EAI

Outline of the Proposed
Methodology for the Estimation
of the Socio-economic Benefits
of MSAT

Econanalysis
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Outline of the Proposed
Methodology for the Estimation
of the Socio-economic Benefits
of MSAT

Report Number 3

of

The Overall Socio-economic

Impact Study of the MSAT Program

prepared by

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for the

Department of Communications
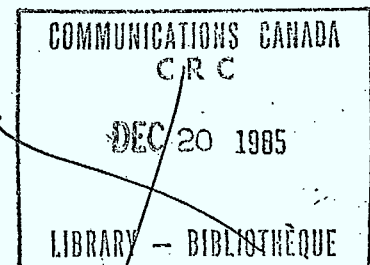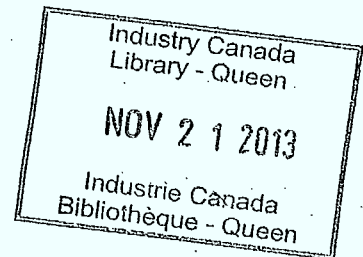
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PRELIMINARY OUTLINE OF THE METHODOLOGY

FOR THE SOCIO-ECONOMIC IMPACT OF MSAT

SUMMARY

This is the third milestone report of the "Overall Socio-Economic Impact Study of the MSAT Program." It provides a preliminary description of the proposed methodology for estimating the economic benefits and costs of the MSAT program and for determining the magnitude of direct government financial assistance for MSAT that can be justified on economic efficiency grounds. This report also provides a summary of the theoretical rationale underlying the computer-based framework that is outlined in Report Number 4 entitled "Preliminary Outline of the Proposed Data Base System and Economic Model for the Estimation of the Socio-Economic Impacts of MSAT".

The first section of the Report examines the interrelationships between incremental cash flows to total capital, economic externalities and the estimation of economic benefits and costs. With respect to cash flows for commodity outputs and inputs, a tradeable/nontradeable classification is introduced. Tradeable commodities are further disaggregated into importable and exportable commodities, whereas the demand for or supply of nontradeable commodities is classified as either incremental or nonincremental. This commodity classification determines which externalities are taken into account. The markets for MSAT services and MSAT-related equipment are used to illustrate the different estimation procedures. There is also a brief discussion of the problem created by the average cost pricing of MSAT services; it will likely result in the underestimation of MSAT's economic benefits. With respect to other economic costs Section 1 contains a brief description of the externalities associated with labour, capital (both domestic and foreign), grants, subsidies and taxes, foreign

exchange, and the cost of abnormal risk. The economic attractiveness of the MSAT program can be measured by the NPV of its overall net economic benefits, discounted by a social discount rate.

Section 2 presents a detailed specification of the economic variables and equations used to estimate the economic benefits and costs and their associated externalities. The material presented in Table 2.1 corresponds to that in Table 1.1 of Report Number 4. For a description of the reasoning that underlies the equations reference can be made to either the indicated chapters in "The Manual for the Analysis and Appraisal of Industrial Projects in Canada" by John C. Evans et al. or to Appendix 2 of the Statement of Work for the Overall Socio-Economic Impact Study.

Section 3 of the Report summarizes a broad set of principles that can be used to determine the magnitude of direct government financial assistance for MSAT. The MSAT program introduces a new twist to the basic methodology since it allows for the possibility that although financial assistance may be both warranted and needed, the NPV of the net economic externalities, which is the maximum amount of financial assistance non-investors would willingly offer to private investors, may not be sufficient to yield them a normal return. This situation would likely require a combination of financial instruments to resolve. The various instruments will be reviewed in Report Number 8.

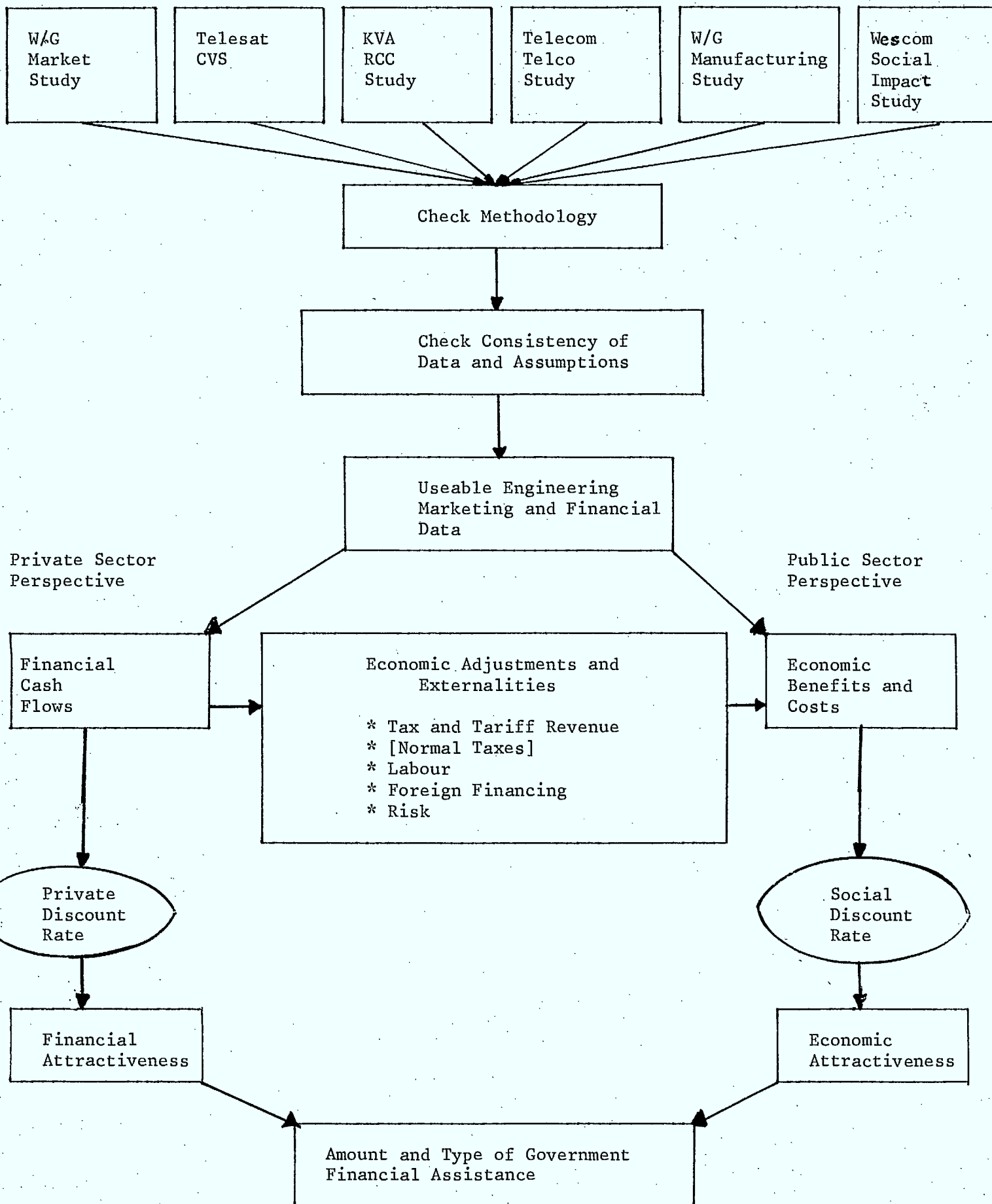## 1.0 OVERVIEW OF THE SOCIO-ECONOMIC BENEFIT STUDY METHODOLOGY

1.1 INTRODUCTION

The purpose of this section is to present an integrated analytical framework within which the financial and economic assessment of MSAT can be performed. The framework is based on an economic cost/benefit analysis methodology that has been developed for Canadian applications by Professors Glenn Jenkins and John Evans in conjunction with a number of departments in the Government of Canada.[1] The overall framework and the steps required to assess the MSAT project are summarized in Figure 1.1.

