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Cost-Effectiveness Analysis

**a module using economic concepts
in the context of development projects**

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Introduction to Cost-Effectiveness Analysis

The choice of a development project depends in part on the underlying financial framework. Projects that are purely private in nature can generally be classified in terms of their expected rates of return, and can be financed essentially through market institutions. However, in the case of quasi-public and pure public goods, private markets will generally produce an under-supply relative to what is a socio-optimal composition of goods and services. Such public goods thus require a measure of public sector funding if they are to be produced.

In this module, we look at projects whose goods and services fall either into the quasi-public or pure public goods category. Since public sector intervention is essential to their production, several questions need to be answered. First, how can one choose among several projects for which the benefits are either quasi-public or pure public in nature? Second, how can one determine the optimal level of public sector intervention, in particular the choice of an optimal fiscal regime? What cost-effectiveness analysis enables one to determine is the life cycle unit cost of several competing alternatives. Once this has been completed, one can then look to public sector financing choices regarding the mix of debt and taxes to support the optimal level of production of such goods.

In the case of goods whose benefits are partly or wholly indivisible, they are known respectively as quasi-public or pure public goods. Often, such projects are classified as "social" rather than "private", in that their benefits are more diffuse across the population. Since such social projects provide no direct means for cost recovery, the choices are fairly straightforward: 1. In the absence of any means for direct cost recovery, do not adopt the project; 2. undertake the project with public sector participation, either through an appropriate ministry, or through an association Non-Governmental Organization (NGO), which in turn maintains a contractual relationship through the government for purposes of undertaking such a project. Regardless of the choice, as long as there are projects with positive public benefit, the question then is to identify a mechanism through which one can assess the yield of the project as well as to determine what budget level is essential to its implementation. The methodology used in this context is cost-effectiveness analysis.

The Framework of Cost-Effectiveness Analysis

What is cost-effectiveness analysis? In financial analysis, the objective is to determine a hierarchy of projects based on standard tools, namely, the Net Present Value (NPV) and the Benefit-Cost Ratio (BCR) and the Internal Rate of Return (IRR). For purely private goods, a project that satisfies the opportunity cost test can then be undertaken by a private sector entity, be that an individual entrepreneur or a company. As long as a project has an underlying internal rate of return that is higher than the opportunity cost of capital, it is rational that one undertake the investment. Thus, private sector institutions determine what and how much of an investment is efficient, and as long as no spillover effects are involved, in the aggregate, the result is a higher level of income that would occur in the absence of such investment.

In the presence of projects whose benefits are diffuse and indivisible across time and across the population, unless there are mechanisms other than private sector funding, the project will not be feasible. From our discussion of the economic functions of the public sector we note that in the presence of external benefits, part of all of the financing of such projects will require public sector funding.

The framework of cost-effectiveness analysis is based on the choice among several projects, from which one then proceeds to determine the extent of public sector funding. In this approach, unless the external benefits so noted can be measurably traced to an increase in the level of socio-economic well-being, it does not follow that all such quasi-public or pure public goods should be undertaken. Given this caveat, cost-effectiveness analysis builds on linking expenditures to quantitative outcomes, which are then discounted to arrive at an estimate of the present discounted unit cost. By using present valuation of costs against quantitative outcomes, one can then compare alternative projects with the same objective to determine which has the lowest life cycle unit cost.

As with the use of a discount rate in the determination of the Net Present Value (NPV) for a private project, one can proceed in a similar fashion in cost-effectiveness analysis. The discount rate for such public sector projects should reflect the government's own opportunity cost of capital. Once determined, one can then proceed to the derivation of present worth coefficients (PWC) for each time period:

$$(1.) PWC_n = \frac{1}{(1+r)^n}, \text{ where:}$$

PWC = the present worth coefficient for a given time period, n,
r = the rate of discount,
n = the number of time periods for the life cycle of a project

From equation 1, one then derives the present value of costs across the life cycle of the project for each period n, and then the same for the present value of output quantities¹. From this one can then derive an estimate of the life cycle unit cost as:

$$(2.) LCUC = \frac{PVC}{PVQ} = \frac{\sum_{i=0}^n \frac{TC_i}{(1+r)^i}}{\sum_{i=0}^n \frac{Q_i}{(1+r)^i}}, \text{ where:}$$

LCUC = the life cycle unit cost,
PVC = the present value of costs,
PVQ = the present value of output quantities

¹ Some have ignored the application of present worth coefficients to output quantities, but this ignores the time value of money in comparison to given outcomes. One should thus apply present worth coefficients to both costs and quantities in cost-effectiveness analysis.

The solution is to select a project with the lowest life cycle unit cost. From our example, the digital laser system appears to be the optimal choice since its life cycle unit cost is seven percent lower than the traditional lighthouse system. Were loan financing not involved, the difference would be even larger, given that the laser system has a higher upfront capital cost than the traditional system.

