The Composition of Public Expenditure, Physical Infrastructure and Economic Growth in Nepal

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This paper investigates the role of composition of public expenditure, particularly the expenditure on physical infrastructure, on economic growth in Nepal from the time series perspective based on the endogenous growth model. The impact of public expenditure on economic growth has been found to be positive. Hence, low economic growth in Nepal in recent years can be attributed to low government expenditure on infrastructure. Availability of infrastructure situation is very dismal. Given the sustainable debt scenario, Nepal can go for more investment in infrastructure by external borrowing at least for the medium term.

I. INTRODUCTION

The role and size of the government expenditure has always been in debate. Although neoclassical economists argue for a small role of the government in economic affair, some roles of the government cannot be ignored in economic activities. There are some public goods like physical infrastructure, and semi public goods like education and health, in which we expect the significant role of the government. Private sectors do not generally enter into these sectors because of externality, long gestation period and need of huge investment. But, private production requires directly or indirectly these public goods.[1] Hence, the impact of public investment on growth has been the subject of much attention in recent academic research and policy debates (Agenor, 2007). Beginning with Aschauer (1989a, 1989b, 1989c), there has been a series of debate about the productivity effects of government expenditure on economic growth from different perspectives.[2]

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[1] In addition, public goods and services even enter into the household's utility function (Barro, 1990).

[2] Public investment for a public infrastructure such as roads, airports and port facilities can have direct and indirect effects on private sector output and productivity growth (Aschauer, 1989b). Public capital can directly influence the production and distribution and indirectly increase the return of private capital through complementary relation.

Cross-country studies on economic growth have explored a large number of determinants of economic growth. Greiner, Semmler and Gong (2005) suggest that specific forces differ from country to country, in line with the stage of development. Public goods like physical infrastructure, education and health are also crucial determinants of economic growth in certain stage of development, for which the role of government cannot be ignored. Public provision is required due to the positive externality effects of the development of public goods.

Following the modeling strategy of Devarajan, Swaroop and Zou (1996), Greiner, Semmler and Gong (2005), and Semmler *et. al.* (2007), this paper discusses a general model that features a government that undertakes public expenditure on (a) education and health facilities which enhance human capital, (b) public infrastructure such as roads and bridges, irrigation, electricity necessary for market production activity, (c) public administration to support government functions, and (d) debt service. Accordingly, this paper examines the impact of the composition of the government expenditure on economic growth in Nepal for the period 1981-2007, since there has not been any study done in Nepal on this matter.[3] It is argued that Nepal's low economic growth is due to lack of adequate availability of infrastructure.

As regards the structure of this paper, Section II sketches a brief review of empirical evidence. Section III deals with a growth model incorporating accumulation of private physical capital as well as the composition of government expenditure. In Section IV, an overview of Nepalese economy is undertaken, followed by the empirical analysis in Section V. Finally, Section VI draws the conclusions.

II. OVERVIEW OF EMPIRICAL EVIDENCE

Endogenous growth models allow analyzing the impact of the fiscal policy on economic growth. Some early attempts were made by Aschauer (1989a, 1989b, 1989c), followed by Barro (1990). Aschauer (1989a) finds that core infrastructure (streets, highways, airports, mass transit etc) has the most explanatory power for private sector productivity in the Unites States during 1949-85. Extending his study to 7 developed countries, Aschauer (1989b) further found the strong positive correlation between the labor productivity and non-military capital expenditure.[4] He further argues that public investment makes crowding-in effect in contrast to general neo-classical view of crowding out effect of government expenditure because marginal return of private capital increases if public infrastructures are available (Aschauer, 1989b).

Barro (1990) found an inverted U-curve relationship between productive government expenditure and economic growth, implying the productivity effect of government expenditure up to a certain level. Based on data of 98 countries, Barro (1991) further found that an increase in resources towards nonproductive government consumption is associated with lower per capita. Moreover, Kessides (1993) examines a wide range of evidence on the impacts of infrastructure on economic development and concludes that infrastructure contributes to economic growth, both through supply and demand channels

[3] Some argue that a time series perspective on economic growth may be more useful for designing development strategies from particular country perspective (Griener *et.al*, 2005).
[4] He included the U.S., Japan, (West) Germany, France, United Kingdom, Italy and Canada.

by reducing costs of production, contributing to the diversification of the economy and providing access to the application of modern technology, raising the economic returns to labor. Infrastructure contributes to raising the quality of life by creating amenities, providing consumption goods (transport and communication services) and contributing to macroeconomic stability.

Using cross-country data of 100 countries for the period of 1970-1988, Easterly and Rebelo (1993) find a positive effect of investment in transport and communication on economic growth. Although the relationship between the per capita GDP growth and expenditure in infrastructure as percentage of GDP yield inconclusive results, Sanchez-Robles (1998) finds a positive impact of road length and electricity generating capacity in explaining subsequent economic growth in Latin American countries. Glomm and Ravikumar (1997) studied the implication of government expenditure on infrastructure and education using overlapping generation model, which depict the direct influence of public education expenditures on human capital accumulation, and subsequently on long term growth.

Based on his cross-regional study comparing infrastructure provision in Spain and the US, De la Fuente (2000) also concludes that causality flows from infrastructure investment to economic growth, but posits that, as a "saturation point" is reached, the returns on such investment declines. Agenor and Neanidis (2006) provide a more disaggregated discussion of government expenditure. Infrastructure affects not only the production of goods but also the supply of health and education services. The production of health (education) services depends also on the stock of educated labor (health spending).

In a recent study, Semmler *et. al*. (2007) propose as a practical rule of thumb that two-thirds of public investment should be directed towards public infrastructure that facilitates market production and the remaining one third to health and education, more or less evenly. Based on the calibration exercise, they argue such an allocation of resources would maximize income and welfare. They further emphasize that so long as resources for public investments are used in a growth maximizing way, debt sustainability will not be a problem.