The overall socio-economic assessment of the MSAT project relies on a number of other studies for detailed marketing, engineering and financial data. The first task is to check the methodology, data and assumptions used by the other contractors to ensure not only their consistency but also their conformity to the overall socio-economic appraisal methodology. A preliminary review of the other contractors studies was contained in our Report Number 2 entitled: "Review of Other Contractors' Reports, Related Memoranda, Potential Problems and Study Gaps of the MSAT Project". This report identified a number of inconsistencies between the various studies that will need to be resolved before a useable set of marketing engineering and financial data is available for further analysis.[2]

The incremental cash flows from Telesat's Commercial Viability Study, KVA's RCC Impact Study, Telecom's Telco Assessment Study, and Woods Gordon's Manufacturing Impact Study provide the basic building blocks for the financial and economic analysis of

Figure 1.1
Overview of the MSAT Appraisal Framework

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┌──────────┐ ┌──────────┐ ┌──────────┐ ┌──────────┐ ┌──────────────┐ ┌──────────┐
│ W/G      │ │ Telesat  │ │ KVA      │ │ Telecom  │ │ W/G          │ │ Wescom   │
│ Market   │ │ CVS      │ │ RCC      │ │ Telco    │ │ Manufacturing│ │ Social   │
│ Study    │ │          │ │ Study    │ │ Study    │ │ Study        │ │ Impact   │
│          │ │          │ │          │ │          │ │              │ │ Study    │
└──────────┘ └──────────┘ └──────────┘ └──────────┘ └──────────────┘ └──────────┘
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Check Methodology

Check Consistency of Data and Assumptions

Useable Engineering Marketing and Financial Data

Private Sector Perspective

Public Sector Perspective

Financial Cash Flows

Economic Adjustments and Externalities

* Tax and Tariff Revenue
* [Normal Taxes]
* Labour
* Foreign Financing
* Risk

Economic Benefits and Costs

Private Discount Rate

Social Discount Rate

Financial Attractiveness

Economic Attractiveness

Amount and Type of Government Financial Assistance

MSAT. The net present value (NPV) of the incremental net cash flow, calculated using a private discount rate, serves as the basis for assessing MSAT's financial attractiveness for each of the participants. However, in order to measure a project's attractiveness from a public perspective, the financial cash flows must be modified to take account of a number of economic adjustments and externalities. The NPV of the resulting economic benefits and costs, calculated using a social discount rate, provides a measure of economic attractiveness. Thus, the economic cost/benefit analysis of MSAT requires (a) accurate and consistant financial data, and (b) a correct specification and estimation of the economic externalities associated with each phase of the overall project.

The economic adjustments and externalities are examined in some detail in Section 2. In Section 3 we show how the results of the financial and economic analyses can be combined to determine the amount of government financial assistance that can be justified on economic grounds.
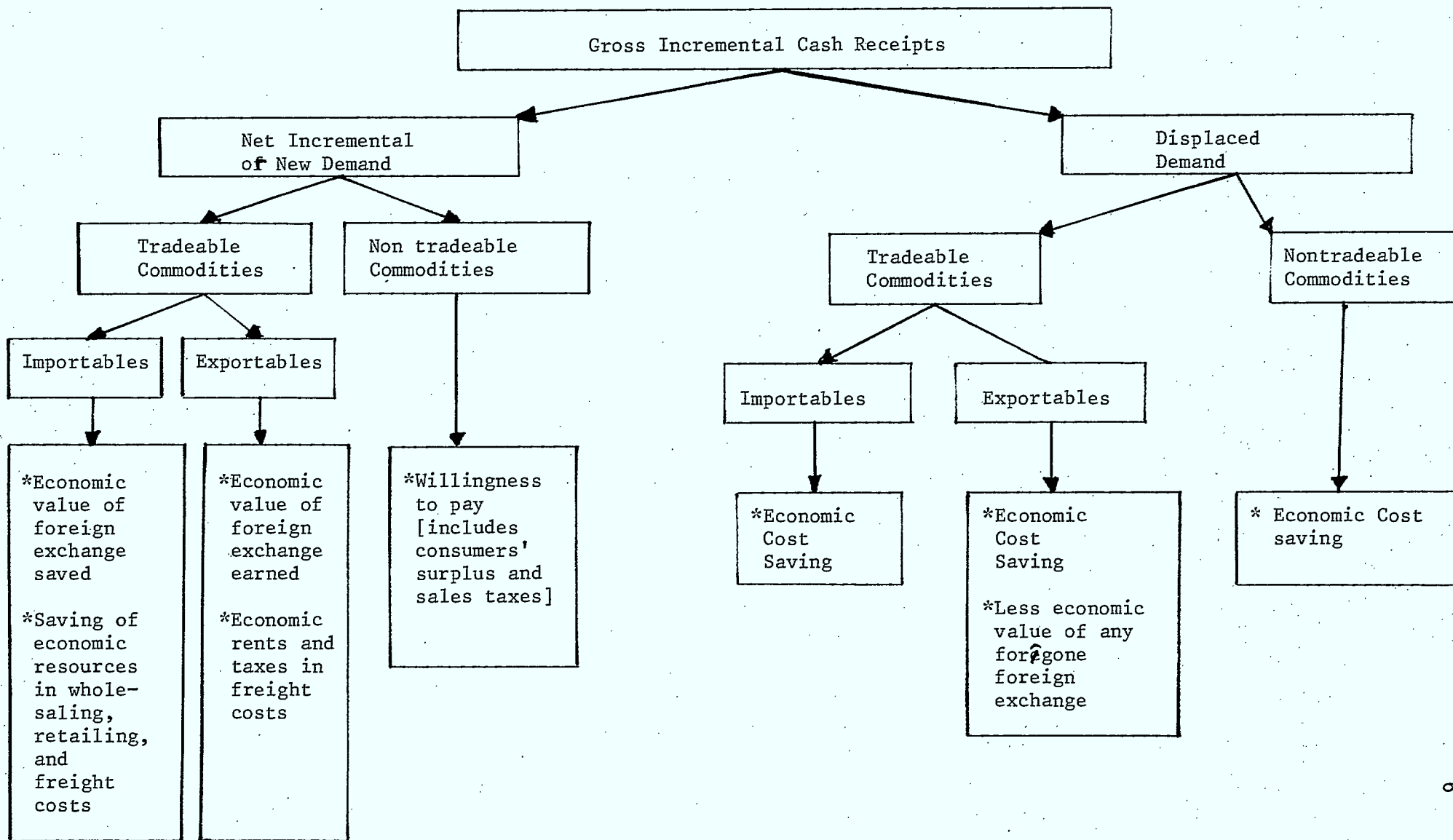
1.2 ESTIMATION OF SOCIO-ECONOMIC BENEFITS

The expected benefits of the MSAT programe can be classified into two broad categories, namely: direct economic benefits and indirect social benefits. Since the latter are the focus of a separate study by Wescom, they need not be examined in this report except to note that they will be included in the overall economic model. (See item (44) in Table 2.1) The direct economic benefits are discussed below.

