II Estimating Subsidies: Methodological Issues

This technical note explains the (i) overall methodology for estimating budget-based subsidies; (ii) the methodology for estimating depreciation costs; (iii) a procedure for decomposing the aggregate recovery rate; and (iv) a methodology for estimating the degree of oversubsidisation.

Estimation of Subsidies: Methodology

Subsidies are measured here as "unrecovered" costs of governmental provision of goods/services that are not classified as public goods. In particular, the goods/services under reference are those that are categorised as social services and economic services. The unrecovered costs are measured as the excess of aggregate costs over receipts from the concerned budgetary head.

The aggregate costs comprise three elements: (i) current costs (RX); (ii) annualised capital cost (opportunity cost of funds used for capital assets and imputed depreciation costs; and (iii) opportunity cost of funds invested in the form of equity or loan for the service (including those given to the PSE's).

In terms of symbols, these costs are:

$$C = RX + (i + d^{*}) K_0 + iZ_0$$

where

RX = revenue expenditure

i = effective interest rate

d^{*} = depreciation rate

K_0 = aggregate capital expenditure at the beginning of the period

Z_0 = sum of loans and equity investment at the beginning of the period

Receipts are:

$$R = RR + (I + D)$$

where

RR = revenue receipts

I = interest receipts

D = dividends

Subsidy is defined as: $S = C - R$

In the estimation exercises here, current costs are given by revenue expenditure on the given service (major or minor head), net of transfers to funds, as also net of transfer payments. Other parameters are effective interest rate and depreciation rate. The effective interest rate is the average interest rate on aggregate Central government borrowing in the concerned year. This is estimated to be 9.60 percent for 1995-96, and 10.23 percent for 1996-97. The depreciation rate is to be calculated with reference to the stock of capital at the beginning of the year. This stock of capital is the sum of nominal investments in previous years. Since these are additions of nominal figures, all at different prices, the calculation of depreciation rate has to take this into account. The methodology used for this purpose is explained below.

Methodology for Estimating Depreciation Costs

Let the life of a capital asset be T years. The rate of depreciation would be $\left(\frac{1}{T}\right)$ per year for the asset to be written off. For example, if T = 50 (years), $\frac{1}{T} = .02$.

Let the current year be T + 1. The past years under consideration are from 1 to T. Let nominal investments in these years be written as

$$I_1, I_2, \ldots\ldots, I_T$$

Assuming an investment growth rate of z, we have

$$I_2 = (1 + z)\, I_1$$

....

$$I_T = (1 + z)^{T-1}\, I_1$$

Thus,

$$I_1 = I_T/(1 + z)^{T-1}$$

Correspondingly,

$$I_1 = I_T/(1 + z)^{T-1}$$
$$I_2 = I_T/(1 + z)^{T-2}$$

$$I_{T-1} = I_T/(1 + z)$$

$$I_T = I_T$$

If the long-term rate of inflation is `i', a nominal amount of 1 in year 1, is $(1 + i)^{T-1}$ in terms of the prices of the T_{th} year.

Then, the sum of I_1, etc., in terms of the prices of the T_{th} year can be written as

$$I_T\left(\frac{1 + i}{1 + z}\right)^{T-1} + I_T\left(\frac{1 + i}{1 + z}\right)^{T-2} + \ldots I_T$$
$$= I_T\,[w^{T-1} + w^{T-2} + \ldots.. + 1]$$

where

$$w = \left(\frac{1 + i}{1 + z}\right)$$

Let, $K_T = (I_T + I_{T-1} + \ldots.. + I_1)$ indicate aggregate capital expenditure obtained by summing investments measured in the prices of the respective years in which they were made. We can write:

$$K_T = I_T + \frac{I_T}{(1+z)} + \ldots + \frac{I_T}{(1+z)^{T-1}}$$

$$= I_T\left[1 + \left(\frac{1}{1+z}\right) + \ldots + \left(\frac{1}{1+z}\right)^{T-1}\right]$$

$$= I_T\,[1 + x + \ldots + (x)^{T-1}]$$

where

$$x = 1/(1+z)$$

or

$$I_T = K_T/(1 + x + \ldots + x^{T-1})$$

Depreciation for one year in terms of the prices of year T is given by

$$= \left(\frac{1}{T}\right) I_T\,(1 + w + w^2 + \ldots + w^{T-1})$$

$$= \left(\frac{1}{T}\right) K_T\,\frac{(1 + w + w^2 + \ldots + w^{T-1})}{(1 + x + \ldots + x^{T-1})}$$