In contrast to above findings, Devarajan *et. al* (1996) found, from the cross country study of 43 developing countries that the relationship between the capital component of public expenditure and per capital growth is negative, but an increase in the share of current expenditure has positive and statistically significant effects. Based on the study, they argue that developing countries governments have been misallocating public expenditures in favor of capital expenditure at the expenses of current expenditure. This contradictory situation of impact of the composition of government expenditure on economic growth has motivated to reexamine this relation in Nepalese economy. Since most of the studies are based on cross-sectional data, their results might have suffered from heterogeneity of countries. Hence, this paper focuses on time series perspective, given that no such study has been found solely using Nepal's data.

III. THE MODEL

This paper develops a model based on Devarajan *et. al* (1996) and Semmler *et. al* (2007), which involves both private and public sector, allowing the government to borrow

in contrast to balance budget in Devarajan *et. al* (1996) and Agenor and Neanidis (2006). It incorporates private physical capital and public capital which includes the public infrastructure to support the market production as well as facilities for health and education services. Hence, it establishes the linkage among the government expenditure, private capital and economic growth. Public capital is used to enhance both human capital and private capital as well.

As in Devarajan *et. al* (1996), the model proposed here considers two types of government expenditure: productive and unproductive.[5] The model will assess the effect of shift in composition of government expenditure and deficit financing on economic growth. In per capita term, aggregate production function is written with private capital 'k', two types of government expenditure 'g_1 (productive) and g_2 (unproductive) in CES type production function as

$$y = f(k, g_1, g_2) = [\alpha k^{-\rho} + \beta g_1^{-\rho} + \gamma g_2^{-\rho}]^{-1/p} \quad (1)$$

where $\alpha>0$, $\beta\geq 0$, $\gamma\geq 0$, $\alpha+\beta+\gamma=1$, $\rho\geq -1$

In contrast to Devarajan *et. al* (1996), I allow that the government can finance its expenditure by levying a flat-rate income tax, τ, and deficit financing in line with Semmler et.al (2007). Hence,

$$g = g_1 + g_2 = Tax + Df = \tau y + \upsilon y = (\tau + \upsilon)y \quad (2)$$

where τ is tax rate and Df is deficit financing ('v' percent of income), and y is national income.

$$g_1 = \phi(\tau + \upsilon)y \text{ and } g_2 = (1-\phi)(\tau + \nu)y \quad (3)$$

Let us assume $(\tau + \upsilon) = T$, hence $g_1 = \phi Ty$ and $g_2 = (1-\phi)Ty$ (3a)

Taking the government decision on τ, ϕ, and ν, the representative agent choose consumption 'c' and capital 'k' to maximize his/her welfare

$$\underset{c}{Max} \int_0^{\infty} e^{-\delta t} u(c)dt \quad (4)$$

u(c) is assumed to be $\frac{c^{1-\sigma}-1}{1-\sigma}$

Subject to

$$\dot{k} = (1-\tau)y - c \quad (5) \text{ [law of motion for capital]}$$

[5] For simplicity, just two types of classification have been made, but it can be extended to different compositions.

$$\dot{b} = rb - \theta g_2 \qquad (6)\ \text{[debt dynamics]}$$

where , δ is time preference, r is interest rate and θ is a part g_2 that is used for debt servicing. Elasticity of intertemopral substitution is the constant as $1/\sigma$. Initial population is normalized to 1.

Current value Hamiltonian,

$$H = \frac{c^{1-\sigma} - 1}{1-\sigma} + \lambda_1 [(1-\tau)y - c] + \lambda_2 [rb - \theta g_2] \qquad (7)$$

First order condition is

$$\frac{\partial H}{\partial c} = c^{-\sigma} - \lambda_1 = 0 \Rightarrow c^{-\sigma} = \lambda_1 \quad (8)$$

For the costate variables according to maximum principle,

$$\dot{\lambda_1} = \delta\lambda_1 - \frac{\partial H}{\partial k} = \delta\lambda_1 - \lambda_1 [(1-\tau)\frac{d(\alpha k^{-\rho} + \beta g_1^{-\rho} + \gamma g_2^{-\rho})^{-1/\rho}}{dk}] \qquad (9)$$

$$\dot{\lambda_2} = \delta\lambda_2 - \frac{\partial H}{\partial b} = \delta\lambda_2 - \lambda_2 r \qquad (10)$$

Equations for first order condition (8), equations for the costate variables (9) to (10), together with two state variable equations (5) and (6) constitute a system of five equations for five variables (c, k,b, λ_1, λ_2). Setting the differential equations (5), (6) (9) and (10) equal to zero and using equation (8), we get stationary state value of (c*, k*, b*, λ_1*, λ_2*). Using this steady state value into the production function, we get steady state per capita income. But our purpose here is to examine impact of composition of government expenditure and debt financing on per capita GDP growth.

From (8) and (9), we get dynamic equation for consumption as

$$\frac{\dot{c}}{c} = -\frac{1}{\sigma}[\delta - (1-\tau)\alpha k^{-\rho-1}(\alpha k^{-\rho} + \beta g_1^{-\rho} + \gamma g_2^{-\rho})^{\frac{-(1+\rho)}{\rho}}] \qquad (11)$$

After simple manipulation of Equation 11 as shown in Annex 1,

$$\frac{\dot{c}}{c} = \frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha + \left(\frac{g}{k}\right)^{-\rho}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho})\right\}^{\frac{-(1+\rho)}{\rho}} - \delta\right] \qquad (12)$$

Assuming steady state growth rate of consumption as λ, which is also equation per capita income growth at steady state, and assume that along the steady state growth path the tax rate τ and 'v' is also constant.

