tr>
<tr>
<td>Gt</td>
<td>0.953</td>
<td>0.912</td>
<td>0.785</td>
<td>0.819</td>
</tr>
<tr>
<td></td>
<td>(1.843)*</td>
<td>(1.819)*</td>
<td>(1.650)</td>
<td>(1.680)</td>
</tr>
<tr>
<td>Gt-1</td>
<td>-1.797</td>
<td>-1.922</td>
<td>-1.306</td>
<td>-1.857</td>
</tr>
<tr>
<td></td>
<td>(-1.819)*</td>
<td>(-2.054)*</td>
<td>(-1.631)</td>
<td>(-2.024)*</td>
</tr>
<tr>
<td>Gt-2</td>
<td>1.487</td>
<td>1.599</td>
<td>1.126</td>
<td>1.637</td>
</tr>
<tr>
<td></td>
<td>(2.223)*</td>
<td>(2.604)**</td>
<td>(2.179)*</td>
<td>(2.779)**</td>
</tr>
<tr>
<td>Lt</td>
<td>-1.623</td>
<td>-</td>
<td>-3.444</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(-0.467)</td>
<td></td>
<td>(-1.257)</td>
<td></td>
</tr>
<tr>
<td>Yt</td>
<td>0.626</td>
<td>0.591</td>
<td>0.769</td>
<td>0.564</td>
</tr>
<tr>
<td></td>
<td>(3.458)**</td>
<td>(3.643)**</td>
<td>(11.060)</td>
<td>(3.888)**</td>
</tr>
<tr>
<td>Kt</td>
<td>0.079</td>
<td>0.105</td>
<td>-</td>
<td>0.120</td>
</tr>
<tr>
<td></td>
<td>(0.857)</td>
<td>(1.465)</td>
<td></td>
<td>(1.831)*</td>
</tr>
<tr>
<td>ΔBCt</td>
<td>0.324</td>
<td>0.354</td>
<td>0.291</td>
<td>0.249</td>
</tr>
<tr>
<td></td>
<td>(1.647)</td>
<td>(1.925)*</td>
<td>(1.517)</td>
<td>(1.421)</td>
</tr>
<tr>
<td>( \bar{R}^2 )</td>
<td>0.9987</td>
<td>0.9988</td>
<td>0.9988</td>
<td>0.9962</td>
</tr>
<tr>
<td>DW</td>
<td>1.890</td>
<td>1.801</td>
<td>2.115</td>
<td>1.850</td>
</tr>
</tbody>
</table>

"* Denotes significant at the 1% level. " Denotes significant at the 5% level.

The estimated result of model (18-1) show that the coefficients of \( G_t \), \( G_{t-1} \) and \( G_{t-2} \) are significant at the 5% level. Assuming a stationary state in evaluating the effect of public capital, the net contribution of aggregate public capital is calculated to be 0.64 (i.e. \( a_1 + a_2 + a_3 = 0.64 \)). The coefficient of \( K_{t-1} \) is positive but insignificant, while that of \( L_t \) is negative and not significant, indicating high multicollinearity among the independent variable. The coefficient of \( ΔBC_t \) is positive and significant at the 10% level, indicating that changes in bank credit to the private sector play a positive role in the determination of national output by enhancing the capital of private business firm/investors. Model (18-2) was estimated by suppressing labor, with the net effect of public capital being 0.59. The coefficient of private capital stock becomes significant at the 10% level. Similarly, model (18-3) was estimated by suppressing \( K_{t-1} \), and model (18-4) by using \( Y/L \) as the dependent variable. The net effect of public capital in both cases is calculated to be 0.60. Incidentally, the net effect of public capital (\( a_1 + a_2 + a_3 = 0.60 - 0.64 \)) is very close in all four cases. From the above results we conclude that the positive effect of public capital on production is more dominant than the negative effect on private investment.

The model in (17) was estimated for different components of public capital at the national level as well. (Results are available from the authors upon request). The results show that the net effect of the \( G_2 \) component of public capital is calculated to be 0.30, though the coeffi-
The coefficients of public capital are statistically insignificant. The net effect of $G_t$ type of public capital is also positive but statistically insignificant.