Depreciation in terms of prices of year (T + 1), i.e., the current year, can be obtained by multiplying the above expression further by (1 + i). Thus, if K_T (i.e., outstanding accumulated capital stock in nominal terms) is to be used as the base, the depreciation rate on this should be

$$\left(\frac{1}{T}\right)\left(\frac{1 + w + w^2 + \ldots + w^{T-1}}{1 + x + x^2 + \ldots + x^{T-1}}\right)(1+i)$$

We will refer to this expression as the adjusted depreciation rate (ADR). By simulating with alternative values of parameters (i, z) the following features regarding the impact of changes in the parameters on the depreciation rate can be derived.

i. The higher the inflation rate, higher is the depreciation rate, for any given rate of growth of investment.

ii. The higher the investment growth rate, lower is the depreciation rate for any given inflation rate.

iii. When both investment growth and inflation rates are equal, the depreciation rate is just below their level upto a critical point (close to 5.63 percent) and the level of both rates increase above this, the depreciation rate is a little higher than the common inflation and investment growth rates. This excess increases as the rate of inflation (and the rate of investment growth) increases.

The parameters used for estimating the ADR are indicated below. For estimation of the long-term parameters, the sample used extends from 1950-51 to 1996-97.

i. Average inflation rate: 7.98 percent per annum. This is calculated for the implicit price deflator of GDCF in the public sector;

ii. Average growth rate for nominal investment: 12.35 percent per annum. This is calculated as compound growth rate with reference to gross capital formation by the central government; and

iii. Average life of a capital asset: 50 years.

In deriving the base capital stock figure, only 1/3rd of investment in three previous years has been taken into account for the fact that all investment does not start giving service from the next year.

The estimated ADRs used for 1995-96, and 1996-97 are 5.24 and 5.25 percent per annum, respectively.

Analysis of Recovery Rates

The recovery rate (receipts/costs) may be decomposed in the following way:

The rate of recovery on directly provided services may be written as

$$r_1 = \frac{RR}{RX + d^* K_o} = \frac{RR}{C} 1 \qquad \text{where} \quad C1 = RX + d^* K_0$$

The rate of return on investment in the form of equity and loans may be written as

$$r_2 = \frac{I + D}{i(Z_o)} = \frac{I + D}{C} 2 \qquad \text{where} \quad C2 = iZ_0.$$

We have:

Total cost = C = C1 + C2 = $(RX + d^*K_0) + iZ_0$
Total recovery = RR + (I + D)
The aggregate recovery rate can decomposed as:

$$r = \frac{RR + (I + D)}{C}$$

$$= \frac{RR}{C} + \frac{(I + D)}{C}$$

$$= \frac{RR}{C1} . \left(\frac{C1}{C}\right) + \frac{I + D}{C2}\left(\frac{C2}{C}\right)$$

$$r = r_1 \,.\, w_1 + r_2 \,.\, w_2$$

Further, r_1 can be written as the product of the recovery rate of variable cost, and the share of variable cost in total cost.

$$r_1 = \left(\frac{RR}{RX}\right).(RX/C\ 1)$$

Hence, aggregate recovery rate may be written as

$$= \begin{bmatrix}\text{Rate of Recovery} \\ \text{of Current Cost}\end{bmatrix} X \begin{bmatrix}\text{Share of Current Cost in Total} \\ \text{Cost of Direct Services}\end{bmatrix} X \begin{bmatrix}\text{Share of Cost of Direct} \\ \text{Services in Total Cost}\end{bmatrix}$$

$$= \begin{bmatrix}\text{Rate of Recovery on Loans} \\ \text{and Equity Investment}\end{bmatrix} X \begin{bmatrix}\text{Share of Annualised Cost of Loans and} \\ \text{Equity Investment in Total Costs}\end{bmatrix}$$

In annex 6, a decomposition of sectoral recovery rates is given along these lines. The overwhelming importance of current costs in the provision of social services is quite apparent. Except for information and broadcasting and `others', the share of current expenditure is usually in the range of 90 to 100 percent. In the case of several economic services also, it is quite high. The main sectors, where the share of capital costs is somewhat higher are energy and transport. In designing a strategy of subsidy reforms, it will be useful to set a target for recovering higher fraction of current costs, as a first step.