3-1980

# Generation of Regional Input-Output Tables for the Northern Territory GRIT II

G. R. West
*Department of Economics, University of Queensland, St. Lucia. Q. 4067*

J. T. Wilkinson
*Department of Economics, University of Queensland, St. Lucia. Q. 4067*

R. C. Jensen
*Department of Economics, University of Queensland, St. Lucia. Q. 4067*

REGIONAL RESEARCH INSTITUTE

# GENERATION OF REGIONAL INPUT-OUTPUT TABLES FOR THE NORTHERN TERRITORY

## GRIT II

Report to the Northern Territory
Department of the Chief Minister

by

G.R. West, J.T. Wilkinson, and R.C. Jensen

Department of Economics,
University of Queensland,
ST. LUCIA. Q. 4067.

March 1980

ISBN 0 909260 08 7

# ERRATA

Please substitute revised

pages 169 and 175

## APPENDIX X

## INVERSE MATRICES FOR 11-SECTOR TABLES (OPEN MODEL)

TABLE X-1 INVERSE MATRIX, 11-SECTOR OPEN MODEL: DARWIN REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0000 | 0.0006 | 0.0037 | 0.0000 | 0.0006 | 0.0000 | 0.0001 | 0.0000 | 0.0014 | 0.0000 |
| 2 | 0.0165 | 1.0020 | 0.0004 | 0.0026 | 0.0000 | 0.0004 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 |
| 3 | 0.0093 | 0.0045 | 1.0774 | 0.0220 | 0.0002 | 0.0046 | 0.0002 | 0.0005 | 0.0001 | 0.0013 | 0.0004 |
| 4 | 0.0134 | 0.2345 | 0.1950 | 1.1447 | 0.0091 | 0.1771 | 0.0088 | 0.0187 | 0.0040 | 0.0504 | 0.0132 |
| 5 | 0.0090 | 0.0089 | 0.0096 | 0.0143 | 1.0075 | 0.0040 | 0.0055 | 0.0039 | 0.0150 | 0.0573 | 0.0191 |
| 6 | 0.0196 | 0.0060 | 0.0038 | 0.0125 | 0.0235 | 1.0026 | 0.0153 | 0.0286 | 0.0203 | 0.2532 | 0.0265 |
| 7 | 0.0407 | 0.0657 | 0.0134 | 0.0171 | 0.0046 | 0.0219 | 1.0686 | 0.0278 | 0.0352 | 0.0388 | 0.0166 |
| 8 | 0.0078 | 0.0119 | 0.0507 | 0.0276 | 0.0059 | 0.0141 | 0.0103 | 1.0273 | 0.0095 | 0.0269 | 0.0033 |
| 9 | 0.0022 | 0.0434 | 0.0041 | 0.0050 | 0.0007 | 0.0066 | 0.0356 | 0.0043 | 1.0265 | 0.0472 | 0.0050 |
| 10 | 0.0001 | 0.0055 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1394 | 0.0000 |
| 11 | 0.0101 | 0.0018 | 0.0021 | 0.0003 | 0.0007 | 0.0003 | 0.0029 | 0.0060 | 0.0102 | 0.0262 | 1.0051 |

TABLE X-2 INVERSE MATRIX, 11-SECTOR OPEN MODEL: TOP END REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0014 | 0.0001 | 0.0054 | 0.0000 | 0.0008 | 0.0001 | 0.0001 | 0.0003 | 0.0049 | 0.0001 |
| 2 | 0.0153 | 1.0006 | 0.0000 | 0.0016 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0001 |
| 3 | 0.0019 | 0.0369 | 1.1400 | 0.1422 | 0.0012 | 0.0258 | 0.0014 | 0.0027 | 0.0007 | 0.0071 | 0.0021 |
| 4 | 0.0150 | 0.3075 | 0.0203 | 1.1863 | 0.0089 | 0.1825 | 0.0111 | 0.0210 | 0.0054 | 0.0500 | 0.0158 |
| 5 | 0.0048 | 0.0096 | 0.0006 | 0.0142 | 1.0069 | 0.0042 | 0.0060 | 0.0039 | 0.0135 | 0.0560 | 0.0193 |
| 6 | 0.0214 | 0.0079 | 0.0455 | 0.0160 | 0.0274 | 1.0041 | 0.0161 | 0.0298 | 0.0204 | 0.2512 | 0.0277 |
| 7 | 0.0735 | 0.0799 | 0.0058 | 0.0498 | 0.0109 | 0.0774 | 1.1175 | 0.0520 | 0.0515 | 0.0561 | 0.0418 |
| 8 | 0.0076 | 0.0122 | 0.0046 | 0.0225 | 0.0051 | 0.0131 | 0.0107 | 1.0269 | 0.0090 | 0.0263 | 0.0034 |
| 9 | 0.0039 | 0.0433 | 0.0006 | 0.0043 | 0.0008 | 0.0077 | 0.0372 | 0.0050 | 1.0254 | 0.0470 | 0.0059 |
| 10 | 0.0001 | 0.0053 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1380 | 0.0000 |
| 11 | 0.0113 | 0.0020 | 0.0026 | 0.0007 | 0.0005 | 0.0005 | 0.0031 | 0.0063 | 0.0096 | 0.0261 | 1.0056 |

# APPENDIX XII

## INVERSE MATRICES, NON-UNIFORM TABLES (OPEN MODEL)

TABLE XII-1 INVERSE MATRIX, 16-SECTOR OPEN MODEL: DARWIN REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0000 | 0.0002 | 0.0000 | 0.0219 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0013 | 0.0000 |
| 2A | 0.0167 | 1.0075 | 0.0002 | 0.0000 | 0.0144 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0000 |
| 2B | 0.0000 | 0.0000 | 1.0001 | 0.0001 | 0.0011 | 0.0000 | 0.0510 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0001 |
| 3 | 0.0001 | 0.0001 | 0.0012 | 1.0742 | 0.0009 | 0.0007 | 0.0015 | 0.0312 | 0.0072 | 0.0002 | 0.0056 | 0.0002 | 0.0034 | 0.0001 | 0.0015 | 0.0064 |
| 4A | 0.0034 | 0.0000 | 0.0105 | 0.0001 | 1.0231 | 0.0000 | 0.0000 | 0.0000 | 0.0025 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0009 |
| 4B | 0.0003 | 0.0001 | 0.0034 | 0.0002 | 0.0004 | 1.0156 | 0.0011 | 0.0006 | 0.0010 | 0.0003 | 0.0120 | 0.0012 | 0.0004 | 0.0006 | 0.0036 | 0.0019 |
| 4C | 0.0001 | 0.0001 | 0.0553 | 0.1239 | 0.0004 | 0.0002 | 1.0038 | 0.0042 | 0.0014 | 0.0019 | 0.0015 | 0.0012 | 0.0057 | 0.0002 | 0.0023 | 0.0003 |
| 4DE | 0.0035 | 0.0016 | 0.0080 | 0.0089 | 0.0315 | 0.0269 | 0.0589 | 1.1772 | 0.0265 | 0.0063 | 0.1664 | 0.0030 | 0.0095 | 0.0036 | 0.0442 | 0.0089 |
| 4F | 0.0019 | 0.0040 | 0.1450 | 0.0474 | 0.0013 | 0.0000 | 0.0099 | 0.0036 | 1.0171 | 0.0006 | 0.0016 | 0.0023 | 0.0026 | 0.0004 | 0.0010 | 0.0011 |
| 5 | 0.0089 | 0.0041 | 0.0082 | 0.0085 | 0.0095 | 0.0045 | 0.0059 | 0.0170 | 0.0125 | 1.0075 | 0.0042 | 0.0055 | 0.0039 | 0.0150 | 0.0573 | 0.0191 |
| 6 | 0.0196 | 0.0086 | 0.0054 | 0.0029 | 0.0115 | 0.0083 | 0.0051 | 0.0135 | 0.0122 | 0.0285 | 1.0027 | 0.0153 | 0.0286 | 0.0203 | 0.2532 | 0.0265 |
| 7 | 0.0404 | 0.0440 | 0.0662 | 0.0127 | 0.0176 | 0.0228 | 0.0112 | 0.0167 | 0.0101 | 0.0046 | 0.0219 | 1.0686 | 0.0270 | 0.0352 | 0.0380 | 0.0166 |
| 8 | 0.0077 | 0.0083 | 0.0083 | 0.0474 | 0.0189 | 0.0127 | 0.0074 | 0.0334 | 0.0102 | 0.0059 | 0.0147 | 0.0103 | 1.0272 | 0.0095 | 0.0270 | 0.0033 |
| 9 | 0.0015 | 0.0016 | 0.0448 | 0.0040 | 0.0032 | 0.0059 | 0.0032 | 0.0053 | 0.0066 | 0.0007 | 0.0066 | 0.0336 | 0.0043 | 1.0265 | 0.0472 | 0.0030 |
| 10 | 0.0000 | 0.0000 | 0.0057 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1394 | 0.0000 |
| 11 | 0.0101 | 0.0002 | 0.0010 | 0.0021 | 0.0004 | 0.0002 | 0.0001 | 0.0003 | 0.0002 | 0.0007 | 0.0003 | 0.0029 | 0.0060 | 0.0102 | 0.0262 | 1.0051 |

TABLE XII-2 INVERSE MATRIX, 16-SECTOR OPEN MODEL: TOP END REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0000 | 0.0005 | 0.0001 | 0.0463 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0046 | 0.0051 |
| 2A | 0.0154 | 1.0058 | 0.0002 | 0.0000 | 0.0122 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0000 |
| 2B | 0.0000 | 0.0000 | 1.0001 | 0.0000 | 0.0013 | 0.0000 | 0.0009 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0001 |
| 3 | 0.0008 | 0.0005 | 0.0097 | 1.1389 | 0.0537 | 0.0068 | 0.0113 | 0.1775 | 0.0437 | 0.0010 | 0.0290 | 0.0058 | 0.0013 | 0.0007 | 0.0076 | 0.0017 |
| 4A | 0.0028 | 0.0000 | 0.0165 | 0.0014 | 1.0206 | 0.0000 | 0.0000 | 0.0002 | 0.0010 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0010 |
| 4B | 0.0003 | 0.0002 | 0.0033 | 0.0010 | 0.0004 | 1.0144 | 0.0011 | 0.0005 | 0.0005 | 0.0003 | 0.0112 | 0.0012 | 0.0004 | 0.0005 | 0.0033 | 0.0019 |
| 4C | 0.0004 | 0.0022 | 0.0485 | 0.0045 | 0.0064 | 0.0002 | 1.0034 | 0.0011 | 0.0005 | 0.0016 | 0.0010 | 0.0013 | 0.0060 | 0.0002 | 0.0019 | 0.0004 |
| 4DE | 0.0041 | 0.0022 | 0.0186 | 0.0084 | 0.0249 | 0.0462 | 0.0760 | 1.2150 | 0.0669 | 0.0062 | 0.1713 | 0.0043 | 0.0102 | 0.0035 | 0.0447 | 0.0095 |
| 4F | 0.0022 | 0.0032 | 0.2096 | 0.0040 | 0.0017 | 0.0016 | 0.0015 | 0.0031 | 1.0148 | 0.0008 | 0.0021 | 0.0036 | 0.0036 | 0.0007 | 0.0013 | 0.0018 |
| 5 | 0.0047 | 0.0034 | 0.0082 | 0.0006 | 0.0079 | 0.0058 | 0.0065 | 0.0161 | 0.0084 | 1.0069 | 0.0044 | 0.0060 | 0.0039 | 0.0155 | 0.0568 | 0.0193 |
| 6 | 0.0214 | 0.0102 | 0.0064 | 0.0454 | 0.0123 | 0.0093 | 0.0060 | 0.0184 | 0.0128 | 0.0274 | 1.0042 | 0.0150 | 0.0297 | 0.0204 | 0.2512 | 0.0277 |
| 7 | 0.0735 | 0.0844 | 0.0794 | 0.0058 | 0.0524 | 0.0733 | 0.0423 | 0.0485 | 0.0498 | 0.0109 | 0.0775 | 1.1175 | 0.0319 | 0.0515 | 0.0561 | 0.0418 |
| 8 | 0.0074 | 0.0069 | 0.0087 | 0.0045 | 0.0146 | 0.0126 | 0.0083 | 0.0253 | 0.0082 | 0.0051 | 0.0133 | 0.0107 | 1.0268 | 0.0090 | 0.0263 | 0.0034 |
| 9 | 0.0033 | 0.0029 | 0.0451 | 0.0006 | 0.0037 | 0.0068 | 0.0041 | 0.0041 | 0.0061 | 0.0008 | 0.0077 | 0.0372 | 0.0050 | 1.0234 | 0.0470 | 0.0059 |
| 10 | 0.0000 | 0.0000 | 0.0057 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1380 | 0.0000 |
| 11 | 0.0113 | 0.0003 | 0.0019 | 0.0026 | 0.0008 | 0.0006 | 0.0002 | 0.0008 | 0.0003 | 0.0005 | 0.0005 | 0.0031 | 0.0063 | 0.0096 | 0.0261 | 1.0056 |

## PREFACE

In 1976 a research group at the University of Queensland were commissioned to produce input-output tables for the state and regions of Queensland. The ensuing report, which is now known as the GRIT Report (Generation of Regional Input-Output Tables) was produced for the Queensland Coordinator General's Department and the Queensland Department of Commercial and Industrial Development.

GRIT is a variable-interference non-survey based system, producing "hybrid" input-output tables. It is based on a combination of survey and non-survey methods but allows interference in the mechanical application of these methods at the discretion of the analyst.

Considerable interest in the GRIT method was evidenced on its appearance, and enthusiasm for developing GRIT type tables for other areas of Australia emerged.

During early 1979 the Governments of the Northern Territory and South Australia commissioned the authors to produce input-output tables at a regional and territory-state level. Since its emergence major modifications have been made to the original GRIT procedure and the new system has been entitled GRIT II. This Report is the Northern Territory section of twin reports and contains input-output tables for the Northern Territory and its regions.

The GRIT II system is a further attempt to promote regional input-output analysis from the status of simply a research technique to that of an operational planning technique.

GRIT II provides a methodology for developing regional input-output tables at relatively low cost, but free of substantial error.

## ACKNOWLEDGEMENTS

The completion of this project was made possible only with a considerable amount of assistance from many sources in terms of the provision of data, expert advice relating to the adjustment of prototype tables and material support.

Representatives of the following organisations provided valuable assistance and sound advice:

Department of the Chief Minister
Australian Bureau of Statistics
Department of Mines and Energy
Department of Primary Production
Northern Territory Development Corporation
Treasury Department
Department of Transport and Works
Northern Territory Electricity Commission.

Particular thanks are due to Mr. K. Willett for his organisational assistance and to his staff who gave freely of their time and energy, to Mr. W. Price for his assistance with the survey data, to Mr. W. Mitchell for his willing assistance with difficult data problems and to Mr. K. Willett and Mr. W. Price for their valuable comments relating to the adjustment of the prototype tables. This project was funded by the Department of the Chief Minister, and the Department of Economics at the University of Queensland provided material assistance.

Thanks are due to Mr. J. Morison, Miss M. Cowan, Mrs. C. Ives and Mrs. N. Wolgast for their willing assistance in the production of this report.

G.R. West
J.T. Wilkinson
R.C. Jensen

TABLE OF CONTENTS

## LIST OF TABLES

APPENDIX TABLES

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of the Study

In 1976, following discussions between representatives of the Queensland Co-ordinator General's Department and a research group at the University of Queensland, it was agreed that the research group would produce input-output tables and multipliers for the state and regions of Queensland. The project, funded both by that department and the Queensland Department of Commercial and Industrial Development, resulted in December 1977 in the report now known as the GRIT report.[1]

The research group faced the major problem that the methods in current use to assemble regional input-output tables were for obvious reasons, unsuitable for the project. The most widely used method, the survey method, ideally involved sample surveys of firms in each industry in each region, of consumers, governments and so on. Such a task was prohibitively expensive, not only in terms of funds, but in terms of time. Tables of this nature frequently involve several man-years; the tables are frequently outdated by the time they are published. The alternatives to the survey approach were a number of 'non-survey' approaches which attempted to produce regional tables from national tables by applying 'single-sheet' conversion techniques of various types; the non-survey tables which resulted from these procedures were of dubious repute, and generally accepted as of insufficient accuracy.

---

1. Jensen, R.C., Mandeville, T.D. and Karunaratne, N.D. (1977), Generation of Regional Input-Output Tables for Queensland. Report to the Co-ordinator General's Department and the Department of Commercial and Industrial Development, Department of Economics, University of Queensland. Published (1979) as Regional Economic Planning: Generation of Regional Input-Output Analysis, Croom Helm.