6. Contribution of Public Capital, Labor and Private Capital Stock

Following Solow (1956), we derived the growth expression by differentiating the production relation with respect to time. The average contribution of each input to the total growth is computed using the estimated parameters for sample period.\(^{11}\) That is,

$$\frac{Y_t}{Y_t} = \beta \ln L_t + \frac{G_t}{G_t} \left( \alpha + \beta (\ln G_t - 2 \ln L_t) \right) + \gamma \frac{K_t}{K_t} \quad (19)$$

where $Z$ denotes $\frac{dZ}{dt}$.

In Table 9, column 1 shows the average growth rates of GDP. Columns 2, 3 and 4 show the percentage contribution of public capital, labor and private capital inputs, respectively, in growth during different time periods. The results indicate the public capital’s contribution in growth has been sufficiently large during early periods of the sample and decreases over time. The contribution of labor input remains low and is more or less the same during the sample period. The contribution of private capital increases over time from 25% during 1964-67 to 44% during 1995-97. During 1970-75, the share of private capital in growth decreases drastically because of nationalization of manufacturing and industries.\(^{12}\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Average growth of GDP (%)</th>
<th>Public Capital (%) (G)</th>
<th>Labor (%) (L)</th>
<th>Private Capital (%) (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-67</td>
<td>5.97</td>
<td>0.72</td>
<td>0.03</td>
<td>0.25</td>
</tr>
<tr>
<td>1967-70</td>
<td>7.50</td>
<td>0.72</td>
<td>0.05</td>
<td>0.23</td>
</tr>
<tr>
<td>1970-75</td>
<td>3.12</td>
<td>0.80</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>1975-80</td>
<td>5.51</td>
<td>0.82</td>
<td>0.06</td>
<td>0.11</td>
</tr>
<tr>
<td>1980-85</td>
<td>6.44</td>
<td>0.58</td>
<td>0.05</td>
<td>0.36</td>
</tr>
<tr>
<td>1985-90</td>
<td>5.25</td>
<td>0.52</td>
<td>0.06</td>
<td>0.42</td>
</tr>
<tr>
<td>1990-95</td>
<td>5.40</td>
<td>0.51</td>
<td>0.04</td>
<td>0.46</td>
</tr>
<tr>
<td>1995-97</td>
<td>2.49</td>
<td>0.50</td>
<td>0.07</td>
<td>0.44</td>
</tr>
</tbody>
</table>

\(^{11}\) We used the estimated parameters of production function in computing the share of each input in growth for the sample period. Table 9 presents the average shares during the stated years.

\(^{12}\) Pakistan has experienced civil war during 1970-71, and nationalization of manufacturing and industries (1972 onward).
7. Concluding Remarks

This study analyzed the role of public capital stock in the economy of Pakistan by estimating the production functions both at national and sectoral levels, including public capital as an input. The Investment behavior of the private sector and the issue of substitutability and complementarity between public and private capital was analyzed by estimating the capacity-acceleration type investment functions. Further, the net effect of public capital on the national economy was also analyzed by estimating the reduced form relation for national output. Finally, the average contribution of each input to the total growth of national economy was assessed. The main findings of the analyses are summarized as follows:

1. The estimates of production functions show that the public capital-labor ratio and private capital have a significantly positive effect on output. It is concluded that the productivity contribution of public capital is sufficiently large at the national aggregate and sectoral levels, and that on the aggregate level public capital plays a very effective role in the production process in the economy of Pakistan. Among alternative components, $G_3$ and $G_2$ have higher productivity than $G_1$.

2. The estimation results of the investment analysis show that the coefficients of output, private capital, public capital ratio and bank credit play important roles in explaining the private sector’s investment behavior. The speed of adjustment to the desired capital stock is explained well by the bank credit variable. The coefficient of growth rate of public capital ratio is negative, indicating that public capital works as a substitute for private capital.

3. The results of the production analysis indicate that public capital significantly increases output, and that output elasticity of public capital is sufficiently large. On the other hand, the investment analysis reveals that aggregate public capital, in many cases, has a negative effect on private investment, though in some cases that effect is statistically insignificant. These opposing effects necessitate investigation of the net effect of public capital on the national economy of Pakistan. We estimated the reduced form relation for national output, finding that the net contribution of public capital to national product is positive.

4. The average contribution of different inputs in total growth of the economy over the time indicates that the public capital’s contribution in growth has been sufficiently large during early periods of the sample and that it decreases over time.

The authors are grateful to Professor Asao Ando for valuable suggestions, and to Dr. Yang Zhang and Mr. Kiyoshi Yonemoto for their help during the course of this research. An earlier version of the paper was presented at the Applied Regional Science Conference at Kumamoto, December 1999. The authors also thank Professor Xiao-Ping Zheng and other participants of the conference for their useful comments, as well the anonymous referees for the helpful suggestions to improve the paper.