Table 1
Evaluation Tableau for a Coastal Lighthouse System

Coastal Lighting Systems						
Traditional Lighthouse System	0	1	2	3	4	5
A. Recurrent Costs:						
A.1 Personnel						
Lighthouse captain	\$125,000	\$125,000	\$125,000	\$125,000	\$125,000	\$125,000
Lighthouse assistant	\$55,000	\$55,000	\$55,000	\$55,000	\$55,000	\$55,000
Ferryboat Service	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000
Maintenance/repair Service	\$45,000	\$45,000	\$45,000	\$45,000	\$45,000	\$45,000
A.2 Fuel and Equipment						
Lighthouse operation	\$30,000	\$30,000	\$30,000	\$30,000	\$30,000	\$30,000
Ferryboat transit	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000
B. Capital Expenditures:						
Lighthouse building	\$1,500,000					
Lighthouse equipment	\$2,500,000					
C. Loans:						
Annual loan payment (PMT)		\$1,026,739	\$1,026,739	\$1,026,739	\$1,026,739	\$1,026,739
D. Total Costs:	\$4,325,000	\$1,351,739	\$1,351,739	\$1,351,739	\$1,351,739	\$1,351,739
E. Quantity Produced	30,000	30,000	30,000	30,000	30,000	30,000
Annual Discounted quantity	30,000	28,571	27,211	25,915	24,681	23,508
Discounted Quantity:	159,884					
F. Evaluation parameters:						
Discount Rate:	5.00%					
Present Value Factors:	1.0000	0.9524	0.9070	0.8638	0.8227	0.7835
Present Value of Annual Cost:	\$4,325,000	\$1,287,371	\$1,226,068	\$1,167,683	\$1,112,079	\$1,059,123
Discounted PV of Costs:	\$10,177,324					
Life Cycle Unit Cost(LCUC):	\$63.65					
<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> Loans: Share of Initial Cost Borrowed: 1.00 Principal \$4,325,000 Interest Rate 6.00% Time Period: 5 Payment: \$1,026,739 </div> <div style="flex: 1;"> $LCUC = \frac{\sum_{j=1}^n \frac{TC_j}{(1+r)^j}}{\sum_{j=1}^n \frac{Q_j}{(1+r)^j}}$ </div> </div>						
ii. Digital Laser System:						
A. Recurrent Costs:						
A.1 Personnel						
Computer Stationmaster	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000
Computer Assistant	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000
Ferryboat Service	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
Mechanic/repair Service	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000
A.2 Fuel and Equipment:						
Lighthouse operation	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000
Ferryboat transit	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000
B. Capital Expenditures:						
Lighthouse building	\$1,000,000					
Lighthouse equipment	\$3,200,000					
C. Loans:						
Annual loan payment (PMT)		\$1,032,200	\$1,032,200	\$1,032,200	\$1,032,200	\$1,032,200
D. Total Costs:	\$4,348,000	\$1,180,200	\$1,180,200	\$1,180,200	\$1,180,200	\$1,180,200
E. Quantity Produced:	30,000	30,000	30,000	30,000	30,000	30,000
Annual Discounted quantity	30,000	28,571	27,211	25,915	24,681	23,508
PV of Quantity:	159,884					
F. Evaluation parameters:						
Discount Rate:	5.00%					
Present Value Factors:	1.0000	0.9524	0.9070	0.8638	0.8227	0.7835
Present Value of Annual Cost:	\$4,348,000	\$1,124,000	\$1,070,476	\$1,019,501	\$970,953	\$924,717
Discounted PV of Costs:	\$9,457,646					
Laser System Life Cycle Unit Cost(LCUC):	\$59.18					
Traditional System Life Cycle Unit Cost(LCUC):	\$63.65					
<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> Loans: Share of Initial Cost Borrowed: 1.00 Principal \$4,348,000 Interest Rate 6.00% Time Period: 5 Payment: \$1,032,200 </div> <div style="flex: 1;"> $LCUC = \frac{\sum_{j=1}^n \frac{TC_j}{(1+r)^j}}{\sum_{j=1}^n \frac{Q_j}{(1+r)^j}}$ </div> </div>						

Let us proceed with an example, the choice of a coastal lighthouse system. Table 1 provides an evaluation framework for two projects: a traditional system and a digital laser alternative system. The goal is to decide between the two which system minimizes commercial shipping accidents. The metric of success is an estimate of the quantity of goods safely passing along the waterway.

The evaluation table involves several inputs and several stages of operation. For each technology, expenditures are listed by category for each period across their respective life cycles. In addition to costs, one can also consider the impact of public sector financing in terms of loans and taxes, but this phase can only proceed once one has accurate estimates of the life cycle unit costs of each technology.