It was clear that a new procedure for producing regional input-output tables was necessary. This procedure should produce tables of an acceptable degree of accuracy in a relatively short period of time and at relatively low cost. Following a period of theoretical research, a procedure termed the Generation of Regional Input-Output (GRIT) procedure was evolved. This procedure employed a number of mechanical means to produce first estimates of regional input-output tables from national input-output tables, and allowed facilities for operator interference to introduce survey-based or other superior estimates into the tables, according to the preferences of the analyst.[2]

Since the emergence of the GRIT report, these further developments associated with the GRIT procedure have occurred. One development has been the use of the procedure for developing and using GRIT input-output tables for impact studies.[3] Another has been the interest shown in evaluation and improvement of the GRIT procedure. A third development has been an active interest in the development of GRIT-type tables for other areas of Australia. It is with the last two of these that this report is concerned.

## 1.2 Objectives of the Study

During early 1979, discussions took place between the authors of this report and the governments of the Northern Territory and South Australia. Both of these governments commissioned the authors to produce input-output tables at a regional and territory-state level. These tables are contained in twin-reports, of which this report refers to the regions

---

2. The procedure is discussed in more detail in Chapter 3.

3. Mandeville, T.D. and Jensen, R.C. (1978), The Impact of Major Development Projects on the Gladstone/Calliope, Fitzroy, Queensland, and Australian Economies: An Application of Input-Output Analysis. Report to the Department of Commercial and Industrial Development and Comalco Limited, Department of Economics, University of Queensland.

and territory of the Northern Territory. The main objective of this report is therefore the portrayal of the economy of the Northern Territory and its regions in input-output tables which are deemed to be free of substantial error.

A second objective of this study is of some importance, and relates to the nature of the original GRIT methodology. This methodology consists of a number of procedural steps, each of which was considered to contribute to the ultimate accuracy and realism of the final input-output tables. Some of these steps have been the subject of criticism in the literature, and were deserving of closer attention in order to improve the accuracy of the calculation procedures. Perhaps more important, however were some of the conclusions reached relating to the accuracy of the GRIT tables. The GRIT report took a pragmatic approach to the question of accuracy, suggesting that a holistic concept of accuracy was appropriate and that such accuracy could be attained by concentrating more effort on the larger coefficients which exert a greater influence on the size of the multipliers, and less on the smaller coefficients which are, apparently, operationally irrelevant.[4] Thus the GRIT report implied a rough concept of accuracy optimisation. This report is much more explicit with respect to this concept, and attempts accuracy optimisation as an explicit additional part of the technique. The report provides some theoretical discussion on the aspect, and some illustrative examples. The authors feel that this major modification to the GRIT procedure, with the several minor modifications mentioned later in the text, require this version of GRIT to be distinguished from the original predecessor, and we have attached the title GRIT II to the procedure which actively incorporates the accuracy optimisation procedure.

---

4. See Jensen, R.C. and West, G.R., "The Effect of Relative Coefficient Size on Input-Output Multipliers", Environment and Planning A (forthcoming).

## 1.3 Outline of the Report

The prime object of this report is the preparation of input-output tables for the regions and territory of the Northern Territory - these results are reported in Chapter 6 and in the various appendices. Two other aspects of this report require, however, description at some length. One of these aspects is the revised definition of the components of input-output multipliers used in this study. This revised definition will replace the conventional definitions used in the past, in all further input-output work by this research team. It is described in some detail in Chapter 2; a copy of a paper written by G.R. West and R.C. Jensen on this topic is included in this report as Appendix IV.

The second aspect requiring description at some length is the revised GRIT system. The system, as published in the original GRIT report is described briefly in Chapter 4. Some significant changes to the original formulation are described in Chapter 5; these are sufficiently significant to warrant an identifying title to the new computational package used in this study and the term GRIT II has been applied.

A brief discussion of the selection of regional boundaries is provided in Chapter 3.

The report is designed so that readability is improved by placing the mass of technical detail in appendices.

## CHAPTER 2

## INPUT-OUTPUT TABLES AND MULTIPLIERS[1]

Input-output tables and analysis have been part of the literature of economic analysis for some time, and it is probably not necessary in a report of this nature to include another simple outline of the technique. A number of useful texts[2] provide introductions to the technique, and these are recommended for further insights into the power and flexibility of input-output. This chapter provides only a brief summary of input-output, by reference to a highly aggregated 3-sector table of the Queensland economy.

This summary is included primarily to demonstrate the multiplier structure and terminology used in the empirical sections of this report. The authors have been dissatisfied for some time with the conventional input-output multipliers and the inconsistencies in interpretation of these multipliers. They have developed a revised structure and terminology for input-output multipliers; this structure is considered to be simpler to interpret and to avoid inconsistencies in interpretation. An outline of these inconsistencies in conventional multipliers and of the revised multiplier format is provided in more detail in Appendix IV.

### 2.1 The Input-Output Transactions Table

An input-output table represents an economy in terms of aggregated industrial or commodity groups, or sectors. The table traces out the value of transactions, in dollar terms, between these sectors for a given year. Sectors sell goods and services to other sectors and to final users or final demand, and buy their inputs from other sectors and sources of primary

---

1. The early pages of this chapter draw heavily from the original GRIT report.

2. See, for example (a) Miernyk, W.H. (1965), Elements of Input-Output Analysis, Random House; (b) Chenery, H.B. & Clark, P.G. (1962), Interindustry Economics, Wiley; and (c) Richardson, H.W. (1972), Input-Output and Regional Economics, Weidenfeld & Nicolson.

inputs. The transactions table summarises the intersectoral flows for a given period and is conventionally presented in matrix form. A highly-aggregated 3-sector transactions table for the Queensland economy is shown as Table 2.1. Each row indicates the sales flows from one sector to another and to final demand. From Table 2.1, Sector 1 sells $129.1m of its output (of $1819.9m) to firms in the same sector, $703.5m to firms in Sector 2, $20.6m to firms in Sector 3, $102.4m to household consumers as final users and $864.3m to other final demand sources. The columns show the purchasing patterns of the sectors. For example, Sector 2 purchases $703.5m from firms in Sector 1, $778.6m from firms in the same sector, $503.2m from firms in Sector 3, $946.9m from primary inputs in the firms of household labour (via wages, salaries etc.) and $1107.6m in the form of other primary inputs.

TABLE 2.1: HIGHLY AGGREGATED TRANSACTIONS TABLE, QUEENSLAND, 1973-4($m)

| | Intermediate Sectors 1 | 2 | 3 | Household Consumption | Other Final Demand | Total Output |
|---|---|---|---|---|---|---|
| | (Quadrant I) | | | (Quadrant II) | | |
| Intermediate Sectors 1 | 129.1 | 703.5 | 20.6 | 102.4 | 864.3 | 1819.9 |
| 2 | 242.5 | 778.6 | 359.2 | 762.2 | 1897.3 | 4039.8 |
| 3 | 224.0 | 503.2 | 536.7 | 1434.2 | 1325.5 | 4023.6 |
| | (Quadrant III) | | | (Quadrant IV) | | |
| Households | 191.6 | 946.9 | 1660.4 | - | - | 2798.9 |
| Other Primary Inputs | 1032.7 | 1107.6 | 1446.7 | 500.1 | 429.2 | 4516.3 |
| Total | 1819.9 | 4039.8 | 4023.6 | 2798.9 | 4516.3 | 17198.5 |

It is usual to define four quadrants (Quadrants I to IV) in an input-output table. Quadrant I is termed the 'intermediate' or the 'processing' quadrant. It shows the flows of transactions between the industrial sectors defined for the study, and, as later described, provides the analytical core of the input-output technique. Quadrant II indicates sales by each sector to final demand. This quadrant in most input-output tables traditionally includes columns relating to personal consumption, capital formation, some government expenditure and exports. Quadrant III lists the primary inputs into each industry, i.e. those inputs which are not purchases from local industrial sectors. It represents mainly value-added in production. Normally included in this quadrant are rows for depreciation, indirect taxes, wages and salaries (the household row in Table 2.1), gross operating surplus, imports and other value-added items. Quadrant IV, showing primary inputs absorbed by final demand, is normally of less importance in most input-output tables and is often ignored in analytical terms. This quadrant includes however, in tables with direct allocation of imports, the basic value of imported goods consumed by householders; this is often a relatively significant entry in input-output models of small or rural economies.

The number of sectors shown in a particular table is determined mainly by the availability of data and the objectives of the study. All endogenous sectors of the economy are included within the intermediate quadrant of the table and all exogenous sectors in other quadrants. Endogenous sectors are those which are assumed to be influenced by the internal structure of the economy, while exogenous sectors are those assumed to be governed by external influences. Thus exports, capital expenditure and government spending are usually treated as exogenous since these are influenced primarily by factors external to the regional economy. Personal consumption expenditure is treated as exogenous in one type of input-output table, the standard or 'open' model, but as endogenous in the 'closed' or induced-consumption model.

The transactions table provides a concise, descriptive snapshot of a particular economy at a point in time. It is also a disaggregated and consistent accounting system for an economy. The final demand components are considered to indicate the equivalent of what GNP or

GRP (Gross Regional Product) measures on the expenditure side, and primary inputs are the same as the receipts side. However, since GNP or GRP accounting seeks to avoid the double-counting involved in all the transactions leading up to final demand, it contains only part of the information represented in an input-output table. In the regional policy and planning context, the transactions table gives both a general understanding of the economy of a particular region, and important information on particular aspects of the region's economy.

Before discussing the output, income and employment multipliers in some detail, it is necessary to distinguish between the treatment of the household sector in 'open' and 'closed' input-output models. In open input-output models, household personal consumption is located in the final demand portion of the table, and its accompanying row comprising wages, salaries and other household income is included with primary inputs. Alternatively, the input-output table may be closed with respect to households by inserting the household row and column into the endogenous matrix. The implications of these alternatives will become clear in the discussion on multipliers in Section 2.2.

## 2.2 The Mathematical Structure of Input-Output

Once the transaction table has been compiled, simple mathematical procedures can be applied to derive output, income and employment multipliers for each sector in the economy. These procedures are illustrated briefly with accompanying comment.

The transactions table may be represented by a series of equations thus:

$$X_1 = X_{11} + X_{12} + \ldots\ldots\ldots + X_{1n} + Y_1$$

$$X_2 = X_{21} + X_{22} + \ldots\ldots\ldots + X_{2n} + Y_2$$

$$\vdots$$

$$X_n = X_{n1} + X_{n2} + \ldots\ldots\ldots + X_{nn} + Y_n$$

where

$X_i$ = Total output of intermediate sector i (row totals)

$X_{ij}$ = Output of sector i purchased by sector j (elements of processing sector)

$Y_i$ = Total final demand for the output of sector i

It is possible, by dividing the elements of the columns of the transactions table by the respective column totals to derive coefficients which represent more clearly the purchasing pattern of each sector. These coefficients, variously termed 'direct' or 'input-output' coefficients or less appropriately 'technical coefficients', are normally notated as the $a_{ij}$, and represent the direct or first round requirement from the output of each sector following an increase in output of any sector.

In equation terms the model becomes:

$$X_1 = a_{11}X_1 + a_{12}X_2 + \ldots\ldots\ldots + a_{1n}X_n + Y_1$$

$$X_2 = a_{21}X_1 + a_{22}X_2 + \ldots\ldots\ldots + a_{2n}X_n + Y_2$$

$$\vdots$$

$$X_n = a_{n1}X_1 + a_{n2}X_2 + \ldots\ldots\ldots + a_{nn}X_n + Y_n$$

where $a_{ij} = X_{ij}/X_j$, when $a_{ij}$ is the input-output coefficient.

This may be represented in matrix terms:

$$X = AX + Y \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where $A = [a_{ij}]$, the matrix of input-output coefficients.

The A matrix of direct coefficients for the Queensland example is given as Table 2.2.

TABLE 2.2: DIRECT COEFFICIENTS MATRIX, QUEENSLAND, 1973-4

| | 1 | 2 | 3 |
|---|---|---|---|
| 1 | .071 | .174 | .005 |
| 2 | .133 | .193 | .089 |
| 3 | .123 | .125 | .133 |
| Total Intermediate | .327 | .492 | .227 |
| Households | .105 | .234 | .413 |
| Other Primary Inputs | .568 | .274 | .360 |
| Total | 1.000 | 1.000 | 1.000 |

Equation (1) can be extended to:

$X(I-A) = Y$ where I-A is termed the Leontief matrix

or $X = (I-A)^{-1}Y$ where $(I-A)^{-1}$ is termed the 'general solution' (or simply the inverse of the open model).

Let this general solution be represented by:

$$Z = (I-A)^{-1} = [z_{ij}]$$

This open inverse is given for the Queensland example by Table 2.3.

TABLE 2.3: $Z = (I-A)^{-1}$, QUEENSLAND, 1973-4

| | 1 | 2 | 3 |
|---|---|---|---|
| 1 | 1.116 | .246 | .032 |
| 2 | .205 | 1.304 | .136 |
| 3 | .188 | .222 | 1.178 |
| Total | 1.509 | 1.772 | 1.346 |

The input-output table can be 'closed' with respect to certain elements of the table. Closure involves the transfer of an item from the exogenous portions of the table (exclusively Quadrants II, III and IV) to inclusion in the endogenous section of the table (Quadrant I); closure implies that the analyst considers that the transferred item is related more to the level of local economic activity than to external influences. Closure of input-output tables with respect to households is common; this is illustrated for the Queensland table in Table 2.4.

TABLE 2.4: MATRIX OF DIRECT COEFFICIENTS, CLOSED WITH RESPECT TO HOUSEHOLDS, QUEENSLAND

| | 1 | 2 | 3 | Households |
|---|---|---|---|---|
| 1 | .071 | .174 | .005 | .036 |
| 2 | .133 | .193 | .089 | .273 |
| 3 | .123 | .125 | .133 | .512 |
| Households | .105 | .234 | .413 | - |

We refer to the 'closed' or 'augmented' matrix as $A^*$; the inverse of the Leontief matrix formed from $A^*$ is given by $Z^* = (I-A^*)^{-1}$, and is provided for this example in Table 2.5.

TABLE 2.5: $Z^* = (I-A^*)^{-1}$, QUEENSLAND, 1973-4

| | 1 | 2 | 3 | Households |
|---|---|---|---|---|
| 1 | 1.165 | .332 | .138 | .204 |
| 2 | .378 | 1.604 | .505 | .710 |
| 3 | .456 | .689 | 1.752 | 1.102 |
| (Total) | (1.999) | (2.625) | (2.395) | |
| Households | .399 | .695 | .856 | 1.643 |

## 2.3 Input-Output Multipliers

### 2.3.1 The Structure of Input-Output Multipliers

This section avoids the use of the conventional terms "direct" and "indirect" because of the confusion of meaning attracted to these terms, as outlined in Appendix IV.[3]

A multiplier is essentially a measurement of response to an economic stimulus. In the case of input-output multipliers the stimulus

3. This section draws heavily from the paper reproduced in Appendix IV.

is normally assumed to be an increase of one dollar in sales to final demand by a sector, and we are interested in the major categories of response in terms of output and income increases. These major categories of effect/response are listed below. They are:

(i) The Initial Effect. This refers to the assumed dollar increase in sales; it is the stimulus. It is the unity base for the output multiplier and provides the identity matrix of the Leontief matrix. Associated directly with this dollar increase in output is an own-sector increase in household (HH) income in wages, salaries etc. used in the production of that dollar of output. This is the household coefficient $h_i$ ($0.105 for Sector 1). Associated also will be an own-sector increase in employment, determined by the size of the employment coefficient.

(ii) The First-Round Effect. This refers to the effect of the first-round of purchases by the sector providing the additional dollar of output. Clearly in the case of the output multiplier this is shown in the elements of the direct coefficients matrix (Table 2.2). For example, the direct effect of an increase of one dollar in the output of Sector 1 is $0.071 on Sector 1, $0.133 on Sector 2, and $0.123 on Sector 3 (these are termed the disaggrogated direct effects) or a total of $0.327 on all intermediate sectors of the economy. The disaggregated effects are given by the individual $a_{ij}$, and the total first-round effects by the $\sum_i a_{ij}$.

First-round income effects are calculated by multiplying the first-round output effects by the appropriate HH income coefficients, as shown in Table 2.6. The total first-round income effect is given by $\sum_i a_{ij} h_i$, in this case $0.089, and

TABLE 2.6: FIRST-ROUND INCOME EFFECTS, SECTOR 1, QUEENSLAND, 1973-4

| Sector | $a_{i1}$ | $h_i$ | $a_{i1}h_i$ |
|---|---|---|---|
| 1 | .071 | .105 | .007 |
| 2 | .133 | .234 | .031 |
| 3 | .123 | .413 | .051 |
| | First-Round Income Effect | = | .089 |

the disaggregated income effects, or the extent to which HH income increases in each sector due to the first-round output effects, is given by the individual $a_{ij}h_i$, i.e. in this case \$0.007 in Sector 1, \$0.031 in Sector 2 and \$0.051 in Sector 3.

