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# Benefit-Cost Analysis of the Dharan-Dhankuta Road, Eastern Nepal

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## I. Introduction

Government of Nepal has recently adopted regional development strategy to reduce the acute socio-economic disparity between the Hills and the Terai (plain) regions of Nepal. Provision of cheap, reliable, and quick means of transportation, specially roads, has been considered one of the basic precondition for implementing development programs in the Hills. Although construction of major Terai-Hill roads might not be economically justifiable at present it has been realised that without improving the accessability meaningful development of the Hills is not possible[1]. Accordingly two such roads are planned for construction during the current Five Year Plan (1975-80) one of which is the Dharan-Dhankuta road in the Kosi Zone of Eastern Nepal.

The general contention amongst planners that the Terai-Hill roads are not economically viable cannot be justified without proper evaluation. Even if construction of such roads have been purely a political decision there is need for assigning priority amongst several such roads that could be considered in future. The fact that decision has been made to go ahead with the construction inspite of the possible economic unviability reflect the higher weight assigned by politicians to the improvement of income of the Hill people. It is important that the amount of trade-off between economic efficiency and regional distribution, if any, implicit in these decisions should be made explicit through proper project evaluation criteria.

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One of the methods commonly used for assigning priority amongst similar projects is the benefit-cost analysis. This paper will attempt to demonstrate a methodology to carry out such an analysis for the proposed Dharan-Dhankuta road as a case study.

## II. Description of the Project

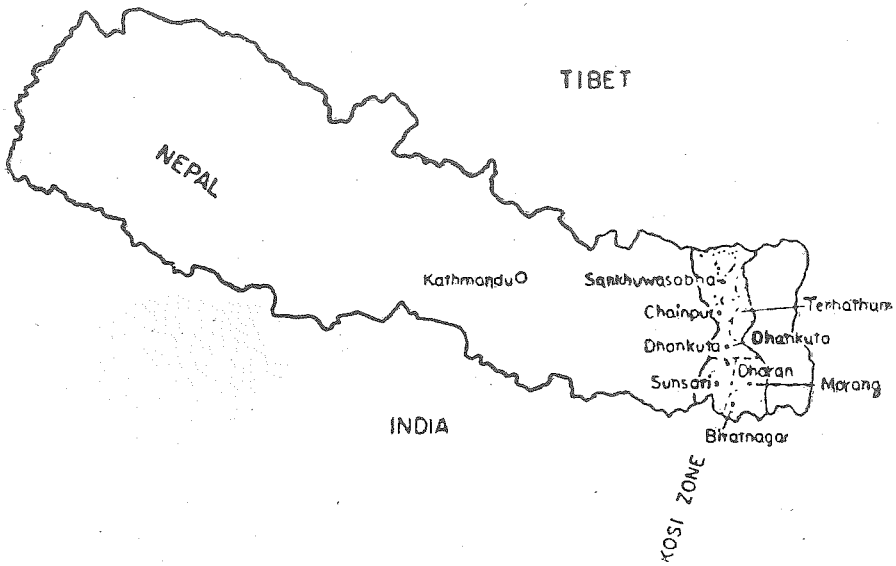
The road will link Dhankuta, a small market town and administrative center in the Hills, with Dharan, an important commercial town situated in the northern edge of the Terai at the foothills (see fig. ). The existing foot trail between these two centers is 25 kms and takes a journey of about two days for a porter with full load. The only means of transportation at present is by foot. The distance of the proposed road will be 65 kms[2] which can be covered in about 3 to 4 hours by truck. Detail allignment survey is already under way and the construction is expected to be completed in 1980. The major cost of the road is being financed under a grant from the British Government.

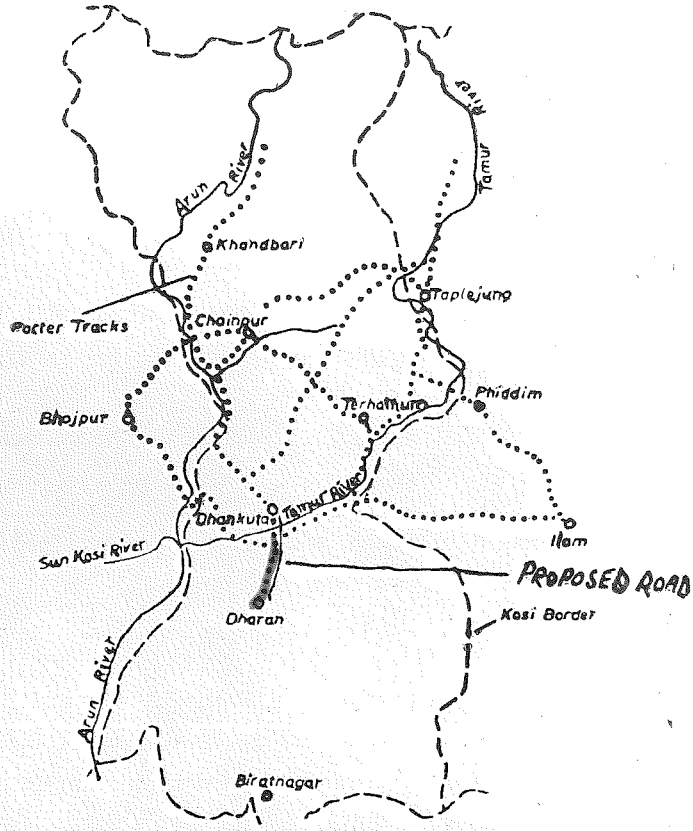
## III Socio-economic Background of the Influence Area

The three Hill districts of Kosi Zone--Dhankuta, Tehrathum, and Sankhuwasabha-can be regarded as the overall influence area of the road. All the goods and people moving to and from the Hills pass through the existing trail between Dharan and Dhankuta. It is reasonable to expect that all the existing traffic will be diverted to the road. However, the effective influence area in terms of developmental impacts will primarily be in the Dhankuta district.

The total population of the Hill districts is 3.32 million. Although the average annual rate of growth of population of Kosi Zone during the sixties has been around 3% the Hill districts registered a growth rate of below 1% due to heavy migration to the Terai[3]. The main reasons for such migration have been the acute pressure of population on land, stagnant or declining fertility of the soil due to lack of fertilizer and heavy erosion, occasional adverse weather causing food shortages, and growing indebtedness of the mass.