Figure 1.2 presents an overview of the methodology for estimating the economic benefits of the MSAT program. The other contractors

Figure 1.2

Overview of the Estimation of Economic Benefits

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                        ┌─────────────────────────────────────┐
                        │  Gross Incremental Cash Receipts     │
                        └─────────────────────────────────────┘
                           ╱                            ╲
        ┌──────────────────────┐              ┌──────────────────┐
        │  Net Incremental     │              │   Displaced      │
        │  of New Demand       │              │   Demand         │
        └──────────────────────┘              └──────────────────┘
          ╱              ╲                       ╱              ╲
┌──────────────┐  ┌──────────────┐      ┌──────────────┐  ┌──────────────┐
│  Tradeable   │  │ Non tradeable│      │  Tradeable   │  │ Nontradeable │
│ Commodities  │  │ Commodities  │      │ Commodities  │  │ Commodities  │
└──────────────┘  └──────────────┘      └──────────────┘  └──────────────┘
    ╱      ╲            │                  ╱        ╲            │
┌────────┐ ┌──────────┐ │         ┌────────────┐ ┌───────────┐  │
│Import- │ │Exportables│ │        │ Importables│ │Exportables│  │
│ables   │ │          │ │        └────────────┘ └───────────┘  │
└────────┘ └──────────┘ │              │              │         │
```

Importables:

*Economic value of foreign exchange saved

*Saving of economic resources in whole-saling, retailing, and freight costs

Exportables:

*Economic value of foreign exchange earned

*Economic rents and taxes in freight costs

Non tradeable Commodities:

*Willingness to pay [includes consumers' surplus and sales taxes]

Displaced — Tradeable — Importables:

*Economic Cost Saving

Displaced — Tradeable — Exportables:

*Economic Cost Saving

*Less economic value of any foregone foreign exchange

Displaced — Nontradeable Commodities:

* Economic Cost saving

are required to provide us with estimates of gross incremental cash receipts subdivided into net incremental, or new, demand and displaced demand. These are then differentiated according to whether the outputs are tradeable or nontradeable commodities. The former have their relative prices determined in world markets as opposed to the latter whose relative prices are determined by local demand and supply conditions. Note that the definition of economic benefits, and hence the economic adjustments and externalities that are made to the cash flows, vary according to the type of output and its market impact.[3] To illustrate this schema we shall examine two categories, namely: (a) MSAT outputs (e.g. MRS, MTS, MPS and DACS) and (b) exports of manufactured, MSAT-related equipment.

MSAT OUTPUTS

MSAT will introduce a new communications technology that will offer an alternative to existing terrestrial services and also extend services to new customers. Since market regulation through the CRTC makes communication services a nontradeable type of commody, the prices of MSAT services are determined in Canada. Local demand and supply conditions influence market prices, but their final level is affected by factors like cross-subsidization and allowable rates of return which are set in the regulatory process.

Figure 1.3(a) shows the likely impact of MSAT on existing markets where terrestrial services are presently available. As drawn, the average cost (AC) of MSAT services lies below that of terrestrial services; hence, a switchover to MSAT can be expected over time. The market demand curve is shown net and gross of retail sales taxes. It is the net-of-tax demand curve (D_n) that is perceived by market

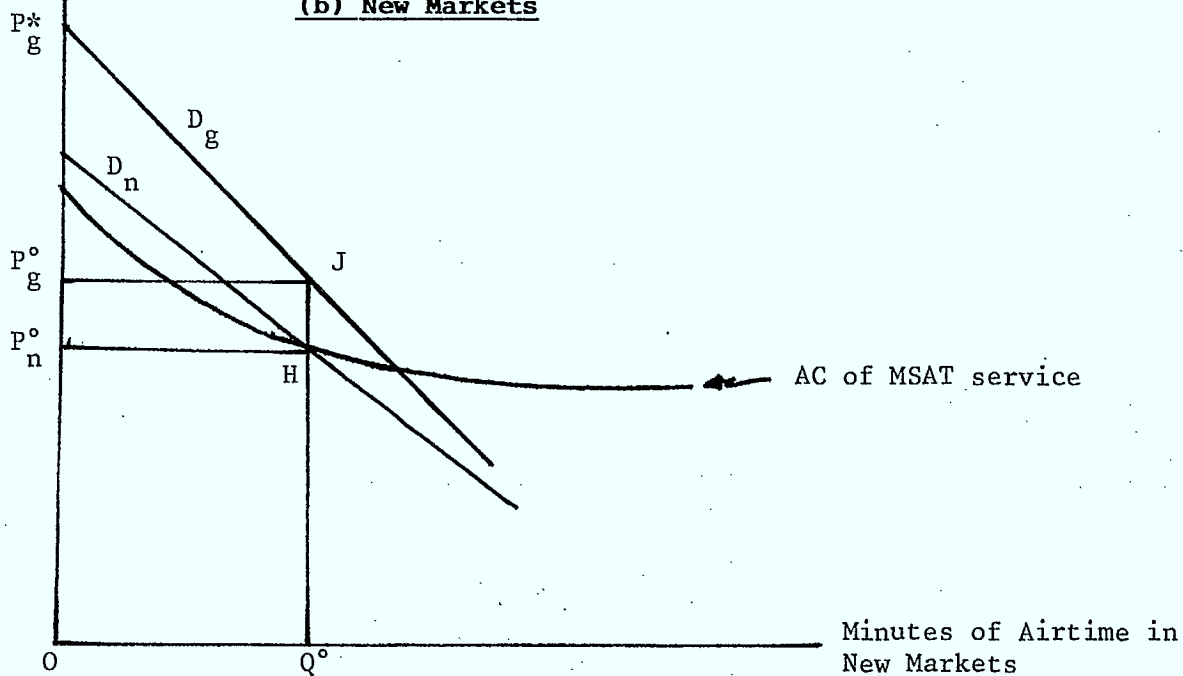## Figure 1.3
Measuring the Benefits of MSAT Outputs

(a) Existing Markets

Price, Cost per Unit

AC of terrestrial service

AC of MSAT service

Minutes of Airtime in Existing Markets
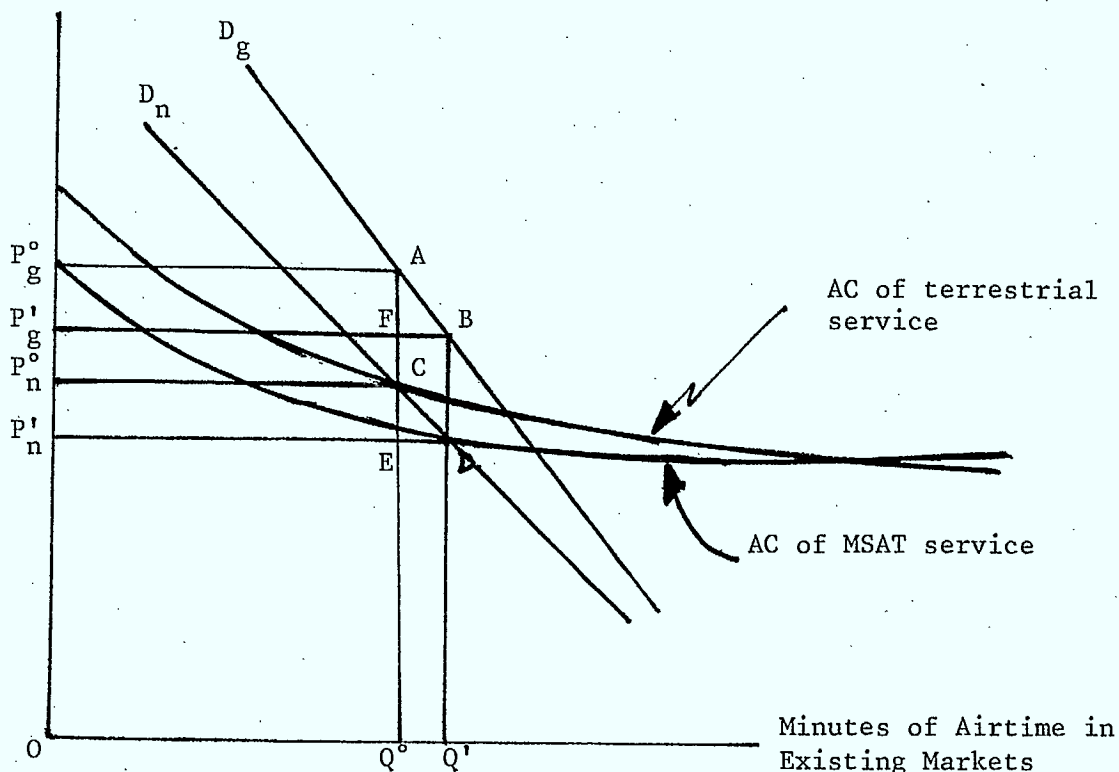
Price, Cost per Unit

(b) New Markets

AC of MSAT service

Minutes of Airtime in New Markets

suppliers and that determines initial and subsequent market prices, P^0 and P^1, respectively. Any decrease in market prices can be expected to generate new demand (Q^0Q^1) in existing markets.

According to the methodology outlined in Figure 1.2, the economic value of displaced, nontradeable output is measured by the value of economic resources saved, i.e., the economic cost saving from no longer producing the terrestrial service. This would include the economic value of materials and labour saved plus the liquidation value of any equipment sold; taxes, which are a private but not an economic cost, as well as any economic rents earned by factors of production would be excluded from this calculation. This saving is approximated by the area $P_n^0CQ^00$ in Figure 1.3(a). The economic value of net incremental, or new, nontradeable output would be measured according to consumers' willingness-to-pay. This is determined by the gross-of-tax demand curve, and for the new output Q^0Q^1, would be approximated by the area ABQ^1Q^0. Since the new airtime by the suppliers of these services (EDQ^1Q^0) is equal to only part of the total economic value, it is necessary to adjust the incremental cash receipts by adding the extra amount of sales tax revenue collected (FBDE) and the added consumer's surplus (ABF) to the airtime revenue. Since access charges are one way to capture part or all of the consumers' surplus, it is important to subtract from these adjustments any added revenue from access charges if that revenue has already been included in total expected cash receipts.

The impact on new markets is examined in Figure 1.3(b). The method for measuring the economic benefits associated with extending services to new communities is analogous to that for net incremental

output in existing markets. The cash receipts ($P_n^0 H Q^0 O$) have to be adjusted by adding the incremental sales tax revenue ($P_g^0 J H P_n^0$) and consumers' surplus ($P_g^* J P^0$ where P_g^* represents the maximum gross-of-tax prices consumers would pay for these services), less any added revenue from access charges if that has already been included in total cash receipts. In order to estimate P_g^* we need to have a good idea of the shape of the market demand curve; the Woods Gordon Market Definition and User Benefit Study is supposed to supply this information.

MANUFACTURED EQUIPMENT EXPORTS

The economic benefit from the increased output of exportable equipment is measured primarily by the economic value of the added foreign exchange earned, and secondarily by any rents and externalities created in the process of exporting the goods. To estimate these amounts, based on the expected sales revenue from equipment exports contained in the Woods Gordon Manufacturing Impact Study, the following steps can be taken.

