

Economy-wide impact of a mineral project in a developing country: a graphic illustration

by G.D. Schena*

SYNOPSIS

The issue of evaluating the economic impact of large mineral projects in developing countries was studied by the use of econometric models.

The evaluating system is demonstrated by its application to an example from Namibia. Three-dimensional graphics are used to illustrate the procedures leading to an assessment of the economic effects of the mineral development.

The analysis allows the assessment of the overall economic consequences of mineral developments where there is a need to incorporate in the evaluation issues that are broader in scope than the pure financial objectives.

Sets of technical coefficients are exploited for the development of input–output models of the productive structure of an economy. The models are refined to incorporate country-specific behaviours. The increased flexibility of the enhanced semi-input–output model permits a more confident investigation of the economy-wide effects associated with a new project in the mineral sector of a developing country.

Synthetic measures of profitability at market and shadow prices are introduced, and the cost/benefit ratio is used to rank mineral projects according to their economic profitability.

The cost is the capital mobilized for the development of the project and for increasing the productive capacity of the related satellite industries. The benefits are identified with the economy-wide increase in value added induced by the project. Both costs and benefits are initially valued at market prices. Their ratio is likely to be an index of economic profitability superior to measures that concentrate exclusively on the benefit side of projects.

To allow for market distortions, the concept of shadow prices is introduced, and accordingly project-related costs and benefits are re-evaluated. A new cost/benefit ratio at shadow prices is recalculated, which is more meaningful to the policy-maker than decision-making based on socio-economic issues.

SAMEVATTING

Die kwessie van die evaluering van die ekonomiese impak van groot mineraalprojekte in ontwikkelende lande is met gebruik van ekonometriese modelle bestudeer.

Die evalueringstelsel word gedemonstreer deur die toepassing daarvan op 'n voorbeeld uit Namibië. Daar word van 3D-grafieke gebruik gemaak om die prosedures wat tot die bepaling van die ekonomiese uitwerking van die mineraalontwikkeling lei, te illustreer.

Die ontleding maak dit moontlik om die totale ekonomiese gevolge van mineraalontwikkelings te bepaal wanneer kwessies met 'n wyer omvang as die suiwer finansiële doelwitte by die evaluering ingesluit moet word.

Daar word 'n stel tegniese koëffisiënte gebruik vir die ontwikkeling van invoer–afvoermodelle van die produktiewe struktuur van 'n ekonomie. Die modelle word verfyn om landspesifieke gedrag in te sluit. Die groter buigsaamheid van die vergrote semi-invoer-afvoermodel maak dit moontlik om die uitwerking van 'n nuwe projek in die mineraalsektor van 'n ontwikkelende land op die hele ekonomie met meer vertroue te ondersoek.

Kunsmatige maatstawwe van winsgewendheid teen mark- en skadupryse word ingebring en die koste/voordeelverhouding word gebruik om die orde van mineraalprojekte volgens hul ekonomiese winsgewendheid te bepaal.

Die koste is die kapitaal wat vir die ontwikkeling van die projek en die verhoging van die produksievermoë van die verwante satelietbedrywe gemobiliseer word. Die voordele word geïdentifiseer met die toename in toegevoegde waarde dwarsdeur die ekonomie wat uit die projek voortspruit. Sowel die koste as die voordele word aanvanklik teen markparyse gewaardeer. Die verhouding tussen hierdie faktore is waarskynlik 'n beter indeks van die ekonomiese winsgewendheid as die maatstawwe wat uitsluitlik op die voordeelkant van die projekte konsentreer.

Die begrip van skadupryse word gebruik om vir markverwringing voorsiening te maak. Daar word 'n nuwe koste/voordeelverhouding teen skadupryse bereken wat meer betekenisvol vir die beleidmaker is by die neem van besluite wat op sosiaal-ekonomiese oorwegings gegrond is.

INTRODUCTION

Governments of developing countries with mineral potential need to channel their scarce financial resources to those mineral projects that hold out most promise in meet-

ing the goals of the nation. In doing so, governments may have allocation criteria that are quite different from those used in the private sector, where maximization of the monetary profit is often the guideline. In general, the contribution of a project to national development consists of money spent compensating the factors of production—labour and capital—and on paying taxes, royalties, and tariffs. However, in order to promote a possible investment in a developing country, a mining company may find it advantageous to consider the social consequences as well as the financial advantages.

* Department of Naval, Ocean, and Environmental Engineering, Division of Geo-resources and Environment, University of Trieste, 34127 Trieste, Italy.

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The socio-economic impact of large industrial projects is assessed by techniques that are used extensively for investments in the manufacturing sectors in developing countries¹⁻³. They are rarely applied to the mineral sector.

The advantages of such cost/benefit analyses are that they quantify the economy-wide implications of projects, and allow choices to be made on that basis rather than on a purely financial one.

This paper seeks to describe an enhanced method of cost/benefit analysis that has been developed from input-output (IO) techniques⁴⁻⁶ integrated with the concept of shadow pricing^{1,2,7}.

GENERAL BACKGROUND

The IO table for an economy illustrates the flow of goods and services between sectors of that economy over a period of time. The sectors included in the table are usually those making up domestic industries and services, and these are linked to labour inputs, personal and government consumption, and imports and exports. The relationships among the various sectors of an economy are illustrated in Figure 1.

All these transactions are recorded in value terms in the IO table of an economy. An example of a simplified IO table of a hypothetical country is shown in Figure 2, which reports only the transactions of the mineral industry.

Here the columns are the monetary values of the inputs to, and the outputs from, a sector. For the purposes of illustration, figures have been included for the mining industry, where it can be seen that the mining sector takes 10 units of input from the manufacturing sector (chemicals for instance), and pays its employees 10 units in wages and salaries. The mining output is taken up by other sectors and

as final demand, exports for instance. Hence the agricultural sector consumes some 15 units of the mining output, perhaps as fertilizer. Characteristic of IO tables for developing countries is that a significant proportion of the cells are empty because whole industrial sectors do not exist. Conversely, if the output of a sector is not used as input by other national sectors, then it ends up as final demand; in the case of mining, as exports. The total of all the inputs to a sector must equal the total of its outputs.

Namibia is an example of a developing country where the mineral sector plays an important role. A section of the IO table for Namibia is shown in Figure 3. Here the sectoral transactions (from and to industries and services) are collected in a single item termed 'total intermediate input'.

The 'total intermediate input' item is disaggregated in Figure 4, which shows the breakdown of the transaction among the sectors of the economy. Only the mining-related sub-set of the table is shown.

The figures were deduced from data derived⁸ to represent this economy in 1991. The complete IO table for Namibia is given in the Addendum.

THE INPUT-OUTPUT MODELS

The objective of the study described here was to investigate, in quantitative terms, the role of the mineral sector in economic growth. A model for the allocation of investments among sectors and projects has to be of an inter-industry type, combining the mineral sector with other productive sectors of the economy. The model must have the capacity to trace the effect of an investment in the mineral sector through the economy. For instance, the model has to be able to translate the effects on the economy of any