The principal economic activity is agriculture with paddy, maize, millet and potato as the main crops. The climate of the area is well suited for various temperate fruits and vegetable crops but their production is stagnant in the absence of any local market and prospect of export to Terai due to high cost of transportation. There are no modern industries but a wide range of cottage iudustries exist. They are still surviving because of the transport cost barrier against the cheaply manufactured consumer goods and also because they are produced during agricultural




Porter tracks in Kosi Zone.

off season, and, therefore, labor costs are not imputed in the price. The overall food balance is marginal at present (1970) with about 200 tons of imports but the deficit is expected to grow with the continuing increase in population.

## IV. Objectives of the Study

The main objective of this study is to assess the economic benefits and costs of the Dharan–Dhankuta road and to arrive at an index of economic efficiency in terms of Benefit/Cost ratio. Since construction and maintainance costs are more or less technically determined the specific objectives are:

(a) to estimate the direct benefits of the road in terms of savings in road user's cost; and
(b) to identify and estimate indirect benefits which are often more important than the direct benefits.

Although important only brief mention will be made about the intangible benefits at the end of this paper.

## V. Calculation of Benefits and Costs

Conceptually the calculation of the costs and benefits of a project is quite simple. Costs are more or less technically determined once the standard and method of construction are decided upon. Evaluation of benefits of infrastructure project like roads are, however, more complex. Besides reducing the costs of transportation improved accessibility creates other far reaching effects in the region which must be taken into consideration when assessing the project from the social point of view. A simple but comprehensive model is used to calculate the benefits in this study.

### 1. General Considerations and Assumptions

For the purpose of comparison all the benefits and costs are reduced (or brought forward) to their equivalent in 1980. Some of the general assumptions are given below. Specific assumptions will be given while discussing individual component of costs and benefits.

(a) **The economic life** of the project is taken as 20 years. Although physical life might be longer the streams of benefits and costs expected 20 years will affect the calculations and results only marginally. Moreover the uncertainity in the estimation of benefits and costs will not make worthwhile to consider a longer period.

(b) **Discount Rate:** Calculations will be based on alternative discount rates of 5%, 10%, and 15%. 5% is choosen assuming that for infrastructure projects like road the societal rate of time preference could be very low specially when extra efficiency criterion such as regional redistribution is being considered. International agencies like World Bank normally use 8% to 12% for most of the projects in developing countries. Therefore, 10% has been choosen as an alternate rate. Finally 15% is the current interest rate offered by the commercial banks in Nepal. This rate is choosen simply as an illustrative purpose.

(c) The analysis will ignore inflation. By doing this we are assuming no relative changes in prices which is quite unrealistic. However, in the absence of data, uncertainty and impossibility of proper forecasting there is no valid ground to consider inflation into the analysis.

(d) The quality of the road constructed under either capital intensive or labor intensive or method is assumed to be the same.

## 2. Costs

Two alternative methods of construction–capital intensive and labor intensive–are considered for analysis. Construction costs under capital intensive method is estimated to be Rs. 130 million ($1=Rs. 12.5) and will take 3 years for completion as against a cost of Rs. 104 million and 4 years of completion under the labor intensive technique (see appendix table A1). The labor intensive method uses relatively higher proportion of Nepali labor and material and services which is important for evaluation of indirect benefits.

The following assumptions are made with respect to cost calculation :

(a) Construction costs are uniformly distributed over the completion period.

(b) Annual operation and maintainance costs are constant throughout the life of the project.

(c) No shadow price is assigned to foreign exchange component of cost. Considering the scarcity and undervaluation of foreign exchange in developing countries like Nepal the use of a shadow price would have been appropriate to arrive at the real cost of the project to the society. However data to this effect in not available.

(d) Labor component of the construction and maintainance costs have been calculated at the opportunity cost of labor which is assumed to be 50% of the market wage rate. Accordingly these costs component have been reduced to 50%.

Present value of costs (for 1980=0) have been calculated using the following equation:

$$PVc = \sum_{t=1}^{20} \frac{O_t}{(1+i)^t} + \sum_{t=-3}^{\circ} K_t (1+i)^{'t'},$$

Where,

t=-3,-2,-1,0,1,....., 20.

i=discount rate

K=construction cost, and

O=operating and maintainance costs.

Calculation of present value of costs are shown in appendix table A2&3.

## 3. Benefits

Quantifiable benefits of the road could be divided into two broad categories of direct and indirect benefits.

### (i) Direct Benefits

Direct benefits are defined as the savings in road user cost resulting from the provision of the road as compared to the cost in the existing mode. Total value of savings depends upon annual projected volume of traffic during the life of the project considered.

A simple macro model as follows has been used for the traffic estimate:

$V_t = E_t + I_t$

$E_t = E_{(t-1)} . (1+g)$

$I_t = M_{(t-1)} . (1+p) + F_t$

$F = P_t . c - O_t$

$P_t = P_{(t-1)} . (1+q)$

$O_t = O_{(t-1)} . (1+r)$

Where,

$V_t$=total traffic; $E_t$=volume of exports; $I_t$=volume of imports;

M=imports of all goods excluding foodgrain;

F=food grain deficit; P=population; O=output of foodgrains;

t=time 1,2,...,20; g=rate of growth of exports;

p=rate of growth of imports; c=per capita annual foodgrain consumption.

q=rate of growth of population; and

r=rate of growth of foodgrains output.

Once the total volume of traffic is ascertained direct benefits (DB) is calculated as follows:

$$DB_t = V_t . \alpha; \alpha = \beta - \gamma$$

where, $\alpha$=savings in operating costs per ton.

$\beta$=existing transportation cost per ton calculated on the basis of opportunity cost of labor (porter),

$\gamma$=estimated vehicle operating cost per ton.

Description of each component for calculating the direct benefits and assumptions thereof are outlined below.

**Imports:** The total volume of imports of the Hills in 1970 is 9650 tons. This has been projected to 1981 at an aunual rate of growth of 2% as a composite of 1% rate of growth of population and 1% natural growth rate. Two alternate projections have been made from 1981 to 2000 assuming a minimum of 3% and a maximum of 5% growth rates. If data were available an ideal projection would have been the consideration of the population growth rate, rate of growth of per capita income, commoditiwise marginal propensity to consume and expected imports for public sector development programs. Instead the 3% growth rate is used assuming 1% population growth and 2% for the composite effects of natural growth, increment in income and government development programs. The alternate 5% is based on 2% population growth and a 3% composite effects of other factors (see App. Tab. A 6 & 7)

**Exports:** Exports from the Hills in 1970 were 3925 tons. Like imports the total volume has been projected for 1981 at 2% rate of growth. Arbritrary rate of growth of 3% and 5% per annum has been used for projection from 1981 to 2000 (see appendix tables A6 and A7).