The first step is to determine the f.o.b. price for the exports. This price will differ from the domestic price if there are any export taxes or subsidies, plus handling costs or added freight costs required to move the goods to a point of export. For example, sales financing obtained through the Export Development Corporation would create an (economic) export subsidy if, as is usually the case, the real interest rate charged by the EDC is less than the social discount rate.

The second step involves an adjustment to the f.o.b. price to take account of the fact that the economic value of foreign

exchange is greater than the market foreign exchange rate. This foreign exchange premium has recently been estimated at 6.94 percent of the market rate.[4]

The third step involves estimating the economic rents and externalities (including taxes) associated with transporting and handling the goods at the point of export. This is another way of recognizing that the market cost of transporting and handling goods can overstate the economic cost of the resources used in these activities.

1.2.1 PRICING OF MSAT OUTPUTS

In Figure 1.3 it was assumed -- as is currently being proposed -- that the prices for MSAT services would be based on their average costs. This pricing assumption would not pose any problems provided that there was no fluctuation in demand within a year. However, if, as seems likely, the demand for MSAT services displays hourly/daily/monthly or seasonal variations, then during some years in its lifetime the satellite will probably be operating at capacity for part of the time and below it for the rest. During these annual peak periods it would be necessary to develop a queuing protocol in order to ration the excess demand.

Average cost pricing creates a problem for the estimation of the economic benefits of MSAT services because it effectively puts a ceiling on revenues during peak periods even though consumers would willingly pay more during these times. By the same token average cost pricing effectively taxes the use of MSAT during off-peak periods when the marginal cost of providing the services lies below

the average cost. Expected revenues during these times could be overstated or understated depending on the elasticity of demand.

If time-of-use (TOU) pricing -- with higher peak period prices and lower off-peak prices -- were employed rather than average cost pricing, the underestimation of expected sales revenues, and hence economic benefits, during peak periods could be at least partly corrected. Unfortunately, hypothetical TOU prices were not included in the Woods Gordon market survey, so we do not have market forecasts that are consistent with this alternate pricing pattern. Under the circumstances this possible source of bias in the estimation of economic benefits should be noted, but an effective remedy may not be immediately forthcoming.

1.3 ESTIMATION OF ECONOMIC COSTS

The economic opportunity costs of the resources (e.g., land, commodities, labour, capital, and foreign exchange) used by the various participants in the MSAT project are largely determined by their supply prices, i.e., by the minimum prices needed to bid these resources away from their alternate uses. These supply prices will often differ from market prices that are the basis for financial costs, on account of economic rents and/or externalities associated with resource use; hence, economic costs will have to be estimated. This can be accomplished either directly or indirectly by first estimating the rents and externalities and using them to adjust market prices. The following discussion is intended to summarize briefly how each of the major economic costs can be estimated.

COMMODITY INPUTS

Commodity inputs refer to the machinery, equipment and materials needed for the construction and operating phases of MSAT. The methodology employed to determine their economic costs is essentially the same as that used to measure the economic value of MSAT outputs. A distinction is made between tradeable and nontradeable commodities as in Figure 1.2. The economic cost of the former is based primarily on the economic cost of the foreign exchange required (inclusive of the foreign exchange premium), while for the latter it is also necessary to specify whether the gross incremental demand for a commodity is met by displacing other uses or through increased production.

According to the Woods Gordon Manufacturing Impact Study, all the required commodity inputs purchased domestically can be obtained from suppliers without any major additional investment in plant, equipment or working capital. Thus, only their production decisions need to be examined.

LABOUR

The economic opportunity cost of labour (EOCL) for the MSAT program is equal to the change in the economic value of the time of those people who respond to the employment opportunities. Time can be divided into three categories, namely employed time, unemployed time and leisure time. To estimate the EOCL it is necessary to estimate both the changes in the amounts and the values of time devoted to each activity, not only for the workers employed in new jobs but also for all other workers who change their allocation of time as a consequence of the MSAT program.

The EOCL is also equal to the difference between the market wage bill to MSAT employers and the labour externality associated with the new jobs. The labour externality consists largely of changes in personal income taxes, unemployment insurance benefits, and economic rents received by workers.

However, since the financial and engineering data from the other contractors contain few details regarding the type of jobs to be created by MSAT, the wage rates to be paid, the degree of job permanency, or even the location of employment opportunities, it will not be possible to carry out a thorough analysis and estimation of the EOCL. Instead, we shall have to rely on estimates that have been made for other projects that have employed workers with similar skills.

FOREIGN EXCHANGE

The sale of tradeable MSAT-related equipment will either save or earn foreign exchange that will help to improve Canada's balance of trade. The purchase of tradeable commodity inputs will use foreign exchange that will cause a deterioration in Canada's balance of trade. In either case the repercussions for Canadian economic well-being will be captured by including the foreign exchange premium mentioned earlier. This premium takes account of a broad range of distortions on both other tradeable and nontradeable goods that cause the economic opportunity cost of foreign exchange to exceed the equilibrium market foreign exchange rate.

GRANTS, SUBSIDIES, AND TAXES

Grants, subsidies and taxes are treated as transfers in the evaluation of the MSAT program. Hence, they are counted as neither