(iii) Industrial Support Effects. This term is applied here to "second and subsequent round" effects, as successive waves of output increases occur in the economy to provide industrial support as a response to the dollar increase in output *per se*. The term excludes any increases caused by increased household consumption. Output effects are calculated from the open Z inverse (Table 2.3), as a measure of industrial response to the first-round effects. The industrial support output requirements must be calculated as the elements of the columns of the Z inverse, less the initial dollar stimulus and the first-round effects, as shown in Table 2.7. This table shows that the industrial support effects of an increase of one dollar in the

TABLE 2.7: CALCULATION OF INDUSTRIAL SUPPORT OUTPUT AND INCOME EFFECTS, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Z column | Initial Stimulus | First-Round Effect | HH coefficient | Industrial Support Effects Output(a) | Industrial Support Effects Income(b) |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 1 | 1.116 | 1.000 | .071 | .105 | .045 | .005 |
| 2 | .205 | - | .133 | .234 | .072 | .017 |
| 3 | .188 | - | .123 | .413 | .065 | .027 |
| | 1.509 | 1.000 | .327 | | .182 | .049 |

(a) Column (1) less columns (2) & (3)
(b) Column (5) by column (4)

sales of Sector 1 to final demand are \$0.045 on Sector 1, \$0.072 on Sector 2, \$0.065 on Sector 3, or a total of $\sum_i z_{ij}-1-\sum a_{ij}$ over all sectors of \$0.182. The industrial support income effects for each sector will be defined consistently with the output effects as column (5) of Table 2.7 multiplied by the HH income coefficients i.e. individually in disaggregated income effects as $z_{ij}h_i-h_i-a_{ij}h_i$, or as total industrial support income effects as $\sum_i z_{ij}h_i-h_i-a_{ij}h_i$.

The first-round and industrial support effects are together termed the production-induced effect.

(iv) Consumption-induced Effects. The consumption-induced effect is defined in a manner similar to that used in conventional input-output multipliers, namely as that induced by increased HH income associated with the original dollar stimulus in output. The consumption-induced output effects are calculated in disaggregated form as the difference between the corresponding elements of the open and closed inverse i.e. $z^*_{ij} - z_{ij}$, and in total as $\sum_i(z^*_{ij} - z_{ij})$. The consumption-induced income effects are simply these output effects multiplied by the household coefficients, i.e. $z^*_{ij}h_i - z_{ij}h_i$ for each disaggregated effect and $\sum_i(z^*_{ij}h_i - z_{ij}h_i)$ for the total consumption-induced income effect.

The four effects are summarised in Table 2.8. It should be noted that employment multipliers are calculated by substituting the employment coefficient $e_i$ for the household coefficient $h_i$ in Table 2.8.

TABLE 2.8: OUTPUT AND INCOME EFFECTS OF AN INCREASE IN SALES TO FINAL DEMAND

| | Output Multipliers | | Income Multipliers | |
|---|---|---|---|---|
| | General Case | Example | General Case | Example |
| (i) Initial Effect | 1 | 1 | $h_i$ | .105 |
| (ii) First Round Effect | $\sum_i a_{ij}$ | .327 | $\sum_i a_{ij} h_i$ | .089 |
| (iii) Industrial Support Effect | $\sum_i b_{ij} - 1 - \sum_i a_{ij}$ | .182 | $\sum_i b_{ij}h_i - h_i - a_{ij}h_i$ | .049 |
| (iv) Induced Effect | $\sum_i b^*_{ij} - \sum_i b_{ij}$ | .490 | $\sum_i b^*_{ij}h_i - \sum b_{ij}h_i$ | .155 |
| Total | $\sum_i b^*_{ij}$ | 1.999 | $\sum_i b^*_{ij} h_i$ | .398 |

Output multipliers for the Queensland example are shown in Tables 2.9 and 2.10, and revised income multipliers of consistent definition in Tables 2.11 and 2.12. These multipliers indicate for example that a dollar increase in sales of sector 1 to final demand results in:

(i) an initial income increase to the workers/staff/owners in Sector 1 of $0.105.

(ii) a first-round output effect on all sectors of $0.327 ($0.071 in Sector 1, $0.133 in Sector 2, and $0.123 in Sector 3), accompanied by a first-round income increase of $0.089, being $0.007, $0.031, and $0.051 in each sector.

(iii) industrial support output effects of $0.182 (being $0.045, $0.072 and $0.065 in the three sectors), which in turn are accompanied by income increases of $0.049, being $0.005, $0.017 and $0.027 respectively.

(iv) consumption-induced output effects of $0.490 ($0.049, $0.173 and $0.268 respectively in the sectors) and accompanying consumption-induced income increases of $0.156, being in each sector $0.005, $0.040, and $0.110 respectively.

TABLE 2.9: SECTOR OUTPUT MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, QUEENSLAND, 1973-4

| Sector | Initial | First Round[(a)] | Industrial Support[(b)] | Induced[(c)] | Total[(d)] |
|---|---|---|---|---|---|
| 1 | 1.000 | .327 | .182 | .490 | 1.999 |
| 2 | 1.000 | .492 | .280 | .853 | 2.625 |
| 3 | 1.000 | .227 | .119 | 1.049 | 2.395 |

(a) from Table 2.2
(b) from Table 2.2 & 2.3, using formula (iii) of Table 2.8.
(c) from formula (iv) of Table 2.8.
(d) from Table 2.5.

TABLE 2.10: DISAGGREGATED OUTPUT MULTIPLIERS, BY FOUR CATEGORIES OF EFFECT, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Initial | First Round[(a)] | Industrial Support[(b)] | Induced[(c)] | Total[(d)] |
|---|---|---|---|---|---|
| 1 | 1.000 | .071 | .045 | .049 | 1.165 |
| 2 | - | .133 | .072 | .173 | .378 |
| 3 | - | .123 | .065 | .268 | .456 |
| | 1.000 | .327 | .182 | .490 | 1.999 |

(a) from Table 2.2.
(b) from Table 2.7.
(c) from section (iv) of text.
(d) from Table 2.5.

TABLE 2.11: SECTOR INCOME MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, QUEENSLAND, 1973-4

| Sector | Initial[(a)] | First Round[(b)] | Industrial Support[(c)] | Induced[(d)] | Total[(e)] |
|---|---|---|---|---|---|
| 1 | .105 | .089 | .049 | .156 | .399 |
| 2 | .234 | .115 | .074 | .272 | .695 |
| 3 | .413 | .077 | .032 | .335 | .857 |

(a) from Table 2.2.
(b) from Table 2.6 & similar calculations.
(c) from Table 2.7 & similar calculations.
(d) from section (iv) of text.
(e) from Table 2.5.

TABLE 2.12: DISAGGREGATED INCOME MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Initial[(a)] | First Round[(b)] | Industrial Support[(c)] | Induced[(d)] | Total |
|---|---|---|---|---|---|
| 1 | .105 | .007 | .005 | .005 | .122 |
| 2 | - | .031 | .017 | .040 | .088 |
| 3 | - | .051 | .027 | .110 | .188 |
| | .105 | .089 | .049 | .155 | .398 |

(a) from Table 2.2.
(b) from Table 2.6.
(c) from Table 2.7.
(d) from section (iv) of text.

## 2.3.2 Type I and Type II Multipliers

The output multipliers are calculated on a 'per unit of initial effect' basis - i.e. output responses to a dollar change in output. Income multipliers as described above refer to changes in income per dollar initial change in output. Income multipliers are conventionally converted to a 'per unit' measurement by the calculation of Type I and II multipliers as:

$$\text{Type IA Income Multiplier} = \frac{\text{Initial} + \text{First Round effects (IF)}}{\text{Initial effects (I)}}$$

$$\text{Type IB Income Multiplier} = \frac{\text{Initial} + \text{Production-induced effects (IP)}}{\text{Initial effects (I)}}$$

$$\text{Type II Income Multiplier} = \frac{\text{Initial} + \text{Production-induced} + \text{Consumption-induced effects (IPC)}}{\text{Initial effects (I)}}$$

The Type I and II income multipliers for the Queensland example are given in Table 2.13. The Type IA multiplier illustrates, for example that for each dollar of initial income effect (as a result of increased output) in sector 1, associated first-round effects will be \$0.85; when industrial support effects are included (Type IB), associated income effects will be \$1.31, and when consumption-induced effects are included (Type II), associated income will be \$2.80.

TABLE 2.13: TYPE I AND II INCOME MULTIPLIERS, QUEENSLAND, 1973-4

| | | |
|---|---|---|
| Type IA = $\frac{IF}{I}$ | Sector 1 | 1.85 |
| | 2 | 1.49 |
| | 3 | 1.19 |
| Type IB = $\frac{IP}{I}$ | Sector 1 | 2.31 |
| | 2 | 1.81 |
| | 3 | 1.26 |
| Type II = $\frac{IPC}{I}$ | Sector 1 | 3.80 |
| | 2 | 2.97 |
| | 3 | 2.07 |

# CHAPTER 3

## THE NORTHERN TERRITORY AND ITS REGIONS

### 3.1 Considerations in the Definition of Region

Consideration of what constitutes a region and of how the nation/state may be subdivided into a system of regions is a prerequisite for any economic analysis at the regional level. The choice and definition of a region is constrained by the number of regions to be considered, and this number depends on the form and nature of the analysis. The approximate number of regions to be considered has to be predetermined before regional delimitation can be attempted.

One approach to the definition of a region is based on the notion that separate spatial units which exhibit particular common characteristics may be linked together to form an homogeneous region. Such characteristics might include similar production structures or consumption patterns, the prevalence of a dominant natural resource or even non-economic variables such as similar typography or climate. However, some areas which can be linked on the basis of some particular characteristics will at the same time exhibit other characteristics which enable them to be linked to a different (or neighbouring) region. This makes the task of deciding appropriate boundaries more difficult.

Differences in economic phenomena will generally be evident in any one region. For example, most regions will contain both urban and rural areas. Moreover, large areas are likely to exhibit an uneven distribution of population with greater numbers clustered in urban centres and fewer people scattered over rural parts. The economic significance of such features is that it becomes difficult to consider such regions as uniformly homogeneous since "large urban centres always introduce heterogeneity".[1]

1. E. Ullman p. 16 quoted in Gajda, R.T. (1964) "Methods of Economic Rationalization", Geographica Polonica 4 (185), reproduced in Richardson, H.W., Regional Economics (1972), Weidenfeld and Nicolson.

There is a functional interdependence between the internal components of a region, and also between the region itself and its neighbouring regions. Internally, functional linkages, may be derived from service connections within the region, while externally, transportation networks, trade links, production links, communication networks, migration flows, and flows of raw materials and manufactured goods etc. link a particular region with a wider spatial framework. Thus, emphasis on one type of region rather than another may depend on the structure of the regional system considered as a whole.

If there are a number of areas with clearly defined economic structures, then the division of the national/state economy into a number of regions is made easier. However, where clearly marked geographic areas of economic specialization are not evident the choice of regional boundaries becomes more difficult and arbitrary. Therefore the choice of an ideal region is constrained by the purpose for which delimitation of a set of regions is required and by the overall structure and degree of integration of the system as a whole.

## 3.2 The Regional Boundaries

Since many input-output studies are commissioned by regional or national government agencies, existing administrative units often form the basis of regional boundaries. However, ideally the "regions" of an input-output analysis should exhibit reasonably stable interregional trade coefficients and conform to a production or supply area which preserves intact local economic structures.

The Northern Territory has a smaller range of regions in terms of economic complexity than do the other states of Australia. The more isolated regions of Katherine and Barkly exhibit a simple economic structure with one or two primary industries providing the export base, very restricted local manufacturing (e.g. bakeries, light engineering) and the importation of most consumer goods. However, the more heavily populated Darwin Region exhibits many of the complexities of a modern city region.

In order to encompass the different levels of complexity of the individual regions, the study team, together with representatives of the various government departments decided to separate the metropolitan region from the other types of regions. The administrative unit which formed the basis for delineation of the regional boundaries was the Statistical Division.[1]

The Darwin region represented the only metropolitan region in the Territory and was considered to exhibit a sufficiently diverse economy to warrant attention in its own right. The administrative unit which formed the Darwin Region was Vernon Statistical Division.[2]

A number of regions were defined under the general heading of provincial regions. These generally contained a significant urban area with some manufacturing activity but where primary activities were relatively diverse.

These provincial regions included the following.[3]

(i) Top End Region

(ii) Katherine-Barkly Region

(iii) Alice Springs Region

The Top End Region comprises the Statistical Divisions of Daly, Vernon, Alligator and East Arnhem. The Katherine-Barkly Region comprises Victorian River, Elsey, Gulf Tableland and Tennant Creek Statistical Divisions. The Alice Springs Region comprises the Statistical Divisions of Tanami, Sandover and Petermann.

---

1. Statistical Division as defined by the Australian Bureau of Statistics.
2. See Map 1.
3. See Map 1.

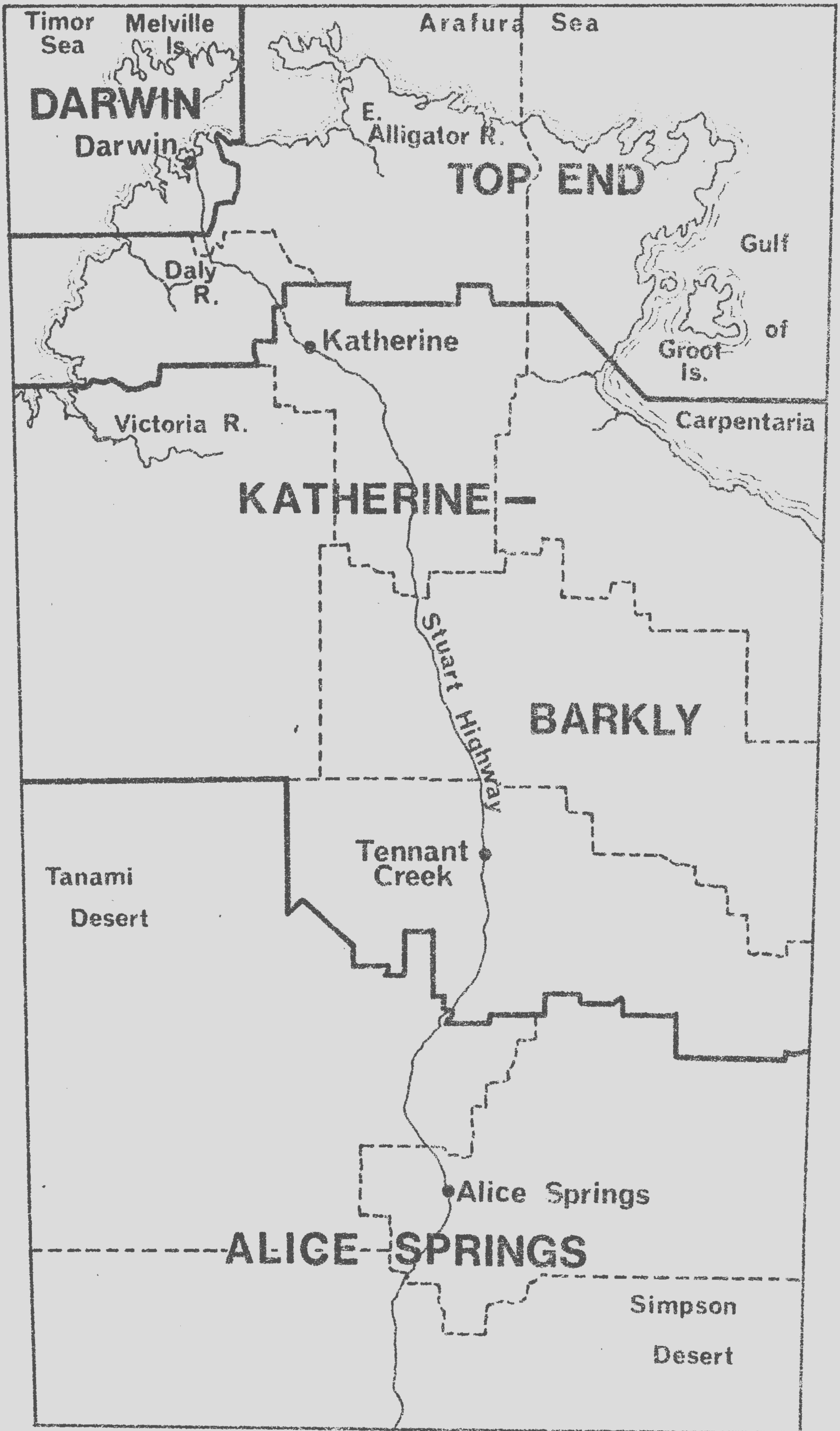
Finally, a region encompassing the State as a whole facilitated the preservation of statistical consistency as well as allowing interstate comparisons to be made.

Summarising the above, the Regional Boundaries for the Northern Territory are shown below.