**Food Deficit:** It is assumed that all the food deficits in the Hills will be imported from the Terai. Inspite of the present indications that the overall productivity in the Hills might be declining a natural rate of growth of 0. 5% per annum has been assumed for the food grain production. The present per capita consumption of foodgrains in the Hills is 162 kg. per annum. This is assumed to remain constant in future as well. 80% of the cultivated land in the influence area of the road (Dhankuta district) is assumed to be brought into improved cultivation practices

due to the impact of the road. The new technology is expected to increase per hectare yield by 1030 kg. However introduction of the new technology has been assumed to be gradual and therefore the full effect will be realised only by 1995. Increment of foodgrain production under these assumptions are also duly considered while calculating the food deficit (see tables A5 and A9 for details of assumptions, sources and calculations).

**Savings in Road User's Cost:** Existing cost per ton has been calculated using a shadow price of porter wages as follows:

| | |
|---|---|
| 50% of daily porter rate | =Rs. 7.50 per day |
| Number of days required per trip | =2 |
| Number of porters required to carry one ton (one porter load=37.03 kg.) | =27 |
| Therefore, cost per ton | =Rs. 405 per trip. |

The current vehicle operating cost (for 1970) on similar road is Rs.1 per ton km. By 1981 it might greatly increase due to the increase in the cost of fuel. Accordingly vehicle operating costs per trip is calculated on two different rates--at Rs.1 and at Rs.3 per ton km. The alternate savings per ton per trip comes to be Rs.340 and Rs.210 respectively.

**Savings in Passenger Travel Time:** There is no valid basis for assigning monetary value to the savings in travel time of passengers using the road. Therefore it has been ignored in the analysis although it might be quite important.

### (ii) Indirect Benefits

All incidental effects on society that arise either in building or in the operation of the road can be considered as the indirect benefits of the road. Only those indirect benefits that can be identified and assigned monetary value have been considered in this paper.

(a) Social cost due to the unemployment of professional porter induced by the road construction could be treated as negative benefit. At the same time there will be additional benefits from the increase of employment among professional porters due to economic development of the influence area. This benefit is rather difficult to ascertain. Therefore it has been assumed that the displaced employment will be equal to the new employment generated and accordingly both these categories have been ignored in the analysis.

(b) Increased Agricultural Production: This would be the most important indirect benefit of the road. Only the value of net incremental production on land assumed to be brought on improved technology is taken as benefit which is assumed to be Rs. 1736 per hectare. (see appendix table A5 for source and calculation).

(c) Icreased employment directly due to the construction and maintainance of the road: Assuming opportunity cost of labor to be 50%, the employment created by these activities has been considered as benefit to the society. (see appendix table A4).

(d) Use of Nepali materials and services during construction and maintainance: The value added component of the total Nepali material can be taken as indirect benefit of the road. Value added has been assumed to be 40% of total cost (see appendix table A4).

### (iii) Present Value of Benefits

The annual direct and indirect benefits have been reduced to the present value of 1980 by using the following equations:

$$PV_B = \sum_{t=1}^{20} \frac{TB_t}{(1+i)^t}$$

$$TB_t = DB_t + IB_t;$$

where,

TB=total benefits; DB=direct benefits; & IB=indirect benifits

## VI. Results and Implications of Analysis

Present value of benefits and costs are given in table 1 under four different combination of assumptions. The benefit/cost ratio are summarised in table 2. The alternative assumptions made are:

I. Growth rates of population 1%, imports 3%, and exports 3%; and road user's savings of Rt. 210 per ton.

II. Growth rates of population 1%, imports 3%, and exports 3%; and road user's savings of Rs. 340 per ton.

III. Growth rates of population 2%, imports 5%, and exports 5%; and road user's savings of Rs. 210 per ton.

IV. Growth rates of population 2%, imports 5%, and exports 5%; and road user's savings of Rs. 340 per ton.

Benefits and costs under each of these assumptions have been assessed under two different methods of construction by using alternative discount rates of 5%, 10%, and 15%.

Obviously the lowest B/C ratio (0.51) is for capital intensive method under the most unfavourable assumption (I) at discount rate of 15%. The highest (2.11) is under assumption IV with labor intensive method at 5% discount rate.

The project has a B/C ratio over 1 under all assumptions at discount rate of (five) 5%. This shows that if the social rate of time preference is low the project is economically feasible and therefore the contention of planners about the unfeasibility of Terai-Hill roads at the current state of Hill economy is not well founded. If labor intensive method is used for construction the project is feasible under assumptions II, III, and IV even at 10% discount rate. This has important implication as to the use of labor intensive method for construction of roads in Nepal. On the whole the analysis shows that labor intensive method is preferable to that of capital intensive one. The present value of benefits is greater for all assumptions for labor intensive methods. Therefore even if the total cost of construction is assumed to be the same (instead of a lower one for labor intensive method) the advantages of using labor intensive method is obvious.

Under the most favourable assumption (IV) the project is feasible with capital intensive technique even at 10% discount rate. The application of 15% discount rate makes the project unfeasible for all assumptions and techniques of construction considered.

Let us now specifically look at results under the labor intensive technique to evaluate the changes in the B/C ratio when one or several assumptions are changed. B/C ratio drops from 1.42 to 0.65 under the most unfavourable assumption (I) and from 2. 11 to O. 89 under the most favourable assumption (IV) when discount rate is increased from 5% to 15%. Similar high drops in B/C ratio are noted under other assumptions (table 2).

The result of changes in the vehicle operating cost from Rs. 1/ton km to Rs. 3/ton km (i. e. savings in user's costs from Rs. 340 to Rs. 210) is also quite important although not as large as in the case of changes in discount rate. To evaluate this effect we have to compare the results obtained under assumption I with II or assumption III with IV pertaining to the same