By using (1), (2), (3), and (3a), we get (as depicted in detail in Annex 1)

$$\frac{g}{k}=\left[\left\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)\right\}^{-\rho}/\alpha\right]^{\frac{1}{\rho}} \tag{13}$$

Substituting (13) into (12), the following is obtained (as elaborated in Annex 1):

$$\frac{\dot{c}}{c}=\lambda=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha T^{\rho}/(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho})\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right] \tag{14}$$

From Equation 10 at steady state,

$\delta = r$: subjective preference equals market real interest rate.

From Equation 14, we can derive a relationship between the steady state growth rate λ and the share of government expenditure devoted to g_1 (derivation is shown in Annex 1)

$$\frac{d\lambda}{d\phi}=\frac{\alpha(1-\tau)(1+\rho)(\alpha T^{\rho})^{\frac{-(1+\rho)}{\rho}}[\beta\phi^{-(1+\rho)}-\gamma(1-\phi)^{-(1+\rho)}]}{\sigma\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\}^{-\frac{1}{\rho}}} \tag{15}$$

The components g1 is productive if $\frac{d\lambda}{d\phi}>0$. The right-hand side of Equation 15 is positive if $\beta\phi^{-(1+\rho)}>\gamma(1-\phi)^{-(1+\rho)}$

or, $$\frac{\phi^{-(1+\rho)}}{(1-\phi)^{-(1+\rho)}}>\frac{\gamma}{\beta}\rightarrow\frac{\phi}{1-\phi}<\left(\frac{\beta}{\gamma}\right)^{\frac{1}{1+\rho}} \tag{16}$$

In Cobb-Douglas production function, ρ=0, Equation 16 becomes

$$\frac{\phi}{1-\phi}<\left(\frac{\beta}{\gamma}\right) \tag{17}$$

According to this condition, if the relative share of public expenditure devoted to the two goods g_1 and g_2 is below their relative output elasticities, then a shift in the mix towards g_1 will increase the economy's long-run growth rate (Devarajan *et al*., 1996). What will be the impact of rise in government expenditure through higher tax and / or higher deficit financing on economic growth? For this, we can differentiate steady state growth rate λ i.e. Equation 14 with respect to T (=τ+υ) so that we get

$$\frac{\partial\lambda}{\partial T} = \frac{T^{-1+\rho}\alpha T^{\rho}(-1-\rho)(1-\tau)\left(\frac{\alpha T^{\rho}}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right)^{-1+\frac{-1-\rho}{\rho}}}{(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho})^{2}}$$

$\frac{\partial\lambda}{\partial T} > 0$ only if $T^{\rho} - \beta\phi^{-\rho} - \gamma(1-\phi)^{-\rho} < 0$ or $T^{\rho} < \beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho}$. In case of Cobb-Douglas production function, this condition implies $\beta+\gamma>1$. Hence, intuitively, an increase in total government spending will raise steady-state growth rate only if productivity of the government spending ($\beta+\gamma$) exceeds the taxes rate and interest rate on debt.

IV. Overview of Nepalese Economy

Macroeconomic Situation of Nepal

Since the mid-eighties, Nepal has been adopting fiscal adjustment and restructuring programs by introducing Structural Adjustment Program (SAP) at 1985 in the initiative of the IMF and World Bank. The main objective in implementing the SAP was to attain macroeconomic balances and raise GDP growth rate on a sustainable basis. The SAP-I, implemented for the period of 1986/87 to 1988/89, sought to provide the transition from economic stabilization to more rapid development on a sustainable basis by laying the foundations for structural reform of the economy. The SAP-I actually focused on improving macroeconomic management by enhancing government revenues and public savings, restraining the growth of less essential expenditures and increasing investment levels, with the liberalization of industry, trade and exchange rate policies for promoting export development and freeing up imports. Moreover, it had also provisions of facilitating private investment and activities, improving management of public enterprises and initiating a longer term program for privatization, and strengthening development administration through a series of measures aimed at improving budgeting, planning and expenditure monitoring.

In order to increase the pace of the reforms and enhance economic growth, the second Structural Adjustment Program SAP-II was implemented in 1989/90 for three years. The SAP-II was complimented by a Policy Framework Paper (PFP) and IMF Structural Adjustment Facility (SAF) arrangement, which covered the same period. In late 1992, the government negotiated a new Enhanced Structural Adjustment Facility (ESAF) arrangement with the Fund. This provides a framework for continued economic reform and adjustment. Nepal recently completed three-year Poverty Reduction and Growth Facility program of IMF in 2007.

However, poverty has still persisted in Nepal because of low economic growth, inadequate social and economic infrastructure, and relatively high population growth.[6]

[6] Politically, Nepal is in a transitional process. After a decade long internal conflict that had begun in 1996 and ended in 2006, Nepal is now a young republic country. The Constituent Assembly election was held in April 2008, which has got mandate to draft new constitution to make Nepal as a federal state. Hence, Nepal is in the process of drafting new constitution, and coalition

One-third of the population are still living under the absolute poverty line. Over the two and half decades, economic growth has averaged about 4.4 percent only marginally exceeding the population growth rate of 2.2 percent. Even by South Asian standards, Nepal's level of social and economic infrastructure is low (UNDP, 2002). The poor have less access to basic social and economic infrastructure.

Figure 1 shows graphical exposition of some important macroeconomic variables related to Nepalese economy and Table 1 reflects summary statistics. In recent years, both per capita GDP growth and GDP growth itself have slowed down after some growth in the beginning of 1990s. Average inflation stood at 8.7 percent, although the first six years of 21st century witnessed inflation below 5 percent. Since 2006, inflation again went up higher than 5 percent. The highest inflation of 21.5 percent was recorded in 1991/92.