THE NORTHERN TERRITORY

- Metropolitan Region
  - Darwin Region (comprising Vernon Statistical Division)
- Provincial Regions
  - (i) Top End Region (Daly, Vernon, Alligator and East Arnhem Statistical Divisions)
  - (ii) Katherine-Barkly Region (Victoria River, Elsey, Gulf Tableland, and Tennant Creek Statistical Divisions)
  - (iii) Alice Springs Region (Tanami, Sandover and Petermann Statistical Divisions)

# Regions of the Northern Territory



# CHAPTER 4

# THE GRIT SYSTEM

## 4.1 Introduction

This chapter provides a summary of the original GRIT procedure (Jensen, Mandeville and Karunaratne (1979)). The objective of this study was the development of techniques to provide an empirical base for regional economic planning, and to apply these techniques to the state of Queensland. It was intended to devise a system which facilitated the examination both of the economic structure of individual regions in reasonable detail, and of the regional structure of the state economy. It was considered that such a requirement could be met only by the development of a series of input-output tables relating to the state and its constituent regions. It was further recognised that the development of such a system of input-output tables would be feasible only if suitable techniques could be developed, or existing techniques modified, to derive the series of regional tables largely from national input-output tables.

Input-output analysis is potentially an excellent descriptive device and a powerful analytical technique. In practice, the time and expense required to complete survey-based tables has restricted the application of the technique to 'research' rather than operational applications. Certainly input-output techniques appear to have played no significant part in most regional planning decisions made by governments, due at least partly to the inability of analysts to produce input-output tables by conventional means within the time span in which most decisions must be made.

Recent input-output literature describes attempts to produce input-output tables by non-survey, or largely mechanical means. These methods have the advantage of relative speed and low cost, but have attracted criticism for an apparently lower degree of reliability. The current 'state-of-the-art' appeared to offer a choice between the more expensive and professionally-respected survey-based tables and the cheaper less-respected non-survey tables. The only further alternative was the so-called 'hybrid' table, which supplements mechanically produced elements of the table with insertions of survey-based data to improve the acceptability of the resulting table.

This study was the result of efforts by the authors to move input-output analysis from the category of a 'research' technique to one of operational application for regional planning and analysis. A system was developed, termed the Generation of Regional Input-Output Tables (or GRIT) system which produced variable-interference non-survey based tables, essentially hybrid in nature. GRIT relied on a series of mechanical steps to produce regional coefficients, but provided the opportunity at three stages for the insertion of 'superior data'.[1]

The system is 'variable-interference' to the extent that the analyst is able to determine the extent to which he interferes with the mechanically-produced tables by insertion of this superior data at various stages in the development of the tables. In this way, the judgement of the analyst is incorporated into the tables. It is argued that such a system incorporates the advantages of both survey-based and non-survey tables, and avoids the cost extravagances of the former. The GRIT system allows the calculation of tables to the degree of accuracy which we would simply claim as 'free from significant error', rather than accuracy in detail. The implication here is one of a concept of holistic accuracy, that the table as a whole is substantially representative of the regional economy in question. It is argued also that since the smaller coefficients in an input-output table have an insignificant effect

---

1. The term 'superior data' refers specifically to data considered by the analyst to be 'more reliable' than that produced by the mechanical process. Such data could originate from surveys, primary or secondary data sources, or simply from "well-informed sources".

on the analytical uses of the tables, the method of calculation of these coefficients is operationally irrelevant. The more significant coefficients in the tables warrant more attention, and may be corrected by the insertion of superior data. It is, therefore, probable that the analytical reliability of GRIT tables would be similar to that of survey-based tables.

The crucial question becomes then the extent of interference in the mechanical process or the extent to which superior data is sought for insertion into the mechanically-produced table. It is tempting to conclude that this interference should be maximised subject to the resources available for the study and this would be an appropriate conclusion. An alternative approach, and one adopted in this study was to ensure that the characteristics of major or dominant industries were faithfully represented, and to search the prototype tables for any anomalies apparent to those familiar with the economic structure of the individual regions.

The GRIT system was designed to incorporate the following features:

(a) that input-output tables and their attendant multipliers could be calculated for any region for which certain minimum levels of data are available, from local government areas, to 'planning' regions, to any ad hoc region devised for a specific purpose.

(b) that the regional tables be consistent with the table developed for the economy as a whole.

(c) that, although the basic GRIT methodology for producing both state and regional tables is a combination of procedures for converting national tables to regional tables, sufficient flexibility exists to allow the insertion of other data at the discretion of the analyst.

(d) that the system be capable of updating with minimum effort, as new data sources become available.

(e) that the input-output tables and multipliers derived for the state and for each region be directly comparable, both conceptually and by sector definition, and internally consistent within the system.

(f) that the application of the system in an empirical context involve a minimum of expense and time, consistent with a reasonable degree of accuracy.

(g) that the application of the system be sufficiently uncomplicated to encourage adoption by analysts without a high level of expertise in 'conventional' approaches in the preparation of input-output tables.

(h) that the system be designed as a series of modular components, each of which might be modified by the analyst.

## 4.2 The GRIT Methodological Sequence

The GRIT methodological system is basically a combination and adaptation of non-survey methods in the literature, reinforced by new approaches formulated by the authors into an overall framework for application to individual regions. For each sector in the tables the objective was to convert the national input structure (cost coefficients) into the regional input structure. The national sector will differ from the regional one by three main factors: (a) imports (the main difference arising from the greater "openness" of regional economies); (b) industrial mix, and (c) production functions. The GRIT methodology accounts for these differences and has been expressed in a sequence of fifteen steps which are arranged in five phases; a brief description of the sequence follows.

### 4.2.1 Phase I Adjustments to the National Table

Phase I provided for selection of an appropriate version of the national table which provided the basic input into GRIT, and for necessary adjustments to this table to develop the most appropriate form for the subsequent calculation of regional tables. Step 1 identified the chosen version of the national tables; this was the 1968-69 109-sector table in basic values with direct allocation of all imports. Step 2, provided for adjustment for price levels and updating, was inserted as an optional step. Procedures for these adjustments are available, and could be incorporated at the discretion of the analyst; in this application to develop regional tables for the state of Queensland, Step 2 was omitted. This decision was taken in the knowledge that updated tables could be substituted for the 1968-69 tables if they became available. The implementation of updating and price adjustment procedures at the 109-sector level were, in any case, beyond the resources available for the study.

The extent to which a nation and any of its constituent regions trade with the 'rest of the world' differs significantly, both in terms of the relative importance of trade, and the trading pattern of the various sectors. Thus Step 3 provided for adjustments to the national table for international trade, to produce a table representing a national closed economy, i.e. that the imports originally shown in the national tables were assumed to be domestically produced. This was achieved by allocating imports over the intermediate entries in the columns of the national table.

Examination of the national tables indicated that the bulk of imports were of inputs to, or of finished products of, secondary industries. This invited the suggestion that accuracy would be served more by restricting the reallocation of the import coefficient in each column to those coefficients representing purchases from secondary industries within that column. This was adopted as a standard reallocation procedure. However, it was recognised that this procedure could produce serious distortions in some sectors where it was known that national imports to the sector were not primarily of secondary commodities. A procedure was therefore implemented to allow interference in the general reallocation procedure to allow the operator to reallocate imports over any combination of the three groups i.e. primary, secondary and tertiary sectors.

### 4.2.2 Phase II Adjustment for Regional Imports

Phase I provided the reference base for that part of the GRIT system which is mechanical in nature, and from which the calculation of any number of tables referring to regions within the nation could be initiated. Phase II and subsequent phases were required with respect to each regional table. Phase II attempted the conversion of national trade coefficients to the first approximations of regional trade coefficients. We begin with the 109-sector matrix of national coefficients adjusted for international trade, and seek to produce a matrix of regional coefficients, by applying two adjustment procedures.

The conversion of national coefficients to regional coefficients is usually stated simply in terms of decomposing the national technical coefficient $a_{ij}$ (from the national coefficient A matrix) into a regional input coefficient $r_{ij}$ and a regional import coefficient $m_{ij}$. The process of decomposition is usually based on the assumption that national and regional technical coefficients are identical, and that the decomposition will provide estimates of regional input-output coefficients $r_{ij}$ and imports $m_{ij}$ which are closer to survey-based coefficients than to national coefficients. We argued that since national tables are derived, in Australia at least, from transactions or flows rather than physical quantities, it is inappropriate to suggest that these national coefficients are technical coefficients in any real sense. The process of regionalisation of national coefficients should then be seen as adjusting national flow or trade coefficients to coefficients which represent regional flows.

Step 4 involved the application of a procedure similar to that proposed by Smith and Morrison (1974)[2]. Where data from the Australian Bureau of Statistics indicated the absence in the region of either firms or employment in any nationally defined sector, the $a_{ij}$ associated with that classification from the 'regional' A matrix was entered as a regional import. Following this, Step 5 provides for downward adjustment of some of the remaining coefficients in the national A matrix, to remove to the imports row that portion of purchases ascribed to these sectors in the national table, but which become imports at the regional level.

The various methods which have been adopted for this conversion in Step 5 have been discussed at length in the literature. The selection of a technique for decomposing the national coefficient has received more attention in the literature than other aspects of developing regional non-survey tables; in fact, apart from the work of Smith and Morrison (1974)[2] and Schaffer (1976)[3] it has been regarded by most previous analysts as the sole method of developing non-survey tables. Certainly the selection of a procedure is important to the ultimate accuracy of the regional tables. It has been suggested by Smith and Morrison (1974) and Czamanski and Malizia (1969)[4] that the simple location quotient (LQ) would produce regional tables closer to survey-based tables than the alternative location quotient and commodity balance procedures. These analysts

---

2. Smith, P.S. and Morrison, W.I. (1974), Simulating the Urban Economy, Pion, London.

3. Schaffer, W.A. (1976), On the Use of Input-Output Models for Regional Planning, Studies in Applied Regional Science, Martinus Nijhoff, Leiden.

4. Czamanski, S. and Malizia, E. (1969), "Applicability and Limitations in the Use of National Input-Output Tables for Regional Studies", Papers and Proceedings of the Regional Science Association, 23 : 65-77.

measured the 'closeness' of the survey-based and derived non-survey tables, in terms of the distance between coefficients of the two tables. The location quotient was thus chosen as the appropriate procedure for the GRIT system. An important criticism of the location quotient rests on the implicit assumption of uniformity in demand and consumption patterns throughout the state. This assumption was inevitable in the absence of studies of consumption on a spatial basis. This problem was overcome to some extent by allowing the analyst the freedom to insert more appropriate consumption data for any region, should this be available.

The location quotient in the GRIT sequence was applied as follows:

(i) Calculation of location quotients on employment data for the 109 sectors of the national tables.

(ii) Isolation of those sectors where $LQ_i < 1$, and the application of the location quotient across the rows of the appropriate sectors to decompose the national trade coefficient into the regional trade coefficient and the regional import coefficients, the latter to be collected in the import row for each column.

### 4.2.3 Phase III Definition of Regional Sectors

Step 6 provided for the insertion of "disaggregated superior data", i.e. estimates which the analyst considers superior to those produced by the mechanical operations of Phases I and II, and which were available at the disaggregated level. In Step 7, sectors were aggregated to form smaller tables which were more commensurate with the simpler economic structure of the regions. Two sets of regional tables were produced, one set at different levels of aggregation to accommodate the variety in regional economic complexity, and one set at a uniform level of aggregation to allow direct comparisons between regions, and between regions and the state, for all sectors.

The mechanics of sector aggregation in Step 7 proceed by aggregation of coefficients weighted by employment data. Shen (1960)[5] produced evidence that some form of weighting of national coefficients by regional data, would be more likely to produce coefficients closer to 'true' regional coefficients by accounting for region-unique industrial mix and production functions. While Shen used the weighting technique as a 'one-shot' method to produce regional from national tables, GRIT uses the weighting technique as a marginal improvement to already estimated 'regional' coefficients. It was recognized that other weights, in particular value-added or output, would be more acceptable weights to incorporate in the aggregation process. Neither value-added nor output data were available at the 109-sector level for any regions and this fact precluded the use of these as weights.

Step 8 provided an opportunity for the insertion into coefficient matrices of superior data which is available only in a more aggregated form consistent with the sector definitions adopted. Together with Step 6, this facility maximised the potential use of the various forms of superior data, some of which were available on a detailed 109-sector basis, and some of which were available at a regional level only with respect to combinations of industries.

### 4.2.4 Phase IV Derivation of Prototype Transactions Tables

The aim of Phase IV was the conversion of regional coefficient tables into prototype transactions tables for each region. These prototype tables were 'next-to-final' regional transactions tables, to be subjected to the detailed scrutiny of the analyst in Phase V of

5. Shen, T.Y. (1960), "An Input-Output Table with Regional Weights", Papers and Proceedings of the Regional Science Association, 6 : 113-119.

the GRIT sequence. The development of the prototype tables and their multipliers was essentially the production of the 'interim results' of the GRIT system. Two steps were required for expansion of these matrices into conventional transactions tables, namely the conversion of the coefficients to transactions and the completion of the final demand quadrants. Step 9 provide for the former, and Step 10 for the latter.

Step 9 simply involved multiplying the elements of each column by estimates of output for each sector to convert the coefficients to first estimates of transactions. The tables produced were termed initial transactions tables, and as suggested above, referred to intermediate and primary inputs quadrants only. The derivation of output levels for the implementation of Step 9 presented some problems. Official statistics of output were available for several sectors at the regional level. For those sectors for which these output statistics were not available, estimates were derived from other input-output studies or by the use of indirect methods of calculation.

Step 10 produced, from the initial transactions tables (detailing the intermediate and primary inputs quadrants only), the prototype transactions table, detailing the four quadrants of each table, by calculation of estimates for the elements of final demand quadrants for all regional tables. Conventionally the components of final demand in a regional input-output table include household consumption, exports, public authority net current expenditure, inventory accumulation and capital formation. The derivation of estimates, by region of these components, was in effect, the estimation of their spatial distribution within the state - these are aspects of economic activity in which there is almost a complete lack of useful data in Australia.

Two questions were considered at this stage: (i) the choice of a level of aggregation in final demand sectors which will be consistent with the probable ultimate uses of the regional tables, and (ii) the choice of technique for the estimation of the final demand sectors chosen in (i).

It is necessary for the ultimate production of multipliers, for the regional tables to contain estimates of household consumption. It was considered a necessary and achievable object of the study for regional exports to be included in the tables. Beyond these two components, no further components of final demand were considered individually measurable for individual regions, and these were therefore aggregated under the heading 'Other Final Demand'.

Two approaches to the estimation of final demand in the regional tables were considered. First, it was possible to use aggregate final demand as a residual item to achieve the necessary row and column consistency within each table. Secondly, it was possible to incorporate independent estimates of final demand. Such a procedure would almost certainly produce inconsistent tables, i.e. column and row totals of intermediate sectors which were not equal, and it would be necessary to enforce consistency using an appropriate mathematical technique.

The decision between these two alternatives must depend on the availability and reliability of data relating to regional final demand. If reliable data relating to final demand was not available for each region, as was the case in the GRIT application to the regions of Queensland, the use of aggregate final demand as a residual item seems the obvious solution; the GRIT tables were derived on this basis.

However, circumstances might exist where analysts are able to develop estimates of final demand for regions, and have an equal or higher degree of confidence in these estimates, compared to those produced by earlier phases in the GRIT sequence. In this case it would be important for these estimates to be entered in the regional transactions tables and some operations undertaken to ensure consistency within these tables. These operations might be carried out manually, or by the use of some iterative constrained-matrix technique (such as the RAS).

Step 11 provided for further aggregation if uniform tables were required. In this application, the 16-sector prototype tables of the state and the metropolitan region were further aggregated to 11-sector tables. Step 12 simply derived inverses and multipliers for the prototype tables using conventional techniques for multiplier calculation.

### 4.2.5 Phase V Derivation of Final Transactions Tables

It is useful to summarise briefly the total effect of Steps 1-12 in producing regional input-output tables. The basic component of GRIT is a multi-stage mechanical sequence for adjusting the national table, calculation of regional imports and weighted aggregation of sectors. Important modifications to this mechanical procedure ensured that where any data, other than that generated by the mechanical processes, was available, this could be incorporated to improve the general level of accuracy. The prototype tables represented therefore the 'best' tables which could be produced by the variable-interference mechanical processes. Phase V, the final stage in the GRIT sequence shifted the responsibility for adjustment from modified mechanical procedures to the analyst. At this stage, the analysts were faced with a series of non-uniform tables (and probably a uniform series) which must be examined in detail, with a view to implementing Step 13, the final superior data insertions and other adjustments.

In most sectors, there could be a reasonable expectation that the estimates generated in Phases I-IV were free of substantial error. These cases would include sectors which did not differ substantially in structure between regions, for example certain categories of manufacturing, service industries and the like. The identification of such sectors by the analyst should be possible as an exercise of his professional judgement. However, the analyst cannot be absolved of the responsibility, either in the use of the GRIT system or in the development of any input-output table, to exercise his professional judgement in the detection of inappropriate entries in the table. Whichever method of table construction is employed, the ultimate responsibility for assessment and final adjustment must be accepted by the analyst, and there should be no refuge in mechanically produced figures. To take such refuge is to abdicate from professional responsibility.