## TABLE: 1

## BENEFIT-COST CALCULATION UNDER ALTERNATIVE ASSUMPTIONS

**I. Growth Rates: Population 1% Imports 3% Exports 3%**
**Road Users' Saving; Rs. 210/ton**

(Rs. in 000)

| Discounted Benefits/costs | Labor Intensive Discount Rate | | | Capital Intensive Discount Rate | | |
|---|---|---|---|---|---|---|
| | 5% | 10% | 15% | 5% | 10% | 15% |
| **Benefits:** | | | | | | |
| Direct (User cost savings) | 16,150 | 42,808 | 30,495 | 61,150 | 42,808 | 30,495 |
| **Indirect:** | | | | | | |
| Labor for Construction and Maintainance | 15,665 | 16,436 | 17,428 | 8,612 | 8,639 | 9,826 |
| Agricultural Benifit (Increment in Production) | 88,516 | 49,694 | 31,903 | 88,516 | 49,694 | 31,903 |
| Nepali Supply of Material & Services | 7,481 | 7,758 | 8,169 | 6,770 | 6,829 | 7,000 |
| Total Benefits: | 172,812 | 116,696 | 87,995 | 165,048 | 107,970 | 79,224 |
| **Costs:** | | | | | | |
| Construction | 112,060 | 120,666 | 129,818 | 136,629 | 143,432 | 150,452 |
| Maintainance | 9,970 | 6,811 | 5,007 | 9,970 | 6,811 | 5,007 |
| Total Costs | 122,030 | 127,477 | 134,825 | 146,599 | 150,243 | 155,459 |
| Benefit/Cost Ratio | 1.42 | 0.92 | 0.65 | 1.13 | 0.72 | 0.51 |

## II. Growth Rate : Population 1%, Imports 3% & Exports 3% Road Users Saving; Rs. 340/ton

| | | | | | | |
|---|---|---|---|---|---|---|
| **Benefits;** | | | | | | |
| Direct (User Cost Saving) | 105,421 | 69,297 | 49,397 | 105,421 | 69,297 | 49,397 |
| **Indirect:** | | | | | | |
| Labor for Const. & Maintainance | 15,665 | 16,436 | 17,428 | 8,612 | 8,639 | 9,826 |
| Agricultural Benefits | 88,516 | 49,694 | 31,903 | 88,516 | 49,694 | 31,903 |
| Nepali Supply of Material and Services | 7,481 | 7,758 | 8,169 | 6,770 | 6,829 | 7,000 |
| Total Benefits: | 217,083 | 143,185 | 106,897 | 209,319 | 134,459 | 98,126 |
| **Costs;** | | | | | | |
| Construction & Maintainance | 122,030 | 127,477 | 134,825 | 146,599 | 150,243 | 155,459 |
| Benfit/Cost Ratio | 1.78 | 1.12 | 0.79 | 1.43 | 0.89 | 0.63 |

Source: Appendix Tables: A2, A3, A4, A5, A11, & A12,

### III. Growth Rates: Population 2%, Imports 5%, & Exports 5%. Road Useres' Savings: Rs 210/ton.

(Rs. in' 000)

| Discounted Benefits And Costs | Labor Intensive Discount Rate | | | Capital Intensive Discount Rate | | |
|---|---|---|---|---|---|---|
| | 5% | 10% | 15% | 15% | 10% | 15% |
| **Benefits:** | | | | | | |
| Direct | 90,222 | 55,616 | 38,493 | 90,222 | 56,616 | 38,493 |
| Indirect* | 111, 662 | 73,888 | 57,500 | 103,898 | 65,162 | 48,729 |
| Total Benifit: | 201,884 | 130,504 | 95,993 | 194,120 | 121,778 | 87,222 |
| **Costs:** | | | | | | |
| Const. & Maintainance | 122,030 | 127,477 | 134,825 | 146,599 | 150,243 | 155,459 |
| Benefit/Cost Ratio | 1.65 | 1.02 | 0.71 | 1.32 | 0.81 | 6 |

### IV. Growth Rates: Population 2%, Imports 5%, & Exports 5% Road Users' Savings: Rs. 320/ton

| | | | | | | |
|---|---|---|---|---|---|---|
| **Benefits;** | | | | | | |
| Direct | 146,073 | 91,668 | 62,627 | 146,073 | 91,668 | 62,627 |
| Indirect* | 111,662 | 73,888 | 57,500 | 103,898 | 65,162 | 48,729 |
| Total Benefits: | 257,735 | 165,556 | 120,127 | 249,971 | 156,830 | 111,356 |
| **Costs;** | | | | | | |
| Const. & Maintainance | 122,030 | 127,477 | 134,825 | 146,599 | 150,243 | 155,45 |
| Benefit/Cost Ratio: | .11 | 1.30 | 0.89 | 1.71 | 1.04 | 0.72 |

*Indirect Benefits are the same under different assumptions. Therefore only total as calculated under assumptions I is given.

Source: Appendix Tables A2 to A5, A11 and A12

## TABLE : 2

### BENEFIT/COST RATIOS UNDER ALTRNATE ASSUMPTIONS

| Alternate§ Assump- tions | Labor Intensive Discount Rate | | | Capital Intensive Discount Rate | | |
|---|---|---|---|---|---|---|
| | 5% | 10% | 15% | 5% | 10% | 15% |
| I | 1·42 | 0·92 | 0·65 | 1·13 | 0 72 | 0·51 |
| II | 1·78 | 1·12 | 0 79 | 1·43 | 0·89 | 0·63 |
| III | 1·65 | 1·02 | 0·71 | 1·32 | 0·81 | 0·56 |
| IV | 2·11 | 1·30 | 0·89 | 1·71 | 1·04 | 0·72 |

§ I. Population growth 1%, imports growth 3%, & export growth 3%, Road user's cost savings=Rs 210/ ton

II. Growth Rate : Population 1%, imports 3%, and exports 3%, Road user's cost savings=Rs. 340/ ton

III. Growth Rate : Population 2%, imports 5%, and exports 5%, Road user's cost savings= Rs. 210/ ton

IV. Growth Rate : Population 2%, imports 5%, and exports 5%, Road user's cost savings= Rs. 340/ ton.

Source : Tabls 1.

discount rate. For 5% discount rate we observe that B/C ratio drops from 1.78 to 1.42 in the former case and from 2.11 to 1.65 in the latter. The drop in the ratio decreases progressively with increase in discount rate from 5% to 10% and 15%. This indicates that at high discount rate effects of changes in other assumptions is lower than at lower discount rate. Comparing results of assumption II with I at 10% discount rate, the change in the vehicle operating cost makes the project unfeasible (B/C 0.92) from a feasible one (B/C 1.12). This assumption regarding savings in user's cost is quite important and implies a need for careful assessment. Considering the tremendous rise in fuel costs during the last few years savings in user's cost in our case would be nearer to Rs. 210 than Rs. 340 per ton.

Changes in the composite assumptions about growth rate of population, imports and exports will be revealed by comparing the B/C ratio obtained under assumptions I and III or assumptions II and IV at specific discount rates. Changes in these assumptions have less significant effect on B/C ratio than in the case of changes in discount rate or savings in users' cost. At 5% discount rate the B/C ratio drops from 1.65 to 1.42 when results of assumption III is compared with I and from 2.11 to 1.75 when comparison is made between assumption IV and II. Similar but reduced drops are observed for 10% and 15% discount rates.