Following the fiscal consolidation with the IMF's structural adjustment program, fiscal deficit has declined to 2.9 percent of GDP in 2004 before picking up to 4.0 percent in 2007. It was also due to almost stable or even slightly declining total expenditure-GDP ratio in the review period. However, the average fiscal deficit in the sample period remained at 5.7 percent because of higher deficit in the first half of 1980s (Table 1). Such an IMF-recommended fiscal consolidation on the one hand and increasing security-related expenses on the other have squeezed the availability of fund to infrastructure development, resulting in weak infrastructure situation in Nepal, which is explained later.

Along with the reduction in fiscal deficit, current account deficit also declined gradually after reaching as high as 8.8 percent of GDP in 1991 and remained continuously higher than 5 percent until 1999. After some deficit in 2000 and 2001, current account turned into surplus since 2002, which still continued to exist, owing to increasing remittance inflows despite a huge trade deficit.

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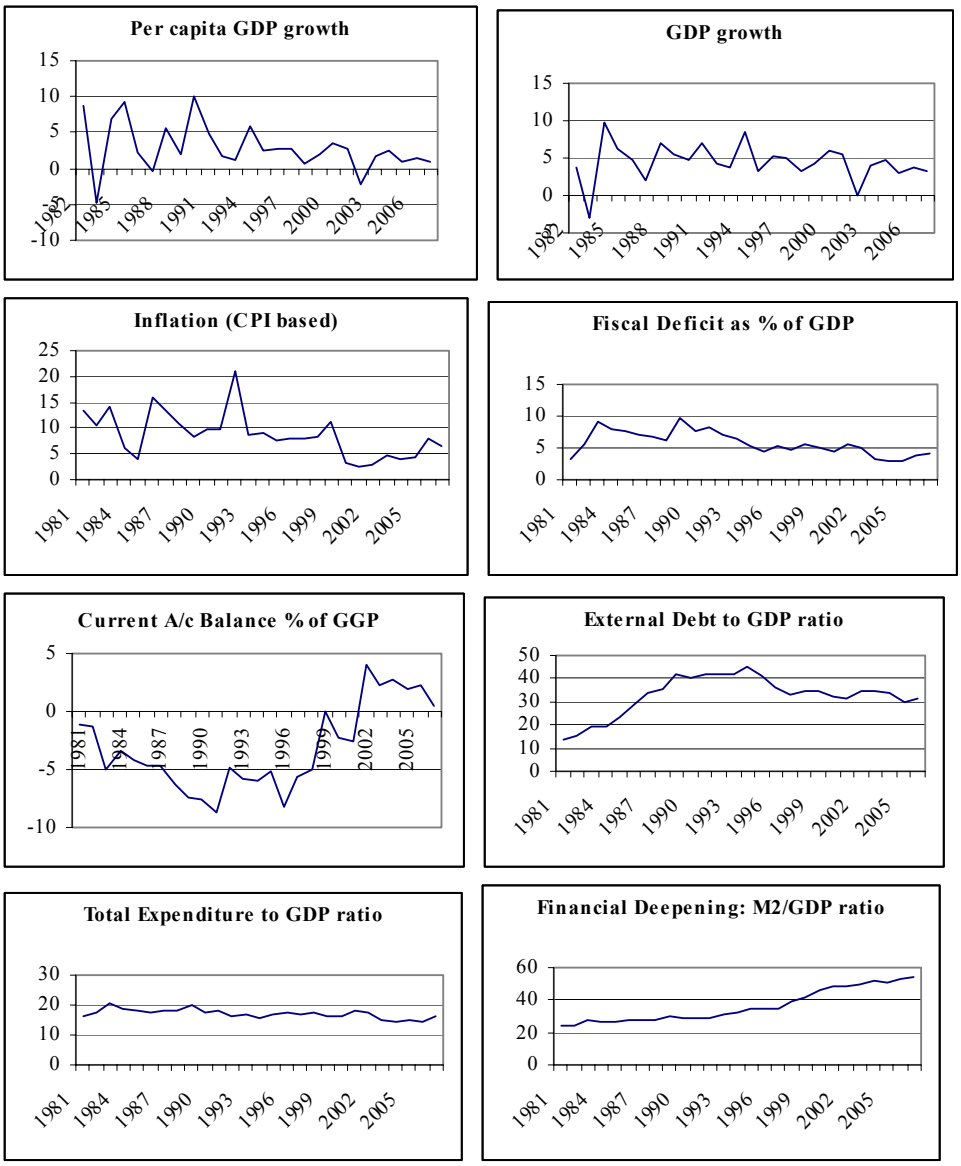
government led by the then rebel party that won the majority of the seats in Constituent Assembly election is in power since mid- 2008.

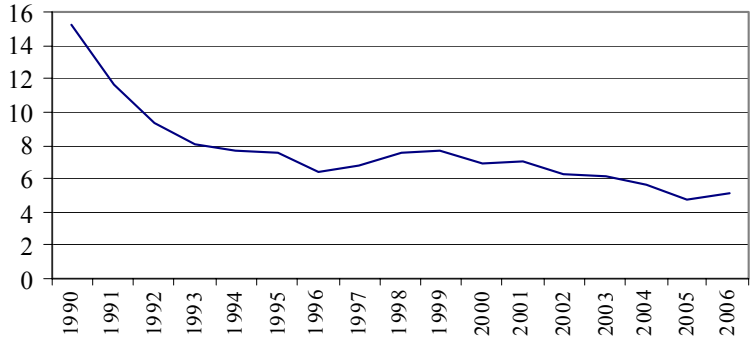
FIGURE 1: Overview of Some Macroeconomic Variables



After current account turned into surplus, external debt-GDP ratio has also declined gradually after mid-1990s. Now, external debt is about one-third of GDP. Hence, debt servicing as percent of exports of goods and services has declined in recent years. Debt

sustainability test, following the Bohn (1998) method[7], showed that Nepal has sustainable debt scenario for the period 1990-2007 (Shrestha and Pineda, 2009).