An Example of Cost-Effective Choices – Educational Television in Côte d'Ivoire

The following data have been extracted and modified from experimental work in educational television in Côte d'Ivoire. They provide a somewhat realistic basis from which to derive cost-effective analysis comparisons. The educational gains were obtained from standardized achievement tests. Results from this experience have been used to pursue further reforms in the program as well as the training materials themselves.

In some cases, educational television was used while in other test cases more traditional methods were employed. Actual costs of the reforms have been calculated. The annual cost per student in the reform program without educational television was \$US 16 dollars, whereas those using educational television has unit costs of \$22 per participant. Tables A1 and A2 illustrate the results of the standardized tests to be used in the cost-effectiveness analysis.

Table A1
Standardized Test Score Results from Alternative Educational Technologies

	Gain	Gain over Traditional Instruction
Mathematics		
Gain over Traditional Classes	1.95	
Gain with Educational Television	5.7	3.7
Gain for the Control Group (Reform Program without Ed. Television)	5.2	3.2
Sciences		
Gain over Traditional Classes	1.34	
Gain with Educational Television	4.2	2.9
Gain for the Control Group (Reform Program without Ed. Television)	5.1	3.8
Social Studies		
Gain over Traditional Classes	2.61	
Gain with Educational Television	6.4	3.8
Gain for the Control Group (Reform Program without Ed. Television)	3.1	1.5

Source: Martin Carnoy, "The Economic Costs and Returns to Educational Television", *Economic Development and Cultural Change* 23:2 (January), 207-248.

From these results, the following cost-effectiveness ratios for the different programs have been found to be:

Table A2		
Cost-Effectiveness Ratios		
	Educational Television	Reform Program Only
Mathematics	3.7/22 = 0.17	3.2/16 = 0.20
Science	2.9/22 = 0.13	3.8/16 = 0.24
Social Studies	3.8/22 = 0.17	1.5/16 = 0.10
Dollar Cost Per Unit Gain		
	Educational Television	Reform Program Only
Mathematics	\$22/3.7 = \$5.95	\$16/3.2 = \$5.00
Science	\$22/2.9 = \$7.59	\$16/3.8 = \$4.21
Social Studies	\$22/3.8 = \$5.79	\$16/1.5 = \$10.67

Carnoy's study suggests that it is only at the level of social studies that educational television seems to be higher than the single reform program only. He concludes his study in recommending that the best program, that is, the most cost-effective program, would be the training of trainers and the educational reform program, as opposed to the educational television option. For the record, Ivoirian officials did continue to experiment with educational television, as well as educational radio, with the notion that there were, and are, still lessons to be learned in terms of the optimal choice of an educational program.

Summary of Cost-Effectiveness Analysis

Unlike capital budgeting, cost-effectiveness analysis does not lead to decisions based on an expected stream of revenues. Instead, it is based on the calculation of life cycle unit costs, which are then used to compare with alternative choices with the same objective. It is sufficient in cost-effectiveness analysis to measure changes in terms of quantities per discounted unit costs, and then to consider the required level of financing to achieve the chosen objective. Cost-effectiveness analysis has been used in a broad range of applications, including the impact of medical outreach services on mortality and fertility rates, and literacy programs, among others. As has been shown, cost-effectiveness analysis uses the tools applied in capital budgeting financial analysis, and in which present value calculations are a deciding factor on which projet to select.

What our discussion of cost-effectiveness does not include at this point is the boundary cutoff conditions for such public sector projects, and whether private sector participation provides a greater impact on the level of socio-economic conditions than purely public sector funding. To address this question, we have to link the financing of cost-effectiveness projects to the macro-economic environment, and whether the positive effects on the macro-environment justify public sector participation. The Harrod-Domar framework and case study provide a logical link for this discussion, to which one can add the derivation of the social rate of return, which is covered in a separate module.

The Gille-Jande Functional Literacy Project²

Case Study Directions:

1. On an individual basis, carefully read the case study document. Your reading will be followed by a brief discussion to clarify any basic underlying concepts to be used in your analysis.
2. You then will be asked to prepare an evaluation table for each of the three programs. This is to be done at first on an individual basis, after which you will proceed with an assigned group to provide a comparative evaluation using an interest rate to be provided by the instructor.
3. Using the tools of cost-effectiveness, your group will select a leader who will present the findings to a visiting group of financial experts working with the local Ministry of Education, and to determine which of the three programs offers the best solution. From the best solution, the instructor will lead a general discussion on the choice of optimal taxes and borrowing, and use this to elaborate on the concepts of social net present value, and the social rate of return to development projects.

Overview of the Literacy Project Initiative

For more than a decade, the Third World Development Bank (TWDB) has placed emphasis on the financing of directly productive investment projects. Officials in the bank have largely selected projects on the basis of underlying rates of return, and thus, on their capacity to generate financial returns. However, during the past ten years, bank officials have found it necessary to decentralize bank lending to increase local participation in the management of projects, regardless of the type of project. In support of this initiative, the bank has decided to put resources into expanding the level of functional literacy among its member country populations. The goal in this initiative is to enable local populations to improve their organization capacity and to more directly manage their own development initiatives.