The above discussin of sensitivity of B/C ratio indicates that we have to be more careful in deciding about the appropriate values of discount rate and users' cost savings than about growth rates of population, imports and exports. Since savings in user's cost also depends upon the opportunity cost of labor the assessment of shadow price for porter rates is also quite important. Another important component is agricultural benefits. A slight changes in assumptions of incremental output as a result of improved technology, the area of land that might be brought under improved technology, and changes in incremental income can change the value of agricultural benefits significantly. This is another area where a careful assessment needs to be made.

## VII. Concluding Remarks :

Benefit-cost analysis is no doubt an useful tool for evaluation and assigning priority amongst similar projects. However, for infrastructure projects like road it cannot take into account quantitatively various other intangible benefits and cost which might be of considerable importance from the point of view of the society. Even the quantifiable benefits and costs are difficult to estimate. The validity of the assumptions made completely determines results of

analysis. Therefore benefit-cost analysis as a tool for decision making for public sector projects should not be given an overt emphasis. They should be used as a guide but other considerations pertinent to the societal objectives such as equity should supplement the decision process. This is particularly true for developing countries where disparity in income distribution is very wide.

Some of the important intangible effects of road project that should be considered might be redistributional impact, environmental effects, effects on social services delivery, effects on the attitude of the people, social and political integration, regional development, and the like. The amount of weight to be attached to the qualitative evaluation is a matter of political decision. Recently some modified version of B/C analysis to consider other effects (specially redistribution) have been attempted but they all have come accross severe limitations.[5] In this sense the role of planners is to indicate the various implications as objectively as possible but the final decision need to be made on the basis of social value judgements by the politicians.

**Notes;**

1. National Planning Commission, **The Fourth Plan,** (1970-75), His Majesty's Government, Kathmandu (1970) p. 286.
2. Center for Economic Development and Administration, **Regional Development Study,** Kathmandu (1975), chpt. 16.
3. Harkha Gurung, **'Population Aspects of Development'** , CEDA, Kathmandu (1974), memeo.
4. Nepal Rastra Bank, 'Agricultural Credit Survy' , Vol III, Kathmandu (1972).,
5. A very good summery concerning the redistribution issues and the application of a modified version of Benefit-cost approach is given in T. H. Stevens and R. J. Kalter, 'Evaluation of Public Investments: Distributional Impacts of Water Resources Projects', **Search Agriculture** Vol. 2 No. 12 (1972) Cornell University, Ithaca.

Appendix

## TABLE : A1

### Road Specification and Costs

**Road Link :** Dharan (Foothills) to Dhankuta (Hills)

**Length** : 65 Kms

**Roadbed** : 5 meters **Pavement** : Gravel

**Construction Cost & Other Components :**

| | Capital Intensive | Labor Intensive |
|---|---|---|
| **Total Cost** : Rs. 130,000,000 (a) | | Rs. 104,000,000 |
| **Nepali Labor** : 11 % of Cost | | 26 % of cost |
| | Rs. 14,300,000 | Rs. 27,040,000 |
| **Nepali Supply of material & Services:** | 11 % of Cost | 15 % of cost |
| | Rs. 14,300,000 | Rs. 15,600,000 |
| **Construction Period :** | 3 yrs. | 4 yrs |
| **maintainance costs** : Rs. 800,000/ yr | | Rs. 800,000/ yr |
| Labor Compoment : 22% | | 22% |
| Nepali material & Services : 19% | | 19% |

Source : (a) Center for Economic Development & Administration : **"Regional Development Study, Nepal,"** Part III a, chpt, 16 b, Kathmandu, (1975)

Other cost components imputed from data on similar road project estimate given in Comtec, Alpina, & Machhi : **"Un-Hmg Nepal Road Feasibility Study,"** Rome, (May 1973)

(U. S. $ 1 = Nepali Rs. 12·5)

## TABLE : A2

### Present Worth of Construction Cost.

**Basis :** In the absence of annual schedule of expenditure, an arbitrary allocation of equal annual costs during the construction period has been assumed.

Construction is to start under labor intensive method in 1977 and completed in 1980 (end). For capital intensive method construction assumed to start in 1978.

**Discounted cost of labor intensive method :**

| | At Discount Rate of | | |
|---|---|---|---|
| Present worth in 1980 of annual construction cost of Rs. 26,000,000 during 1977–1980 : | 5% | 10% | 15% |
| | Rs. 112,060,000 | 120,666,000 | 129,818,000 |

**Discounted cost of cap. intensive method :**

| | | | |
|---|---|---|---|
| Present Worth in 1980 of Annual Cost of Rs. 43,333,000 During 1978-1980 : | Rs. 136,629,000 | 143,432,000 | 150,452,000 |

Source : Table A 1.

## TABLE : A3

### Present Worth of Maintainance Cost

Present worth of annual maintainance costs of Rs. 800,000 at;

5% Discount rate=Rs. 9,970,000
10% " " =Rs. 6,811,000
15% " " =Rs. 5,007,000

applicable to both for the road constructed under labour intensive as well as capital intensive methods).

Source: Table A 1.

## TABLE: A4

## Present Worth of Benefits During Road Construction And Maintainance

**Benefits Due to Employment of Labor:**

**Assumption** : Opportunity cost of labor is only 50% of wages paid. Therefore only 50% of the total labor component will be taken as benefit.

(Rs in '000)

| | Labor Intenrive | | | Capital Intensive | | |
|---|---|---|---|---|---|---|
| | at 5% | 10% | 15% | 5% | 10% | 15% |
| Construction: | 14,568 | 15,867 | 16,877 | 7.515 | 7,890 | 8,295 |
| Maintainance | 1,097 | 749 | 551 | 1,097 | 749 | 551 |
| Total: | 15,665 | 16,436 | 17,428 | 8,612 | 8,639 | 9,826 |

## Present Worth of Benefits Due to Use of Nepali Material & Services:

**Assumption** : Value added in Nepali materials & services used is only 40%. Therefore, only this proportion is taken as benefit.

(Rs. in '000)

| | Labor Intensive | | | Capital Intensive | | |
|---|---|---|---|---|---|---|
| | at 5% | 10% | 15% | 5% | 10% | 15% |
| Construction | 6,723 | 7,240 | 7,789 | 6,012 | 6,311 | 6,620 |
| Maintainance | 758 | 518 | 380 | 758 | 518 | 380 |
| Total | 7,481 | 7,758 | 8,169 | 6,770 | 6,829 | 7,000 |

Source : Table A 1.