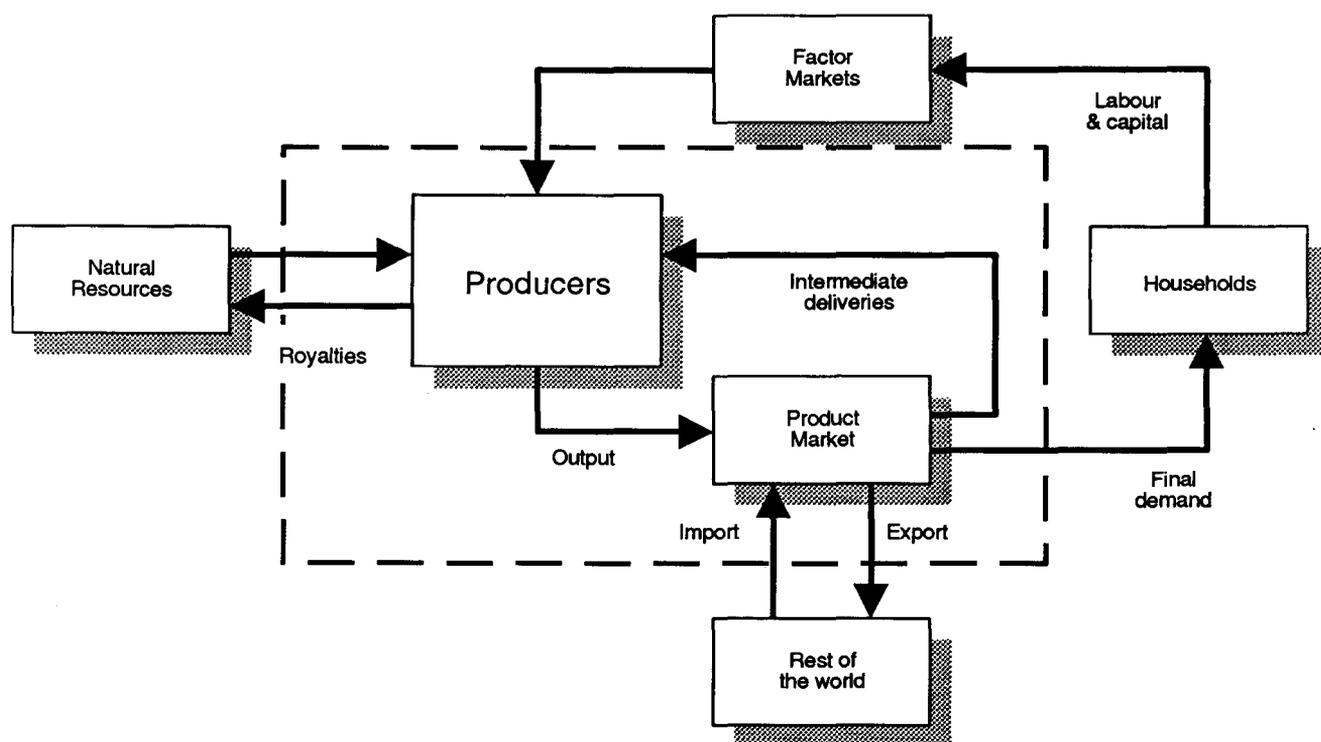


Figure 1—Schematic relationship between the sectors of an economy

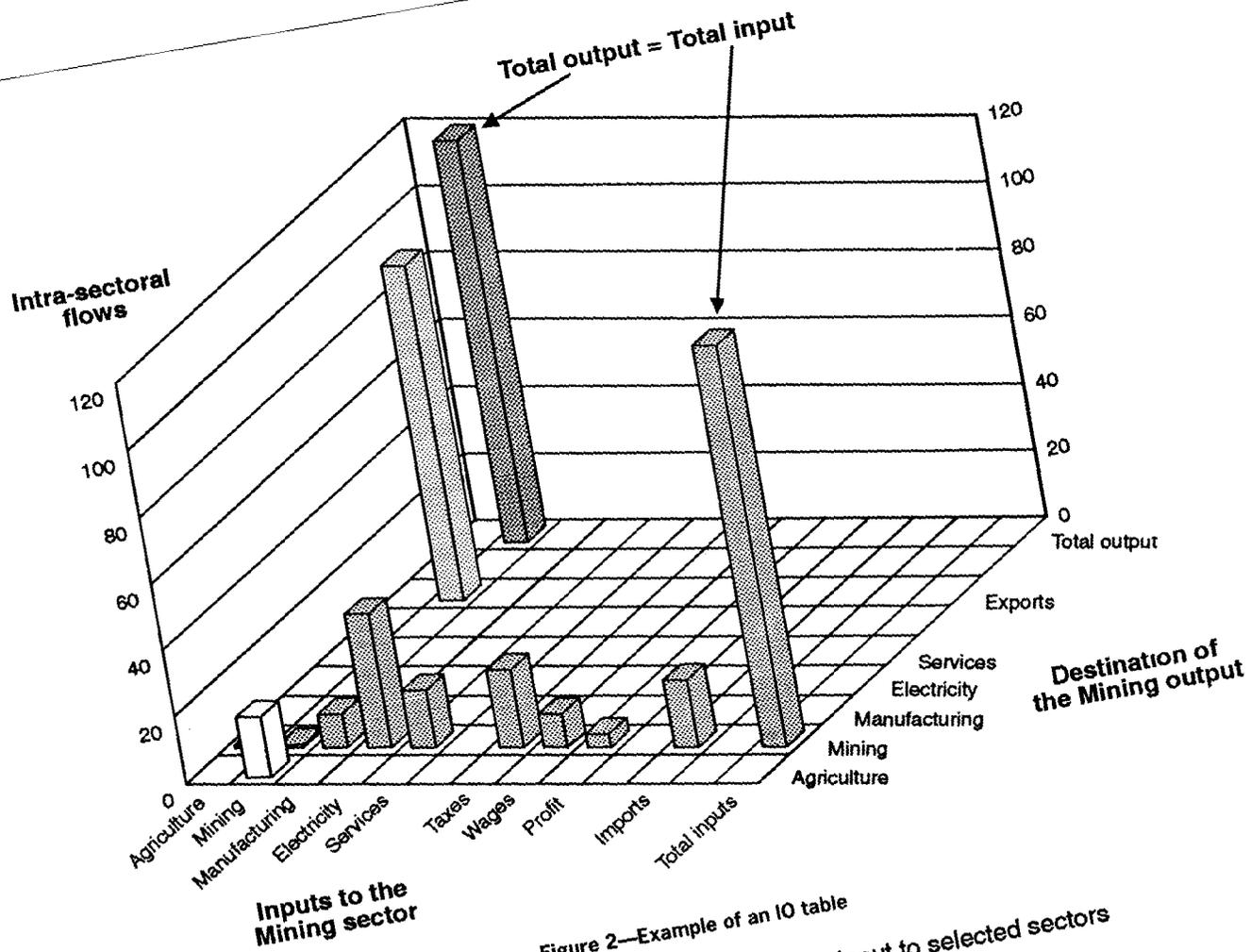
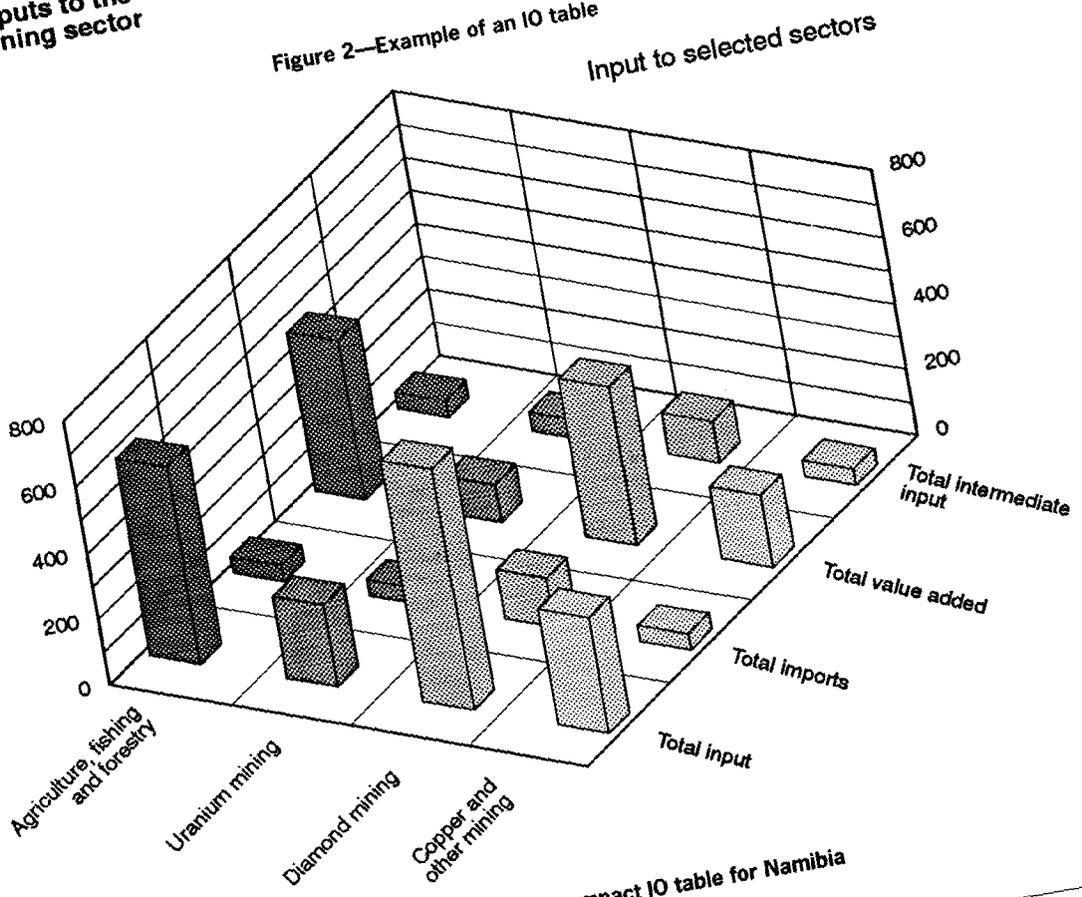


Figure 2—Example of an IO table



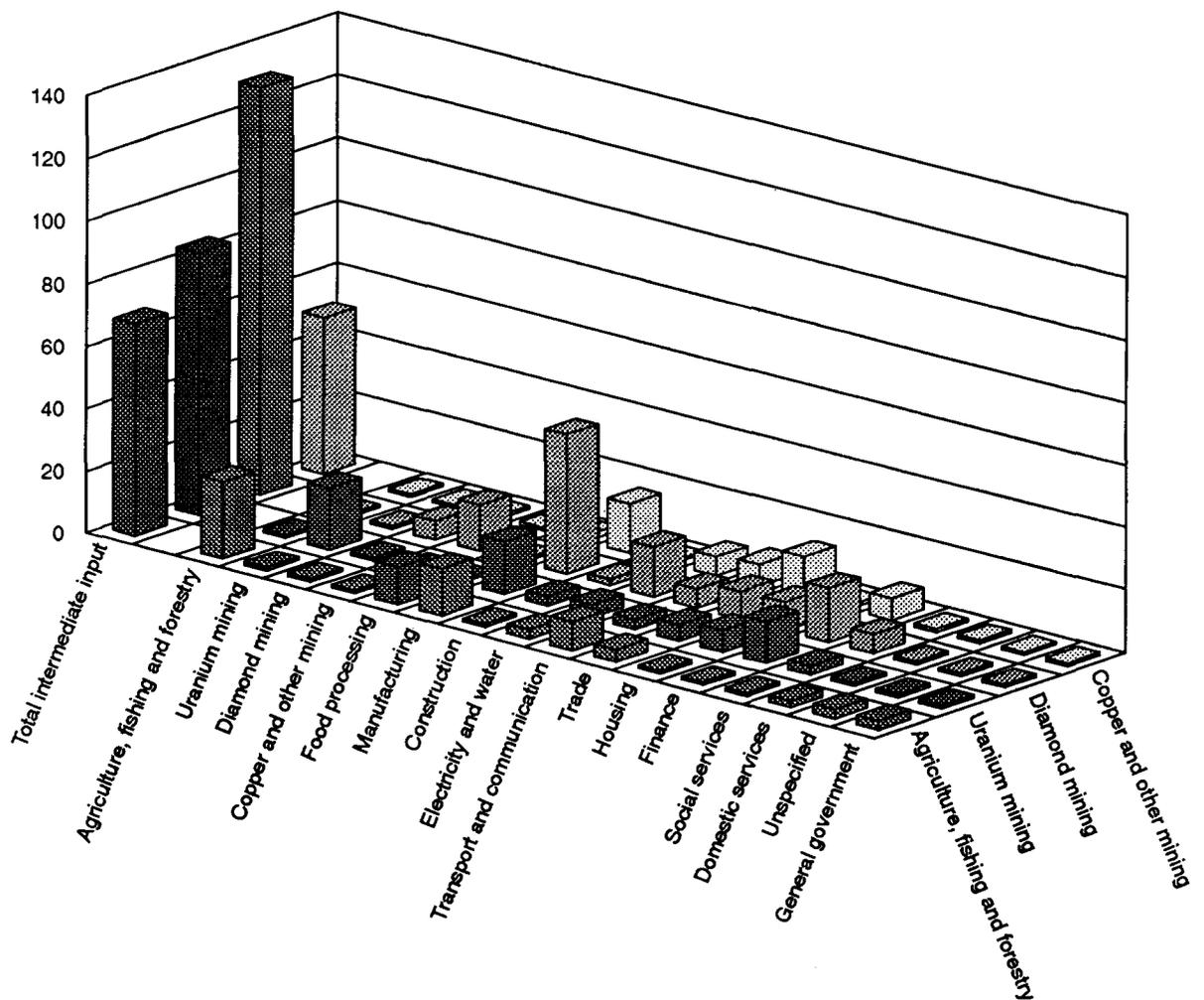


Figure 4—Inter-industrial transactions to selected sectors—Namibia

changes in final demand caused by increased exports from the mineral sector. This can be achieved through an analysis of the IO table.