The experience of the GRIT team was that inspection of the final tables showed that few adjustments were required. However, some of these adjustments were significant, and the tables would have been inadequate representations of these economies if this examination had been avoided. The GRIT team drew on the extensive knowledge of other input-output workers, government officers skilled in economic interpretation of the various facets of the regional and state economies, and other useful sources of opinion. From this consultation emerged a series of tables which were accepted as conforming with the original main criterion of GRIT, namely as 'free of significant error'.

The number of 'major' adjustments to the prototype tables was restricted to sectors which showed either unique regional characteristics, or which had been 'submerged' by dominant national industries outside the region through their effect on the national coefficients. Most entries in the prototype tables were acceptable and conformed to expected magnitudes. Examination of the multipliers of the prototype tables, and comparison of these multipliers with those from other studies assisted in highlighting potential 'problem areas'.

Step 14 provided for the derivation of the final transactions table, and Step 15 for the calculation of inverses and multipliers for each of the regional tables and for the state table.

# CHAPTER 5

## GRIT II

This chapter sets out the major differences between the original GRIT system and the GRIT II system used in this study. Three major modifications were introduced: (i) the location quotient technique used to obtain the basic regional table was modified; (ii) a technique to isolate the critical cells of the prototype table to allow a more cost-effective approach to table accuracy was incorporated; and (iii) changes in the aggregation system were introduced to allow better compatability between tables. There were, of course, numerous other minor modifications of an operational nature incorporated to make the procedure more efficient. For example, the GRIT computer program has been largely modified and is now split into two parts. Part A derives the initial transactions tables, and Part B is a standalone package which allows the operator to update, impact, aggregate, RAS, etc. the derived tables. The resultant package allows the operator extreme flexibility in the manipulation and use of the tables.

### 5.1 Modifications to the Simple Location Quotient

The location quotient (LQ) is a measure which compares the relative importance of an industry in a region to its relative importance in the nation.

i.e. $LQ_i = (X_i^r/X^r)/(X_i^n/X^n)$

where X represents output or employment and the superscripts r and n denote region and nation respectively. The LQ is used to estimate regional imports, on the assumption that the regional trade coefficients differ from the national technical coefficients only by the magnitude of the regional import coefficient. Thus

$$a_{ij} = r_{ij} + m_{ij}$$

where $a_{ij}$ is the national technical coefficient, $r_{ij}$ is the regional trade coefficient, and $m_{ij}$ $(0 \leq m_{ij} \leq a_{ij})$ is a regional import coefficient. Operationally, the regional coefficients for row i are estimated by multiplying the national coefficient by $LQ_i$ and approportioning the difference to imports.

$$\text{i.e.} \quad r_{ij} = a_{ij}\, LQ_i \qquad \text{where} \quad LQ_i \leq 1$$

This means that the region produces less than its share of national output in industry i, and imports are therefore required. Alternatively, if $LQ_i > 1$, the region is deemed to produce more than its fair share of output of industry i, and the balance is exported.

There are a number of deficiencies in the simple LQ, however. They tend to overestimate intraregional interdependence and ignore cross-hauling. Also they assume uniformity in production and demand/consumption patterns throughout the nation. Thus large regional industries that conform to the national 'average' would be fairly well represented, but the more unique a regional industry is in terms of different production function and demand/supply characteristics, the less appropriate is the simple LQ. Identification of these industries and the addition of superior transactions data into the table is a characteristic of the GRIT methodology. The system is enhanced, however, if some of these abnormalities can be taken account of at the LQ stage of the procedure.

The simple LQ used in GRIT uses employment data, as this is the only reliable data available at the 109 national sector level. Thus

$$LQ_i^E = \frac{E_i^r / E^r}{E_i^n / E^n}$$

The first modification introduced was to adjust the national employment figures. If national production levels of industry i include a significant export component, then $E_i^n$ is an inappropriate base for estimation of the LQ for industry i in a region, since $E_i^n$ implicitly represents national employment in industry i for domestic consumption. Therefore the $E_i^n$'s were adjusted to represent national employment in the production of industry i for domestic use. Similar adjustments were carried out for industries which comprised substantial import components.

The second modification attempts to take account of labour productivity differences between corresponding regional and national industries and between the region and the nation, where data were available. The only measure of productivity which we could hope to obtain fairly comprehensive data on was labour output ratios. The productivity ratio of the region relative to the nation is thus

$$\theta = (E^r/X^r)/(E^n/X^n)$$

where X refers to output, and the productivity ratio for the corresponding industries is

$$\theta_i = (E_i^r/X_i^r)/(E_i^n/X_i^n)$$

The simple employment LQ was thus modified to become

$$LQ_i^X = LQ_i^E \cdot \frac{\theta}{\theta_i}$$

If labour output ratios were not available for some industries, the LQ automatically reverted back to the simple employment LQ.

Thirdly, in an attempt to take account of demand and consumption pattern differences throughout the nation, estimates of personal consumption were derived where possible and consumption ratios were obtained for the region relative to the nation and also between corresponding regional and national sectors. Thus

$$C = C^r/C^n$$

and $$C_i = C_i^r/C_i^n$$

where $C_i$ refers to the per capita consumption levels of significant commodities or groups of commodities. Where possible, price differentials were taken into account in deriving $C_i$. The modified LQ thus becomes

$$LQ_i^{CX} = LQ_i^X \cdot \frac{C}{C_i}$$

$$= LQ_i^E \cdot \frac{\theta}{\theta_i} \cdot \frac{C}{C_i}$$

Therefore if the local per capita consumption for commodity i is higher than the corresponding national per capita consumption, the $LQ_i$ will be lower resulting in relatively higher imports and/or lower exports of commodity i. Again, if the relevant data were not available, $LQ^{CX}$ automatically reverted back to $LQ^X$ or $LQ^E$.

It appears that the above modified LQ gives a more accurate measure of regional trade coefficients in regions which are relatively more distant from the national 'average'. The greater the difference between the region and the nation, the less satisfactory is the simple LQ. Empirical testing of the various LQ's to the Northern Territory regional economies showed that the modified LQ above produced more realistic coefficients than the other less modified LQ's.

## 5.2 Accuracy Optimization[1]

The completion of regional input-output tables within any reasonable budget/time constraint makes it virtually impossible for close scrutiny to be given, and superior data obtained for all the coefficients in the prototype table. In addition it would be very difficult to justify such a procedure in terms of cost-benefit considerations. Analysts would agree that some sections of the table are more 'critical' than others. Thus first priority of those limited resources should go to ensuring that

1. This section draws heavily from the paper reproduced in Appendix V.

the 'critical' areas are relatively accurate; less attention can be given to the 'non-critical' areas.

The problem has been determining which coefficients are 'critical'. Up to now there have been only vague rules of thumb in this regard, the majority of which have been derived from shocking and simulation techniques. Some of these rules of thumb were implicit in GRIT, but lacked mathematical backing. Recent developments have shown that there is a simple mathematical relationship between errors in coefficients and errors in input-output multipliers. This relationship is explicitly included in this study.

### 5.2.1 The Concept of Accuracy[2]

Accuracy in input-output can be bisected into two broad categories:

(i) Accuracy of the transactions table, which refers to the exactness with which the input-output table represents the 'true' table for the economy. This is the accounting intrepretation of the input-output table epitomised by those concerned with the preparation of the national tables, where the exercise is seen simply and appropriately as an extension of the national accounts. This interpretation requires cell-by-cell accuracy in the statistical sense, on the assumption that if each cell of the table is an accurate record of the 'true' transaction, the table as a whole will reflect the 'true' table with a high degree of accuracy. This interpretation can be called partitive accuracy.

(ii) Model accuracy, which refers to the exactness with which the input-output model reflects the realism of the operation of the regional economy. This emphasises the 'snapshot' interpretation of the economy. This interpretation relies, not on accuracy in each cell of the table, but

---

2. For a full discussion on the concept of accuracy in regional input-output see Jensen (1979).

with the accuracy with which the table represents the main features of the economy in a descriptive sense and preserves the importance of these features in an analytical sense. This interpretation of accuracy can be called holistic accuracy. While partitive accuracy represents the accounting accuracy of the table, holistic accuracy represents the operational accuracy of the table.

Once we move from the world of the more reliable 'hard' data and technical input-output teams at the national level to the world of inadequate and often unreliable data and limited research resources at the regional level, the distinction between these two interpretations becomes more important. Input-output literature casts doubt on our ability to achieve partitive accuracy with existing data sources and research resources; that although partitive accuracy is possible in some portions of the table, it is not appropriate as a general approach to regional input-output tables.

This therefore means that we require some technique for isolating those portions of the table where partitive accuracy can be strived for. The following section outlines the procedure for isolating the relatively more important cells of the table, and ranking them in the order of their relative importance.

### 5.2.2 Coefficient Errors and their Effects on Multipliers

Suppose we have an initial estimate of an input-output direct coefficient matrix, A. It is likely that all, or some, of the direct coefficients, $a_{ij}$, contain errors, $d_{ij}$. These errors could be expressed either in absolute or proportional terms. If the errors are absolute errors, we in fact have initial estimates of $(a_{ij} + d_{ij})$. On the other hand, the errors may be proportional, in which case $d_{ij} = a_{ij}\, p_{ij}$.

This section shows what affects, if any, coefficient errors have on the various input-output multipliers, and then explains how this can be used to maximize the accuracy of the final transactions table in the light of limited budget resources. The analysis that follows is based on the assumption that the initial coefficient error is proportional, but this does not restrict the analysis in any way. The assumption of absolute coefficient errors is more restrictive, and the theory can easily be converted from one system to the other. In the empirical sense, there is little to suggest either error format is more likely to occur, and one can find arguments in favour of both propositions. Given that a decision had to be made, however, the research team were inclined towards the proportional error theory, primarily on the basis that one would expect, ceteris paribus, larger coefficients to contain larger errors.

All the input-output multipliers are calculated from the Leontief inverse $B = (I-A)^{-1}$. Therefore we need to know how the error matrix $D = [d_{ij}] = [a_{ij}p_{ij}]$ affects B. If we apply the usual theory to the initial matrix A we obtain $B \neq (I-A-D)^{-1}$. Therefore we need to know how $(I-A-D)^{-1}$ is related to B.

It can be shown that

$$
\begin{aligned}
(I-A-D)^{-1} &= B + (BD)B + (BD)^2B + (BD)^3B + \ldots. \\
&= B + E1 + E2 + E3 + \ldots. \\
&= B + E
\end{aligned}
$$

where $E = E1 + E2 + E3 + \ldots$ is the error induced into B in response to an initial error D introduced into A.

Consider the error component E1 first. The $(i,j)^{th}$ element of E1 is $\sum_{\ell} \sum_{k} b_{ik}\, a_{k\ell}\, p_{k\ell}\, b_{\ell j}$, and thus the error in the jth output multiplier is

$$\varepsilon 1\ (om_j) = \sum_{\ell} \sum_{k} om_k\, a_{k\ell}\, p_{k\ell}\, b_{\ell j}$$

where $om_k$ denotes the kth output multiplier.

We now have to make an additional decision; what criteria do we want to use to measure the effects of the initial coefficient errors D? The answer to this lies in the primary use to which the tables are intended to be put. The majority of current input-output impacts concentrate on multiplier analysis, and therefore the primary aim should be to minimize the error in the multipliers. Which multipliers? This is not a simple answer and will again depend on the intended impact projects; obviously income and employment multipliers are more important than output multipliers, and in this study the final decision was left to the Northern Territory Government. The following discussion, for the sake of simplicity, will be in terms of the output multiplier; the analysis, however, is equally applicable to income or employment multipliers. The final question to be answered is how should the error in the output multipliers be measured? Again there are several alternatives such as total absolute multiplier error or average proportional multiplier error. Absolute multiplier error does not take into account the magnitude of the multipliers, and it was decided that average proportional multiplier error was the more appropriate measure, bearing in mind the model can be used with various other criteria.

The average proportional output multiplier error is:

$$\frac{1}{n} \sum_j \left(\frac{\varepsilon 1(om_j)}{om_j}\right) = \frac{1}{n} \sum_\ell \sum_k om_k \; a_{k\ell} \; p_{k\ell} \sum_j \left(\frac{b_{\ell j}}{om_j}\right)$$

where $\frac{b_{\ell j}}{om_j}$ is the proportion of the column total which lies in cell (1,j) of B, and n is the number of intermediate sectors.

The average proportional multiplier error can thus be expressed as a summation of terms, and can be rewritten as:

$$\frac{1}{n}\sum_j \left(\frac{\varepsilon 1(om_j)}{om_j}\right) = \frac{1}{n}\left[om_{k1}\, a_{k1.\ell 1}\, p_{k1.\ell 1} \sum_j \left(\frac{b\ell_{1.j}}{om_j}\right) + om_{k2}\, a_{k2.\ell 2}\, p_{k2.\ell 2} \sum_j \left(\frac{b\ell_{2.j}}{om_j}\right)\right.$$

$$\left. + \ldots + om_{ki}\, a_{ki.\ell i}\, p_{ki.\ell i} \sum_j \left(\frac{b\ell_{i.j}}{om_j}\right) + \ldots \right]$$

where the terms in the series [ ] can be rewritten in sequential order from high to low. We then have a sequential list of cells which contribute, in order of importance, to the average proportional multiplier error. In terms of relative efficiency, therefore, we should concentrate firstly on reducing the error in the coefficient $a_{k1.\ell 1}$, secondly in the coefficient $a_{k2.\ell 2}$, and so on.

In the operational sense, we need to make the broad assumption that the proportional error in each coefficient is roughly of the same magnitude. We need not specify a particular value. In situations where more detailed knowledge of the local economy is available, one may be able to obtain rough ratios of these errors e.g. one may be led to believe that the error in one particular coefficient is approximately twice as large as in other coefficients. Remember the procedure does not aim to tell us what the errors are (although in some circumstances it can provide a rough estimate). It only gives us a pointer which indicates which cells we should be concentrating on, in the light of all the prior available information.

The above analysis can be extended to include the error components E2, E3, etc., and, in general, we find the (j)th term in the series is (under the assumption p = 1):

$$\frac{1}{n}\sum_j \left(\frac{\varepsilon(om_j)}{om_j}\right) = \frac{1}{n}\left[\ldots + \left(om_j + \sum_m \sum_q om_q\, a_{qm}\, b_{mj} + \sum_r \sum_s \sum_m \sum_q om_r\, a_{rs}\, b_{sm}\, a_{mq}\, b_{qj}\right.\right.$$

$$\left.\left. + \ldots\right) a_{ji} \sum_k \left(\frac{b_{ik}}{om_k}\right) + \ldots \right]$$

In empirical tests it was found that the ranking of the coefficients did not alter past the error components E1 + E2, although all rankings in this study were taken to E1 + E2 + E3. If we are interested primarily in the rankings, E1 + E2 appears to be sufficient. An example of the ranking of the first 25 coefficients for the prototype Northern Territorytable, using three criteria, output multipliers, income multipliers and employment multipliers, is given in Table 5.1.

The above analysis can be extended into a cost optimization model by deriving an error function which relates the average proportional multiplier error remaining after say X cells have been re-estimated. By assigning a cost, implicit or otherwise, to the possibility of a 100% proportional multiplier error occuring, the total cost function of re-estimation and remaining multiplier error can be minimized to find the optimal value of X. However this extension of the model was not explicitly included in this study. A full explanation of the procedures, with an example, is given in Appendix V.

