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**Health
Financing
and
Sustainability
Project**

**HFS Technical Training Note
No. 13**

**METHODOLOGICAL GUIDE:
COST ESTIMATES WITH ACCOUNTING AND
ECONOMETRIC METHODS**

By

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PREFACE

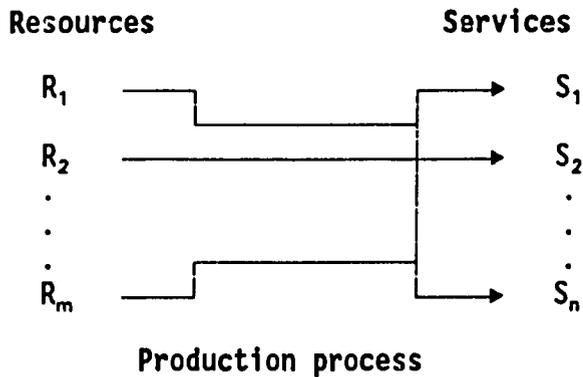
These brief notes were prepared for discussion with a team of enumerators and local researchers during the training stage of the Senegal Study. The notes are not intended to be an exhaustive explanation of cost measurement using the accounting and econometric methods. Rather, they are intended to illustrate the basic features of the two cost measurement methods to a group of developing country enumerators and researchers who have little to no technical training in this area. It was hoped that understanding of these basic concepts would facilitate their understanding of the study objectives and its data requirements.

ACCOUNTING AND ECONOMETRIC METHODS

THE PROBLEM

Given a process that produces several services S_1, S_2, \dots, S_n using several resources R_1, R_2, \dots, R_m , how can one calculate the unit cost of production of each service?

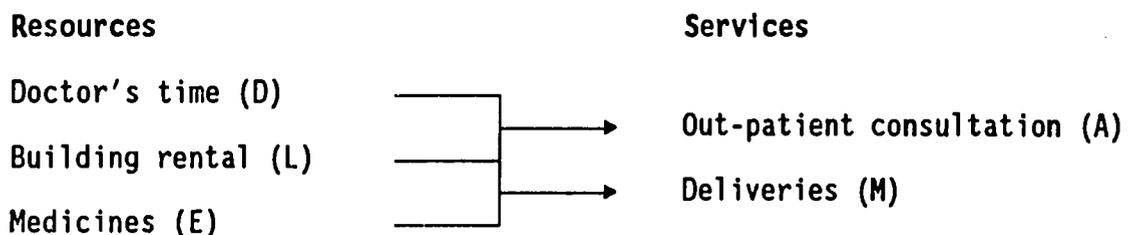
The problem is a complex one because each service uses several resources for its production or, in other words, each resource shares in the production of several services. This situation is reflected in the diagram below:



ACCOUNTING METHOD

This method consists in determining the cost of each of the resources used and distributing this cost among the different services that use this resource.

The example below illustrates this method:



Each of the three resources is used in the production of each of the two services. What is the unit cost of a consultation and a delivery if the monthly volumes of production are Q_A et Q_M ?

In order to determine this unit cost one must calculate the proportion of each resource allocated to each service. For instance, D_A is the proportion of time that the doctor devotes to out-patient consultations and D_M is the proportion time the doctor devotes to deliveries. Therefore:

$$D_A + D_M = 1$$

If the doctor's monthly cost is equal to C_D then the doctor's consultation cost is

$$D_A \cdot C_D$$

and the doctor's delivery cost is

$$D_M \cdot C_D$$

The doctor's unit cost for a consultation is

$$\frac{D_A \cdot C_D}{Q_A}$$

where Q_A is the monthly number of consultations.

Also, the doctor's unit cost for delivery is

$$\frac{D_M \cdot C_D}{Q_M}$$

where Q_M is the monthly number of deliveries.

Example:

$C_D = \$1000$ per month

The doctor works 8 hours a day, 22 days a month and he spends 6 hours each day on consultations and 2 hours on deliveries. Therefore:

$$D_A = 6/8 = 0.75$$

$$D_M = 2/8 = 0.25$$

$$D_A + D_M = 0.75 + 0.25 = 1.00$$

If the doctor produces $Q_A = 200$ consultations and $Q_M = 25$ deliveries a month, then the doctor's consultation cost is:

$$D_A \times C_D = 0.75 \times \$1000 = \$750$$

and the doctor's cost for *one* consultation is:

$$(D_A \times C_D)/Q_A = (0.75 \times \$1000)/200 = \$750/200 = \$3.75$$

By the same token, the doctor's delivery cost is:

$$D_M \times C_D = 0.25 \times \$1000 = \$250$$

and the doctor's cost for *one* delivery is:

$$(D_M \times C_D)/Q_M = (0.25 \times \$1000)/25 = \$250/25 = \$10$$

To calculate the unit cost of consultations and deliveries, one must calculate the costs of rent and medicines and allocate them between the production of A and M. An example of this calculation is produced in the table on the following page:

Possible Cost Distribution Criteria
Accounting Method
Example

Resource	Monthly Resource Cost	Distribution criterion	Consultations ($Q_A = 200$)		Deliveries ($Q_D = 25$)	
			Total cost	Unit cost	Total cost	Unit cost
Doctor time (D)	\$1000	75% consultations 25% deliveries	$\$1000 \times 0.75 = \750	$\$750/200 = \3.75	$\$1000 \times 0.25 = \250	$\$250/25 = \10.00
Building rental (L)	\$400	30% surface consultations 70% surface deliveries	$\$400 \times 0.30 = \120	$\$120/200 = \0.60	$\$400 \times 0.70 = \280	$\$280/25 = \11.20
Medicines (M)	\$800	\$600 consultations \$200 deliveries	\$600	$\$600/200 = \3.00	\$200	$\$200/25 = \8.00
Total Cost and Unit Cost	\$2200		$\$750 + \$120 + \$600 = \1470	$\$3.75 + \$0.60 + \$3.00 = \7.35	\$730	\$29.20

In short, with the accounting method for cost allocation, the following stages need to be followed:

1. Identify all production resources R_1, R_2, \dots, R_m and all the services produced over a given period S_1, S_2, \dots, S_n .
2. Obtain or calculate the total monthly cost of each of the resources:

Resource	Total monthly cost
R_1	C_1
R_2	C_2
R_m	C_m

3. Using the most suitable and rational criteria, calculate the proportion r of each resource allocated to the production of each service.

Resource	Service			
	S_1	S_2	...	S_n
R_1	r_{11}	r_{12}	...	r_{1n}
R_2	r_{21}	r_{22}	...	r_{2n}
.				
.				
.				
R_m	r_{m1}	r_{m2}	...	r_{mn}

4. Distribute the costs of the resources to each service by multiplying the monthly cost of each resource by the cost distribution proportion for each service.

Resource	Monthly Cost	Service			
		S_1	S_2	...	S_n
R_1	C_1	$r_{11}C_1$	$r_{12}C_1$...	$r_{1n}C_1$
		$r_{21}C_2$	$r_{22}C_2$...	$r_{2n}C_2$
R_2	C_2			...	
				...	
R_m	C_m	$r_{m1}C_m$	$r_{m2}C_m$...	$r_{mn}C_m$
Total monthly cost per service		$TC_1 = r_{11}C_1 + r_{21}C_2 + \dots r_{m1}C_m$	$TC_2 = r_{12}C_1 + r_{22}C_2 + \dots r_{m2}C_m$		$TC_n = r_{1n}C_1 + r_{2n}C_2 + \dots r_{mn}C_m$

5. Divide the total monthly cost per service by the volume of production of each service. This give the unit cost of each service, therefore:

	Service			
	S_1	S_2	...	S_n
Monthly volume of production	Q_1	Q_2	...	Q_n
Total monthly cost of the service	TC_1	TC_2	...	TC_n
Unit cost of the service	$c_1 = TC_1 / Q_1$	$c_2 = TC_2 / Q_2$...	$c_n = TC_n / Q_n$

THE ECONOMETRIC METHOD

The econometric method also serves to calculate the unit costs of the different services produced by the health units. However, the two methods require rather different sets of information.

The econometric method requires the total cost of the health unit, while the accounting method calls for the cost of each of the resources used in the production and the breakdown of these resources among the different services. In contrast, the econometric method needs the *unit prices* of the resources of production. Both methods have need of the volume of production of each service. The information required by the two methods is summarized and compared in the table below.

Comparison of the Information Needs of the Two Methods

INFORMATION	ACCOUNTING METHOD	ECONOMETRIC METHOD																																														
Volume of production	<table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="4">Service</th> </tr> <tr> <th colspan="2"></th> <th>S_1</th> <th>S_2</th> <th>...</th> <th>S_n</th> </tr> </thead> <tbody> <tr> <th rowspan="2">Volume of prod</th> <th>Q₁</th> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <th>Q₂</th> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Service						S_1	S_2	...	S_n	Volume of prod	Q ₁					Q ₂					<table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="4">Service</th> </tr> <tr> <th colspan="2"></th> <th>S_1</th> <th>S_2</th> <th>...</th> <th>S_n</th> </tr> </thead> <tbody> <tr> <th rowspan="2">Volume of prod</th> <th>Q₁</th> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <th>Q₂</th> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Service						S_1	S_2	...	S_n	Volume of prod	Q ₁					Q ₂				
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Way in which the resources are allocated among the services	<table border="1"> <thead> <tr> <th rowspan="2">Resource</th> <th colspan="4">Service</th> </tr> <tr> <th>S_1</th> <th>S_2</th> <th>...</th> <th>S_n</th> </tr> </thead> <tbody> <tr> <th>R_1</th> <td>r_{11}</td> <td>r_{12}</td> <td></td> <td>r_{1n}</td> </tr> <tr> <th>R_2</th> <td>r_{21}</td> <td>r_{22}</td> <td></td> <td>r_{2n}</td> </tr> <tr> <th>⋮</th> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <th>R_m</th> <td>r_{m1}</td> <td>r_{m2}</td> <td></td> <td>r_{mn}</td> </tr> </tbody> </table>	Resource	Service				S_1	S_2	...	S_n	R_1	r_{11}	r_{12}		r_{1n}	R_2	r_{21}	r_{22}		r_{2n}	⋮					R_m	r_{m1}	r_{m2}		r_{mn}	NOT NECESSARY																	
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Total cost of the unit	NOT NECESSARY (although once one has obtained C_1, C_2, \dots, C_m , the total cost is simply $TC = C_1 + C_2 + \dots + C_m$)	TC																																														
Unit price of each of the resources of production	NOT NECESSARY although to obtain C_1, C_2, \dots, C_m , the unit prices are sometimes needed)	<table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="4">Resource</th> </tr> <tr> <th colspan="2"></th> <th>R_1</th> <th>R_2</th> <th>...</th> <th>R_m</th> </tr> </thead> <tbody> <tr> <th rowspan="2">Unit price</th> <th>W_1</th> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <th>W_2</th> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Resource						R_1	R_2	...	R_m	Unit price	W_1					W_2																											
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The econometric method is a method of statistical regression. The dependent variable is the total cost of the health unit. The independent variables are: the volumes of production of the services and the unit prices of production inputs.