FIGURE 2: Debt Servicing as Percent of Export of Goods and Services



Source: Asian Development Bank. 2008. *Key Indicators*.

During the economic liberalization process in Nepal, which began in mid-eighties, the financial sector has expanded substantially. M2/GDP ratio, an indicator of financial deepening, increased from 24.7 percent in 1981 to 54.7 percent in 2007.

TABLE 1: Summary Statistics of Some Macroeconomic Indicators

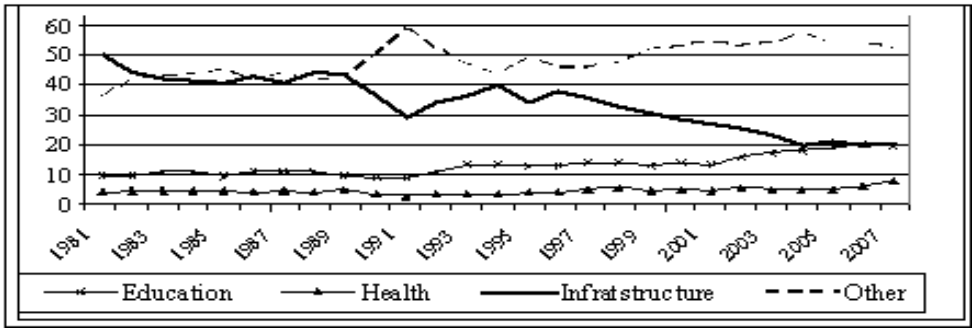
	Per Capita GDP Growth	GDP Growth	Inflation (CPI based)	Fiscal Deficit as % of GDP	Current A/c Balance as % of GDP	External Debt to GDP Ratio	Total Expenditure to GDP Ratio
Mean	2.91	4.44	8.71	5.71	-3.19	32.63	17.09
Standard Error	0.66	0.49	0.83	0.36	0.70	1.66	0.29
Median	2.37	4.50	8.28	5.45	-4.64	34.24	17.30
Standard Deviation	3.35	2.48	4.33	1.85	3.66	8.45	1.51
Sample Variance	11.20	6.16	18.79	3.43	13.39	71.38	2.27
Kurtosis	0.70	2.73	1.15	-0.69	-0.87	0.16	0.23
Skewness	0.33	-0.71	0.86	0.35	0.47	-0.86	0.41
Range	14.76	12.66	18.62	6.63	12.76	31.46	6.09
Minimum	-4.78	-2.98	2.45	2.95	-8.76	13.40	14.54
Maximum	9.98	9.68	21.07	9.57	4.00	44.86	20.64

[7] $\frac{S_t}{Y_t} = \alpha + \beta \frac{B(t)}{Y(t)} + \varepsilon_t$, where St is primary surplus, Yt is national income, B(t) is external debt. $\beta>0$ guarantees that intertemporal budget constraint of the country holds. Thru OLS estimates of this equation based on 1990 to 2007 data for Nepal, the following results are obtained which shows that Nepal's external debt is sustainable so far.

$$\frac{S_t}{Y_t} = \underset{(-5.04)}{-16.8} + \underset{(2.59)}{0.17} * \frac{B(t)}{Y(t)}, \quad \text{AdjR}^2 = 0.26, \text{DW} = 1.52$$

Figure 3 shows the movement of the composition of the government expenditure. Data shows that government has been giving an importance to education and health sector, which share in total expenditure have been rising. Due to increase in security related expenses with growing internal conflict since 1996, other expenses also went up since the mid-1990s. However, the share of expenditure to infrastructure has declined substantially.

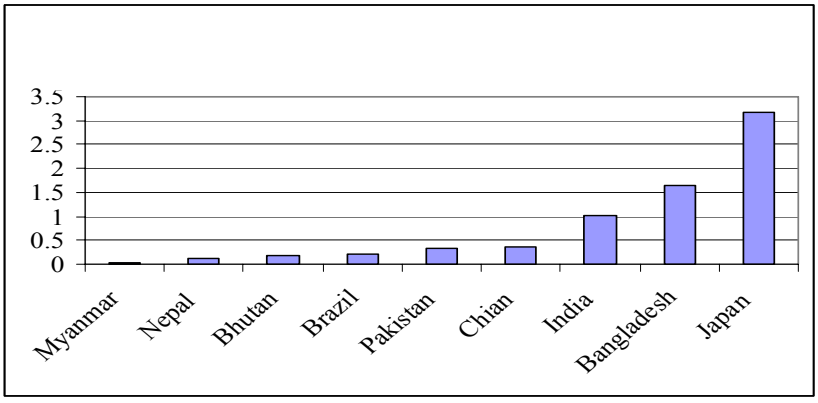
FIGURE 3: Composition of Government Expenditure (in percentage of total)



Infrastructure Situation in Nepal

As a result of low priority in infrastructure investment, the situation of infrastructure has remained quite weak in Nepal. Figure 4 reflects the road density of Nepal, which is comparatively very low. Road density per square km of land was 0.12 as of 2004 in Nepal compared to 1.01 in India (2006) and 3.16 in Japan (2006). In Nepal, only 37 percent of households have paved road within 30 minutes, while 27 percent have to travel for 3 hours or more according to the *Nepal Living Standard Survey 2003/04* (CBS, 2004).

FIGURE 4: Road Density (Km roads per square km of land)



Source: IRF. 2008. *World Road Statistics*.

Nepal has considerably improved its postal and telephone services, though they remain deficient in rural areas. Telephone penetration has reached 18.86 per hundred populations as of December 2008 (NTA, 2009). However, in international standard, it is quite low. Table 2 and Figure 5 show Nepal's comparative position in telephone facility, both mainlines and mobiles. Compared to 554 main line telephone per 1000 people in Japan and 46 in India, Nepal has 16 mainline telephones per 1000 people as of 2003. Similar is the situation for the access of mobile telephone.