The most important information contained within the IO table for Namibia is located within its inter-industry transaction quadrant. Let $W_{j,h}$ be the value of the absorption of goods from the sector j by sector h . As an example, the value of the electricity and water (8th sector in the table) purchased by the uranium industry (2nd sector) is \$ $4,1 \times 10^6$. Hence $W_{8,2} = 4,1 \times 10^6$, and the total value of the inputs that the uranium-mining sector absorbs from the other productive sectors is $\sum_j W_{j,2} = 73,2$ units. (Here 1 unit is taken to represent \$ 1×10^6 .)

However, the total input for the uranium sector, x_2 , is made up of 73,2 units of intermediate inputs plus 132,66 units of value added and 50,50 units cost of imports. This total is 256,4 units (these values are reported in the 2nd column of the Addendum).

Generally,

$$x_h = \sum_j W_{j,h} + V_h + M_h, \quad [1]$$

where V_h and M_h are respectively the value added and the imports of the sector, h .

This information can also be represented in terms of sums of deliveries from the sectors since the total inputs and total outputs of individual sectors must balance. Hence:

$$x_j = \sum_h W_{j,h} + F_j, \quad [2]$$

where F_j is the final demand for products from sector j , and is made up of components such as personal and government consumption and exports. For uranium, $F_2 = 238,6$, and is made up of exports of yellowcake only, there being no market for this product within the country.

In practice, IO tables are usually translated into a collection of coefficients known as the input-output technical coefficients, $a_{j,h}$. These are simply the proportion of column total that appears in a particular cell. For instance, for uranium mining, the technical coefficient regulating its relationship with the electricity and water sector is

$$a_{8,2} = 4,1/256,4 = 0,016.$$

Generally,

$$a_{j,h} = \frac{W_{j,h}}{x_h}, \quad [3]$$

and these dimensionless coefficients make possible a comparison between economies when the original data are in different currencies or of differing magnitudes.

The sum of all 16 productive sectors of the uranium industry column is

$$\sum_{j=1}^{16} a_{j,2} = 0,285.$$

Similarly, the coefficient for the value added is $V_2/x_2 = 132,7/256,4 = 0,517$, and the coefficient for imports is $M_2/x_2 = 50,5/256,4 = 0,197$. The sum of all the coefficients in a column of the technical coefficient matrix must add up to 1.

Once a set of constant technical coefficients has been established specifying the amount of goods, services, and production factors that one industry has to absorb per unit of its own output, the final mathematical structure of the model can be expressed as a set of linear equations, one for each producing sector or industry. They can be seen as accounting balance equations for each sector, and their collection as the balance equation of the entire economy.

The technical coefficients are average values for a range of industries within an industrial sector. When an IO model is used for marginal analysis, it is intrinsically assumed that these average values correspond to the marginal requirements at the existing level of production. This neglects any existing surplus industrial capacity.

The model uses the set of balance relations given by equation [2], which is the sum of the use made of the output of a sector by the other productive sectors and the final demand.

By use of the technical coefficients described in [3], equation [2] becomes

$$x_j = \sum_j a_{j,h} \cdot x_h + F_j. \quad [4]$$

This set of linear balance equations can be rewritten as

$$x = A_{NN} \cdot x + F, \quad [5]$$

where A_{NN} is the matrix of the technical coefficients, N rows and N columns (16 by 16 in the case of the Namibian table), and x and F are the vectors of output and final demand, respectively.

Relationship [5] can be rewritten as

$$x = [I - A_{NN}]^{-1} \cdot F, \quad [6]$$

where I is the unit matrix and $[I - A_{NN}]$ is the Leontief matrix.

This model can be used to assess the effect of specific changes in final demand, ΔF . The technical coefficients are assumed to remain the same when F is subjected to a perturbation and the changes in output Δx are calculated. ΔF propagates through the table framework, and its influence on the economy can be assessed by the magnitude of the changes in output. The exercise is referred to as impact analysis. When ΔF is unity, the values of Δx are output multipliers. Hence, in matrix terms, by differentiation of equation [6] with respect to x ,

$$\Delta x = [I - A_{NN}]^{-1} \cdot \Delta F, \quad [7]$$

and the total change in gross output for all the sectors is $\sum_h \Delta x_h$, $h=1, \dots, N$.

The k th column of the Leontief inverse, $[I - A_{NN}]^{-1}$, is the vector of output multipliers, Δx in equation [7], corresponding to a change in final demand, $\Delta F_k = 1$.

For the development of the numerical model used here, project benefits are identified with the increase in value added, measured in terms of change in domestic earning. Indeed, IO models provide a quick method of analysing the benefit side of sector appraisal.

The total change produced by ΔF in the value-added segment of the economy ΔY is then calculated by use of a value-added coefficient:

$$v_h = \frac{V_h}{x_h}. \quad [8]$$

Thus,

$$\Delta Y = \sum_h v_h \cdot \Delta x_h \quad h = 1 \dots N. \quad [9]$$

Similarly, the import coefficients are

$$m_h = \frac{M_h}{x_h}, \quad [10]$$

and the change in imports is

$$\Delta K = \sum_h m_h \cdot \Delta x_h \quad h = 1 \dots N. \quad [11]$$

If the level of employment in each sector is known, sectoral labour coefficients can be calculated as is done in equations [8] and [10] for value-added and import coefficients. Similarly, the employment impact as a result of an increased output can be derived as in equations [9] and [11]. However, modern mining and mineral processing are generally low labour-intensive, and a nation should not expect to extract major benefits from these activities in terms of wages and employment. An intelligent fiscal policy is the way to obtain benefits from the exploitation of mineral reserves.

The first four columns of output multipliers for Namibia are reported in Figure 5. They are related to a unitary change in final demand for output of the agricultural, uranium, diamond, and copper sectors respectively. A vertical logarithmic scale was used for ease of presentation, and one unit of increase in output is here taken as 10^5 .

This analysis can be demonstrated by increasing the final demand of the uranium sector of the Namibian economy by one unit, i.e. $\Delta F_2 = 1$ and $\Delta F_j = 0$ for $j \neq 2$. In effect, more yellowcake is exported. Using equation [7], we can calculate that a 1 unit change in F_2 generates a $\sum_h \Delta x_h = 1,38$ units of increase in total output. In other words, the total output increases from \$ 4255,5 million to \$ 4256,9 million.

The amount of the total increase in output that accrues to the other industries is $1,38 - 1,07 = 0,31$ units.

The amount of the total increase in output of the uranium sector, $\Delta x_2 = 1,07$, which is used up by other industries is 0,07 units, and the remaining unit goes to satisfy final demand.

On the primary input side, such a unitary initial increase in final demand results in a total increase in value added ΔY of 0,7 (equations 7, 8, and 9), and in an increase in imports of 0,3 units (equations 7, 10, and 11).

Out of the 0,7 units of increase in value added, the increase in wages and salaries is 0,2 units only. Hence taxes and profits account for the rest. These measures are also termed primary input multipliers.