The Bank is currently examining three alternative projects under its functional literacy initiative. A brief description of these projects is given below.

Program 1 – Training of Local Trainers in Functional Literacy

This program provides for the training of local trainers. The trainers are to be chosen in each village that is participating in the project. They will undertake a three-month training program in the capital city. Following the training program, each trainer will return to his/her original village to serve as a local trainer. These trainers do not receive any salary, but do receive an annual stipend. They are members of a local village group that are involved in literacy training. The literacy courses will be held over the course of two to three evenings on a weekly basis for a period stretching over a year's duration. The program will result in the training of 30 trainers.

² This case study module was prepared originally in French by Dr. Richard Vengroff, Provost of Kennesaw State University, Atlanta, Georgia. The current English language version has been provided by Dr. Phillip LeBel, of Montclair State University, Montclair, New Jersey.

Program 2 – Technical Assistance

This program involves the sending of a team of experts to designated villages. Each team will consist of three expatriates who will lead literacy classes over a period of two to three weeks in the designated villages. 100 to 150 local village residents will participate in these courses. The selection of participating villages will be based on the degree of interest in the program, as expressed by local representatives from the village community.

Program 3 – Creation of Village Literacy Centers

The thrust of this program is on the construction of literacy centers. One center will be built in each local administrative commune. Each center will employ a professional trainer who works on a full-time basis. The trainer will be responsible for organizing literacy courses as components of a regular program operated under the auspices of the Ministry of Education. Literacy needs assessment will be determined by representatives from the Ministry of Education and directors of the Literacy Centers who are responsible for the scheduling of short-term courses to meet demand. Local villagers interested in participating will receive a modest stipend to cover their subsistence expenses.

Each region, department, or canton of membership countries can submit proposals for project financing. The Bank then will undertake feasibility studies to determine which proposals can be funded. For each participating country, only one program of the three alternatives described above will be funded.

The Prefect of the department of Gille-Jande has expressed an interest in starting a functional literacy program in his region. However, he would like to be sure that the program would provide real benefit to the population and that it would be sufficiently clear to seek funding from the Regional Development Bank (RDB), a semi-autonomous agency of the Government that is affiliated with the Third World Development Bank (TWDB).

The Prefect decides to call a meeting of the Department Development Council to discuss the possibility of such a program. The objective of the Council is to choose among the three programs described above which they consider to respond best to the goals and objectives outlined by the Council. The program they choose will be submitted to the Regional Development Bank for funding consideration, the financing of which would come from the Ministry of Finance via the Ministry of Education. To make their decision, members of the Department Development Council have obtained information on the costs of each of the programs during an initial trial phase. Information on these costs, and the associated outcomes is provided below.

As a member of the Department Development Council, you suggest that a cost-benefit analysis be undertaken for the three programs. You point out that the Regional Development Bank will be more receptive to a request for funding if such an analysis is undertaken and included in the application. Other members of the Department Development Council note the difficulty in quantifying the benefits from a functional

literacy program. Their primary concern is how to measure the value, or financial worth, of someone who has acquired functional literacy compared to someone who has not. What makes this particularly challenging is that the target population consists of local farmers all engaged in subsistence production. Their question thus is whether it is reasonable to speak of benefits from such a program as the functional literacy initiative under consideration.

In reply, you suggest that the meeting members consider using cost-effectiveness analysis as a variation of cost-benefit analysis. Since the majority of Council members are not familiar with this technique, you are given the opportunity to introduce its application to the membership. The information below is a summary of the work of two known experts in the field, Rossi and Friedman, and you use this framework to proceed with a feasibility evaluation³.

Data for the Three Alternative Functional Literacy Programs

Costs and results from the three alternative programs for consideration in Gille-Jande are given below. For all three programs, the Regional Development Bank is expected to apply a 10 percent discount rate of interest.

Program 1 – Training of Local Trainers in Functional Literacy

This program consists in the training of 2,500 participants annually by a group consisting of 30 trainers. The program will require material training costs estimated at CFA900 per participant and per year. The deployment of the thirty trainers will involve the following additional costs:

- (1.) Per diem expenditures are estimated at CFA1,500 per day and per trainer during the 3 months of the program, but only for the first year of the program.
- (2.) Stipends per trainer are set at CFA50,000 per trainer and per year during the life cycle of the project
- (3.) Transport costs are estimated at CFA10,000 per trainer and operating costs at CFA30,000 per month during the first three months of the first year of the program.
- (4.) In addition, expenses for the training of the trainers are estimated at CFA1,125,000, and only for the first year of the project.