economic benefits nor economic costs. However, since grants and subsidies appear as revenues and taxes are private costs to a firm, we must include the same items as externalities, but with the opposite sign to the revenue and cost items, so that the two sum to zero for all Canadians.[5]

CAPITAL

(a) The Social Discount Rate

The social discount rate (SDR) measures the time value of a project's economic benefits and costs, and hence, is used to calculate their net present values. Although there is no concensus on the magnitude of the social discount rate, there is general agreement in favour of Harberger's formulation of the problem.[6] In this formulation the SDR is taken to be a weighted average of the economic costs of any forgone investment and consumption and of any induced change in foreign-owned capital, where the weights are the proportions of the incremental government borrowing that are drawn from each source. Although there is some evidence that the SDR is roughly equal to 10 percent, it will be possible, using the computer-based evaluation framework described in Report No. 4, to examine alternate estimates of the SDR.

Given that the private and social cost of risk is the same (see discussion below), the difference between a social and a private discount rate is primarily due to the amount of forgone government tax revenue per dollar of capital invested. By using a SDR, therefore, a project is in essence charged for the normal tax revenue and any other externalities that

is simply assumed to reallocate the foreign capital already present in Canada away from its alternate uses. Thus, the crucial question is whether the MSAT project would yield foreign investors a greater than normal return. If the project's foreign investors were earning a higher than normal return, then a negative externality would be computed. This externality also includes foreign exchange and country risk externalities. However, if a positive externality were estimated, then it should not be included, in the amount of the externalities that will determine the magnitude of government financial assistance. The reason is that government assistance may be designed to bring investors up to a normal rate of return, but if this were achieved, then the positive externality would be eliminated and too much assistance would have been offered. The only way to avoid this circularity is to exclude the positive externality.

If MSAT is deemed to receive partly incremental and partly non-incremental foreign financing, then a weighted average of the above externalities can be used.

COST OF ABNORMAL RISK

Although risk does not entail the use of real resources, it does create a social cost because uncertainty and risk reduce net economic well-being. In the evaluation of the MSAT project we shall distinguish between normal risk and abnormal risk. Those benefit and cost streams that have the same risk as investors would have experienced elsewhere will be classified as having normal risk. No risk adjustment will be necessary in this case. However, when

benefit and cost streams have more or less risk than normal, a risk adjustment will be made to the annual private and social discount rates. A positive risk premium will raise the discount rates when risk is abnormally high; a negative risk premium will signify abnormally low risk, and lower discount rates will be used.

In the computer printouts both the normal and risk-adjusted discount rates will be shown for each of the major cash flow items in the summary tables.[7] The cost of risk, calculated as the difference between the NPV of that item discounted at the risk-adjusted discount rate and its NPV discounted at the normal discount rate, will also be reported. The advantage of separately examining the riskiness of each major cash flow item and its associated externalities is that it is possible to vary not only the magnitude of the risk premia but also the timing of the underlying uncertainty. Hence, it is not necessary to assume that all items have the same riskiness or that uncertainty compounds continuously over time for all items.

Note that the same risk premium will be built into both the private and social discount rates. This approach presumes that the government is no more efficient at diversifying risk than are private investors.

2.0 METHOD OF CALCULATING THE ECONOMIC ADJUSTMENTS AND EXTERNALITIES

The method of calculating the economic adjustments and externalities lies at the heart of the framework used to analyze the MSAT program. A summary of variables and formulas used in the econmic model is presented in Table 2.1. The number of each variable or equation corresponds to that used in Table 1.2 of Report Number

4. An index is provided at the front of Table 2.1 in order to facilitate finding those variables and equations that relate to the headings discussed in Section 1 of this report.

It would require a fairly lengthy report to explain in detail the rationale underlying each equation. Fortunately, such an explanation is not as necessary because it is readily available from at least two sources. One source,, referenced at the beginning of Section 1, is the Manual by Professor John Evans et al. The relevant chapters are as follows:

Item to be Adjusted or Type of Externality	Chapter References in "A Manual for the Analysis and Appraisal of Industrial Projects in Canada"
(a) Commodity Outputs/Inputs	Chapter 11/15
(b) Labour	Chapter 13
(c) Grants, Subsidies and Income Taxes	Chapter 12
(d) Social Discount Rate	Chapter 10
(e) Foreign Financing	Chapter 17
(f) Cost of Abnormal Risk	Chapter 20

A second source, which has the advantage of offering a reasonably concise summary of the Manual material, is Section 3 and 4 of Appendix 2 to the "Statement of Work for the Overall Socio-Economic Impact Study of the MSAT Program", (November 14, 1983), prepared by DOC. This Appendix also contains an index for ease of reference.

TABLE 2.1

THE ECONOMIC MODEL:

VARIABLES AND EQUATIONS

INDEX TO TABLE 2.1

TABLE 2.1

Variables and Equations for the Estimation of Economic Adjustments, Externalities, Benefits and Costs

ECONOMIC ADJUSTMENTS TO TRADEABLE PROJECT OUTPUTS/INPUTS

<u>Importables</u>

(1) Cash Flow Item Amount ($): A

(2) Proportion Tradeable: P_1

(3) Amount Tradeable (Financial Value) $P_1 \cdot A$

(4) Proportion Importable: P_2

(5) Proportion Subject to Duty Remission: P_3

(6) Average Tariff Rate: t_1

(7) Average Manufacturing Sales Tax Rate: t_2

(8) Average Retail Sales Tax Rate t_3

(9) Wholesale and Retail Trade Margin: m_1

(10) Proportion of Freight Costs on Importables: P_4

(11) Foreign Exchange Premium: f_x

(12) Foreign Exchange Externality and Importables:

$$\left[\frac{f_x \cdot P_1 \cdot P_2 \cdot (1-P_4)}{(1+(1-P_3)\, t_1)((1+t_2)(1+t_3)(1+m_1))} \right] \times A = B \times A$$