This method calls for several observations in order to obtain results with an acceptable level of statistical reliability. Each health facility constitutes *one* observation. In general, one needs at least 30 observations or units. The accounting method, on the contrary, does not need a minimum number of observations, and can be used even with a single unit.

In order to apply the econometric method one needs to organize the information as follows:

Observation	Unit	Dependent variable and total cost	Independent variables							
			Volume of Production				Unit Price of Inputs			
			S ₁	S ₂	...	S _n	R ₁	R ₂	...	R _m
1	1	TC ₁	Q ₁₁	Q ₁₂	...	Q _{1n}	W ₁₁	W ₁₂	...	W _{1m}
2	2	TC ₂	Q ₂₁	Q ₂₂	...	Q _{2n}	W ₂₁	W ₂₂	...	W _{2m}
.
.
.
.
.
F	F	TC _F	Q _{F1}	Q _{F2}	...	Q _{Fn}	W _{F1}	W _{F2}	...	W _{Fm}

Next, a "model" or "cost equation" is formulated in the following way:

$$CT = \text{function of } (a_1 \cdot Q_1, a_2 \cdot Q_2, \dots, a_n \cdot Q_n, b_1 \cdot W_1, b_2 \cdot W_2, \dots, b_m \cdot W_m)$$

where the a are coefficients to be estimated statistically in association with the volumes of production and the b are coefficients to be estimated statistically in association with the unit prices of the resources.

After performing the regression with all the observations, one obtains estimated values of the coefficients of the cost factor. These coefficients are replaced in the model, allowing us to calculate the "average supplementary cost" as well as the "marginal cost" for each of the n services.

Example:

Let us suppose that we have a sample of 40 health centers. These health centers produce curative consultations (A), deliveries (M), preventive consultations (V), and family planning consultations (F). The health centers use the following resources: Doctor type A (D_A); Doctor type B (D_B); Doctor type C (D_C); Nurse type 1 (I_1); Nurse type 2 (I_2); Medicines (E); Equipment (T); and Supplies (U).

For the econometric method one must obtain two types of data for each of the establishments in the sample: (1) the volume of production of each service (Q) and (2) the unit price of each resource (W). One must therefore complete the following matrix:

Unit	Volume of production				Unit price of resources							
	A	M	V	F	$W_{D,A}$	$W_{D,B}$	$W_{D,C}$	$W_{I,1}$	$W_{I,2}$	W_E	W_T	W_F
Health center 1												
Health center 2												
Health center 40												

The unit price of labor will be, for example, the monthly or annual salaries (including allowances) of doctors and nurses. To arrive at the unit price of medicines the researchers decided to collect the unit prices of 20 medicines and pharmaceutical products whose consumption in \$ represents some 80-90% of the total \$ consumption of medicines in the facilities. To this end, the researchers prepared a table of 20 rows, one for each type of product, and a column for the unit price paid by the health facility at the time of its last order. With this information, the research team's econometrician will later draw up the medication price index for each facility (see column W_E , above). For the unit prices of the equipment, a similar procedure is used: the researchers make a list of 10 items of equipment which are most important from the point of view of their capital cost. They estimate their useful life and purchase (or replacement) cost and from this they obtain the estimated monthly (or annual) depreciation. This information is also set out in a special table. The researchers also include the capital cost of the building in their list. Next, the econometrician creates a price index of investment in equipment and buildings (see W_T above). A similar procedure is followed for supplies.

With all this information, the econometrician estimates a function of the total cost and then obtains estimates for the average and marginal cost of each service. This cost function may also be used to make projections of the total cost for establishing budget estimates.