The outcome performance data for Program 1 are estimated as follows: in the first year, there is a 45 percent successful training rate; 40 percent for the second year, 35 percent for the third year, and 30 percent for the fourth and fifth years.

³ Rossi, Peter H., and Howard E. Freeman (1993). *Evaluation: A Systematic Approach*. (Newbury Park, California: Sage Publications).

Program 2 – Technical Assistance

This program consists in the hiring of three experts to conduct literacy training for 1,500 participants per year. Material costs are estimated at CFA7,500 per participant per year and per diem of CFA15,000 per day and per expert for a period of 64 days per year, and which will apply during the life of the program. In addition to their per diem, each expert will receive a salary of CFA300,000 per month for a period of three months each year during the life of the project. The program also entails transport costs at CFA40,000 per training session (there are four of these sessions per year). Operating and maintenance costs for the training facilities are estimated at 25 percent of the total salaries of the experts.

In terms of outcome performance data, Program 2 estimated to have a successful training rate of 60 percent per year during the life of the project.

Program 3 – Creation of Village Literacy Centers

The third program involves construction costs of CFA400,000 per center, and only for the first year of the project. The program anticipates the training of 1,200 participants per year, or 100 participants per month. However, during the second through the fifth year of the program operating and maintenance costs are estimated to be CFA50,000 each year. Expenses for training materials are estimated at 1,500 per participant per year, with per diem expenses estimated at CFA500 per day and per participant for a duration of 14 days per year. The trainer will be paid CFA85,000 per month during the life of the project.

In terms of performance, the training success rate is estimated at 48 percent for each year. To begin, the program will be able to use free of charge the meeting room in the local Prefecture of Gille-Jande.

In a separate (spreadsheet) file, your task is to evaluate the data for the programs and to help the local Council arrive at a recommendation regarding a proposal to be submitted to the Regional Bank for Development for funding consideration.

On the Choice of an Optimal Financing Regime for Public Projects

Effective management of development investment projects requires that one take into account relative rates of return. In the case of cost-effectiveness, as this module has shown, this means selecting projects that have the lowest life cycle unit costs. Once this has been determined, the next question is how public projects should be financed. We look here at two principal public sector options, namely, bank lending, and taxation.

Debt Financing Through Bank Loans

Table 1 showed how cost-effectiveness analysis can be used to derive the life cycle unit costs. The table also includes an illustration of a loan option. For a lender, there needs to be a mechanism to assure the gradual liquidation of loan financing over the course of the project. In our case study, we noted the role of the Regional Development Bank (RDB), which had made a commitment to expanding lending in the social sector, that is, for projects that are not considered to be self-financing. Who, then, assures the reimbursement to the Regional Development Bank for a loan extended to launch a functional literacy program – the Ministry of Education, the Ministry of Finance, or local financial institutions that manage local taxes and financial resources?

The answer to this question is to assign responsibility to the public agency most closely associated with the day-to-day operation of the project, even if the ultimate source of funding comes from the central government. Budgetary management can be delegated by a central government agency to a local one that is capable of handling expenses for designated projects. But the local administrative entity can just as well be a private financial institution, particularly if it has a corresponding relationship regarding the collection and deposit of tax receipts on behalf of the central government. What is critical in this decision is that whatever public agency is charged with managing the project's finance, it must also be involved in the reimbursement process to a larger central, or external financial agency such that a timely liquidation of the debt is secured.

Taxation in Support of Public Projects

Lending to the public sector is essentially a form of deferred taxation. Eventually, at some level, some government agency will have to collect taxes at a sufficient level to amortize the debt created to support a public sector project⁴. In this section, we look at how economic tools can be applied to determine the optimal choice of taxation to serve a particular objective.

Governments impose taxes to achieve a variety of objectives⁵. Taxes can be used to discourage consumption, as in specific levies on energy, tobacco, and alcohol products. At the same time, government may be interested in using taxes and spending to stabilize the economy, in which case once the benefit of lower risk has been taken into

⁴ We are ruling out the option of inflation, which is a hidden form of taxation in which government spends today and repays its loans in depreciated currency. Experience has shown that this is such a crippling instrument to economic efficiency that an economy eventually will either go into recession, or go into sovereign debt default, which carries its own penalties in terms of higher interest rate terms for any sovereign debt that a government agency may choose to pursue.

⁵ Much of this discussion can be found in greater detail in the module on Economic Analysis, which covers the respective roles of government and the private sector in the allocation of resources.

consideration, the net effect is theoretically nil. Another reason for government taxation and government spending is simply to redistribute income in pursuit of some notion of distributive justice. But the last concern is to re-allocate resources to change the composition of goods and services produced. Quasi-public and pure public goods fall into this category, as does our example of the functional literacy program.