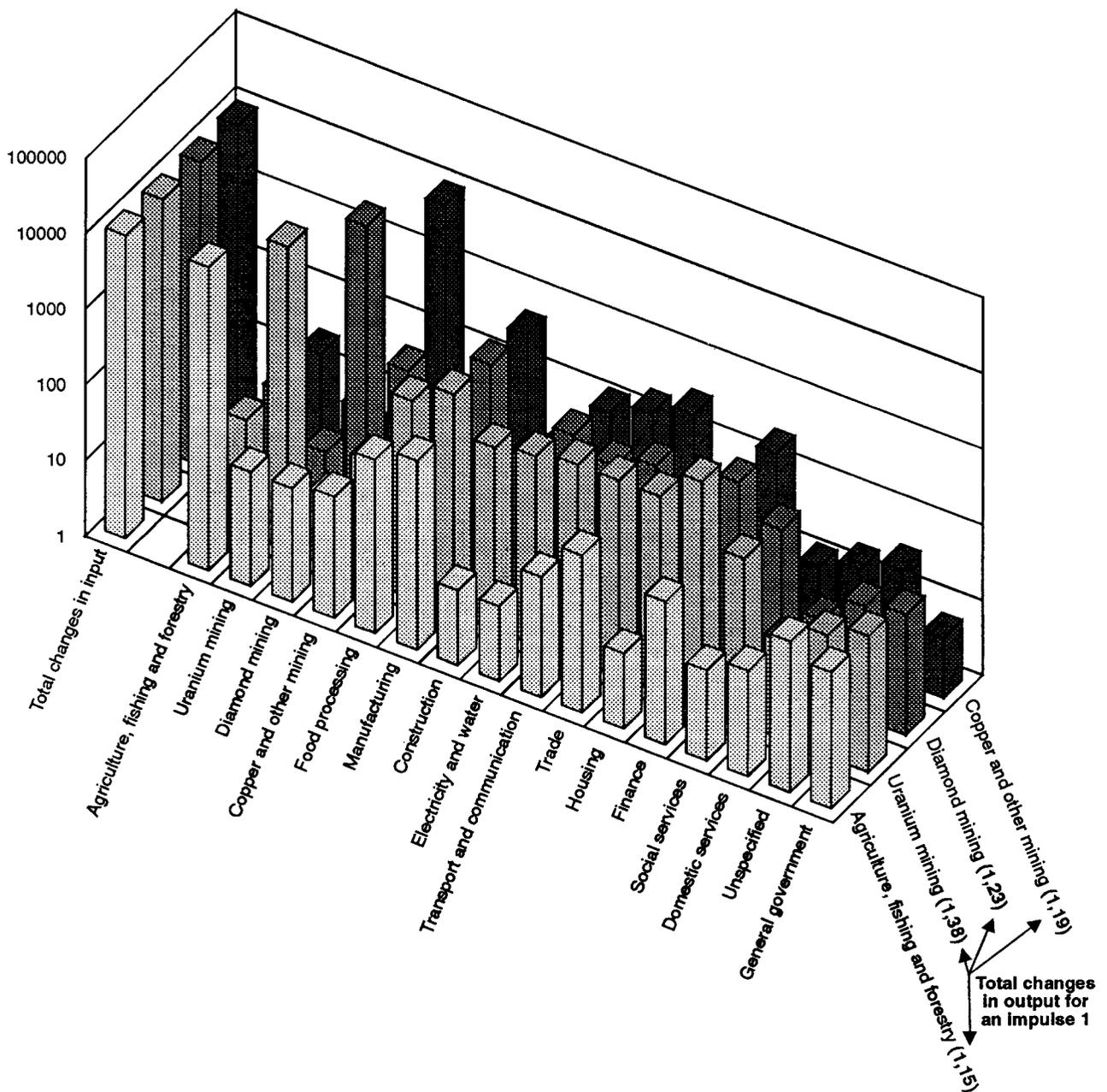


Figure 5—Economy-wide changes in output due to an expansion of one unit ΔF in selected sectors

The economic impact on wages and salaries can be directly assessed by the use of item-specific primary input coefficients rather than the total value-added figures. This breakdown can show the distribution of remuneration and benefits within the industry between social classes. A government could decide whether sufficient rewards were going to a particular group given an increase in uranium exports brought about by new investment. Item-specific input coefficients can be calculated as in equation [8] using the relevant value-added figure rather than the consolidated figures. Both consolidated and item-specific figures can be found in the IO table (Addendum).

It is evident that the consequences of an increase of 1 unit in uranium demand could be compared with investment in another sector: agriculture, fishing, or forestry for instance. Indeed, a ranking of all 16 sectors could be derived. The magnitude of the actual investment in any sector will depend on the current projects available and any targeting suggested by the agency providing investment funds.

Any new demand or 'push' to the uranium sector (or any sector) will involve increases in the output of supplying sectors, e.g. electricity and water, etc. This is called backward linkage, and provides a valuable planning tool.

For Namibia, the average value of the $\sum_j \Delta x_{js}$ due to expansions in final demand of $\Delta F = 1$ for each sector is 1,396. The so-defined backward linkage for the uranium sector is 0,988 (1,38/1,396), that for the agricultural and fishing sector is 0,822, that for the diamond-mining sector 0,88 and that for the copper-mining sector 0,85. According to these measures, the mining sectors impart the highest stimulus to the others, and are more deserving of investment than the agricultural sectors. Indeed, they offer more opportunities for suppliers—such as the electricity sector—requiring additional output from them.

This conclusion is reversed if one looks at the total value-added increases, which are 0,729 for uranium mining, 0,754 for diamond mining, 0,819 for copper mining, and 0,874 for the agricultural and fishing sector. If we look at only the

increase in tax collection, the appraisal of the three mineral goods sectors generates an extra income of 0,130, 0,134, and 0,146 units respectively, and the agricultural sector an extra income of 0,156 units. It can be concluded that, based on backward linkage measures, the mining industry is the one to which the government must give more consideration, but the agricultural sector is the one that contributes more to value added. Clearly, there are many answers to the question as to which sector is the most worthy of investment.

The analysis shows that there is no absolute ranking procedure, but 'dominant' mineral sectors can be identified by use of a particular multiplier. The final decision to expand a sector has to be based on a decision-making process that is more articulate than simple ranking according to multiplier values.

The criteria presented here for the allocation of scarce financial resources are quite different from those used in the private sector. The private entrepreneur would consider the revenues to be earned from the sale of ores and concentrates, compare these with operating costs at market prices, make allowances for taxation, and calculate the yearly operating margins. He would use discounted cash-flow techniques to establish synthetic values of profitability and would promote, for instance, the project with the highest positive net present value. His objective is the maximization of 'profit'. The method of analysis presented here allows the overall benefits that the project disseminates throughout the economy to be calculated, and is useful when the objectives are broader than purely financial ones.

In the development of the model, the assumption was made that the production of all the sectors will increase as a consequence of the extra demand resulting from the expansion of the mineral sector. For a number of reasons, this assumption may be quite inappropriate in a developing country. Therefore, using the complete IO model, one can over-estimate the real increase in output for all sectors, and as a consequence the related benefits. Indeed, the absolute need to expand production capacity exists only for those sectors producing goods and services that cannot be imported; that is, for the so-called 'national sectors', i.e. construction, banking, inland transportation, etc. The actual increase in domestic production may be less than that calculated with the complete IO method. In the next section, we present an enhancement to the model that allows for a country's trade behaviour.

THE SEMI-INPUT-OUTPUT FRAMEWORK

With the IO model, there is a danger of over-estimating the need to increase output from other sectors as a direct or indirect consequence of increased production in one of the mineral sectors. For instance, there may be no need to expand a sector producing goods that could be obtained by international trade, or sectors with surplus production capacity. It is therefore realistic to expect all the national sectors to expand fully, and some international sectors to expand only partially to meet part of the need for the extra output predicted, the remaining need being met by international trade. For instance, the increased need for electricity may be met by imports from a neighbouring country rather than by the provision of new generating capacity. The capital saved by not incrementing the productive capacity of the sectors engaging in trade can thus be allocated to more deserving uses. Moreover, in developing

countries, purchased by international trade often cost less than the same goods produced internally.

The semi-input-output (SIO) model^{9,10} can be used to calculate the production levels of the national sectors under the assumption that the production of the international sectors remains unchanged (except for the perturbation placed on an international sector for the purposes of manipulating the model).

In the following formal treatment of the model, the vectors and the matrices carry upper-case subscripts to indicate their order: N is the total number of sectors, I the number of international sectors, and N - I = D the number of national (domestic) sectors.

Under the assumptions of the full SIO model for the increase in output of the domestic expanding sectors due to a push in the kth international sector, we can write:

$$\Delta x_{mD} = [I - A_{DD}]^{-1} \cdot (A_{DK} \cdot \Delta x_k), \quad [12]$$

where Δx_{mD} is the vector of the extra output in the domestic expanding sectors and A_{DD} and A_{DI} are two of the sub-matrices of the complete matrix A_{NN} of the technical coefficients. A_{DI} is associated with the deliveries of the domestic sectors to the international ones, and A_{DK} is its kth column. Similarly, for the sub-matrix A_{DD} refers to deliveries from or to the domestic sectors.

Equation [12] for the SIO model corresponds to equation [7] for the full IO model.

Given these assumptions, the matrix to be inverted in the application of the SIO technique to impact studies ($\Delta x_k = \Delta F_k = 1$) is smaller than the complete Leontief matrix. It is only the square matrix $[I - A_{DD}]$ derived from the sub-matrix A_{DD} of complete matrix A_{NN} , where the delivering and receiving sectors are the domestic ones.

In applying the SIO model to the example of Namibia, we have assumed that the first six ($I = 6; j = 1 \dots I$) inter-industrial sectors of the table are international, and the remaining 10 are domestic ($N = I + D = 6 + 10 = 16; j = I + 1 \dots I + D$). Whether a particular sector is included in the international group often involves a subjective professional judgement. When a sector is definitely labelled international, the model recognizes that products from that sector required by other sectors will be provided by trade from abroad.

By the use of SIO model, it was found that the indirect domestic increase in output ($\sum_j \Delta x_j, j = I + 1 \dots N$) due to a ΔF_2 value of 1 in uranium mining is now 0,16 units. The total (direct plus indirect) inter-industrial increase in output ($\Delta x_2 + \sum_j \Delta x_j, j = I + 1 \dots N$) is therefore 1,16 units (Δx is seen as a column vector and the index j is used). This value can be compared with the 1,38 units of total increase ($\sum_j \Delta x_j, j = 1 \dots N$) predicted by the full IO model. The saving in domestic output has been met by extra imports. The components of the vector Δx_D , solution of the equation [12] for SIO analysis applied to the uranium sector, are given in Figure 6. For comparison, the values of the elements of Δx obtained from the full IO analysis are also reported. The stimulus ΔF was taken as 10^4 , and a logarithmic scale was used for the graphical representation.