## TABLE 5.1 SENSITIVITY ANALYSIS (COEFFICIENTS): NORTHERN TERRITORY

***********************************

### PROPORTIONAL COEFFICIENT ERROR - PROPORTIONAL MULTIPLIER ERROR

*****************************************************************

### OUTPUT MULTIPLIERS

RANK : DIRECT COEFFICIENT (COORDINATES)

| | | | | |
|---|---|---|---|---|
| 1: .1657 ( 8, 8) | 2: .1267 ( 8,11) | 3: .2164 (11,15) | 4: .2360 ( 9, 3) | 5: .1215 (15,15) |
| 6: .1260 ( 4, 4) | 7: .1187 ( 4, 8) | 8: .0961 (12,12) | 9: .0572 ( 8, 7) | 10: .0483 ( 8, 9) |
| 11: .0576 (12,11) | 12: .0775 ( 1, 5) | 13: .0607 (12, 2) | 14: .0589 (12, 1) | 15: .0599 (12, 6) |
| 16: .0356 ( 8, 6) | 17: .0350 (11, 4) | 18: .0424 (12,13) | 19: .0425 (12,14) | 20: .0302 (14,12) |
| 21: .0392 (12, 9) | 22: .0334 (12, 8) | 23: .0570 (12, 3) | 24: .0269 (11,13) | 25: .0543 ( 7, 3) |

### INCOME MULTIPLIERS

RANK : DIRECT COEFFICIENT (COORDINATES)

| | | | | |
|---|---|---|---|---|
| 1: .1657 ( 8, 8) | 2: .0350 (11, 4) | 3: .1260 ( 4, 4) | 4: .1267 ( 8,11) | 5: .1215 (15,15) |
| 6: .0961 (12,12) | 7: .2164 (11,15) | 8: .2360 ( 9, 3) | 9: .0302 (14,12) | 10: .0589 (12, 1) |
| 11: .0483 ( 8, 9) | 12: .0270 (13, 8) | 13: .0607 (12, 2) | 14: .1187 ( 4, 8) | 15: .0264 (11, 1) |
| 16: .0775 ( 1, 5) | 17: .0576 (12,11) | 18: .0572 ( 8, 7) | 19: .0543 ( 7, 3) | 20: .0115 (16, 1) |
| 21: .0131 (11,12) | 22: .0051 (13, 4) | 23: .0356 ( 8, 6) | 24: .0235 (11,10) | 25: .01[illegible] (13,12) |

### EMPLOYMENT MULTIPLIERS

RANK : DIRECT COEFFICIENT (COORDINATES)

| | | | | |
|---|---|---|---|---|
| 1: .1657 ( 8, 8) | 2: .2164 (11,15) | 3: .1260 ( 4, 4) | 4: .1215 (15,15) | 5: .2360 ( 9, 3) |
| 6: .0775 ( 1, 5) | 7: .0961 (12,12) | 8: .1187 ( 4, 8) | 9: .1267 ( 8,11) | 10: .0350 (11, 4) |
| 11: .0270 (13, 8) | 12: .0334 (12, 8) | 13: .0576 (12,11) | 14: .0543 ( 7, 3) | 15: .0302 (14,12) |
| 16: .0235 (11,10) | 17: .0425 (12,14) | 18: .0424 (12,13) | 19: .0375 (14,15) | 20: .0222 (13,13) |
| 21: .0221 (16,15) | 22: .0044 ( 7, 4) | 23: .0382 (12, 5) | 24: .0483 ( 8, 9) | 25: .0392 (12, 9) |

## 5.3 Modifications to the Aggregation Scheme

The original GRIT system employed a two-tier weighting aggregation scheme to obtain the non-uniform and uniform transactions tables. The non-uniform tables are derived using an employment weighted aggregation scheme, by necessity, as reliable output data are not available at the 109 sector regional level. The uniform tables were then derived from the non-uniform tables by an output weighted aggregation scheme.

This two-tier system thus creates problems. If the non-uniform tables are not of the same dimension, then the tables are not directly comparable, as weights have been applied to different numbers of sectors. This is particularly true at the uniform table level, as different weighting systems have been applied over different sectors. Thus, even though all the uniform tables are of the same dimension and contain the same sectors, an individual transaction in one table cannot be compared with the corresponding transaction in another table. Although each individual table is representative of that region, comparisons across regions, or with the state, are not possible, and this is further complicated by regional imports and exports.

To overcome the aggregation problem, several alternative schemes were hypothesised and empirically tested. The problem arises that there is no simple benchmark for comparison between differently derived tables for a given region. It was finally decided, in the interests of consistency and ease of manipulation, to continue the aggregation from the non-uniform stage to the uniform tables using employment weights. The study team felt that the output weighting system is marginally superior, but were concerned with the possibility that users of the tables could become disconserted by the inevitable across table inconsistencies, despite the fact that across table comparisons of <u>any</u> input-output tables requires extreme caution.

The present GRIT II system may still produce some minor inconsistencies, but to a lesser extent. Wholly mechanically produced tables should not be inconsistent, but the GRIT system depends on operator manipulation at various stages of the procedure, with the insertion of superior data, etc. Very often superior estimates are available for a particular industry at a regional level but not at the state level, or vice versa, or the two estimates are inconsistent but cannot be verified. It is virtually impossible to verify transactions across tables in any case, as each regional transaction between industries contains an element of imports and/or exports. It is maintained, however, that every effort is taken to ensure obvious inconsistencies are minimized.

# CHAPTER 6

## EMPIRICAL APPLICATION OF THE GRIT SYSTEM

Previous chapters have outlined relevant regional input-output economics, the objectives of the GRIT II system, and have described in detail the GRIT II methodology. This chapter provides some of the empricial results of the application of the GRIT II system to the regions of the Northern Territory.

With the metropolitan and rural regions categorized as in Chapter 3, the aggregation system as shown in Appendix II combines the national sectors listed in the right hand column to sectors defined for the metropolitan region. The aggregation procedure for the metropolitan region ceases at this stage, defining 16 sectors for the Darwin region table. For the non-metropolitan regions the aggregation continues until 11 sectors have been formed for the rural regions. This method was designed to cater for the detail required for the different economy types and also to produce comparability of definition of the sectors between regions of different types. The latter is achieved by the fact that sectors in the smaller tables are aggregates of identifiable sectors in the larger tables, as indicated by the alpha-numeric sector identification system in Appendix II.

The GRIT II computer program allows for the aggregation procedure to be continued to produce uniform tables as required by the analyst. The uniform tables are aggregations of adjusted tables.

The aggregation system described above produced the following variety of tables.

TABLE 6.1 SUMMARY OF TYPES OF GRIT II TABLES IN THIS REPORT

| Input-Output Tables of: | Non-uniform Tables | Uniform Tables |
|---|---|---|
| Northern Territory | 16-sector | 11-sector |
| Darwin region | 16-sector | 11-sector |
| Top End region | 16-sector | 11-sector |
| Katherine-Barkly region | | 11-sector |
| Alice Springs region | | 11-sector |

Two sets of transactions tables with accompanying tables of coefficients and multipliers were produced. A series of 11-sector tables, termed uniform tables, was produced for the region economies. Secondly, a series of non-uniform tables was produced, namely 16-sector tables for the Darwin and Top End regions and the Northern Territory. The presentation of the tables of transactions, coefficients and multipliers required the preparation of approximately sixty tables. The disposition of these tables throughout this report is itemised in Table 6.2 to assist the reader with ready reference to the results of the study.

These tables contain an enormous amount of information relating to the economic structure of the regions of the Northern Territory. The sheer volume of the information prevents comment in detail on each table. This chapter therefore is restricted to general comment on the 11-sector uniform transactions tables and associated multipliers. Non-uniform transactions tables and multipliers, and all coefficient tables have been presented in appendices. However, the general comment on the uniform tables in this chapter is relevant also to the non-uniform tables which should, of course, be considered simply as providing more detail relating to those sectors which are shown in a more disaggregated form.

TABLE 6.2 LIST AND LOCATION OF GRIT II INPUT-OUTPUT RESULTS FOR THE REGIONS OF THE NORTHERN TERRITORY

| Form of Results | Uniform Tables (11-Sector Tables) | Non-Uniform Tables (16-Sector Tables for the Northern Territory and Metropolitan Regions) |
|---|---|---|
| Transactions Tables | Chapter 6 (Tables 6.3 to 6.7) | Appendix VI (Tables VI-1 to VI-3) |
| Direct Coefficients | Appendix VIII (Tables VIII-1 to VIII-5) | Appendix IX (Tables IX-1 to IX-3) |
| Direct and Indirect Coefficients (Inverse of Open Model) | Appendix X (Tables X-1 to X-5) | Appendix XII (Tables XII-1 to XII-3) |
| Direct, Indirect and Induced Coefficients (Inverse of Closed Model) | Appendix XI (Tables XI-1 to XI-5) | Appendix XIII (Tables XIII-1 to XIII-3) |
| Output Multipliers | Chapter 6 (Tables 6.8; 6.11; 6.14; 6.17; 6.20) | Appendix VII (Tables VII-1 to VII-3) |
| Income Multipliers | Chapter 6 (Tables 6.9; 6.12; 6.15; 6.18; 6.21) | Appendix VII (Tables VII-4 to VII-6) |
| Employment Multipliers | Chapter 6 (Tables 6.10; 6.13; 6.16; 6.19; 6.22) | Appendix VII (Tables VII-7 to VII-9) |

In both the uniform and non-uniform transactions and coefficient tables, sectors are represented by numbers in the interests of space. These numbers represent sectors as defined in Appendix II. It will be noted that the same sector number is retained throughout uniform and non-uniform tables, the numbering is modified to denote disaggregation for non-uniform tables. For example Sector 4 in the uniform tables refers to the Manufacturing sector; in the 16-sector tables, Sector 5 is disaggregated to Sectors 4A-4F.

For convenience in the reading of this chapter the sector titles for the eleven-sector tables are provided below:

| Sector No. | Title |
|---|---|
| 1 | Animal Industries |
| 2 | Other primary industries |
| 3 | Mining |
| 4 | Manufacturing |
| 5 | Electricity, gas and water |
| 6 | Building and construction |
| 7 | Trade |
| 8 | Transport and communication |
| 9 | Finance |
| 10 | Public Administration and defence |
| 11 | Community services and entertainment, recreation |

## 6.1 Eleven-Sector Tables for the Regions of the Northern Territory

The discussion is now focussed on the uniform transactions tables for the regions of the Northern Territory. These are presented as tables 6.3 to 6.7 for the five regions of the territory.

TABLE 6.3 11-SECTOR TRANSACTIONS TABLE: DARWIN REGION, 1976-77 ($'000)

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 181 | 0 | 0 | 0 | 0 | 0 | 184 | 0 | 0 | 0 | 241 | 606 |
| 2 | 10 | 2 | 0 | 126 | 0 | 0 | 0 | 1 | 0 | 97 | 6 | 186 | 0 | 8306 | 8734 |
| 3 | 0 | 0 | 302 | 1009 | 0 | 185 | 2 | 4 | 0 | 0 | 8 | 0 | 0 | 2893 | 4403 |
| 4 | 3 | 1780 | 695 | 6013 | 57 | 26297 | 655 | 623 | 26 | 580 | 559 | 1133 | 13179 | 4004 | 56404 |
| 5 | 5 | 41 | 28 | 680 | 119 | 257 | 605 | 177 | 534 | 7917 | 1432 | 1193 | 3519 | 0 | 16507 |
| 6 | 11 | 2 | 0 | 538 | 461 | 0 | 1776 | 1476 | 698 | 36088 | 1966 | 1743 | 125740 | 7 | 170506 |
| 7 | 22 | 494 | 35 | 714 | 57 | 2999 | 8455 | 1336 | 1192 | 4143 | 1130 | 19578 | 95075 | 0 | 135229 |
| 8 | 4 | 44 | 183 | 1260 | 86 | 1582 | 1186 | 1399 | 315 | 3130 | 182 | 1025 | 35054 | 9209 | 54659 |
| 9 | 0 | 341 | 11 | 200 | 6 | 857 | 4375 | 163 | 931 | 6260 | 322 | 6424 | 15467 | 2658 | 38015 |
| 10 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 20254 | 0 | 662 | 101437 | 43202 | 165601 |
| 11 | 6 | 9 | 7 | 0 | 10 | 16 | 317 | 314 | 369 | 3682 | 383 | 5976 | 53104 | 13339 | 77532 |
| H-H | 66 | 2998 | 1030 | 15706 | 4492 | 54550 | 19392 | 23191 | 14862 | 67196 | 44127 | 0 | 0 | 0 | 247610 |
| O.V.A. | 286 | 1702 | 835 | 5832 | 9568 | 22772 | 45563 | 9102 | 13831 | 3002 | 11280 | 0 | 0 | 0 | 123773 |
| IMPORTS | 193 | 1279 | 1277 | 23345 | 1651 | 60991 | 52903 | 16873 | 5253 | 13068 | 16137 | 55313 | 0 | 0 | 248283 |
| TOTAL | 606 | 8734 | 4403 | 56404 | 16507 | 170506 | 135229 | 54659 | 38015 | 165601 | 77532 | 93233 | 442575 | 83858 | 0 |

TABLE 6.4 11-SECTOR TRANSACTIONS TABLE: TOP END REGION, 1976-77 ($'000)

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 517 | 0 | 0 | 0 | 0 | 0 | 917 | 0 | 0 | 0 | 203 | 1637 |
| 2 | 25 | 2 | 0 | 144 | 0 | 0 | 0 | 1 | 0 | 131 | 10 | 209 | 0 | 9468 | 9990 |
| 3 | 0 | 0 | 17331 | 11935 | 0 | 657 | 2 | 5 | 0 | 0 | 101 | 0 | 0 | 113527 | 143466 |
| 4 | 8 | 2578 | 1269 | 17323 | 63 | 29129 | 813 | 729 | 34 | 637 | 694 | 1363 | 51110 | 7562 | 113312 |
| 5 | 6 | 46 | 29 | 1308 | 139 | 298 | 630 | 181 | 592 | 10657 | 1482 | 1388 | 2976 | 0 | 19644 |
| 6 | 32 | 3 | 5667 | 892 | 527 | 0 | 1782 | 1618 | 750 | 48577 | 2082 | 1989 | 126361 | 74 | 190354 |
| 7 | 102 | 575 | 172 | 3991 | 147 | 11770 | 13818 | 2479 | 1757 | 5576 | 2754 | 21983 | 63448 | 7000 | 135573 |
| 8 | 10 | 51 | 459 | 1985 | 88 | 1645 | 1191 | 1461 | 317 | 4213 | 183 | 2090 | 38567 | 6100 | 58360 |
| 9 | 1 | 388 | 14 | 222 | 5 | 872 | 4388 | 169 | 942 | 8427 | 336 | 12562 | 12090 | 581 | 40996 |
| 10 | 0 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 27263 | 0 | 733 | 135824 | 60965 | 224837 |
| 11 | 18 | 11 | 316 | 7 | 9 | 18 | 319 | 346 | 376 | 4957 | 431 | 6595 | 20210 | 46158 | 79769 |
| H-H | 186 | 3480 | 2782 | 25984 | 5053 | 60776 | 19454 | 24886 | 15981 | 90266 | 48075 | 0 | 0 | 0 | 296923 |
| O.V.A. | 758 | 1947 | 875 | 13671 | 11798 | 25445 | 45679 | 9517 | 14924 | 3878 | 11304 | 0 | 0 | 0 | 139796 |
| IMPORTS | 491 | 862 | 114552 | 35333 | 1823 | 59743 | 47497 | 16969 | 5320 | 19337 | 12409 | 55850 | 0 | 0 | 370186 |
| TOTAL | 1637 | 9990 | 143466 | 113312 | 19644 | 190354 | 135573 | 58360 | 40996 | 224837 | 79770 | 104682 | 450586 | 251637 | 0 |

TABLE 6.5 11-SECTOR TRANSACTIONS TABLE: KATHERINE-BARKLY REGION, 1976-77 ($'000)

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 213 | 0 | 0 | 0 | 0 | 0 | 73 | 0 | 0 | 0 | 14241 | 14527 |
| 2 | 84 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 6 | 1 | 28 | 0 | 1676 | 1800 |
| 3 | 0 | 0 | 4729 | 90 | 0 | 46 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 67219 | 72084 |
| 4 | 63 | 131 | 575 | 102 | 0 | 960 | 38 | 21 | 0 | 19 | 69 | 366 | 1752 | 858 | 4953 |
| 5 | 93 | 5 | 0 | 54 | 6 | 61 | 141 | 27 | 95 | 844 | 530 | 186 | 2671 | 10 | 4723 |
| 6 | 297 | 1 | 0 | 46 | 54 | 0 | 229 | 227 | 52 | 3848 | 481 | 93 | 16796 | 18 | 22142 |
| 7 | 526 | 65 | 0 | 97 | 15 | 574 | 1074 | 184 | 116 | 442 | 305 | 1367 | 15540 | 69 | 20373 |
| 8 | 87 | 7 | 0 | 76 | 27 | 176 | 96 | 68 | 26 | 334 | 40 | 862 | 4568 | 120 | 6487 |
| 9 | 3 | 0 | 0 | 2 | 1 | 48 | 160 | 2 | 27 | 668 | 20 | 876 | 1956 | 9 | 3771 |
| 10 | 0 | 0 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 2160 | 0 | 105 | 15567 | 46 | 17913 |
| 11 | 159 | 2 | 0 | 0 | 2 | 2 | 45 | 24 | 25 | 393 | 56 | 969 | 10154 | 4864 | 16694 |
| H-H | 1671 | 554 | 4160 | 1262 | 1173 | 7281 | 2933 | 2850 | 1519 | 7162 | 10026 | 0 | 0 | 0 | 40590 |
| O.V.A. | 6734 | 369 | 7 | 477 | 3006 | 2930 | 6745 | 1205 | 1356 | 313 | 2389 | 0 | 0 | 0 | 25531 |
| IMPORTS | 4810 | 664 | 62579 | 2531 | 439 | 10065 | 8912 | 1879 | 557 | 1652 | 2776 | 8417 | 0 | 0 | 105280 |
| TOTAL | 14527 | 1799 | 72084 | 4953 | 4723 | 22142 | 20372 | 6487 | 3771 | 17913 | 16694 | 13269 | 69004 | 89129 | 0 |