Figure 1

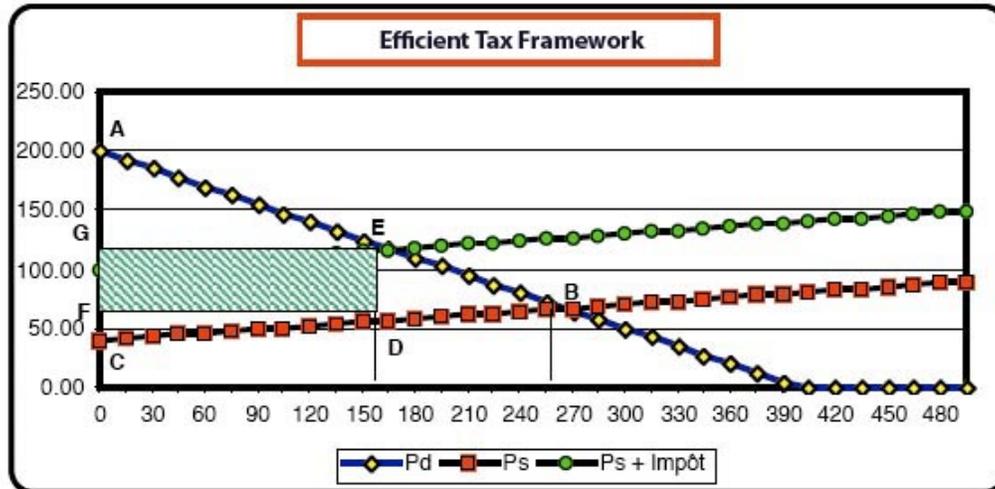


Figure 1 illustrates the framework for deriving a test for the efficiency of a tax. The inversely sloped line represents the demand for a good, while the lower upward sloping line represents the supply for a good prior to any form of government intervention. As such, a market equilibrium is generated at point B on the demand and supply curve, with the corresponding quantity measured along the x axis with the corresponding price on the y axis.

Within the market framework, we also can identify in addition to the initial market equilibrium the initial level of social welfare. Social welfare here means the sum of all of the benefits to be obtained from the production and consumption of a good at a given market equilibrium. In Figure 1, this is illustrated by the area of the triangle ABC.

Now consider the effect of a tax on the good. A tax will shift the supply curve upward, generating a new intersection of supply and demand at point E on the demand curve. As the new post-tax equilibrium is achieved, tax revenues equal to the rectangle denoted EDFG will be generated. The tax will result in a reduction in social welfare since the rectangle constitutes an extraction from the initial social welfare triangle ABC. Depending on the slopes of the demand and supply curves, one can then derive who bears the burden of the tax, consumers or producers. The general principle is that the steeper is the slope of the demand curve relative to the slope of supply, the greater is the relative burden of the tax on consumers.

Beyond the reduction in social welfare to support a given level of taxation, we now turn to the principle of fiscal efficiency. As can be seen in Figure 1, not only is there a reduction in social welfare through the imposition of the tax. There also is a deadweight

loss in social welfare, as indicated by the triangle BDE. It is called a deadweight loss because consumers and producers lose a measure of social welfare and it is not captured by the imposition of the tax.

Economists now define the efficiency of the tax as the excess burden of taxation. The excess burden of the tax is defined as the ratio of the deadweight social welfare loss to the level of tax receipts collected. In Terms of Figure 1, this means BDE/EDCG.

Having defined the efficiency of a tax, how can it be used to decide whether efficiency should apply in the selection or rejection of a tax. Drawing on statistical logic, we usually reject an hypothesis if an event occurs less than five percent of the time. In the case of fiscal efficiency, this implies that a tax that has an excess burden of five percent or less is considered to be relatively efficient, whereas any rate above that level is considered to be relatively inefficient.

In many countries, government agencies want answers to basic questions when it comes to taxes. How much revenue will be generated by a tax? Who bears the burden of the tax? And is it efficient? All three of these questions have been addressed in the above framework. While economists might argue on efficiency grounds that the excess burden tax ratio should never exceed five percent, government agencies often ignore this principle in seeking to achieve a target level of revenue, or to achieve a targeted change in behavior, or a targeted redistribution of income. Yet to the extent that taxes create significant distortions, this is equivalent to a drag on economic activity, thus lowering the rate of potential growth. And this is why programs of structural adjustment so often include measures to reduce the distorting effects of taxation and government spending.

Assuming that one could justify the use of taxation to underwrite the costs of our functional literacy programs, we now need to link the effects of the positive outcomes of literacy with the burden of taxation. To the extent that one can identify measurably positive effects of literacy on per capita income, one can then compare the value of additional income generated against the burden of taxation borne today. This is a subject of research by economists, but which we will defer for our present purposes of understanding how cost-effectiveness analysis can be used to select a particular program or project.

How do African countries compare with their fiscal systems? We list below a brief comparison to provide some idea of how Africa as a region compares to other parts of the global economy.