(13) Proportion of Economic Rents, Taxes In Freight Costs: P_5

(14) Proportion of Economic Rents, Taxes In Trade Margins: P_6

(15) Economic Rents and Taxes In Freight Costs and Trade Margins:

$$0 - [(P_1 \cdot P_2 \cdot P_4 \cdot P_5) + B \cdot \frac{1}{f_x} \cdot (1+(1-P_3) \cdot t_1)(1+t_2) \cdot m_1 \cdot P_6] \times A,$$

where B is defined in equation (12)

Importables cont'd

(16) Tariff and Tax Revenue:

$$0 - [B \cdot \frac{1}{f_x} \cdot (1-P_3)t_1 + B \cdot \frac{1}{f_x} \cdot (1+(1-P_3)t_1)t_2$$

$$+ B \cdot \frac{1}{f_x} \cdot (1+(1-P_3)t_1)(1+t_2)(1+m_1)t_3] \times A$$

(17) Total Adjustments and Externalities
on Importables:

$$\underset{(12)}{\begin{bmatrix} \text{Foreign Exchange} \\ \text{Externality} \end{bmatrix}} + \underset{(15)}{\begin{bmatrix} \text{Economic Rents} \\ \text{and Taxes In} \\ \text{Freight Costs and} \\ \text{Trade Margins} \end{bmatrix}} + \underset{(16)}{\begin{bmatrix} \text{Tariff and} \\ \text{Tax Revenue} \end{bmatrix}}$$

Economic Value Cost of Importables:

$$(18) \quad \underset{(1)}{\begin{bmatrix} \text{Financial Value of} \\ \text{Importables} \end{bmatrix}} + \underset{(17)}{\begin{bmatrix} \text{Total Adjustments and} \\ \text{Externalities on Importables} \end{bmatrix}}$$

$$(19) \quad [(1+f_x) \cdot B \cdot \frac{1}{f_x})$$

$$+ (1-P_5) \cdot P_1 \cdot P_2 \cdot P_4) + (1-P_6)(1+ (1-P_3)t_1) \cdot (1+t_2) \cdot m_1 \frac{B}{f_x})] \times A$$

Exportables

(20) Average Export Subsidy Rate: $\qquad S_1$

(21) Average Export Tax Rate: $\qquad t_4$

(22) Proportion of Freight Costs:
On Exportables $\qquad P_7$

(23) Foreign Exchange Externality on Exportables:

$$[f_x \cdot P_1 \cdot (1-P_2) \cdot (1+P_7)(1+t_4-S_1)] A = C \cdot A$$

(24) Proportion of Economic Rents
and Taxes in Freight Costs: $\qquad P_8$

(25) Economic Rents and Taxes in Freight Costs:

$$[P_1 \cdot (1-P_2) \cdot P_7 \cdot P_8] \cdot A$$

(26) Export Tax Revenue Less
Subsidy Payments: $[P_1 \cdot (1-P_2) \cdot (1+P_7)(t_4-S_1)] \cdot A$

(27) Total Economic Adjustments and
Externalities on Exportables:

$$\underset{(23)}{\begin{bmatrix} \text{Foreign Exchange} \\ \text{Externality} \end{bmatrix}} + \underset{(25)}{\begin{bmatrix} \text{Economic Rents and} \\ \text{Taxes in Freight Costs} \end{bmatrix}} + \underset{(26)}{\begin{bmatrix} \text{Export Tax} \\ \text{Revenue less Subsidy} \\ \text{Payments} \end{bmatrix}}$$

Economic Value of Exportable Output/Input

(28)
$$\underset{(1)}{\begin{bmatrix} \text{Financial Value} \\ \text{of Exportables} \end{bmatrix}} + \underset{(27)}{\begin{bmatrix} \text{Total Economic Adjustments} \\ \text{and Externalities on} \\ \text{Exportables} \end{bmatrix}}$$

(29) $[(1+f_x)(C \cdot \frac{1}{f_x}) - ((1-P_8) \cdot P_1 \cdot (1-P_2) \cdot P_7)]\, A,$

where C is defined in equation (23)

(30) Economic Value of Tradeable
Output/Input: $\underset{(18)}{\begin{bmatrix} \text{Economic Value} \\ \text{of Importable} \\ \text{Output/Input} \end{bmatrix}} + \underset{(28)}{\begin{bmatrix} \text{Economic Value} \\ \text{of Exportable} \\ \text{Output/Input} \end{bmatrix}}$

ECONOMIC ADJUSTMENTS TO NON-TRADEABLE PROJECT OUTPUTS/INPUTS:

(31) Amount Non-tradeable (Financial Value): $(1-P_1) \cdot A$

(32) Proportion of Non-tradeable Output/Input that
is Incremental: P_9

(33) Average Sales Tax Rate: t_5

(34) Change in Consumers' Surplus: Exogenously Determined

(35) Total Adjustments on Incremental
Output/Input: $[(1-P_1) \cdot P_9 \cdot t_5] \cdot A$

+ Change in Consumers Surplus
(34)

(36) Economic Value of Incremental
Output/Input: $\underset{(32) \cdot (31)}{\begin{bmatrix} \text{Financial Value} \\ \text{of Incremental} \\ \text{Output/Input} \end{bmatrix}} + \underset{(35)}{\begin{bmatrix} \text{Total Adjustments} \\ \text{on Incremental} \\ \text{Output/Input} \end{bmatrix}}$

(37) Non-Incremental Output/Input
(Financial Value) :

$$(1-P_1) \cdot (1-P_9) \cdot A$$

(38) Ratio of Forgone Rent, Taxes
and Externalities to Market
Price of Non-tradeable
Output/Input:

$$P_{10}$$

(39) Total Adjustments and Externalities on Non-incremental
Output/Input:

$$0 - [P_{10} \cdot (1-P_1)(1-P_9)] \cdot A$$

(40) Economic Value of Non-
incremental Output/Input:

$$\underset{(37)}{\begin{bmatrix} \text{Financial Value of} \\ \text{Non-incremental} \\ \text{Output/Input} \end{bmatrix}} + \underset{(39)}{\begin{bmatrix} \text{Total Adjustments and} \\ \text{Externalities on} \\ \text{Non-incremental} \\ \text{Output/Input} \end{bmatrix}}$$

(41) Total Adjustments on Non-
Tradeable Output/Input:

$$\underset{(35)}{\begin{bmatrix} \text{Total Adjustments on} \\ \text{Incremental Output/} \\ \text{Input} \end{bmatrix}} + \underset{(39)}{\begin{bmatrix} \text{Total Adjustments on} \\ \text{Non-incremental} \\ \text{Output/Input} \end{bmatrix}}$$

Total Economic Value of Non-
tradeable Output/Input:

(42)
$$\underset{(31)}{\begin{bmatrix} \text{Financial Value of} \\ \text{Non-tradeable} \\ \text{Output/Input} \end{bmatrix}} + \underset{(35)}{\begin{bmatrix} \text{Total Adjustments} \\ \text{on Incremental} \\ \text{Output/Input} \end{bmatrix}} + \underset{(39)}{\begin{bmatrix} \text{Total Adjustments} \\ \text{on Non-incremental} \\ \text{Output/Input} \end{bmatrix}}$$

(43)
$$\underset{(36)}{\begin{bmatrix} \text{Economic Value} \\ \text{of Incremental} \\ \text{Output/Input} \end{bmatrix}} \underset{(40)}{\begin{bmatrix} \text{Economic Value of} \\ \text{Non-Incremental} \\ \text{Output/Input} \end{bmatrix}}$$

(44) Indirect Social Benefits: Exogenously Determined

(45) Economic Value of Total
Output/Input Excluding
Indirect Social Benefits:

$$\underset{(30)}{\begin{bmatrix} \text{Economic Value of} \\ \text{Tradeable Output/} \\ \text{Input} \end{bmatrix}} + \underset{(42)}{\begin{bmatrix} \text{Economic Value of} \\ \text{Non-tradeable} \\ \text{Output/Input} \end{bmatrix}}$$

(46) Economic Value of Total
Output/Input Including
Indirect Social Benefits:

$$\underset{(45)}{\begin{bmatrix} \text{Economic Value of} \\ \text{Total/Output Input} \\ \text{Excluding Indirect} \\ \text{Social Benefits} \end{bmatrix}} + \underset{(44)}{\begin{bmatrix} \text{Indirect} \\ \text{Social} \\ \text{Benefits} \end{bmatrix}}$$

OTHER ADJUSTMENTS AND EXTERNALITIES

Labour Adjustments

(47) Ratio of Economic Opportunity Cost
of Labour to the Wage Bill: λ

(48) Wage Bill (Financial Value):   A

(49) Economic Cost of Labour: $\lambda \cdot A$

(50) Labour Externality $(\lambda - 1) \cdot A$

Grants, Subsidies and Tax Adjustments

(51) Adjustments for Grants,
Subsidies and Income Taxes: $0 - A$

Foreign Financing Adjustments

(52) Proportion of Foreign Capital
That is Incremental: P_{11}

(53) Country Risk Premium γ

(54) Adjustment on Incremental Foreign Capital: $[(1+f_x)(P_{11}(1-\gamma)] \cdot A$

(55) Ratio of the Normal Return on
Foreign Capital to the Project