It can also be calculated that the other mineral sectors, diamonds and copper, have a total (direct plus indirect) generated output of 1,105 and 1,112 respectively, and rank better than the agricultural sector, to which a value 1,04 is associated. The total increases in output calculated from the

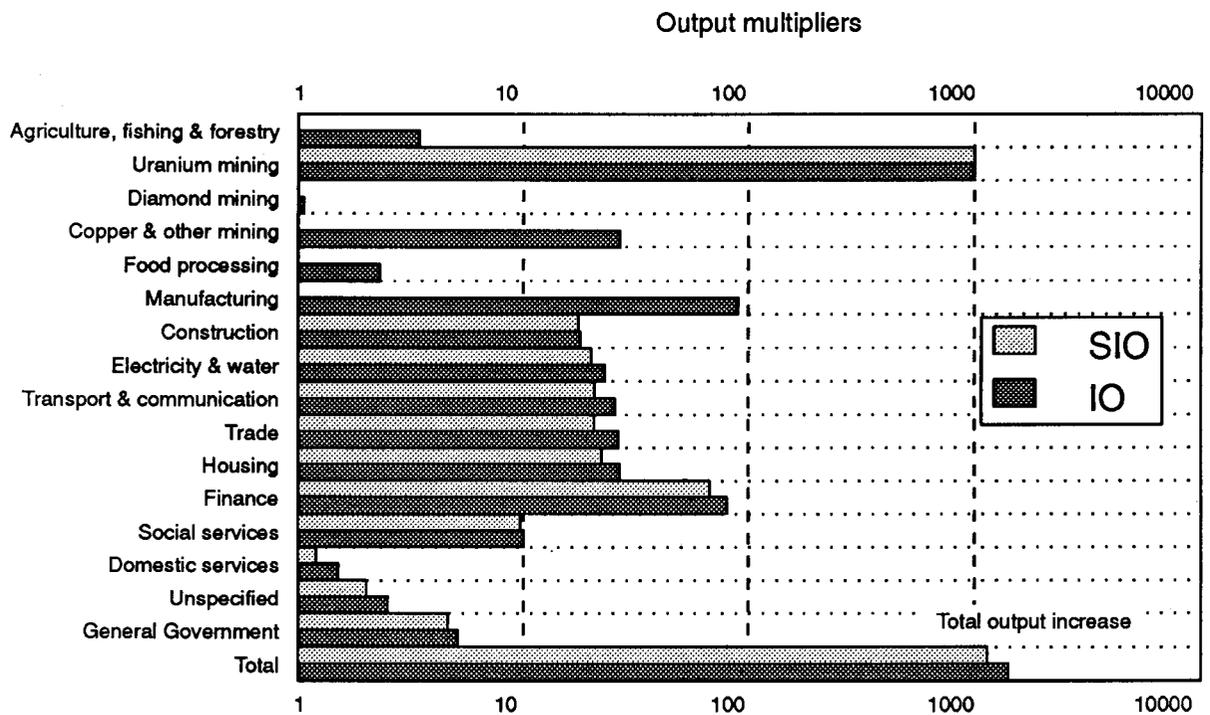


Figure 6—Breakdown of the output multipliers for an investment in the uranium sector calculated with the IO and SIO models

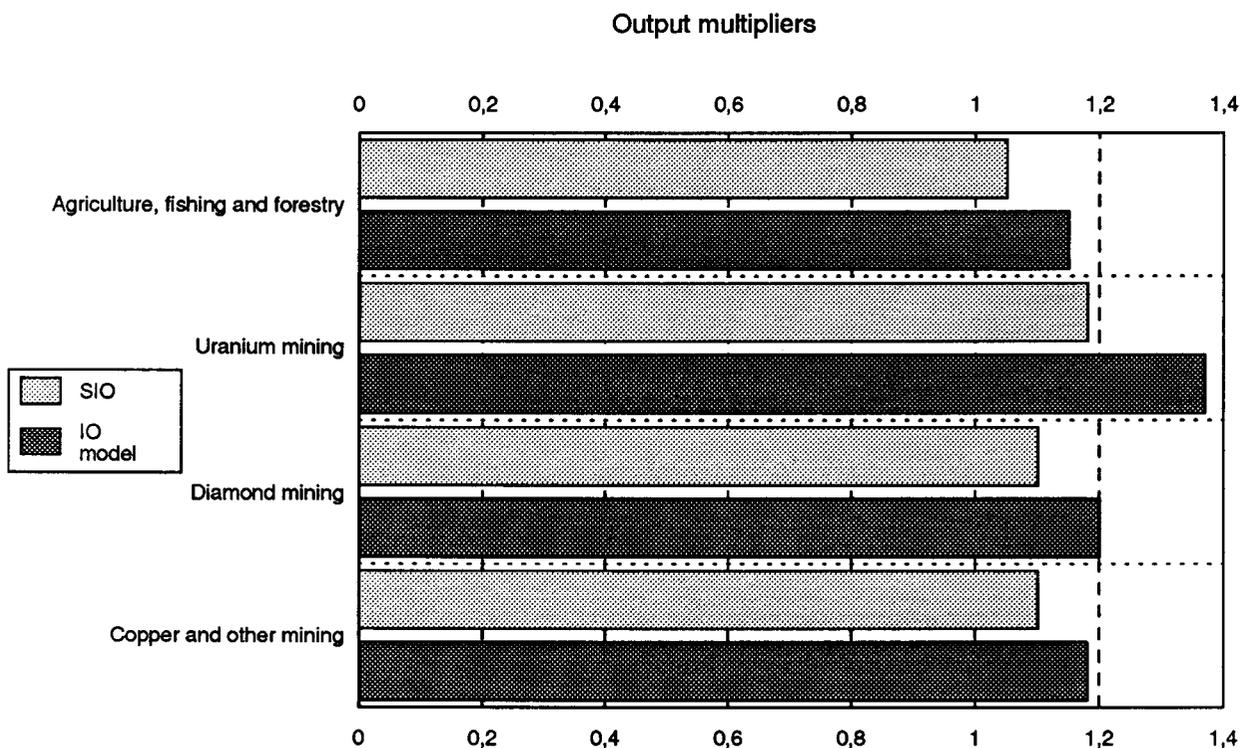


Figure 7—Total output multipliers for an investment in the uranium sector calculated with the IO and SIO models

SIO analysis for selected sectors are compared to the corresponding values derived from the full IO model in Figure 7.

The equation for the changes in total value added corresponding to the SIO model can be written as

$$\Delta Y = \sum_h y_h \cdot \Delta x_h \quad h = k, I + 1 \dots N. \quad [13]$$

Equation [13] indicates that the benefits of the project can be traced as the sum of the change in value added in the appraised international sector (the kth), plus the value-added change due to the related compulsory expansion of the domestic sectors. For the uranium sector, the total value-added increase is 0,62. For the full IO model, the

same unitary initial increase in final demand resulted in a total increase in value added of 0,73 units.

For the full IO model, the changes in imports were calculated from equation [11]. The calculated value of the change in imports, ΔK , for the appraisal of the uranium sector ($\Delta F_2 = 1$) was 0,27 units. The changes were also calculated for the diamond- and copper-mining sectors, and for the agricultural sector. The respective values were 0,25, 0,18, and 0,13. Hence, with the full IO model, the copper-mining sector is seen to be the least import-intensive among the mining sectors.

According to the SIO model, the intermediate deliveries that are not met by the expansion in output of the international sector must be met by means of expansion in imports. The original import coefficient matrix has to be modified to describe the effect of an increased involvement in trade to meet the need for international products¹¹.

To account for the extra imports in the SIO model, the original row of import input coefficients, m_h from equation [10], is augmented by adding, row-by-row, the coefficients of the upper international part, A_I , of A_{NN} . Indeed, the import to satisfy the total need arising from the expansion of the k th mineral sector has two components. The first is calculated from the original m_h coefficients given by equation [10], and is often termed the 'anyway' imports component. The second component accounts for the 'extra' imports needed to remedy the non-expansion of the domestic sectors.

Given the assumption of the SIO model that the extra output requirement for international goods generated by the mineral project is met by imports from abroad, and continuing with the example developed for the uranium sector, we calculated that ΔK is 0,38. The value of ΔK calculated previously by the aid of the full IO model was 0,27 units. The total ΔK value for the diamond sector is 0,30, which can be compared with that previously calculated at 0,25 units. For the copper sector the value is 0,21 as against 0,18 units. For the agricultural sector, the value calculated is 0,19, and that calculated using the full IO model was 0,13. The values of imports ΔK calculated with the IO and compared with the corresponding values derived from SIO analysis show that the copper-mining sector is still the least import-intensive of the mining sectors¹².

If the complete IO model can lead to an over-estimation of the domestic output because it does not incorporate any mechanism allowing for change in trade behaviour, the SIO model takes an opposite, but more sensible, position allocating to imports all the demand for international products.

The multiplier and linkage analyses concentrate on the benefits related to the project; they completely neglect the cost side. Therefore, they do not offer a robust ranking for selecting the most favourable projects given the constraints over the capital availability under which the economy of a developing country has to work. To improve the criteria for project ranking and selection, one has to weight the investment outcomes against the investment costs.

PROJECT-RELATED COSTS

The costs are the total capital requirements. These are the sum of the investment directly related to the development of the mineral project (in the k th international sector of the economy) and the investment necessary to adapt the other expanding domestic sectors (the h th sectors) to the new requirements brought about by the mineral project.

Calculations were carried out with the help of sectoral capital/gross-output coefficients c_h , expressing the amount of capital needed for a unit expansion of the sector output capacity. The total cost can be expressed as

$$C = \sum_h c_h \cdot \Delta x_h, \quad [14]$$

where $h = k, I + 1 \dots N$, and the values of Δx_h are calculated using the SIO model; $c_k \cdot \Delta x_k$ and $\sum_h c_h \cdot \Delta x_h$, where $h = I + 1 \dots N$, are the direct and the indirect cost elements respectively.

Hence, if Δx_8 is the value of the extra electricity required when the demand of the uranium sector increases by 1 unit ($\Delta F_2 = 1$), then c_8 is the factor that translates this requirement into the cost of providing the extra electricity.