Table A3
Tax Revenue by Type of Tax
(percent of GDP)

	1987		Income Tax				Domestic				Foreign		
	GNP per capita	Total Tax	Total	Individual	Corporate	Other	Tax Total	Sales, VAT	Excises	Other	Total Tax	M Duties	X Duties
Industrial	\$13,477	31.21	10.96	8.45	2.37	0.14	9.43	5.58	3.02	0.83	0.72	0.70	0.00
Developing	\$1,241	18.05	5.51	2.08	3.29	0.40	5.21	2.46	2.07	0.68	5.13	4.32	0.62
Africa	\$621	19.53	6.65	2.28	4.13	0.33	4.85	2.96	1.44	0.45	6.84	5.74	1.01
Asia	\$743	14.84	4.46	2.37	2.64	0.09	4.55	1.59	2.23	0.72	5.46	4.82	0.48
Europe	\$3,361	21.88	5.80	3.44	1.53	0.83	6.86	3.43	2.48	0.96	2.80	2.80	0.00
Middle East	\$2,339	14.73	4.83	0.47	4.44	0.45	2.30	0.04	1.58	0.67	4.16	4.11	0.04
Western Hemisphere	\$1,581	18.16	4.84	1.63	2.71	0.64	6.47	2.75	2.81	0.90	3.46	2.50	0.49

Sources: IMF, Government Finance Statistics Yearbook (1989).

Although one of the poorest regions of the world, Africa's tax burden is slightly higher than for other developing economies. In addition, African countries depend less on income taxes than some regions, in part because of the size of the informal sector. In addition, African economies have the highest dependence on trade taxes, particularly on imports, but also on exports. What most studies have shown is incentives to bring the informal and subsistence sectors into the economy could help shift the burden of taxes away from trade and commodities and in favor of income. Yet that is still a process in transition, and even now the profile above appears not to have changed that much.

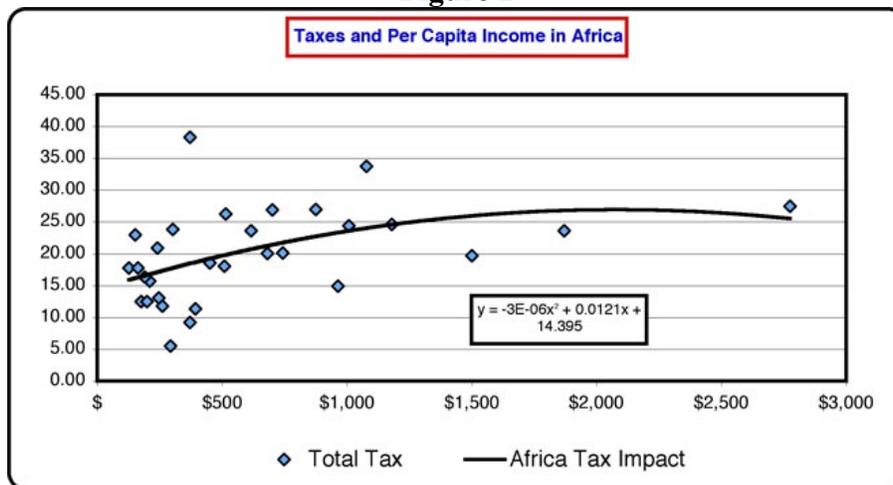
Table A4
Central Government Expenditure by Type
(percent of total GDP)

	Gen. Public Administration	Defense	Education	Health	Social Security	Transpt. Comm.	Other Econ. Services	Other	Central Gov. Exp. %GDP	Central Gov. Rev. %GDP
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.46	26.99
Developing	4.30	3.04	3.58	1.58	3.20	1.83	4.07	3.79	25.4	21.1
Africa	3.55	2.58	2.86	1.03	1.42	2.23	3.86	2.35	25.63	21.23
Asia	4.03	1.89	3.50	2.08	4.70	1.70	2.97	4.16	19.89	17.25
Europe	4.75	2.27	4.09	1.41	2.11	1.82	4.48	4.68	29.15	28.46
Middle East	4.92	3.97	2.12	1.82	6.72	1.90	6.17	1.51	33.12	25.82
Western Hemisphere	4.40	8.84	4.15	1.61	4.38	1.23	3.66	4.85	25.04	19.64

Sources: Robin Burgess and Nicholas Stern, "Taxation and Development", *Journal of Economic Literature*, XXX1:2 (June 1993), 762-830

On the expenditures side, African economies spend less than other regions on public administration. However, they devote a relatively small share to education and to health, and even less to social security than other regions. What this suggests is that the burden of taxation in Africa may be putting less into human resources than what might be economically justified, and numerous studies have suggested that social returns to human resource investment bring larger returns than market measures alone would suggest.

Figure 2



Finally, we look briefly at the relationship between the burden of taxes and the level of per capita income. For a sample of some thirty African countries, if we look at the trend implied by a scatter diagram, it suggests that African economies could expand the burden of taxes over a small range, after which further increases would result in lower levels of

income. How and which countries are affected by this depends on the mix in individual economies, as summarized in Table A5.