As regards the electricity development, Nepal has remained very weak, despite having tremendous potentiality. According to *Nepal Living Standard Survey 2003/04* (CBS, 2004), only 37 percent of the households have access to electricity in their dwellings. Nepal has been in unprecedented energy crisis for last three years, with continuous load shedding (power-off) of as high as 16 hours a day recently, which has been adversely impacting the economic activities in recent years. Of the feasible potentiality of 43,000 megawatts (MW), Nepal has so far utilized a mere 560 MW, i.e. just 1.3 percent of total feasible potentiality. As a result, per capita electric power consumption in Nepal is comparatively very low as shown in Table 2 and Figure 6.

TABLE 2: Comparative Telephone Facility and Electricity Consumption

Countries	Telephone Mainline per 1000 People 2003	Mobile per 1000 People 2003	Electric Power Consumption Per Capita (Kwh) – 2002
Bangladesh	5	10	100
Nepal	16	2	64
Ethiopia	6	1	25
India	46	25	380
China	209	215	987
Brazil	223	264	1776
Japan	554	679	7718
France	566	696	6606

Source: World Bank. 2005. *World Development Indicators.*

FIGURE 5: Availability of Telephone Facility

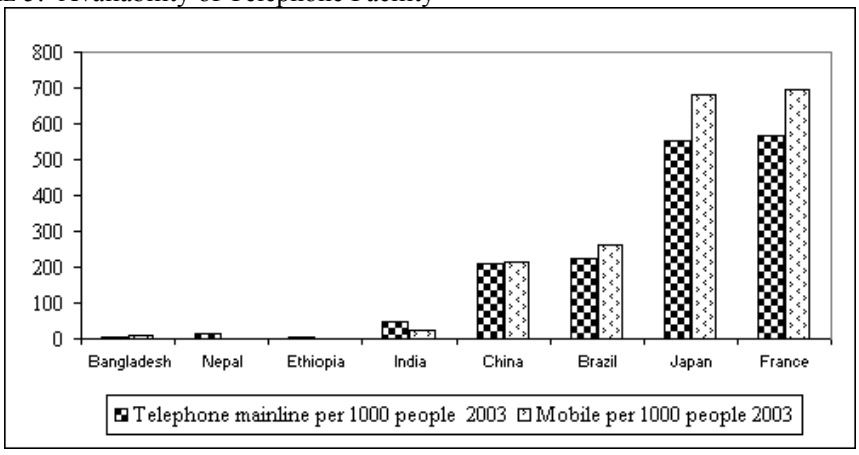
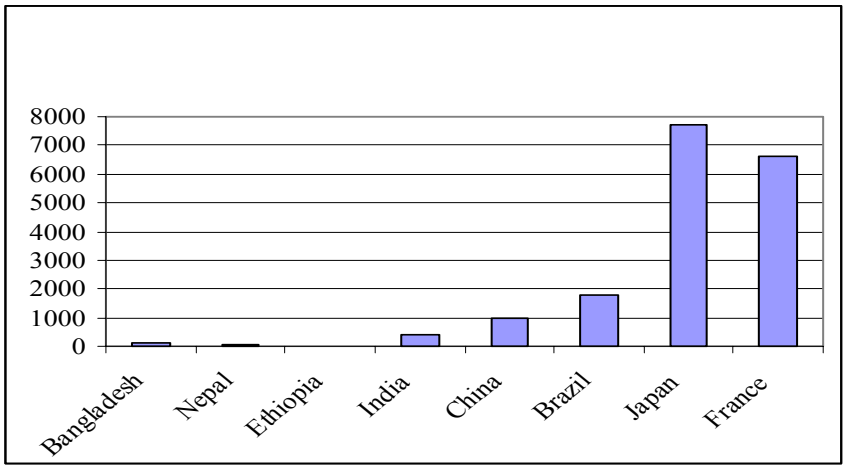


FIGURE 6 : Electric Power Consumption per Capita (Kwh) 2002



V. EMPIRICAL ANALYSIS

My empirical analysis focuses on the link between various components of government expenditure, deficit financing and economic growth in Nepal based on the above discussed model. The empirical analysis uses the data from 1981 through 2007 to examine the link between components of government expenditure, deficit financing and economic growth. Data are taken from the Asian Development Bank's website. The dependent variable is the five-year and three-year forward moving average of per capita real GDP to reflect that there is lag effect of public expenditure on public goods as in Devarajan *et. al*.(1996).

The method of OLS is used to estimate the following equation

$$RGDPC_{(t,\ t+5)} = \alpha_0 + \alpha_1 (TE/GDP)_t + \alpha_2 G_{Et} + \alpha_3 G_{Ht} + \alpha_3 G_{It} + \alpha_4 G_{Ot} + \alpha_4 (Df/GDP)t + \varepsilon_t \quad (18)$$

where RGDPC(t,t+5) =five-year forward moving average of per capita real GDP growth. TE/GDP is the share of total government expenditure in GDP, G_E and G_H is ratio of government expenditure on education and health to total expenditure, necessary for building human capital, G_I is the ratio of government expenditure on physical infrastructure to total expenditure[8], G_O is the other expenditure. Df/GDP is the ratio of deficit financing to GDP. Government can borrow to finance the expenditure on physical infrastructure, education and health. If the government is spending by borrowing abroad on productive areas, one can expect the per capita GDP to increase, but at the same time increasing external debt can drain up resources for debt financing, thereby reducing the government expenditure for productive purpose.

[8] It includes the government expenditure on transportation, communication, electricity and irrigation.