TABLE 6.6 · 11-SECTOR TRANSACTIONS TABLE: ALICE SPRINGS REGION, 1976-77 ($'000)

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 75 | 0 | 0 | 0 | 8683 | 8797 |
| 2 | 120 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 129 |
| 3 | 0 | 0 | 4077 | 268 | 0 | 150 | 3 | 2 | 0 | 0 | 13 | 0 | 0 | 6706 | 11219 |
| 4 | 42 | 0 | 310 | 931 | 8 | 3934 | 317 | 231 | 13 | 39 | 508 | 354 | 2881 | 1366 | 10934 |
| 5 | 39 | 1 | 1 | 91 | 25 | 69 | 599 | 42 | 429 | 868 | 1391 | 419 | 1352 | 4 | 5330 |
| 6 | 173 | 1 | 0 | 108 | 101 | 0 | 1327 | 400 | 343 | 3958 | 1544 | 670 | 28840 | 39 | 37504 |
| 7 | 510 | 7 | 12 | 443 | 33 | 2057 | 9750 | 920 | 1083 | 454 | 1957 | 6193 | 76900 | 313 | 100631 |
| 8 | 73 | 1 | 17 | 293 | 38 | 438 | 644 | 392 | 151 | 343 | 205 | 1652 | 13715 | 1745 | 19707 |
| 9 | 3 | 0 | 0 | 10 | 1 | 181 | 3208 | 7 | 480 | 687 | 112 | 4806 | 15035 | 171 | 24701 |
| 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2221 | 0 | 204 | 9334 | 6489 | 18251 |
| 11 | 102 | 0 | 15 | 0 | 3 | 4 | 278 | 191 | 214 | 404 | 434 | 1880 | 40440 | 24956 | 68920 |
| H-H | 1016 | 33 | 249 | 2919 | 1349 | 12189 | 14497 | 7798 | 9789 | 7524 | 42263 | 0 | 0 | 0 | 99626 |
| O.V.A. | 4072 | 60 | 2 | 1103 | 3275 | 4983 | 33980 | 3590 | 8984 | 401 | 9444 | 0 | 0 | 0 | 69894 |
| IMPORTS | 2647 | 26 | 6535 | 4727 | 497 | 13499 | 36028 | 6133 | 3214 | 1275 | 11048 | 13310 | 0 | 0 | 98938 |
| TOTAL | 8797 | 129 | 11219 | 10934 | 5330 | 37504 | 100631 | 19707 | 24701 | 18251 | 68920 | 29488 | 188497 | 50474 | 0 |

TABLE 6.7 11-SECTOR TRANSACTIONS TABLE: NORTHERN TERRITORY, 1976-77 ($'000)

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1088 | 0 | 0 | 0 | 0 | 0 | 1066 | 0 | 0 | 0 | 22807 | 24961 |
| 2 | 350 | 7 | 0 | 159 | 0 | 0 | 0 | 1 | 0 | 144 | 24 | 289 | 0 | 10945 | 11919 |
| 3 | 1 | 0 | 28569 | 12292 | 0 | 889 | 5 | 7 | 0 | 0 | 24 | 0 | 0 | 184982 | 226769 |
| 4 | 141 | 2804 | 2734 | 18429 | 76 | 34787 | 1306 | 1015 | 56 | 760 | 1369 | 2019 | 58800 | 4902 | 129199 |
| 5 | 138 | 58 | 50 | 1767 | 200 | 495 | 1537 | 293 | 1278 | 12392 | 3702 | 1913 | 5874 | 0 | 29697 |
| 6 | 510 | 5 | 7937 | 1057 | 698 | 0 | 3372 | 2278 | 1195 | 56487 | 4275 | 2754 | 169286 | 145 | 249999 |
| 7 | 1469 | 682 | 290 | 4537 | 195 | 14401 | 24652 | 3582 | 2955 | 6484 | 5087 | 35253 | 156759 | 230 | 256576 |
| 8 | 203 | 61 | 1152 | 3112 | 173 | 2834 | 2852 | 2383 | 516 | 4899 | 448 | 1617 | 54034 | 10270 | 84554 |
| 9 | 9 | 457 | 14 | 234 | 7 | 1135 | 7756 | 178 | 1448 | 9799 | 495 | 22744 | 25193 | 0 | 69468 |
| 10 | 0 | 57 | 36 | 0 | 0 | 0 | 0 | 0 | 6 | 31702 | 0 | 1043 | 228158 | 0 | 261001 |
| 11 | 287 | 14 | 578 | 8 | 14 | 24 | 641 | 561 | 614 | 5764 | 921 | 9445 | 115959 | 30554 | 165383 |
| H-H | 2073 | 4067 | 7191 | 30164 | 7575 | 80246 | 36884 | 35535 | 27289 | 104952 | 100364 | 0 | 0 | 0 | 437140 |
| O.V.A. | 11564 | 2303 | 1227 | 15224 | 18054 | 33351 | 86372 | 14326 | 25265 | 4586 | 22814 | 0 | 0 | 0 | 235167 |
| IMPORTS | 7416 | 1324 | 176991 | 41128 | 2705 | 81837 | 91199 | 24395 | 8846 | 21966 | 25860 | 70362 | 0 | 0 | 554029 |
| TOTAL | 24961 | 11919 | 226769 | 129199 | 29697 | 249999 | 256576 | 84554 | 69468 | 261001 | 165383 | 147439 | 814063 | 264833 | 0 |

The tables summarise the interindustry transactions[1] in dollar terms at basic values for 1976-77 for the regions of the terriroty. The first eleven entries in each row indicate the sales from that sector to other sectors in the same region; the last three entries in each row indicate the sales from that sector to households, other final users in the region and to markets outside the region. For example the sales of the Animal Industries sectors in all tables are virtually restricted to the Manufacturing sector (including rural processing factories), the government sector, and to exports. The proportion of the output of this sector exported reflects the importance of this activity in the region. Over ninety percent of the total output of this sector is exported from the Northern Territory, with the majority coming from the Katherine-Barkly and Alice Springs regions.

A more detailed study of the rows of the regional tables draws attention to some important characteristics of the Northern Territory regions. As noted previously, the Territory is divided into three broad bands, top, middle and bottom, and in this context some interesting comparisons can be made. Firstly, the service type sectors are mainly concentrated in the top, and to a lesser extent the bottom, regions. Public Administration, Community Services, Tourism, Building and Construction and Trade are particularly important in the Top End, and are also dominant in the Alice Springs region. These appear to be the two main centres of government and tourist activity, whilst Trade is a relatively important sector in all three regions. Building and Construction is particularly important in the Top End region. This is largely a reflection of the large scale construction by the Mining industry, and also building and construction within the Darwin region.

---

1. Other terms used in the literature for these tables include 'gross flows tables' or 'interindustry flows'.

Secondly, mining activity is particularly important in the top half of the territory. Mining is dominant in both the Top End and Katherine-Barkly regions, although overall much more concentrated in the Top End. This is due to the large scale mining activity in the Alligator and Arnhem Land areas, with mining becoming less important as we proceed southward.

Thirdly, the agricultural industries (animal industries) are mainly centred in the middle to bottom regions, with the main cattle production being in the Katherine-Barkly Tableland areas. Relatively little cattle production occurs in the Top End region. Fourthly, the majority of manufacturing occurs in the Top End region, half of that in the Darwin area. Most of the manufacturing outside the Darwin region would be associated with the mining industries.

The first eleven entries in each column show the purchases which each sector makes from other intermediate sectors in the same region; the remaining three entries show the purchases of labour (in the households row), the imports of that sector, and the components of other value added (depreciation, indirect taxes, interest, profits etc.). In general terms, the relative size of the entries in the intermediate and primary inputs quadrants indicates the extent to which each sector obtains its inputs from other local sectors.

The column structure of the regional tables is important. Since the columns show the pattern of purchases of each sector, they are the basis for the calculation of tables of coefficients for the analytical application of the table described in the next section. An examination of the columns of the transactions tables is an important prerequisite to the analytical stage, and highlights some important points with respect to the Northern Territory regions.

Firstly, the column shows, within the household row, the sources by sector of the wages, salaries and supplements paid within the region, and indirectly the importance of each sector as a source of local employment. It shows, for example, the dominance of the service sectors as the source of employment in most regions, particularly the Community services and entertainment sector, Transport and communications, Public Administration and Finance Sectors. One the other hand the income component of the Mining Sector is low reflecting the proportion of the total wages and salaries paid to mining personnel that is actually spent within the region. Secondly, the columns show the importance of imports by sector for the regions of the state. Almost inevitably (except the Darwin region), the highest level of imports for each region is shown by the Mining sector, to the extent of over eightly percent of total inputs in the Top End and Katherine-Barkly regions. Other very high import sectors are Manufacturing, Building and Construction and Trade. The lowest importing sectors are, of course, the service sectors.

Each cell entry in the transactions table represents, of course, the sum of the transactions between two sectors for the time period under study. Consequently each cell entry is important, as it indicates whether the economic linkages between the sectors concerned are strong or weak, i.e. the extent to which a change in the level of output of one sector is likely to affect the other. While it is important to identify weaker linkages, it is the stronger intersectoral linkages which are more important in identifying those characteristics of an economy which determine its response to changing economic circumstances. The relative size of each cell entry, the distribution of these relative sizes over the table, and the tendency for larger entries to appear in particular sectors are therefore important in understanding the nature of each regional economy and the variation between regional economies.

The tables of the regions of the Northern Territory demonstrate the importance of these linkages. All the non-metropolitan tables are relatively dominated by the Animal industries, Mining or Service sectors. This is particularly noticeable in the Top End Region where there are strong intrasectoral linkages between the Mining, Manufacturing and Building and Construction sectors. For example the Building and Construction sector purchases a large proportion of its inputs from the Manufacturing sector. Similarly the cell Mining to Mining reflects the large purchases from the services to mining industry by the Mining companies. As well as the large intersectoral linkage of the Public Administrative sector, the government purchases large amounts from the Electricity and Building and construction sectors.

The important distinction between the regional tables lies in the number of 'significant' cell entries; few significant entries denotes a regional economy dominated by one or two sectors, several significant entries describe a more highly developed and complex economy with a high degree of intersectoral interaction. The Top End region provides a constrast to the tables of the other regions. A much larger proportion of the cell entries are relatively large in magnitude, since the table covers the large metropolitan Darwin region as well as the major mining areas. On the other hand, the Katherine-Barkly region would be the best developed of the regional economies.

## 6.2 The Northern Territory Tables

An eleven-sector transactions table for theNorthern Territory is provided in Table 6.7, and a 16-sector table in Table VI-3.

Table 6.7 is in effect a summation of Tables 6.3 to 6.6, in terms of sector output levels and some non-trade components of primary inputs and final demand. Many items which comprise interregional trade in the regional tables were not components of trade at the territory level and adjustments were made for these items. Those items which comprised overseas or interstate trade at the regional level were retained in the territory table, and appear as territory imports or exports in Table 6.7.

The Northern Territory table is typical of input-output tables describing advanced economies; it shows the many significant linkages expected in a fairly diversified economy. In the same way as regional tables illustrated the facets of the regional economies, Table 6.6 demonstrates the feature of the Northern Territory economy in terms of sources of inputs of each sector and the sales pattern of these sectors for the territory as a whole.

The choice between the use of the territory table or regional tables for an analyst will be influenced by the problem he faces and the point of view from which the study must be carried out. If the analyst is concerned with the repercussions of an event or policy on the territory as a whole, Table 6.7 provides the appropriate analytical base; if the question of interest concerns the spatial incidence of the effects of an event, one or more of the regional tables will provide the appropriate base.

## 6.3 Regional Input-Output Multipliers

Chapter 2 outlined the procedures adopted in this study for the calculation of input-output multipliers, and briefly discussed the interpretation of these multipliers. Output, income and employment multipliers were calculated; these appear in Tables 6.8 to 6.22. The tables of direct coefficients, and the inverses of both open and closed versions of the uniform tables are presented in Appendices VIII, X, and XI respectively.

This section provides only a brief discussion of the multipliers derived by the GRIT II procedure for the Northern Territory and its regions. The tables of multipliers provide a large volume of information with respect to output, income and employment characteristics; such information has only been available previously in Australia for the Queensland and South Australian economies and their constituent regions. The input-output tables and multipliers provide a sufficient empirical base for a detailed study of the spatial structure of the Northern Territory economy, and this would be a useful topic for future research. However, this section has more modest aims, namely the identification from the multipliers of the most significant features or regularities; detailed comment is not provided in this report.

Output Multipliers

Three types of multiplier effects were calculated:

(i) First Round Effects (the effect of the first round of purchases by the sector providing the additional dollar of output). This is shown in the elements of the direct coefficients matrix. For example, for the Darwin region (Table VIII-1) the direct effect of a $1 change in the output of Sector 1 is $0.0165 on Sector 2, $0.0050 on Sector 4, and a total of $0.1007 on all intermediate sectors of the economy (Table 6.8).

(ii) Industrial Support Effects
This measures the "second and subsequent round" effects, as successive waves of output increases occur in the economy to provide industrial support as a response to the $1 increase in output. This does not include any increases caused by increased household consumption. Output effects are calculated from the Open Z inverse (Table X-1), as a measure of industrial

TABLE 6.8 **TOTAL SECTOR OUTPUT MULTIPLIERS** DARWIN REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1007 | 0.0193 | 0.1199 | 0.0768 | 1.1967 |
| 2 | 1.0000 | 0.3154 | 0.0682 | 0.3836 | 0.2411 | 1.6248 |
| 3 | 1.0000 | 0.2864 | 0.0708 | 0.3572 | 0.1808 | 1.5380 |
| 4 | 1.0000 | 0.2043 | 0.0456 | 0.2499 | 0.1877 | 1.4376 |
| 5 | 1.0000 | 0.0482 | 0.0090 | 0.0572 | 0.1556 | 1.2128 |
| 6 | 1.0000 | 0.1888 | 0.0433 | 0.2321 | 0.2064 | 1.4385 |
| 7 | 1.0000 | 0.1285 | 0.0189 | 0.1474 | 0.0978 | 1.2452 |
| 8 | 1.0000 | 0.1005 | 0.0168 | 0.1173 | 0.2474 | 1.3647 |
| 9 | 1.0000 | 0.1070 | 0.0147 | 0.1218 | 0.2300 | 1.3518 |
| 10 | 1.0000 | 0.4972 | 0.1457 | 0.6429 | 0.3352 | 1.9780 |
| 11 | 1.0000 | 0.0772 | 0.0122 | 0.0894 | 0.3197 | 1.4091 |

TABLE 6.9 **TOTAL SECTOR INCOME MULTIPLIERS** DARWIN REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1089 | 0.0287 | 0.0053 | 0.0340 | 0.0216 | 0.1646 | 1.2639 | 1.3126 | 1.5113 |
| 2 | 0.3433 | 0.0862 | 0.0195 | 0.1057 | 0.0679 | 0.5169 | 1.2512 | 1.3080 | 1.5059 |
| 3 | 0.2339 | 0.0824 | 0.0203 | 0.1027 | 0.0509 | 0.3876 | 1.3522 | 1.4390 | 1.6567 |
| 4 | 0.2783 | 0.0579 | 0.0130 | 0.0710 | 0.0529 | 0.4023 | 1.2081 | 1.2548 | 1.4447 |
| 5 | 0.2721 | 0.0151 | 0.0025 | 0.0176 | 0.0438 | 0.3335 | 1.0553 | 1.0646 | 1.2257 |
| 6 | 0.3199 | 0.0521 | 0.0123 | 0.0644 | 0.0582 | 0.4425 | 1.1628 | 1.2012 | 1.3830 |
| 7 | 0.1434 | 0.0334 | 0.0053 | 0.0387 | 0.0276 | 0.2097 | 1.2332 | 1.2700 | 1.4621 |
| 8 | 0.4243 | 0.0315 | 0.0047 | 0.0363 | 0.0697 | 0.5302 | 1.0743 | 1.0855 | 1.2497 |
| 9 | 0.3918 | 0.0330 | 0.0042 | 0.0372 | 0.0648 | 0.4938 | 1.0845 | 1.0952 | 1.2609 |
| 10 | 0.4058 | 0.1727 | 0.0456 | 0.2182 | 0.0944 | 0.7184 | 1.4256 | 1.5379 | 1.7706 |
| 11 | 0.5691 | 0.0227 | 0.0034 | 0.0261 | 0.0901 | 0.6854 | 1.0399 | 1.0459 | 1.2042 |