Table A5
Tax Revenue by Type of Tax
(percent of GDP)

	1987		Income Tax				Domestic			Foreign			
	GNP per capita	Total Tax	Total	Individual	Corporate	Other	Tax Total	Sales, VAT	Excises	Other	Total Tax	M Duties	X Duties
Gabon	\$2,776	27.46	18.04	1.20	16.34	0.50	2.44	1.93	0.00	0.51	6.22	5.72	0.50
South Africa	\$1,870	23.61	13.51	7.41	5.83	0.29	8.19	6.14	1.99	0.07	0.79	0.75	0.04
Mauritius	\$1,500	19.70	2.19	1.04	1.15	0.00	4.12	1.52	1.41	1.18	11.63	9.03	2.30
Tunisia	\$1,180	24.60	4.79	1.97	2.08	0.76	7.03	4.18	2.48	0.37	8.65	8.37	0.14
Botswana	\$1,078	33.75	24.06	2.25	18.97	2.83	0.76	0.56	0.00	0.20	8.88	8.88	0.03
Djibouti	\$1,008	24.39	4.66	2.79	1.86	0.01	15.39	9.13	4.08	2.18	1.65	1.62	0.03
Cameroon	\$965	14.92	7.12	1.75	7.38	0.01	2.60	1.24	1.12	0.23	3.50	3.01	0.45
Congo	\$875	26.99	17.21	2.96	14.21	0.03	2.69	2.46	0.17	0.07	4.57	4.46	0.07
Côte d'Ivoire	\$743	20.10	3.26	1.69	1.27	0.30	4.49	2.23	1.28	0.98	7.62	5.44	2.18
Swaziland	\$701	26.87	7.62	3.98	3.03	0.60	2.16	1.92	0.00	0.24	16.91	16.87	0.04
Morocco	\$681	20.05	4.26	2.38	1.70	0.18	9.77	5.42	3.63	0.73	3.24	3.04	0.17
Egypt	\$616	23.63	5.83	0.52	4.64	0.67	4.33	0.00	4.01	0.32	5.39	5.27	0.12
Zimbabwe	\$515	26.26	12.42	7.49	4.46	0.47	8.96	5.84	3.04	0.09	4.55	4.47	0.00
Senegal	\$510	18.02	3.88	2.31	1.02	0.55	5.40	3.72	1.36	0.32	7.19	7.06	0.11
Liberia	\$451	18.57	7.40	5.70	1.58	0.11	5.03	0.40	2.25	2.39	5.56	5.51	0.03
Ghana	\$394	11.33	2.61	1.00	1.61	0.00	3.31	0.69	2.57	0.05	5.39	2.36	3.02
Lesotho	\$372	38.29	4.43	3.09	1.34	0.00	5.73	4.82	0.42	0.51	28.04	27.99	0.05
Nigeria	\$371	9.17	6.45	0.01	6.35	0.23	0.92	0.00	0.92	0.00	1.79	1.78	0.01
Togo	\$303	23.82	10.20	2.24	7.17	0.78	2.72	2.13	0.31	0.28	8.77	6.93	0.25
Sierra Leone	\$294	5.52	1.44	0.63	0.80	0.00	1.40	0.00	1.14	0.26	2.63	2.52	0.11
Uganda	\$261	11.74	0.74	0.05	0.69	0.00	2.74	2.17	0.43	0.14	8.26	1.03	6.64
Burundi	\$247	13.05	2.74	1.20	1.35	0.18	3.59	0.00	3.43	0.16	5.24	3.64	1.60
Zambia	\$241	20.91	6.36	1.76	4.01	0.59	8.26	5.28	2.83	0.10	6.14	3.73	3.13
Tanzania	\$210	15.70	4.85	1.62	2.95	0.05	9.20	9.06	0.00	0.23	1.23	1.18	0.01
Mali	\$199	12.45	1.51	0.55	0.84	0.11	4.56	3.04	1.33	0.19	3.62	2.39	1.16
The Gambia	\$190	16.38	2.64	1.15	1.24	0.25	1.25	0.00	0.60	0.65	12.31	11.40	0.91
Burkina Faso	\$176	12.47	2.34	1.45	0.37	0.52	2.27	0.88	0.85	0.54	5.37	4.71	0.25
Malawi	\$163	17.74	7.37	2.60	4.77	0.00	6.39	5.52	0.60	0.27	3.86	3.48	0.38
Zaire	\$153	22.97	7.44	3.64	3.78	0.02	4.40	3.27	1.07	0.06	10.16	6.82	3.32
Ethiopia	\$127	17.77	6.98	1.93	4.59	0.46	5.46	1.83	3.57	0.06	4.77	2.92	1.85