Return on Foreign Capital: $\dfrac{\text{NPV of all foreign capital inflows (debt issued) at 6\%}}{\text{NPV of all foreign capital outflows (interest and debt repayment) at 6\%}} = R$

(56) Adjustment on Non-Incremental Foreign
Capital:

$$[(1+f_x) \times (1-P_{11})(1-\gamma)(1-R)] \cdot A$$

(note: this formula applies only if R > 1 and A, the financial
value of the non-incremental foreign capital flow, is negative --
i.e. an outflow.)

(57) Total Externality on Foreign Financing:

<div style="text-align:center">

(54)   (56)

$\begin{bmatrix} \text{Adjustment on Incremental} \\ \text{Foreign Capital} \end{bmatrix} + \begin{bmatrix} \text{Adjustment on Non-Incremental} \\ \text{Foreign Capital} \end{bmatrix}$

</div>

Cost of Abnormal Risk

(58) Private Discount Rate: $\qquad$ r_p

(59) Risk Adjusted Private Discount Rate: $\qquad$ $\bar{r}_p$

(60) Social Discount Rate: $\qquad$ r_s

(61) Risk Adjusted Social Discount Rate: $\qquad$ $\bar{r}_s$

(62) Factor to Determine Normal
       Equivalent of Cash Flow Items: $\qquad$ $\left[\dfrac{1 + r_p}{1 + \bar{r}_p}\right]^t$

(63) Factor to Determine Normal
       Equivalent of Economic Benefit/Cost: $\qquad$ $\left[\dfrac{1 + r_s}{1 + \bar{r}_s}\right]^t$

(64) Private Cost of Risk: $\qquad$ $A \cdot \left[\left(\dfrac{1+r_p}{1+\bar{r}_p}\right)^t - 1\right]$

(65) Social Cost of Risk: $\qquad$ $A \cdot \left[\left(\dfrac{1+r_s}{1+\bar{r}_s}\right)^t - 1\right]$

(66) Total Economic Adjustments and
       Externalities with Normal Risk: $\qquad$ (17) + (27) + (41) + (44) + (50) + (51)
       + (57)

(67) Total Economic Benefits/Costs with
       Normal Risk: $\qquad$ (1) + (66)

3.0 Determining the Magnitude of Direct Government Financial Assistance

Although the basic methodology for determining the magnitude of direct government financial assistance is discussed both in the Manual (Chapter 21) and in the Statement of Work (Appendix 2, Section 6.0), the MSAT program may introduce an interesting new wrinkle that warrants examination. In order to explore this issue without repeating explanations that are already available elsewhere, the basic methodology will be summarized by means of a set of propositions and with reference to Figure 3.1. Since there can be many reasons for offering an investment project financial assistance, including the achievement of political and cultural objectives, it should be made clear that we are concerned at this point only with an economic justification for assistance, i.e., only with a justification that is based on a potential improvement in the economic well-being of some Canadians without leaving other Canadians worse off. In economic jargon this is referred to as a potential Pareto improvement in economic efficiency.

<u>Propositions Concerning the Economic Rationale for Financial Assistance to the MSAT PROGRAM:</u>

(a) The first step is to determine whether direct financial assistance is warranted. The economic well-being of all Canadians would be improved as a result of the MSAT program only if the NPV of its incremental net economic benefits, discounted by the social discount rate, is positive.[8] Only when this condition is satisfied can direct financial assistance be justified on the basis of improving the allocation of resources.

Figure 3.1

"Decision Tree" – Determining the Magnitude of Government Direct Financial Assistance
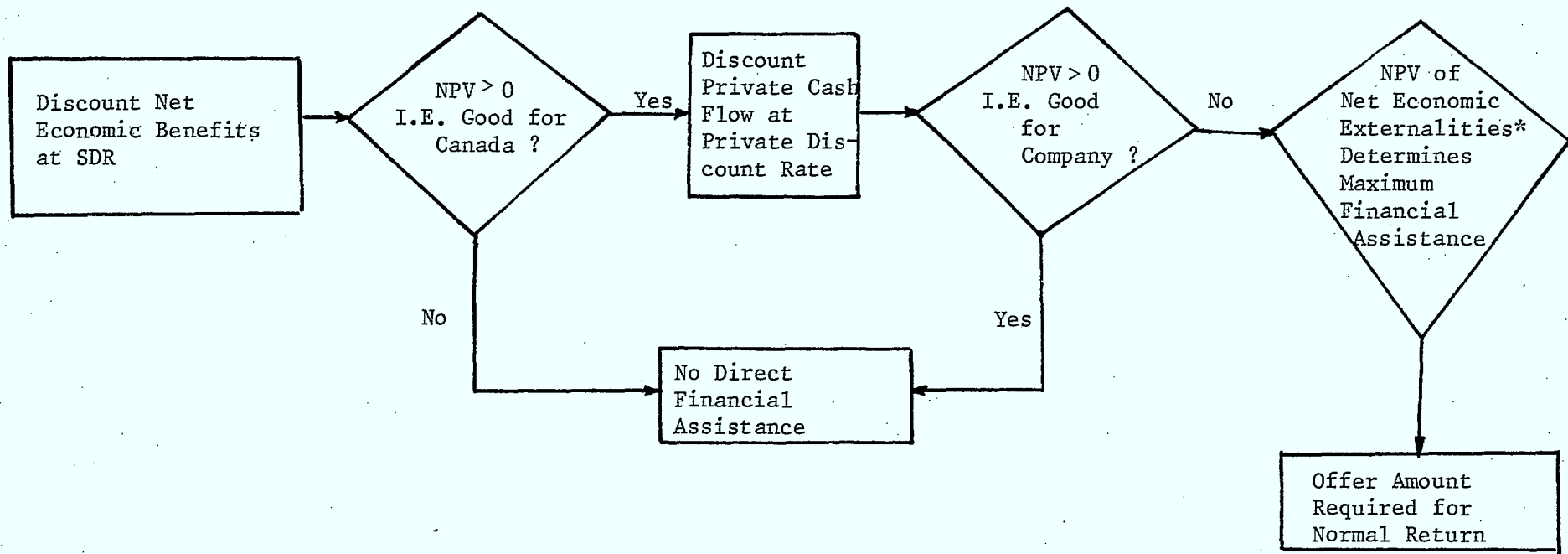
*Net Economic Externalities are over and above the normal externalities generated by a normal investment project.

(b) The next step is to determine whether financial assistance is needed. If the NPV of the incremental net cash flow to total capital, discounted by the private discount rate, is positive, then private investors are earning a greater return than they could have earned in the capital market, and no financial assistance should be offered. Hence, only when the NPV of the net cash flow is negative would financial assistance appear to be needed.

(c) It is worth pointing out in connection with propositions (a) and (b) that only when government financial assistance is incremental, i.e., the project would not proceed without government assistance, can Canadians not investing in the project be made better off than they would have been without the assistance. To see this, consider a situation where government financial assistance is non-incremental, i.e., a project would be undertaken by the private investors regardless of whether it receives financial incentives. In this case Canadians not investing in the project would receive all the associated externalities regardless of whether assistance is offered. From their perspective, therefore, any assistance would represent a needless transfer of income that would leave them worse off than if it had not been offered. Since government financial assistance is more likely to be incremental when the NPV of the net cash flow is negative, it is only then that Canadians not investing in a project are likely to be made better off.

(d) The maximum amount of direct financial assistance that Canadians not investing in a project would want to make available is

measured by the NPV of a project's net economic externalities, discounted by the social discount rate. These net economic externalities can be measured as the sum of the added consumers' surplus and economic rents, plus any added commodity tax and tariff revenues, plus added income taxes, plus the externalities on labour and foreign financing, minus the cost of abnormal risk minus the externalities that would have been generated by the capital if it had been invested in the capital market. (See Figure 1.1.) The NPV of the net economic externalities can also be measured as follows:

NPV of Net Economic Externalities discounted by the SDR	=	NPV of net economic benefits discounted by the SDR	−	NPV of net cash flow discounted by the private discount rate

(e) From the equation in proposition (d) and from what was said in propositions (a) - (c), it should be clear that direct government financial assistance should be offered to the investors in the MSAT program only if the NPV of the net economic benefits is expected to be positive and only if the NPV of the net cash flow is expected to be negative. Under these circumstances the NPV of the net economic externalities will be positive and any assistance is likely to be incremental.

(f) From the equation in proposition (d) it should also be clear that if the financial assistance were just sufficient to yield the private investors a normal return, then the NPV of the net cash flow would equal zero, and Canadians net investing in the project would receive its full net economic benefits. Thus, under these circumstances the private investors would <u>ex ante</u> be no worse off