## Table : A5

### Present Worth of Incremental Production of Foodgrains (Estimate) as a Result of Road

| Period | Land under improved technology (Hectares) | Total incremental net income over existing technology (Rs '000) | Present worth (1980) on incremental income @ 5% discount rate (Rs'000) | @ 10% discount rate (Rs'000) | @ 15% discount rate (Rs'000) |
|---|---|---|---|---|---|
| 1981 | 1,000 | 1,736 | 1,653 | 1,578 | 1,510 |
| 1982 | 1,000 | 1,736 | 1,575 | 1,435 | 1,313 |
| 1983 | 1,000 | 1,736 | 1,500 | 1,307 | 1,141 |
| 1984 | 1,000 | 1,736 | 1,428 | 1,186 | 993 |
| 1985 | 1,000 | 1,736 | 1,360 | 1,078 | 863 |
| 1986 | 4,000 | 6,944 | 5,180 | 3,920 | 3,002 |
| 1987 | 4,000 | 6,944 | 4,935 | 3,564 | 2,610 |
| 1988 | 4,000 | 6,944 | 4,700 | 3,232 | 2,270 |
| 1989 | 4,000 | 6,944 | 4,476 | 2,945 | 1,965 |
| 1990 | 4,000 | 6,944 | 4,263 | 2,677 | 1,717 |
| 1991 | 6 000 | 10,416 | 6,090 | 3,651 | 2,238 |
| 1992 | 6,000 | 10,416 | 5,800 | 3,319 | 1,947 |
| 1993 | 6,000 | 10,416 | 5,524 | 3,018 | 1,693 |
| 1994 | 6,000 | 10,416 | 5,261 | 2,743 | 1,472 |
| 1995 | 6,000 | 10,416 | 5,010 | 2,495 | 1,280 |
| 1996 | 8,232 | 14,290 | 6,546 | 3,110 | 1,528 |
| 1997 | 8,232 | 14,290 | 6,235 | 2,827 | 1,328 |
| 1998 | 8,232 | 14,290 | 5,937 | 2,571 | 1,155 |
| 1999 | 8,232 | 14,290 | 5,655 | 2,336 | 1,005 |
| 2000 | 8,232 | 14,290 | 5,386 | 2,123 | 873 |
| Total | | | 88,516 | 49,694 | 31,903 |

**Assumptions** : (a) Influence Area of Road=70% of Dhankuta District
Total area cultivated in Dhankuta=14,700 Hectares.
70% of total cultivated area=10,290 Hectares.

(b) 80% of cultivated area of 10,290 Ha, will be brought into improved technology=8,232 Ha.

(c) Expected schedule of Land brought into improved cultivation :

First five yrs. -1,000 ha. average

5th to 10th yr.–4,000 ha. "

10th to 15th yr.-6,000 ha. "

15th to 20th yr.–8,232 ha. "

(d) Net incremental income from land under improved technology over existing technology = Rs. 1,736/ ha.

Sources for : (a) **'U. N. –Hmg Nepal Road Feasibility Study,'** Comtec, Alpina & Macchi, Rome (May 1973).

(b) Own assumption

(c) Own assumption.

(d) **'Agricultural Credit Survey, Nepal,'** Nepal Rastra Bank, Kathmandu (1972) –Vol. I (Chapt. 7).

## TABLE: A6

### Imports and Exports of Kosi Zone Hill Districts (1970)

Quantity in met. tons

| Imports | | Exports | |
|---|---|---|---|
| Commodities | Quantity | Commodities | Quantity |
| Foodgrains | 220 | Medicinal Herbs | 195 |
| Edible oil | 360 | Tangarine & Other Fruits | 1,320 |
| Pulses | 60 | Potato | 370 |
| Sugar | 300 | Ghee | 38 |
| Spices | 165 | Cardamoms | 56 |
| Kerosene oil | 1,600 | Ginger & Dried Chillee | 222 |
| Salt | 4,000 | Hides & Skins | 40 |
| Cigarrettes & Bidi | 230 | Wollen products | 20 |
| Clothes | 1,375 | Bamboo shoots | 50 |
| Others (Soap, Spices, Stationer, Medicines, Iron & Brass etc.) | 1,365 | Others (Brass Utensils, Honey etc.) | 1,600 |
| Total | 9,675 | Total | 3,925 |

Total Traffic flow (1970)=13,600 m. tons.

Source : Center for Economic Development & Administration, **"Regional Development Study, Nepal,"** Kathmandu, (1975)-Part III a, Chpt. 16c.

## TABLE : A7

### Projection of Total Quantity of Imports and Exports (Excluding Food Grains) Under Different Assumptions

(Qty. in m. tons)

| Period | Imports | | Exports | |
|---|---|---|---|---|
| | Rate of growth (3%) (1% pop. growth+ 2% growth due natural & dev. impacts) | Rate of growth-5% (2% pop. growth+ 3% natural and deve-lopmental impact) | Rate of growth-3% | Rate of growth-5% |
| 1981 | 12,030 | 12,030 | 4,880 | 4,880 |
| 1982 | 12,391 | 12,632 | 5,026 | 5,124 |
| 1983 | 12,762 | 13,263 | 5,177 | 5,380 |
| 1984 | 13,145 | 13,926 | 5,333 | 5,649 |
| 1985 | 13,540 | 14,623 | 5,492 | 5,932 |
| 1986 | 13,946 | 15,353 | 5,657 | 6,228 |
| 1987 | 14,365 | 16,121 | 5,827 | 6,540 |
| 1988 | 14,795 | 16,927 | 6,002 | 6,867 |
| 1989 | 15,239 | 17,773 | 6,182 | 7,210 |
| 1990 | 15,697 | 18,662 | 6,367 | 7,570 |
| 1991 | 16,167 | 19,595 | 6,558 | 7,949 |
| 1992 | 16,652 | 20,274 | 6,755 | 8,364 |
| 1993 | 17,152 | 21,603 | 6,958 | 8,764 |
| 1994 | 17,667 | 22,683 | 7,166 | 8,808 |
| 1995 | 18,196 | 23,818 | 7,381 | 9,248 |
| 1996 | 18,742 | 25,008 | 7,603 | 9,710 |
| 1997 | 19,304 | 26,259 | 7,831 | 10,196 |
| 1998 | 19,363 | 27,572 | 8,066 | 10,706 |
| 1999 | 19,944 | 28,950 | 8,308 | 11,240 |
| 2000 | 20,542 | 30,398 | 8,557 | 11,297 |

Source : Table A6

Note : Projection of imports and exports from 1970 to 1981 was done assuming 2% rate of growth each.