The value calculated from equation [14] is the cost of purchases of capital goods only, in the form of the output from other sectors that is needed to bring the project into operation. It should be noted that wages and taxes are not considered to be 'costs' in this type of analysis. They are of benefit to the national economy.

For industrial countries, values for c_h are available [13]. However, for emerging nations, there is generally little valuable information, or the existing data are not readily available². In the case of Namibia, values of c_h could not be obtained, and data deduced from other sources were utilized. The capital output coefficients that were assumed are reported in Figure 8. The total investment, C , required to meet a one-unit increase in the uranium-sector output is therefore 3,304 (equation [14]). Within this total cost, the cost of the expansion in the uranium industry is $c_2 \cdot \Delta x_2 = 3,0 \cdot 1,0$ units.

Finally, C can be interpreted as the units of capital needed for an annual earning of one unit of foreign exchange at current prices from export of the output; all the project output is yellowcake for export, and ΔF was taken as 1 in this analysis. The imports calculated from the SIO analysis were 0,38 units per unit of output, which brings the gross foreign earnings per unit of export to 0,62 ($= 1,0 - 0,38$) units.

The uranium column in the IO table shows that, from a strictly financial point of view, an average investment in the uranium sector has a very long payback period, making the project unattractive for the profit maximizer. Indeed, the profit-related coefficient calculated from the value-added quadrant is 0,055 ($0,055 = (1,75 + 12,27) / 256,36$) and $C = 3$. Further analysis would show that the sector is unattractive also from a broader economic point of view.

PROJECT-INDUCED BENEFITS

The benefits from an expansion in demand clearly last over the entire lifetime of a project, and may persist even longer. The sectoral estimates of the productive period, T_h (in years), of an investment used for the application example developed here are reported on the right-hand side of Figure 8.

Finally, the benefits disseminated over time were reduced to present value by the use of a time discount rate, r , of 0,12 and summed. A simplified model was used, implying that all the investment is made at year zero, but production will start and reach full capacity at year 4, extending in each sector up to the year $4 + T_h$.

For an investment in uranium mining ($T_k = T_2 = 15$ years), the direct value added, ΔV_2 , is 0,513, and the corresponding

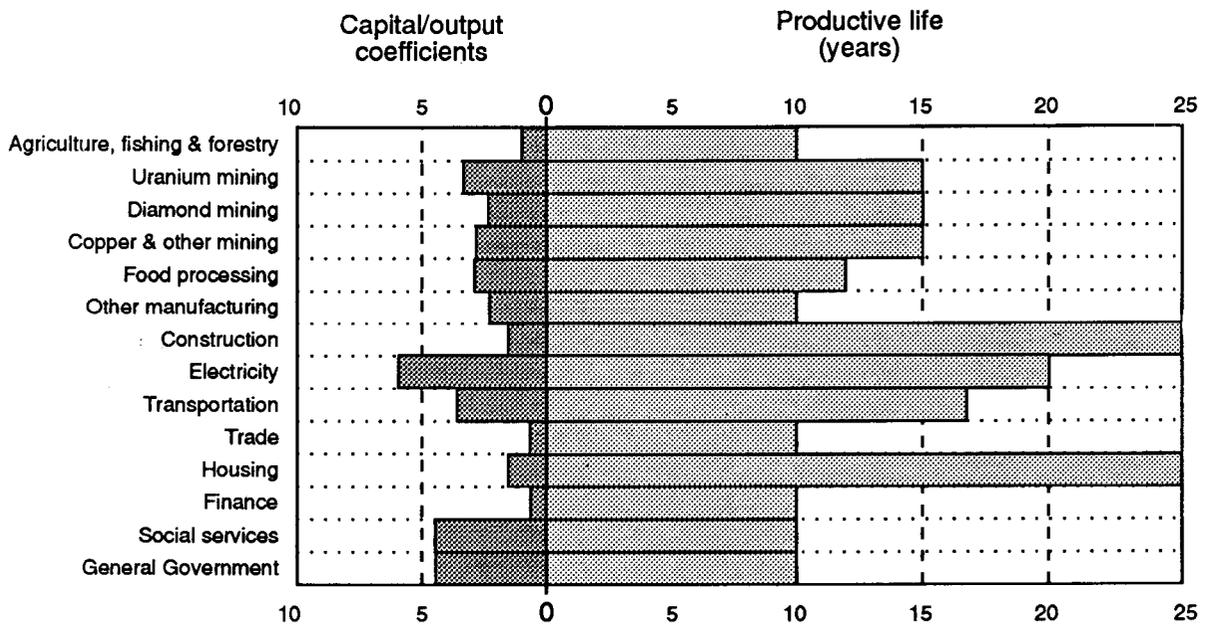


Figure 8—Capital output coefficients and productive life of sectoral investment

time accumulated benefits are 2,227 units. They are direct benefits because they accrue to the expanded sector.

The total present value of the benefits derived from an investment in the uranium-mining sector distributed throughout the economy is the sum of the present value of the benefits arising in each of the 16 Namibian sectors:

$$B = \sum_{h=1}^{16} B_h, \quad [15]$$

where $h = k, I + 1 \dots N$.

The total project-induced change in value added is 0,62 units. The direct and indirect contributions are respectively 0,513 and 0,103 units.

The total present value of the benefits deriving from an investment in the uranium-mining sector distributed throughout the economy is 2,711 units, the sum of a direct component B_2 of 2,227 units and an indirect one of 0,484 units.

If we break down the benefits into their destinations (known as G-group components), we can write

$$B = \sum_g B^{(g)} \quad [16]$$

where $g = 1 \dots G$ and $B^{(g)}$ is the portion of the benefit B accruing to the g th earning group.

For example, out of the 2,711 units of benefit arising from the increase in value added, those captured by income tax are 0,065, and those taken by taxing proprietaries are 0,418. Wages paid account for 0,751 units.

So far, we have allowed for the total benefits related to the mineral project ($B = B_0$). They accrue from the time the project starts functioning in year 4 up to the end of its life, and embody the indirect benefits arising in all the expanding sectors from year 4 and extending up to the end of the full-productive-capacity year, $T_h + 4$. In trying to identify all the benefits that the project spreads throughout the economy, we can also add the benefits arising during the project commissioning (B_1).

The total benefits are

$$B = B_1 + B_0. \quad [17]$$

The following reasoning can lead to an estimate of B_1 . The cost of the project as defined here is essentially made up of capital mobilized for its implementation. The capital is used to purchase capital goods, that is sectoral output, for a total value of 3,30 units. These intra-sectoral outputs purchased to prepare the project for operation in year 4 themselves generate benefits. A yearly economy-wide project-related output of 1,16 gives an overall value-added (ΔY) contribution of 0,62 units; so we can estimate that an output of capital goods of 3,30 contributes to the value added in the same ratio, i.e. 1,77 units. If we imagine this project-implementation-related contribution to be distributed equally during years 1 to 3, and discount it using $r = 0,12$, we get 1,414, which is then added to 2,711 units of discounted benefits, bringing the benefit value up to 4,125 units.

COST/BENEFIT RATIOS

The cost and benefit items give rise to the synthetic cost/benefit ratios (C/B).

The ratio obtained relating the sole direct costs for appraising the sector—i.e. neglecting all the indirect costs—to the sole direct discounted benefit arising from the uranium project is

$$\frac{c_2}{B_2} = \frac{c_2}{\Omega_2 \cdot \Delta V_2} = \frac{3}{2,227} = 1,35,$$

where

$$\Omega_2 = \sum_{y=4}^{T_2+4} (1+r)^{-y}$$

is the cumulative discount factor for the change in value added, ΔV_2 .

When the indirect elements of the cost and benefit items are included, and the SIO model is used to calculate the size of the induced sectoral expansions, then

$$\begin{aligned} \frac{C}{B} &= \frac{C}{\sum_h \Omega_h \cdot \Delta V_h} \\ &= \frac{3,3}{2,711} \\ &= 1,22, \end{aligned}$$

where Ω_h is the cumulative discount factor for the benefits arising from sector h , ΔV_h .

The C/B that would have been obtained in an isolated evaluation of the project is some 12 per cent higher than the one that accounts also for indirect costs and benefits, thus tending to suggest that the project is less profitable than it actually is.

The values of C/B in this case are above 1 and suggest that, within the accuracy of the data, Namibia should restructure its fiscal policy to obtain more benefits and reduce the ratio to less than 1. Moreover, no allowance was made for the component of value added accruing through profits to the foreign owner, which is transferred abroad with no benefit for the country. The attractiveness of the project would be reduced further if this feature were taken into account.

The C/B of 1,22 could be reduced to less than 1 either by the granting of investment aid (for example, if some 0,20 per cent of the total 3,3 investment units were granted to Namibia, the C/B would be less than 1), or by the addition of the benefits encountered during project implementation, $B_1 = 1,414$, to those occurring during operations, $B_0 = 2,711$, to yield

$$\begin{aligned} \frac{C}{B_1 + B_0} &= \frac{3,3}{4,125} \\ &= 0,80. \end{aligned}$$

This makes the project considerably more attractive.

The C/B can be seen as the capital needed for one unit of increase in value added; its inverse is the yield to the economy of one unit of capital. The ratio is likely to be an index of economic profitability superior to measures that concentrate on the benefit side of the projects only, but is still capable of improvement.

SHADOW PRICING

In developing countries, the prices of goods and services are often distorted by taxes and price controls. Such distortions also exist in developed economies, but they are likely to be more severe in emerging nations, which try to protect their economies. As an example, traded goods can be bought and sold subject to tariffs and subsidies, and import and export quotas can restrict their availability.

In developing countries, these protective measures are often a result of poor management and poor policies. Different sectors may receive different degrees of protection, and this may occur without rational economic justifications: a global approach to tariff policy is rarely used. Protection for infant industries may be advisable when other means of stimulation are inadequate. Conversely, free trade may lead to countries producing only minerals in which they have an

international comparative advantage. Often the natural endowment of developing countries is very diversified, but some mineral sectors need protection to allow competition in the early stages of development with well-established international rivals. For a developing country, these are good reasons for encouraging a diverse economy and achieving long-term policy objectives rather than maximizing real national income by free trade. If properly designed, the protection of the mineral industry may make the economy work in a manner more conducive to society's benefits than would a *laissez-faire* commercial policy.