Table 3 shows the empirical estimates of the above Equation 18 in different version. In all versions of equations, share of expenditure on physical infrastructure in total expenditure has been found significantly positive to influence per capita real GDP. It shows the importance of physical infrastructure in Nepal. In fact, economic growth has been low in Nepal due to mainly lack of enough physical infrastructures. As discussed in Section IV, Nepal is seriously lacking necessary infrastructure. As a result, market is narrow for domestic product, and private production has been seriously suffering from lack of enough energy and road network.

Surprisingly, coefficient of education is significantly negative, against the general belief. Government has been focusing on the development of education, but economy is not growing much in response to that. In reality, there are unemployed educated people. With increasing access to the world, following the recent phase of globalization, there has been heavy brain drain. As a result, education expenditure in Nepal has actually been benefiting foreign countries and Nepal is just receiving remittance, but not internal output production and employment generation. Moreover, Nepal's education so far has not been able to develop entrepreneurship skill in the economy. One can even argue that education is not suitable for Nepal's reality. Educated people hardly live in village and contribute to increase in domestic output.

TABLE 3: Composition of Government Expenditure and Economic Growth
Dependent variables: five-year forward moving average of per capita growth rate

	Eq.1	Eq.2	Eq.3	Eq.4
Constant	0.03	0.05	0.04	0.05
	(1.08)	(1.36)	(1.08)	(1.35)
TE/GDP		-0.14		-0.21
		(-0.86)		(-0.83)
G_E	-0.21*	-0.26*	-0.24**	-0.24**
	(-2.16)	(-2.25)	(-1.79)	(-1.80)
G_H	-0.20	-0.12	-0.20	-0.08
	(-0.80)	(-0.43)	(-0.76)	(-0.29)
G_I	0.10*	0.11*	0.10*	0.11*
	(2.92)	(3.01)	(2.86)	(2.95)
G_O	-0.008	-0.00	-0.006	-0.00
	(-0.21)	(-0.01)	(-0.15)	(-0.01)
Df/GDP			-0.05	0.08
			(-0.34)	(0.36)
Adj R2	0.72	0.71	0.70	0.69
DW	1.94	1.72	1.82	1.80
Obs	22	22	22	22

Coefficient of health expenditure is found insignificant and negative. Government has also focused on health. However, it is also not contributing much to economic growth.

Because of decreasing mortality, expansion of health facility has been sustaining higher population growth. Because of other economic and non-economic factors like political instability, economy has remained sluggish despite improvements in health front. Expenditure on other areas which is contributing nothing to economic growth has been increasing even by lowering expenditure on infrastructure. It was due to rising internal conflict during 1996-2006; still Nepal is in political transition and has vulnerable security situation, seriously hampering productive activities. Internal insurgency has actually been compelling people to leave the country.[9] In this way, coupled with lack of security on the one hand and lack of energy on the other, industrial sector has been stagnant, even exhibiting negative growth in recent years, contributing less than 10 percent in GDP.

Using three-year average real per capital GDP growth as a dependent variable has not changed the result much as shown in Table 4. In this case also, coefficient of share of expenditure on physical infrastructure is still statistically significant and other variables are not.

TABLE 4: Composition of Government Expenditure and Economic Growth
Dependent variables: three-year forward moving average of per capita growth rate

	Eq.1	Eq.2	Eq.3	Eq.4
Constant	-0.03	-0.03	-0.06	-0.02
	(-0.74)	(-0.45)	(-1.10)	(-0.30)
TE/GDP		-0.03		-0.43
		(-0.11)		(-1.13)
G_E	-0.11	-0.12	0.01	-0.008
	(-0.77)	(-0.68)	(0.005)	(-04)
G_H	-0.35	-0.34	-0.37	-0.15
	(-0.90)	(-0.77)	(-0.94)	(-0.33)
G_I	0.14*	0.14*	0.14*	0.15*
	(2.61)	(2.48)	(2.50)	(2.72)
G_O	0.09	0.09	0.08	0.09
	(1.49)	(1.44)	(1.34)	(1.53)
Df/GDP			0.23	0.51
			(0.95)	(1.47)
Adj R2	0.54	0.51	0.53	0.54
DW	1.44	1.41	1.77	1.79
Obs	24	24	24	24

[9] More than 13,000 people were killed during 1996-2006 in internal armed conflict.

VI. CONCLUSION

Physical infrastructure plays the very important role to enhance economic growth by promoting private market production. Development of infrastructure demands serious role of government, because of being public goods. The analytical model above shows that a mix of public spending could lead to a higher steady-state growth rate for the economy. Based on the model, the empirical results suggest that expenditure on physical infrastructure is productive in Nepal, but its share is declining, resulting in slow growth of per capita income. In this context, similar to the conclusion of Semmler *et. al* (2007), it would be better to allocate more resources to develop physical infrastructure in Nepal, which not only facilitates private productive activities, but also generates employment in the economy for the mass unemployment, in contrast to the conclusion of Devarajan *et. al* (1996).

Given the sustainable debt scenario so far, Nepal has some leeway for increasing investment on public infrastructure from foreign borrowing. As the model in this paper shows, so long as productivity of the expenditure is higher than the interest rate, increase in expenditure will increase the growth rate in the economy. However, weak government and political transition are dragging the country into low development trap, with low capacity of the government to expend on physical infrastructure.