## TABLE : A8

### Basis for Calculation of Foodgrain Deficit in the Hill Districts of Kosi Zone

| | | |
|---|---|---|
| Area under cultivation in 1970 | : | 36,700 Hectares |
| Total physical output of foodgrains | : | 72,400 m. tons |
| Output per hectare | : | 1,970 kg. |
| Edible foodgrains after processing loss, provision for seed & livestock feed | : | 53,600 m. tons |
| Ratio of edible to physical output | : | 0·74 |
| Total population in 1970 | : | 332,000 |
| Total edible foodgrain supply (Prod.: 53,600 tons+imports 200 tons) | : | 53,800 m. tons |
| Per capita foodgrains consumption | : | 162 kgs/person/yr. |

Source : Ministry of Food & Agriculture : "**Agricultural Statistics of Nepal,**" Kathmandu, 1972 (table 18.1)

## TABLE : A9

Calcutation of Estimated Annual food Grain Deficit in the Hill Districts Assuming 0·5% Rate of Growth of Food Grain Production and Alternate Population Growth Rate of 1% & 2% p.a.

| Period | Total edible Food grain production [1] (1 M. tons) | 1% pop. growth | | | 2% pop. growth | | |
|---|---|---|---|---|---|---|---|
| | | Estimated total population [2] | dible grain requierment @162 kg./ capita (m. tons) | Deficit (m. tons) | Estimated total population [2] | t dible grain reqmt @ 162 kg/ capita (m. tons) | Deficit (m. tons) |
| 1981 | 57,103 | 370.400 | 60,004 | 2,901 | 370,400 | 60,004 | 2,901 |
| 1982 | 57,384 | 374,104 | 60,604 | 3,220 | 377,808 | 61,204 | 3,820 |
| 1983 | 57,645 | 377,847 | 62,213 | 3,566 | 385,364 | 62,429 | 4,784 |
| 1984 | 57,929 | 381,623 | 61,822 | 3,893 | 393,071 | 63,677 | 5,748 |
| 1985 | 58,215 | 385,440 | 62,442 | 4,226 | 400,932 | 64,951 | 6,736 |
| 1986 | 60,789 | 389,294 | 63,065 | 2,276 | 408,951 | 66,250 | 5,461 |
| 1987 | 61,078 | 393,187 | 63,696 | 2,618 | 417,130 | 67,575 | 6,497 |
| 1988 | 61,368 | 397,119 | 64,333 | 2,965 | 425,473 | 68,926 | 7,558 |
| 1989 | 61,659 | 401,090 | 64,976 | 3,317 | 433,982 | 70,305 | 8,646 |
| 1990 | 61,953 | 405,101 | 65,626 | 3,673 | 442,661 | 71,711 | 9,758 |
| 1991 | 63,771 | 409,152 | 66,282 | 2,511 | 451,515 | 73,145 | 9,374 |
| 1992 | 64,067 | 413,243 | 66,945 | 2,878 | 460,545 | 74,608 | 10,541 |
| 1993 | 64,365 | 417,375 | 67,614 | 3,249 | 469,756 | 76,100 | 11,735 |
| 1994 | 64,663 | 421,549 | 68,290 | 3,627 | 479,151 | 77,622 | 12,959 |
| 1995 | 64,964 | 425,765 | 68,976 | 4,012 | 488,734 | 79,175 | 14,211 |
| 1996 | 66,968 | 430,022 | 69,663 | 2,695 | 498,509 | 80,758 | 13,790 |
| 1997 | 67,271 | 434,325 | 70,360 | 3,089 | 508,479 | 82,374 | 15,103 |
| 1998 | 67,577 | 438,666 | 71,063 | 3,486 | 518,648 | 84,021 | 16,444 |
| 1999 | 67,883 | 443,052 | 71,774 | 3,891 | 529,021 | 85,701 | 17,818 |
| 2000 | 68,191 | 447,483 | 72,492 | 4,301 | 539,602 | 87,415 | 19,224 |

1 Total edible foodgrain production includes incremental production of land area estimated to be brought under improved technology as a result of road (see table A5). Incremental yield assumed to be 1030 kg/hectare. This is a realistic assumption since existing estimate of incremental yield range from 530 kg/hectare (Regional Analysis of Kosi Zone', CEDA/GDI, Kathmandu/Berlin, 1972) to 2730 kg/hectare ('Regional Development Study, Nepal,' CEDA, Kathmandu, 1975).

2 Population for 1981 was projected at 1% growth rate from 1970 population.

Source : Table A8

## TABLE : A10

### Estimated Saving in Road User's Charges Under Alternative Assumptions

| Period | Rate of growth of : (a) pop. 1% (b) imports 3%, & (c) exports 3% | | | Rate of growth of : @ pop.-2% (b) imports 5% & (c) exports-5% | | |
|---|---|---|---|---|---|---|
| | expected goods traffic (m. tons) | Savings @ Rs. 340/ ton (Rs '000) | Savings @ Rs. 210/ ton (Rs '000) | Expected goods traffic (m. tons) | Savings @Rs. 340 per ton (Rs '000) | Savings @ Rs. 210/ton (Rs '000) |
| 1981 | 19,811 | 6,736 | 4,160 | 19,811 | 6,736 | 4,160 |
| 1982 | 20,637 | 7,017 | 4,341 | 21,576 | 7,336 | 4,531 |
| 1983 | 21,159 | 7,194 | 4,443 | 23,427 | 7,965 | 4,920 |
| 1984 | 22,371 | 7,606 | 4,698 | 25,323 | 8,610 | 5,318 |
| 1985 | 23,258 | 7,908 | 4,884 | 27,291 | 9,279 | 5,731 |
| 1986 | 21,879 | 7,439 | 4,595 | 27,042 | 9,194 | 5,679 |
| 1987 | 22,468 | 7,639 | 4,718 | 29,158 | 9,914 | 6,123 |
| 1988 | 23,765 | 8,080 | 4,991 | 31,352 | 10,660 | 6,584 |
| 1989 | 24,738 | 8,411 | 5,195 | 33,629 | 11,434 | 7,062 |
| 1990 | 25,737 | 8,751 | 5,405 | 33,990 | 11,557 | 7,138 |
| 1991 | 25,236 | 8,580 | 5,300 | 36,918 | 12,552 | 7,753 |
| 1992 | 26,285 | 8,937 | 5,520 | 3 9,161 | 13,315 | 8,224 |
| 1993 | 27,359 | 9,302 | 5,745 | 42,102 | 14,315 | 8,841 |
| 1994 | 28,460 | 676 | 5,977 | 44,450 | 15,113 | 9,335 |
| 1995 | 29,589 | 10,060 | 6,214 | 46,856 | 15,931 | 9,840 |
| 1996 | 29,040 | 9,874 | 6,0 | 48,508 | 16,493 | 10,186 |
| 1997 | 30,224 | 10,276 | 6,347 | | 17,530 | 10,827 |
| 1998 | 30,915 | 10,511 | 6 ,492 | 54,722 | 18,605 | 11,492 |
| 1999 | 31,643 | 10,759 | 6,645 | 58,00 | 19,723 | 12,182 |
| 2000 | 33,400 | 11,356 | 7,014 | 60,919 | 20,712 | 12,793 |

Note : (1) Expected goods traffic includes imports+exports+food deficit.