and other Canadians would be better off. Any amount of assistance greater than that required for a normal private return would leave both groups better off provided it did not exceed the NPV of the net economic externalities. If the financial assistance did not exceed this ceiling, the private investors would _ex ante_ be made better of at the expense of other Canadians. These individuals, if they could directly vote on the matter, would obviously approve of the assistance only if their economic well-being were imporved, i.e., only if the financial assistance offered is kept below the NPV of the net economic externalities.

(g) If direct financial assistance were offered when the NPV of the net economic benefits was negative, then other Canadians not investing in the MSAT program would be worse off unless MSAT had other benefits like the attainment of valid political and/or cultural objectives not captured in the cost-benefit calculation.

Propositions (a) - (g) summarize the principles of determining the magnitude of government financial assistance discussed at greater length elsewhere. The following example briefly illustrates these points.

Example 1:
(Negative numbers are shown in parentheses)

Let NPV of net economic
    benefits discounted
    by the SDR   = $100M

less
NPV of the net cash
flow discounted by
the private
discount rate   =   ($90) M

equals
NPV of net economic
externalities discounted
by the SDR   = $190 M

If the private investors were offered $90M in assistance, then other Canadians could expect to receive externalities worth $100M which equals the overall NPV of the net economic benefits. Under these circumstances, therefore, all Canadians can enjoy an improvement in economic well-being, and those Canadians who are made better off can potentially compensate those who are made worse off. The maximum amount of assistance non-investors would willingly offer in this case is $190M.

Where the MSAT project appraisal introduces an interesting wrinkle on the above methodology is the explicit examination of more than one group of private investors. The RCC's and the Telco's will retail most of MSAT's services, Telesat will act like a whole-saler, and the manufacturing industry will supply the above partici-pants as well as any export markets with equipment. Each level of activity will have its own group of investors and will create its share of the overall economic externalities. To illustrate the possible complications consider the following example which to simplify the discussion assumes only two groups of investors. In this example the aggregate net economic benefits etc. are the same as in Example 1.

Example 2:
(Negative numbers are shown in parentheses)

	NPV of net economic benefits	NPV of net cash flow	NPV of net economic externalities
Investor Group A:	$100M	$110M	$(10M)
Investor Group B:	$ 0M	($200M)	$200M
Overall Project	$100M	($ 90M)	$190M

In example 2 the NPV of the overall net economic benefits is positive, so according to proposition (a) direct financial assistance is warranted. However, only investor group B has a negative NPV on its net cash flow, so according to proposition (b) and (c) only this group requires financial assistance. The problem that arises is that the NPV of the overall net economic externalities is not sufficiently large to bring investor group B up to a normal return (i.e., a zero private NPV). The reason in this example is obvious, namely that investor group A is benefiting at the expense of both investor group B and other Canadians.

One straightforward solution would be for the government to offer investor group B direct financial assistance equal to $190M and to encourage investor group A to assist the project in the amount of $10M. In this way investor group B and other Canadians would ex ante be no worse off than without MSAT, while investor group A would be better off by $100M. However, this solution may offer returns that are not commensurate with the perceived risks; moreover, investor group A may not cooperate in the hope of forcing the government to pay the full $200M. Unfortunately, this would ex ante leave other Canadians not investing in MSAT worse off by $10M, which is

a solution they would not willingly support.

Another possible solution would be to use two instruments to transfer income first between investor group A and other Canadians and second between other Canadians and investor group B. For example, by regulating the prices charged by investor group A the return it earns could be lowered and the consumers' surplus enjoyed by other Canadians could transfer an additional $30M in NPV terms from investor group A to other Canadians, then the NPV of aggregate net economic externalities would equal $220M. With this amount of externalities the government could offer $200M of direct financial assistance to investor group B and still leave other Canadians better off.

As Example 2 illustrates, there exists a wide variety of instruments and instrument combinations that can be used to effectuate income transfers between the participants in the MSAT program. What we have done in this section is to outline the broad principles that ought to govern the amount of assistance that can be justified on the grounds of potentially improving the economic well-being of some Canadians without leaving others worse off. Report No. 8 will contain a more detailed examination of the choice of instruments.

FOOTNOTES

1. John C. Evans et al., "A Manual for the Analysis and Appraisal of Industrial Projects in Canada", prepared for the Departments of Regional Economic Expansion and Industry, Trade and Commerce (Ottawa, 1983).

2. The need to resolve these inconsistencies and to fill potential study gaps was emphasized at a review meeting with DOC staff on April 13, 1984.

3. The methods of calculating the economic benefits of tradeable commodities shown in Figure 1.2 assume that Canadians are price-takers in these markets. This "small country" assumption reasonably applies to all the markets addressed by the MSAT program.

4. Glenn P. Jenkins and Chun-Yan Kuo, "On Measuring the Social Opportunity Cost of Foreign Exchange" (Ottaw: Department of Finance, 1984).

5. The payment of corporation income taxes by a firm is not an economic cost because there is no corresponding incremental use of real resources. The only time a change in government revenue would represent the incremental use of resources is in the case of user fees levied in an amount equal to the economic opportunity costs of the resources.

6. A.C. Harberger, "The Opportunity Cost of Public Funds", Project Evaluation (London, 1972), Chapter 4.

7. These summary tables are illustraded in Report No. 4, Table 1.3.

8. Note that the economic criterion focusses on an improvement in the economic well-being of Canadians, not on an improvement in Canadian national income. This distinction between economic well-being and national income is elaborated on in Chapter 9 of the Manual.