Final version received May 2001.

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References

Appendix. Data Sources and Stock Series

Most of the time series data used for the analysis were collected from various secondary sources. The main sources are the *Pakistan Economic Survey*, *State Bank of Pakistan Annual Report*, *United Nations Yearbook on National Accounts Statistics*, and *Labor Force Survey*. We adopted the following classification of national accounts for sectoral analysis:

1. Agriculture, including fishing, forestry, hunting and animal husbandry;
2. Manufacturing, including mining and quarry;
3. Energy, including gas and electricity;
4. Construction;
5. Transport and communication, including storage;
6. Wholesale and retail trade; and
7. Services, including finance, insurance, real estate and community services.

All raw data, except population and labor force, were in nominal terms. Since sectoral price deflators were not available, we used a GDP deflator, in which the basis is 1987 prices, to transform nominal figures into real terms. (The GDP deflator was taken from UN National Accounts Statistics for Pakistan, 1997).

For the capital stock series, we followed a similar approach used by Young (1994), Nehru and Dhareshwar (1993) and others to estimate capital stock series from fixed investment series, using the perpetual inventory method. The following equation gives estimates for the capital stock series:

\[ K_{it} = (1 - d_i) K_{i(t-1)} + I_{it} \]

where
\[ I_{it} \]: is fixed investment during time \( t \) in sector \( i \).
\[ K_{it} \]: is capital stock at the end of time \( t \) in sector \( i \).
\[ d_i \]: is the average depreciation rate of capital stock in sector \( i \).

A problem with the method in equation (A-1) is how to calculate the capital stock of the initial period in the sample. There are some alternatives in the literature, such as assuming zero or taking the first three or five years of investment. Our method is as follows: first we computed initial capital stock for aggregate level using following relationships,
\[ K_0^T = \frac{IK_0^T}{g_K + d_K^T} \]
\[ G_0^T = \frac{IG_0^T}{g_G + d_G^T} \]

where

\[ K_0^T, G_0^T \]: initial total private and total public capital stocks, respectively;

\[ IK_0^T, IG_0^T \]: total private and public fixed investment respectively, at initial period;

\[ g_K, g_G \]: growth rates of total private and public fixed investments, respectively; and

\[ d_K^T, d_G^T \]: weighted depreciation rate of total private and public capital stocks, respectively.

We used the following formula to compute the weighted average depreciation rates for private and public capital stock at the aggregate level:

\[ d_K^T = \sum w_k^i d_i, \quad d_G^T = \sum w_G^i d_i \]  

where

\[ d_i \]: depreciation rate of capital stock in sector \( i \); and

\[ w_k^i, w_G^i \]: weights, defined as average share of each sector’s fixed investment in total private and public investment, respectively.

Since sectoral depreciation rates were not available, we used the flat rate for both private and public capital stock in each sector, as given for Pakistan in the United Nations Yearbook on National Accounts Statistics (1988).

The growth rate of fixed investment \( g \) has been used differently in the literature; some researchers considered it for a three-year average, while others used a five-year average. In our sample, the initial period is close to the establishment year of the country. Starting from a low base, the initial periods are characterized by large investment and capital stock build-up relative to later periods. A low base will tend to generate a high growth rate in the early periods, which may lead to a downward bias in capital stock values. We thus used the average growth rate over the entire sample period employing the following relations:

\[ g_K = \frac{(\ln IK_{1997} - \ln IK_{1964})}{33}, \quad g_G = \frac{(\ln IG_{1997} - \ln IG_{1964})}{33} \]  

Initial capital stocks for each sector are calculated using following ratios:

\[ K_0^i = \frac{\sum_{i=1964}^{1997} IK_i}{\sum_{i=1964}^{1997} IK^T} \times K_0^T \]

\[ G_0^i = \frac{\sum_{i=1964}^{1997} IG_i}{\sum_{i=1964}^{1997} IG^T} \times G_0^T \]
Capital stock series both at the aggregate and sectoral levels were calculated using equation (A-1). Public capital stocks were grouped into three broad categories:

- $G_1$: irrigation, dams and other agriculture-related public capital.
- $G_2$: roads, highways and other transportation facilities and communication.
- $G_3$: social welfare, community services and financial sector facilities provided by the government.