By the same arguments, the prices of non-traded goods that have import components can be distorted. Prices of factors can also be distorted by minimum wages, subsidies, and poorly designed compensation schemes. The result is that the set of domestic market prices do not reflect the real value of commodities and factors to the society, and they are of no relevance for the social appraisal of projects. In an effort to remedy this, economists use shadow prices.

The shadow price of goods or services, as opposed to the market price, is by definition its real value to society—i.e. the contribution made to social welfare by the availability of one extra unit of the goods. The difference between market and shadow prices is determined by the constraints on the availability of resources, and by the controls enforced on the market to attain the political development objectives. In other words, shadow prices depend on market distortions—i.e. on deviations from a perfect competitive market behaviour.

The UNIDO Method for Shadow Pricing

The United Nations Industrial Development Organization (UNIDO) has proposed a method for the shadow pricing of capital for investment and the revaluation of project-related benefits according to the earning group¹⁴. Today the UNIDO guidelines are very well established and widely used.

In general, the establishment of a set of shadow prices requires the specification of a welfare function, against which the social benefits related to the availability of an extra unit of goods, services, and resources are measured. By suitable selection of the objective function, the shadow prices can be measured directly.

The UNIDO method does not resort to economy-wide models for the purpose of shadow pricing, and is therefore referred to as a short-cut method. The method establishes a standard against which cost and benefit are evaluated. This standard or 'yardstick' is called *numeraire*. The UNIDO method assumes aggregate consumption in domestic currency as *numeraire*. Hence, the national objective is the maximization of the aggregate consumption benefits. We have found the UNIDO method very appropriate for the improvement of the cost-benefit ratios previously calculated at market prices.

The concept of shadow prices is better understood if we think of them as a measure of scarcity. As an example, the judgement that saving is more valuable than consumption is a reason for shadow pricing (one unit of) capital targeted to investment and setting its value greater than unity, $P^{inv} > 1$. Indeed, saving allows investments and determines higher future growth.

The use of the UNIDO *numeraire*, P^{inv} , is the present value of the consumption stream generated by one unit of marginal investment.

The UNIDO guidelines¹⁴ express the shadow price of investment as

$$P^{inv} = \frac{(1-s) \cdot q}{i - s \cdot q}, \quad [18]$$

where s , q , and i are three values that must be estimated for the economy as a whole. They are respectively the economy-wide marginal propensity to save, the marginal productivity of capital, and the social rate of discount¹⁵. In many developing countries, these values are made available by local development-planning offices.

The benefits that accrue to the diverse groups affected by the project (wage earners, profit earners, government, etc.) have different social values. According to the UNIDO guidelines, the social value, U_g , of a unitary benefit that accrues to the g th group is

$$U_g = (1 - s_g) \cdot 1 + s_g \cdot P^{inv}, \quad [19]$$

where s_g is the group's marginal propensity to save¹⁶. The $(1 - s_g)$ proportion of a unit of benefit is diverted by the receiving group to consumption and is weighted 1 with respect to the consumption *numeraire*; the rest, s_g , is saved and goes to investments, which are weighted P^{inv} in the same *numeraire*.

Cost/Benefit Analysis at Shadow Prices

To develop the Namibian example, the following national parameters were used: $s = 0,3$, $q = 0,2$, $i = 0,1$. The resulting shadow price of investment is $P^{inv} = 3,5$ (equation [18]). This shadow price is used to revalue the cost of investment ($C = 3,3$) originally calculated at market prices (equation [14]) and generate its shadow cost $C^s = 3,5 \cdot 3,3 = 11,55$ units. This high cost of investment reflects the difficulty of providing capital in Namibia.

For the purposes of our application, we have used our model to calculate the total benefits in terms of added value generated during the life of the project, and to discount and accumulate them at the same time horizon using $i = 0,1$. The discounted value was found to be 3,24 units. We allocated the 0,1 fraction of the total value added as calculated above to factor payments abroad, 0,28 to government receipts by taxation, and 0,62 to the payment of wages and salaries.

The wages and salaries accrue to the labour force. This is made up by low-income local unskilled workers, with a propensity to use their income primarily for consumption, and by expatriate workers contributing little to Namibia as most of their benefits are remitted abroad. For the overall wage-earning group we considered a low propensity to save $s_{wkr} = 0,2$. Thus, by equation [19],

$$U_{wkr} = (1 - s_{wkr}) \cdot 1 + s_{wkr} \cdot P^{inv} = 1,5.$$

We assumed that, at the margin, the Namibian government is ready to devote a substantial part of the available funds collected by taxation of the mineral project to investment ($s_{gov} = 0,65$). This is to avoid large backlogs in capital work and investment requirements in the mineral sector. Such a behaviour implies a social value,

$$U_{gov} = (1 - s_{gov}) \cdot 1 + s_{gov} \cdot P^{inv} = 2,625,$$

for their benefits.

The payments abroad to foreign personnel and the foreign ownership profits flowing out of Namibia do not bring any benefit to the country; hence $U_{abr} = 0$.

The total benefits at shadow prices can be recalculated using different weights for the different groups to which they accrue:

$$B^s = B \cdot (0,62 \cdot U_{wkr} + 0,28 \cdot U_{gov}) = 1,68 \cdot B.$$

These lead to the following expression for the C/B at shadow prices:

$$\frac{C^s}{B^s} = \frac{C}{B} \cdot \frac{P^{inv}}{0,62 \cdot U_{wkr} + 0,28 \cdot U_{gov}} = 2,09 \cdot \frac{C}{B}.$$

The C/B at market prices discounted at $r = i = 0,1$ is 0,701 (lower than the value of 0,80 previously calculated using $r = 0,12$) and gives rise to the following ratio at shadow prices:

$$\frac{C^s}{B^s} = \frac{2,09 \cdot C}{B_1 + B_0} = \frac{2,09 \cdot 3,3}{1,46 + 3,243} = 1,467.$$

This ratio shows that the analysis at shadow prices makes the project less attractive than it was at market prices. To be profitable at shadow prices, a project requires a minimum C/B at market prices of 0,478 ($2,09 \cdot 0,478 = 1,0$), and our analysis shows that a new project in the uranium-mining sector is not economically profitable at either market or shadow prices. Figure 9 shows the C/B calculated according to different assumptions.

CONCLUSIONS

The method presented permits the economic appraisal of mineral sectors. The economy-wide impact of large mineral projects, or multiple medium- and small-scale investments, in a given sector can be measured in broad economic terms rather than simply in financial terms.

The procedure synthesizes the consequences of increased investment in the mining industry with cost/benefit ratios. A refined method derived from the classical full input-output models traditionally used for multiplier analysis is employed as a tool for deriving costs and benefits related to the investment rather than for project ranking. The introduction of shadow pricing calculated according to the consumption *numeraire* enhances the analysis. Indeed, the originality of the procedure lies in the integration of classical impact analysis with cost/benefit ratios via shadow pricing. Classical procedures for sectoral studies confine themselves to multiplier analysis. Traditional methods of project evaluation focus on costs and benefits directly related to the project, and tend to neglect the economy-wide (indirect) element of these items. The framework presented allows for a straightforward calculation of both the direct and indirect components. Shadow pricing is rarely employed, and the case study developed offers a practical example that illustrates its utilization.

The method has the advantage of allowing a quick ranking of the sectors. The basic information used for the develop-

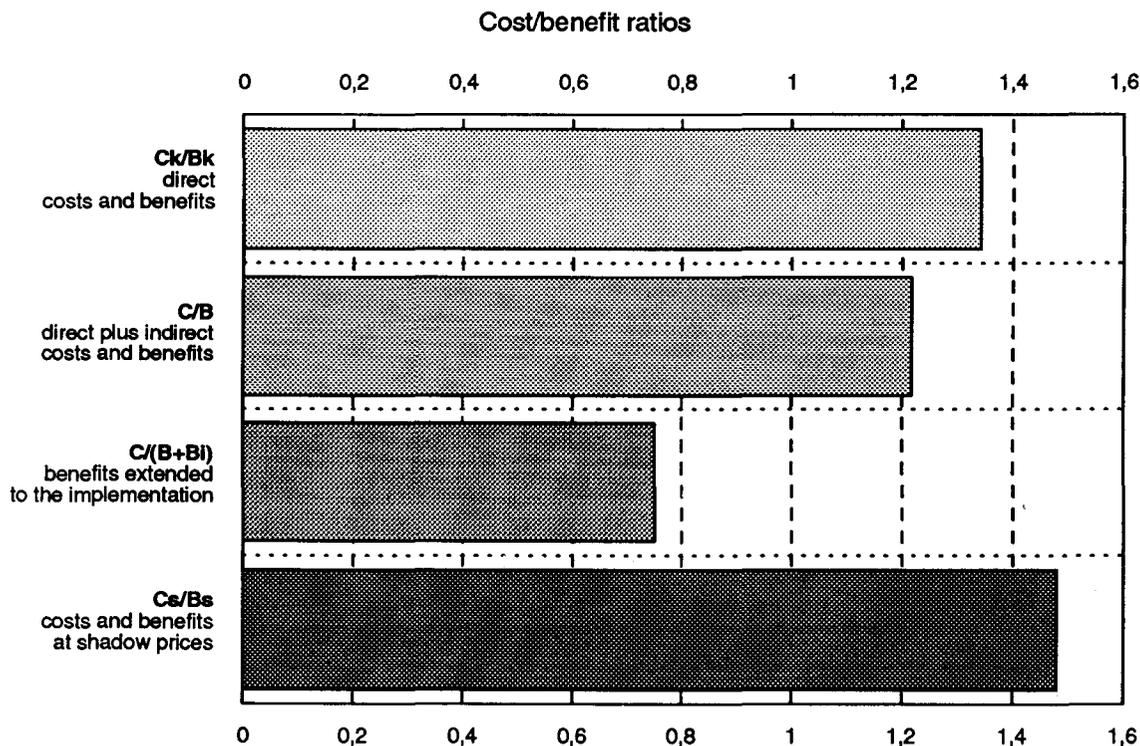


Figure 9—Cost/benefit for an investment in the Namibian uranium industry

ment of the model presented is extracted from IO tables and therefore is quite aggregated; local site- and project-specific conditions are not included in the analysis. Indeed, once the most promising mineral sectors are selected for expansion, all the available projects within these sectors need to be scrutinized more closely by the use of traditional project-evaluation procedures. In the appraisal with traditional project-evaluation techniques, there is no limit to the inclusion of project-specific conditions and consequences. In fact, the method presented here does not replace the traditional methods of economic feasibility, but allows a screening of mineral sectors that produces a ranking based on the capacity of an average mineral project within the sector to contribute to social welfare.