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ANNEX 1: Calculations

Solving Equation (11)

$$\frac{\dot{c}}{c} = -\frac{1}{\sigma}[\delta - (1-\tau)\alpha k^{-\rho-1}(\alpha k^{-\rho} + \beta g_1^{-\rho} + \gamma g_2^{-\rho})^{\frac{-(1+\rho)}{\rho}}] \tag{11}$$

$$= \frac{1}{\sigma}\left[\alpha(1-\tau)k^{-\rho-1}(\alpha + \beta\frac{g_1^{-\rho}}{k^{-\rho}} + \gamma\frac{g_2^{-\rho}}{k^{-\rho}})^{\frac{-(1+\rho)}{\rho}}.k^{\rho.\frac{1+\rho}{\rho}} - \delta\right]$$

$$= \frac{1}{\sigma}\left[\alpha(1-\tau)(\alpha + \beta\frac{(\phi Ty)^{-\rho}}{k^{-\rho}} + \gamma\frac{((1-\phi)Ty)^{-\rho}}{k^{-\rho}})^{\frac{-(1+\rho)}{\rho}} - \delta\right]$$

$$= \frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha + \frac{(Ty)^{-\rho}}{k^{-\rho}}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho}\right\}^{\frac{-(1+\rho)}{\rho}} - \delta\right]$$

$$= \frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha + \left(\frac{g}{k}\right)^{-\rho}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho}\right\}^{\frac{-(1+\rho)}{\rho}} - \delta\right] \tag{12}$$

Derivation for g/k

$$\frac{g}{k} = \frac{Ty}{k} = \frac{T(\alpha k^{-\rho} + \beta g_1^{-\rho} + \gamma g_2^{-\rho})^{-\frac{1}{\rho}}}{k}$$

$$= \frac{T(\alpha + \beta\frac{g_1^{-\rho}}{k^{-\rho}} + \gamma\frac{g_2^{-\rho}}{k^{-\rho}})^{-\frac{1}{\rho}}.k^{-p..(-\frac{1}{\rho})}}{k}$$

$$= T\left[\alpha + \beta\frac{(\phi Ty)^{-\rho}}{k^{-\rho}} + \gamma\frac{((1-\phi)Ty)^{-\rho}}{k^{-\rho}}\right]^{\frac{-1}{\rho}}$$

$$= T\left[\alpha + \frac{(Ty)^{-\rho}}{k^{-\rho}}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho})\right]^{\frac{-1}{\rho}}$$

$$\frac{g}{k}.\frac{1}{T} = \left[\alpha + \left(\frac{g}{k}\right)^{-\upsilon}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho})\right]^{\frac{-1}{\rho}}$$

$$\left(\frac{g}{k}.\frac{1}{T}\right)^{-\rho} = \left[\alpha + \left(\frac{g}{k}\right)^{-\upsilon}(\beta\phi^{-\rho} + \gamma(1-\phi)^{-\rho})\right]$$

$$\left(\frac{g}{k}\right)^{-\rho}\frac{1}{T^{-\rho}}-\left(\frac{g}{k}\right)^{-\rho}(\beta\phi^{-\rho}+\gamma(1-\phi)^{-\rho})=\alpha$$

$$\left(\frac{g}{k}\right)^{-\rho}(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho})=\alpha$$

$$\left(\frac{g}{k}\right)^{\rho}=(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho})/\alpha$$

$$\frac{g}{k}=\left[(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho})/\alpha\right]^{\frac{1}{\rho}} \tag{13}$$

Derivation of Equation (14)

By substituting (13) into (12), we get

$$\frac{\dot{c}}{c}=\lambda=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha+\left(\left\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\right\}/\alpha\right)^{-\rho.\frac{1}{\rho}}(\beta\phi^{-\rho}+\gamma(1-\phi)^{-\rho})\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right]$$

$$\frac{\dot{c}}{c}=\lambda=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha+\left(\left\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\right\}/\alpha\right)^{-1}(\beta\phi^{-\rho}+\gamma(1-\phi)^{-\rho})\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right]$$

$$\frac{\dot{c}}{c}=\lambda=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha+\left(\alpha/\left\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\right\}\right)(\beta\phi^{-\rho}+\gamma(1-\phi)^{-\rho})\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right]$$

$$=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha\frac{(T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}+\beta\phi^{-\rho}+\lambda(1-\phi)^{-\rho})}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right]$$

$$=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\alpha\frac{(T^{\rho})}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right] \tag{14}$$

Derivation of Equation (15)

$$\lambda=\frac{1}{\sigma}\left[\alpha(1-\tau)\left\{\frac{(\alpha T^{\rho})}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right\}^{\frac{-(1+\rho)}{\rho}}-\delta\right]$$

$$\frac{\partial\lambda}{\partial\phi}=\frac{1}{\sigma}\left[\alpha(1-\tau)[-\frac{1+\rho}{\rho}\left\{\frac{(\alpha T^{\rho})}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right\}^{\frac{-(1+\rho)}{\rho}-1}\cdot\frac{\alpha T^{\rho}(-1)\{\beta\rho\phi^{-\rho-1}-\gamma\rho(1-\phi)^{-\rho-1}}{\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\}^{2}}\right]$$

$$=\frac{1}{\sigma}\left[\alpha(1-\tau)(1+\rho)\left\{\frac{(\alpha T^{\rho})}{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}}\right\}^{\frac{-1-2\rho}{\rho}}\cdot\frac{\alpha T^{\rho}\{\beta\phi^{-\rho-1}-\gamma(1-\phi)^{-\rho-1}}{\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\}^{2}}\right]$$

$$=\frac{1}{\sigma}\left[\alpha(1-\tau)(1+\rho)\left\{\frac{(\alpha T^{\rho})^{-\frac{(1+\rho)}{\rho}}}{\left\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\right\}^{-\frac{1}{\rho}}}\right\}.\{\beta\phi^{-\rho-1}-\gamma(1-\phi)^{-\rho-1}\}\right]$$

$$\frac{\partial\lambda}{\partial\phi}=\frac{\alpha(1-\tau)(1+\rho)(\alpha T^{\rho})^{-\frac{(1+\rho)}{\rho}}\{\beta\phi^{-(1+\rho)}-\gamma(1-\phi)^{-(1+\rho)}\}}{\sigma\{T^{\rho}-\beta\phi^{-\rho}-\gamma(1-\phi)^{-\rho}\}^{-\frac{1}{\rho}}} \tag{15}$$