(2) Calculation of savings per ton:

**Existing**: Opportunity costs of porter = Rs. 7.50/day.

Total distance = 25 Kms.

# of days per trip = 2

# of porters to carry one ton = 27. (@ 37·03 kg/porter).

Therefore, total cost per ton = Rs. 405·

**Vehicle operating cost**: (a) Extsting based on similar routes = Rs. 65/- (@ Rs. 1/ton Km.).

(b) Maximum possible = Rs. 195/- (@ Rs. 3/ton Km.).

Therefore alternate savings in user's cost = @ Rs. 340/ton (b) Rs. 210/ton.

Source for Expected traffic : Tables A7 and A9

## Table : A11

### Present Worth of Savings in Road User Charges Under Rate of Growth of Pop. 1%, of Imports 3% & of Exp. 3%

(Value in Rs '000)

| Period | Savings @ Rs. 340/ton | | | Savings @ Rs. 210/ton. | | |
|---|---|---|---|---|---|---|
| | Discount rate 5% | 10% | 15% | 5% | 10% | 15% |
| 1981 | 6,415 | 6,123 | 5,858 | 3,962 | 3,782 | 3,618 |
| 1982 | 6,364 | 5,799 | 5,306 | 3,937 | 3,587 | 3,263 |
| 1983 | 6,214 | 5,418 | 4,730 | 3,838 | 3,346 | 2,921 |
| 1984 | 6,258 | 5,195 | 4,349 | 3,865 | 3,209 | 2,686 |
| 1985 | 6,196 | 4,910 | 3,932 | 3,827 | 3,032 | 2,428 |
| 1986 | 5,551 | 4,199 | 3,216 | 3,429 | 2,594 | 1,986 |
| 1987 | 5,429 | 3,920 | 2,872 | 3,353 | 2,421 | 1,773 |
| 1988 | 5,469 | 3,769 | 2,641 | 3,378 | 2,328 | 1,632 |
| 1989 | 5,589 | 3,567 | 2,391 | 3,349 | 2,203 | 1,477 |
| 1990 | 5,372 | 3,373 | 2,163 | 3,318 | 2,084 | 1,336 |
| 1991 | 5,017 | 3,007 | 1,844 | 3,099 | 1,858 | 1,139 |
| 1992 | 4,976 | 2,847 | 1,670 | 3,074 | 1,759 | 1,032 |
| 1993 | 4,933 | 2,695 | 1,512 | 3,047 | 1,664 | 934 |
| 1994 | 4,888 | 2,548 | 1,367 | 3,019 | 1,574 | 845 |
| 1095 | 4,839 | 2,408 | 1,236 | 2,989 | 1,488 | 764 |
| 1996 | 4,523 | 2,148 | 1,056 | 2,793 | 1,327 | 652 |
| 1997 | 4,484 | 2,033 | 955 | 2,769 | 1,255 | 590 |
| 1998 | 4,367 | 1,891 | 849 | 2,697 | 1,168 | 525 |
| 1999 | 4,257 | 1,759 | 756 | 2,629 | 1,086 | 467 |
| 2000 | 4,280 | 1,688 | 694 | 2,042 | 1,644 | 429 |
| Total | 105.421 | 69,297 | 49,397 | 61.150 | 42,808 | 38,495 |

Source : Table A10

## Table : A12

### Present Worth of Savings in Road User Charges Under Rate of Pop. Growth 2%, Imports 5% and Exports 5%

| Period | Savings @ Rs. 340/ton | | | Savings @ Rs. 210/ton. | | |
|---|---|---|---|---|---|---|
| | Discount rate 5% | 10% | 15% | 5% | 10% | 15% |
| 1981 | 6,415 | 6,124 | 5,858 | 3,962 | 3,782 | 3,618 |
| 1982 | 6,654 | 6,062 | 5.547 | 4,110 | 3,744 | 3,426 |
| 1983 | 6,880 | 5,998 | 5,237 | 4 250 | 3,705 | 3,235 |
| 1984 | 7,083 | 5,881 | 4.923 | 4,375 | 3,632 | 3,041 |
| 1985 | 7,270 | 5,761 | 4,614 | 4,490 | 3,558 | 2,849 |
| 1986 | 6,861 | 5,190 | 3,975 | 4,238 | 3,206 | 2,455 |
| 1987 | 7,046 | 5,088 | 3,727 | 4,352 | 3,142 | 2,302 |
| 1988 | 7,215 | 4,973 | 3,485 | 4,456 | 3,071 | 2,152 |
| 1989 | 7,370 | 4,849 | 3,251 | 4,552 | 2,995 | 2,008 |
| 1990 | 7,095 | 4,455 | 2,857 | 4,382 | 2,752 | 1,765 |
| 1991 | 7,339 | 4,399 | 2,697 | 4,533 | 2,716 | 1,666 |
| 1992 | 7,414 | 4,242 | 2,489 | 4,579 | 2,620 | 1,537 |
| 1993 | 7,591 | 4,147 | 2,326 | 4,688 | 2,561 | 1,249 |
| 1994 | 7,634 | 3,979 | 2,135 | 4,715 | 2,458 | 1,319 |
| 1995 | 7,663 | 3,814 | 1,958 | 4,733 | 2,356 | ,209 |
| 1996 | 7,555 | 3,589 | 1,763 | 4,666 | 2,216 | 1,089 |
| 1997 | 7,648 | 3,467 | 1,629 | 4,724 | 2,142 | 1,006 |
| 1998 | 7,730 | 3,347 | 1,503 | 4,775 | 2,067 | 929 |
| 1999 | 7,804 | 3,225 | 1,387 | 4,820 | 1,992 | 856 |
| 2000 | 7,806 | 3,078 | 1,266 | 4,822 | 1,901 | 782 |
| Total | 146.073 | 91.668 | 62.627 | 90.222 | 56,616 | 38,493 |

Source : Table A10