LIST OF SYMBOLS

$1 - s_g$	Marginal propensity for group g to consume
A_{DD}	Matrix of technical coefficients for deliveries from or to domestic expanding sectors
A_{DI}	Matrix of technical coefficients for deliveries from domestic to international sectors
$a_{j,h}$	Technical coefficient calculated in values terms
A_{NN}	Matrix of technical coefficients of rank N
B	Present value (p.v.) of project benefits
$B^{(g)}$	p.v. of benefits accruing to the g th earning group
B_h	p.v. of benefits related to V_h
B_I	p.v. of benefits related to project development
B_O	p.v. of benefits related to project operation
B_s	p.v. of shadow benefit
C	Project cost
c_h	Consolidated capital output coefficient for sector h
C^s	Shadow value of investment cost

D	Number of domestic expanding sectors
F	Vector of final demand
F_j	Final demand for sector j output
G	Number of groups to which benefits accrue
g	Group destination index
I	Number of international sectors
i	Social rate of discount ($0 - 1,0$)
K	Total inter-industrial imports
k	Index of the international sector undergoing SIO analysis
M_h	Total value of imports of sector h
m_h	Import coefficient for sector h
N	Number of industrial sectors
P^{inv}	Shadow price of capital targeted to investment
q	Marginal productivity of capital
r	Financial rate of discount ($0 - 1,0$)
s	Economy-wide marginal propensity to save
s_g	Marginal propensity to save for group g
T_h	Productive period of an investment in sector h
U_g	Shadow price 1 unit benefit accruing to group g
V_h	Total value added by sector h
v_h	Value added coefficient for sector h
$W_{j,h}$	Sales from sector j to sector h
x	Vector of total gross output
x_D	Domestic part of the vector x of total gross output
x_h	Gross input of sector h
x_I	International part of the vector x
x_j	Output of sector j
Y	Total value added
y	Year index
Δ	First-order differential operator describing changes
Ω_h	Cumulative discount factor for $V_h : B_h = \Omega_h \cdot V_h$

ADDENDUM: INPUT-OUTPUT FOR NAMIBIA (US\$ 1 000 000), after Torries, et al.⁸

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	Total intermediate output	Total final demand	Total gross output
Agriculture, fishing, and forestry	22,03	0,03	0,00	0,03	47,00	2,97	0,11	0,00	0,00	0,78	0,00	0,00	3,48	0,00	3,83	80,25	522,39	602,64
Uranium mining	0,00	17,71	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	17,71	238,64	256,35
Diamond mining	0,00	0,00	4,85	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,85	723,78	728,63
Copper and other mining	0,00	6,35	13,66	0,00	0,00	3,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	23,91	311,00	334,91
Food processing	10,74	0,02	0,04	0,89	13,42	3,33	1,11	0,13	1,84	2,19	0,47	1,52	4,89	0,49	7,19	48,26	187,11	235,37
Manufacturing	12,87	14,67	43,40	14,77	3,87	29,91	29,12	0,67	17,79	6,10	4,75	8,44	1,61	5,10	8,91	201,98	55,16	257,14
Construction	0,00	2,79	2,50	0,65	0,37	0,21	21,71	0,00	0,24	0,52	4,50	4,79	0,00	0,00	16,51	54,79	280,37	335,16
Electricity and water	2,00	4,10	14,30	4,77	1,05	1,41	0,56	0,63	1,45	1,07	0,88	0,43	0,44	0,46	2,36	35,88	4,84	40,72
Transport and communication	8,68	3,37	4,89	5,86	10,29	11,55	9,54	0,45	23,22	8,72	1,25	6,11	3,90	3,28	19,68	120,80	157,87	278,67
Trade	2,69	3,91	7,79	12,22	0,13	12,08	18,08	0,45	11,61	4,19	2,82	1,27	0,39	4,51	3,72	85,87	257,26	343,13
Housing	0,00	4,96	8,00	0,21	0,57	0,82	1,57	0,00	3,38	9,16	1,83	3,47	2,02	0,80	0,65	37,43	59,02	96,45
Finance	0,00	11,52	17,44	6,09	12,73	17,79	15,81	1,73	12,25	31,73	4,50	21,21	11,19	4,72	11,65	180,36	90,59	270,95
Social services	0,00	2,23	6,21	0,27	0,24	0,30	0,67	0,00	3,33	0,82	0,00	0,48	0,37	0,00	3,55	18,44	100,79	119,23
Domestic services	1,50	0,11	0,27	0,41	0,13	0,00	1,00	0,00	7,58	0,52	0,47	1,02	0,00	0,41	3,01	16,42	55,40	71,82
Unspecified	2,55	0,33	1,05	0,64	-1,98	0,56	3,46	0,00	1,05	0,22	0,74	0,16	0,12	0,39	2,31	11,61	-11,61	0,00
General government	2,49	1,09	2,15	0,13	0,16	0,14	1,46	0,00	0,30	0,22	0,00	0,16	0,00	0,53	1,42	10,25	274,12	284,37
Total intermediate input	65,56	73,20	126,52	46,94	87,97	84,94	104,19	4,07	84,05	66,24	22,22	49,06	28,40	20,69	84,79	948,81	3306,73	4255,54
Native household	10,50	2,92	10,06	5,27	2,50	1,75	3,00	0,75	3,00	5,50	1,25	4,25	1,75	0,75	3,50	56,77		
Native wage and salary	44,12	12,27	42,26	22,15	10,50	7,35	12,61	3,15	12,61	23,11	5,25	17,86	7,35	3,15	14,71	238,45		
Native profit	6,30	1,75	6,04	3,16	1,50	1,05	1,80	0,45	1,80	3,30	0,75	2,55	1,05	0,45	2,10	34,06		
Expatriate wage and salary	88,24	24,55	84,52	44,30	21,01	14,71	25,21	6,30	25,21	46,22	10,50	35,72	14,71	6,30	29,41	476,90		
Expatriate profit	44,12	12,27	42,26	22,15	10,50	7,35	12,61	3,15	12,61	23,11	5,25	17,86	7,35	3,15	14,71	238,45		
Income tax	11,35	3,16	10,87	5,70	2,70	1,89	3,24	0,81	3,24	5,94	1,35	4,59	1,89	0,81	3,78	61,32		
Tax on proprietors	73,53	20,45	70,43	36,92	17,51	12,26	21,01	5,25	21,01	38,52	8,75	29,76	12,26	5,25	24,51	397,42		
Other value added	198,74	55,28	190,37	99,79	47,32	33,12	56,78	14,20	56,78	104,10	23,66	80,44	33,12	14,20	66,25	1074,16		
Total value added	476,90	132,66	456,80	239,44	113,55	79,48	136,26	34,06	136,26	249,80	56,77	193,03	79,48	34,06	158,97	2577,53		
Total imports	60,18	50,50	145,30	48,52	33,86	92,72	94,71	2,59	58,37	27,09	17,45	28,86	11,34	17,07	40,61	729,19		
Total input	602,63	256,36	728,62	334,90	235,38	257,14	335,16	40,72	278,68	343,13	96,45	270,95	119,23	71,82	284,36	4255,53		

SOURCE: TORRIES, T., ROSE, A., AND CHIA-YON CHEN. Mineral project selection and economic development: the case of Namibia. *Mater. Soc.*, vol. 12, nos. 3-4, 1988, pp. 263-294.

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BOOK Review

Caring for the earth

by D.J. van Niekerk

Caring for the Earth: South Africa—A strategy for sustainable living, by John Yeld. Southern African Nature Foundation in partnership with the World Conservation Union. Soft cover. Tel.: (02231) 72801.

The publication of *Caring for the Earth—South Africa* is a significant step in the follow-up to *Caring for the Earth*—the parent document which was published in 1991 by IVCN, UNEP and WWF—published by the South African Nature Foundation in partnership with the World Conservation Union (IUCN).

A golden thread runs through this most stimulating book: 'South Africans must now undertake the difficult task of rehabilitating those eco-systems that have been seriously degraded, and conserving those that remain healthy and productive'.

According to author the ultimate goal is a global sustainable society, which can be achieved by applying the following nine principles for sustainable living:

- respect and care for the community of life
- improve the quality of life

- conserve the Earth's vitality and diversity
- minimize the depletion of non-renewable resources
- keep within the Earth's carrying capacity
- change personal attitudes and practices
- enable communities to care for their own environments
- provide a national framework for integrating development and conservation
- create a global alliance.

The author expands the argument by suggesting suitable priority actions for each of the nine principles.

Part 2 of the book discusses areas where additional actions for sustainable living is required. These include land, energy, water agriculture, forestry, population, growth, marine resources, the coastal zone, urbanization, environmental education, mining, commerce and industry, and alien invasives, as well as individual action.

The author concludes with recommendations as to how strategy should be implemented with specific reference to funding the transition to sustainability.