TABLE 6.10 **TOTAL SECTOR EMPLOYMENT MULTIPLIERS** DARWIN REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0822 | 0.0026 | 0.0004 | 0.0030 | 0.0058 | 0.0910 | 1.0315 | 1.0369 | 1.1070 |
| 2 | 0.0281 | 0.0067 | 0.0016 | 0.0083 | 0.0181 | 0.0545 | 1.2384 | 1.2937 | 1.9384 |
| 3 | 0.0207 | 0.0061 | 0.0016 | 0.0076 | 0.0136 | 0.0419 | 1.2938 | 1.3692 | 2.0261 |
| 4 | 0.0180 | 0.0044 | 0.0010 | 0.0054 | 0.0141 | 0.0375 | 1.2451 | 1.3011 | 2.0831 |
| 5 | 0.0142 | 0.0011 | 0.0002 | 0.0013 | 0.0117 | 0.0272 | 1.0788 | 1.0921 | 1.9130 |
| 6 | 0.0238 | 0.0037 | 0.0010 | 0.0047 | 0.0155 | 0.0440 | 1.1552 | 1.1955 | 1.8458 |
| 7 | 0.0220 | 0.0034 | 0.0005 | 0.0039 | 0.0073 | 0.0332 | 1.1536 | 1.1751 | 1.5089 |
| 8 | 0.0332 | 0.0027 | 0.0004 | 0.0031 | 0.0186 | 0.0549 | 1.0802 | 1.0918 | 1.6507 |
| 9 | 0.0351 | 0.0029 | 0.0004 | 0.0033 | 0.0173 | 0.0557 | 1.0837 | 1.0939 | 1.5858 |
| 10 | 0.0234 | 0.0125 | 0.0034 | 0.0158 | 0.0252 | 0.0644 | 1.5338 | 1.6779 | 2.7554 |
| 11 | 0.0477 | 0.0018 | 0.0003 | 0.0021 | 0.0240 | 0.0738 | 1.0374 | 1.0436 | 1.5465 |

TABLE 6.11 **TOTAL SECTOR OUTPUT MULTIPLIERS** TOP END REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1235 | 0.0313 | 0.1548 | 0.1008 | 1.2557 |
| 2 | 1.0000 | 0.3705 | 0.1361 | 0.5067 | 0.3051 | 1.8118 |
| 3 | 1.0000 | 0.1760 | 0.0440 | 0.2201 | 0.0304 | 1.2505 |
| 4 | 1.0000 | 0.3382 | 0.1056 | 0.4438 | 0.2007 | 1.6445 |
| 5 | 1.0000 | 0.0494 | 0.0126 | 0.0620 | 0.1812 | 1.2431 |
| 6 | 1.0000 | 0.2332 | 0.0832 | 0.3164 | 0.2538 | 1.5702 |
| 7 | 1.0000 | 0.1692 | 0.0339 | 0.2031 | 0.1259 | 1.3289 |
| 8 | 1.0000 | 0.1197 | 0.0280 | 0.1477 | 0.3082 | 1.4559 |
| 9 | 1.0000 | 0.1164 | 0.0212 | 0.1376 | 0.2831 | 1.4207 |
| 10 | 1.0000 | 0.4953 | 0.1698 | 0.6651 | 0.4088 | 2.0738 |
| 11 | 1.0000 | 0.1001 | 0.0219 | 0.1220 | 0.4184 | 1.5404 |

TABLE 6.12 **TOTAL SECTOR INCOME MULTIPLIERS** TOP END REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1136 | 0.0321 | 0.0070 | 0.0390 | 0.0292 | 0.1819 | 1.2822 | 1.3435 | 1.6005 |
| 2 | 0.3483 | 0.0887 | 0.0248 | 0.1135 | 0.0884 | 0.5502 | 1.2546 | 1.3259 | 1.5795 |
| 3 | 0.0194 | 0.0199 | 0.0067 | 0.0266 | 0.0088 | 0.0548 | 2.0279 | 2.3735 | 2.8275 |
| 4 | 0.2293 | 0.0569 | 0.0177 | 0.0745 | 0.0581 | 0.3620 | 1.2480 | 1.3250 | 1.5785 |
| 5 | 0.2572 | 0.0144 | 0.0026 | 0.0170 | 0.0525 | 0.3267 | 1.0559 | 1.0662 | 1.2702 |
| 6 | 0.3193 | 0.0500 | 0.0150 | 0.0649 | 0.0735 | 0.4577 | 1.1565 | 1.2033 | 1.4335 |
| 7 | 0.1435 | 0.0392 | 0.0079 | 0.0470 | 0.0364 | 0.2270 | 1.2730 | 1.3277 | 1.5817 |
| 8 | 0.4264 | 0.0340 | 0.0061 | 0.0401 | 0.0892 | 0.5557 | 1.0797 | 1.0940 | 1.3032 |
| 9 | 0.3898 | 0.0337 | 0.0050 | 0.0387 | 0.0820 | 0.5105 | 1.0865 | 1.0993 | 1.3096 |
| 10 | 0.4015 | 0.1706 | 0.0455 | 0.2161 | 0.1181 | 0.7358 | 1.4250 | 1.5384 | 1.8327 |
| 11 | 0.6027 | 0.0260 | 0.0047 | 0.0307 | 0.1212 | 0.7545 | 1.0431 | 1.0509 | 1.2520 |

TABLE 6.13 **TOTAL SECTOR EMPLOYMENT MULTIPLIERS** TOP END REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0849 | 0.0035 | 0.0007 | 0.0042 | 0.0075 | 0.0965 | 1.0416 | 1.0493 | 1.1377 |
| 2 | 0.0330 | 0.0064 | 0.0023 | 0.0087 | 0.0227 | 0.0644 | 1.1947 | 1.2631 | 1.9498 |
| 3 | 0.0069 | 0.0022 | 0.0006 | 0.0028 | 0.0023 | 0.0120 | 1.3121 | 1.4031 | 1.7284 |
| 4 | 0.0127 | 0.0049 | 0.0016 | 0.0066 | 0.0149 | 0.0342 | 1.3875 | 1.5171 | 2.6898 |
| 5 | 0.0126 | 0.0011 | 0.0002 | 0.0014 | 0.0135 | 0.0274 | 1.0894 | 1.1078 | 2.1790 |
| 6 | 0.0236 | 0.0039 | 0.0014 | 0.0053 | 0.0189 | 0.0477 | 1.1667 | 1.2259 | 2.0270 |
| 7 | 0.0240 | 0.0045 | 0.0008 | 0.0053 | 0.0094 | 0.0387 | 1.1860 | 1.2208 | 1.6097 |
| 8 | 0.0329 | 0.0032 | 0.0006 | 0.0038 | 0.0229 | 0.0596 | 1.0970 | 1.1147 | 1.8115 |
| 9 | 0.0349 | 0.0033 | 0.0005 | 0.0038 | 0.0210 | 0.0597 | 1.0952 | 1.1094 | 1.7132 |
| 10 | 0.0209 | 0.0126 | 0.0036 | 0.0162 | 0.0303 | 0.0675 | 1.6029 | 1.7765 | 3.2267 |
| 11 | 0.0667 | 0.0024 | 0.0004 | 0.0028 | 0.0311 | 0.1006 | 1.0356 | 1.0423 | 1.5090 |

TABLE 6.14 TOTAL SECTOR OUTPUT MULTIPLIERS KATHERINE-BARKLY REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0903 | 0.0086 | 0.0989 | 0.0673 | 1.1662 |
| 2 | 1.0000 | 0.1179 | 0.0151 | 0.1330 | 0.1595 | 1.2925 |
| 3 | 1.0000 | 0.0741 | 0.0068 | 0.0809 | 0.0304 | 1.1113 |
| 4 | 1.0000 | 0.1380 | 0.0134 | 0.1514 | 0.1343 | 1.2857 |
| 5 | 1.0000 | 0.0222 | 0.0020 | 0.0242 | 0.1208 | 1.1450 |
| 6 | 1.0000 | 0.0843 | 0.0102 | 0.0945 | 0.1655 | 1.2600 |
| 7 | 1.0000 | 0.0875 | 0.0080 | 0.0935 | 0.0782 | 1.1737 |
| 8 | 1.0000 | 0.0851 | 0.0080 | 0.0931 | 0.2196 | 1.3127 |
| 9 | 1.0000 | 0.0901 | 0.0068 | 0.0969 | 0.2025 | 1.2994 |
| 10 | 1.0000 | 0.4905 | 0.1035 | 0.5940 | 0.2847 | 1.8786 |
| 11 | 1.0000 | 0.0901 | 0.0065 | 0.0966 | 0.2956 | 1.3922 |

TABLE 6.15 TOTAL SECTOR INCOME MULTIPLIERS KATHERINE-BARKLY REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1150 | 0.0257 | 0.0021 | 0.0277 | 0.0234 | 0.1662 | 1.2233 | 1.2412 | 1.4447 |
| 2 | 0.3079 | 0.0272 | 0.0032 | 0.0304 | 0.0555 | 0.3937 | 1.0883 | 1.0986 | 1.2787 |
| 3 | 0.0577 | 0.0060 | 0.0008 | 0.0068 | 0.0106 | 0.0751 | 1.1041 | 1.1177 | 1.3010 |
| 4 | 0.2547 | 0.0270 | 0.0031 | 0.0301 | 0.0467 | 0.3315 | 1.1059 | 1.1181 | 1.3014 |
| 5 | 0.2484 | 0.0074 | 0.0005 | 0.0079 | 0.0420 | 0.2982 | 1.0296 | 1.0317 | 1.2008 |
| 6 | 0.3288 | 0.0200 | 0.0022 | 0.0222 | 0.0575 | 0.4085 | 1.0608 | 1.0674 | 1.2424 |
| 7 | 0.1440 | 0.0200 | 0.0019 | 0.0219 | 0.0272 | 0.1931 | 1.1392 | 1.1524 | 1.3414 |
| 8 | 0.4394 | 0.0244 | 0.0019 | 0.0263 | 0.0764 | 0.5420 | 1.0554 | 1.0598 | 1.2335 |
| 9 | 0.4028 | 0.0250 | 0.0017 | 0.0267 | 0.0704 | 0.4999 | 1.0620 | 1.0663 | 1.2411 |
| 10 | 0.3998 | 0.1713 | 0.0325 | 0.2038 | 0.0990 | 0.7026 | 1.4285 | 1.5097 | 1.7572 |
| 11 | 0.6006 | 0.0246 | 0.0016 | 0.0262 | 0.1028 | 0.7296 | 1.0410 | 1.0437 | 1.2148 |

TABLE 6.16 TOTAL SECTOR EMPLOYMENT MULTIPLIERS KATHERINE-BARKLY REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0749 | 0.0025 | 0.0002 | 0.0027 | 0.0055 | 0.0832 | 1.0336 | 1.0364 | 1.1104 |
| 2 | 0.0467 | 0.0024 | 0.0005 | 0.0029 | 0.0131 | 0.0627 | 1.0511 | 1.0610 | 1.3431 |
| 3 | 0.0069 | 0.0006 | 0.0001 | 0.0007 | 0.0025 | 0.0101 | 1.0885 | 1.1027 | 1.4652 |
| 4 | 0.0186 | 0.0052 | 0.0004 | 0.0055 | 0.0111 | 0.0352 | 1.2783 | 1.2974 | 1.8921 |
| 5 | 0.0110 | 0.0006 | 0.0000 | 0.0007 | 0.0099 | 0.0217 | 1.0588 | 1.0631 | 1.9666 |
| 6 | 0.0274 | 0.0019 | 0.0003 | 0.0021 | 0.0136 | 0.0431 | 1.0651 | 1.0770 | 1.5749 |
| 7 | 0.0208 | 0.0021 | 0.0002 | 0.0023 | 0.0064 | 0.0295 | 1.0995 | 1.1087 | 1.4189 |
| 8 | 0.0399 | 0.0023 | 0.0002 | 0.0025 | 0.0181 | 0.0605 | 1.0566 | 1.0614 | 1.5142 |
| 9 | 0.0326 | 0.0021 | 0.0002 | 0.0023 | 0.0167 | 0.0516 | 1.0649 | 1.0699 | 1.5814 |
| 10 | 0.0206 | 0.0128 | 0.0026 | 0.0154 | 0.0234 | 0.0594 | 1.6200 | 1.7456 | 2.8831 |
| 11 | 0.0492 | 0.0019 | 0.0002 | 0.0021 | 0.0243 | 0.0756 | 1.0386 | 1.0419 | 1.5368 |

TABLE 6.17 **TOTAL SECTOR OUTPUT MULTIPLIERS** ALICE SPRINGS REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1207 | 0.0203 | 0.1410 | 0.1196 | 1.2607 |
| 2 | 1.0000 | 0.0828 | 0.0136 | 0.0964 | 0.2147 | 1.3111 |
| 3 | 1.0000 | 0.3952 | 0.2374 | 0.6326 | 0.0408 | 1.6734 |
| 4 | 1.0000 | 0.1999 | 0.0512 | 0.2511 | 0.2542 | 1.5053 |
| 5 | 1.0000 | 0.0392 | 0.0070 | 0.0462 | 0.2107 | 1.2568 |
| 6 | 1.0000 | 0.1822 | 0.0414 | 0.2236 | 0.2979 | 1.5214 |
| 7 | 1.0000 | 0.1602 | 0.0274 | 0.1876 | 0.1487 | 1.3363 |
| 8 | 1.0000 | 0.1109 | 0.0201 | 0.1310 | 0.3409 | 1.4719 |
| 9 | 1.0000 | 0.1099 | 0.0165 | 0.1263 | 0.3407 | 1.4670 |
| 10 | 1.0000 | 0.4959 | 0.1439 | 0.6398 | 0.4959 | 2.1357 |
| 11 | 1.0000 | 0.0895 | 0.0145 | 0.1039 | 0.5063 | 1.6103 |

TABLE 6.18 **TOTAL SECTOR INCOME MULTIPLIERS** ALICE SPRINGS REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1155 | 0.0311 | 0.0048 | 0.0359 | 0.0368 | 0.1882 | 1.2692 | 1.3168 | 1.6291 |
| 2 | 0.2515 | 0.0170 | 0.0032 | 0.0202 | 0.0660 | 0.3377 | 1.0674 | 1.0882 | 1.3425 |
| 3 | 0.0221 | 0.0171 | 0.0124 | 0.0294 | 0.0125 | 0.0641 | 1.7706 | 2.3296 | 2.8952 |
| 4 | 0.2670 | 0.0459 | 0.0089 | 0.0548 | 0.0781 | 0.3999 | 1.1718 | 1.2052 | 1.4978 |
| 5 | 0.2531 | 0.0118 | 0.0017 | 0.0135 | 0.0647 | 0.3314 | 1.0468 | 1.0534 | 1.3092 |
| 6 | 0.3250 | 0.0431 | 0.0089 | 0.0519 | 0.0915 | 0.4685 | 1.1325 | 1.1598 | 1.4415 |
| 7 | 0.1441 | 0.0375 | 0.0066 | 0.0441 | 0.0457 | 0.2338 | 1.2600 | 1.3060 | 1.6231 |
| 8 | 0.3957 | 0.0310 | 0.0048 | 0.0357 | 0.1048 | 0.5362 | 1.0783 | 1.0903 | 1.3551 |
| 9 | 0.3963 | 0.0308 | 0.0041 | 0.0349 | 0.1047 | 0.5359 | 1.0778 | 1.0880 | 1.3522 |
| 10 | 0.4122 | 0.1733 | 0.0421 | 0.2154 | 0.1524 | 0.7800 | 1.4203 | 1.5224 | 1.8921 |
| 11 | 0.6132 | 0.0241 | 0.0034 | 0.0276 | 0.1556 | 0.7964 | 1.0394 | 1.0450 | 1.2987 |

TABLE 6.19 **TOTAL SECTOR EMPLOYMENT MULTIPLIERS** ALICE SPRINGS REGION: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0754 | 0.0084 | 0.0004 | 0.0089 | 0.0048 | 0.0891 | 1.1121 | 1.1176 | 1.1820 |
| 2 | 0.4607 | 0.0048 | 0.0003 | 0.0050 | 0.0087 | 0.4745 | 1.0104 | 1.0110 | 1.0298 |
| 3 | 0.0119 | 0.0051 | 0.0032 | 0.0083 | 0.0017 | 0.0219 | 1.4308 | 1.6983 | 1.8366 |
| 4 | 0.0249 | 0.0045 | 0.0010 | 0.0055 | 0.0103 | 0.0407 | 1.1826 | 1.2215 | 1.6356 |
| 5 | 0.0118 | 0.0009 | 0.0001 | 0.0011 | 0.0085 | 0.0214 | 1.0771 | 1.0892 | 1.8113 |
| 6 | 0.0257 | 0.0039 | 0.0008 | 0.0047 | 0.0121 | 0.0425 | 1.1499 | 1.1821 | 1.6511 |
| 7 | 0.0131 | 0.0026 | 0.0005 | 0.0031 | 0.0060 | 0.0223 | 1.1998 | 1.2367 | 1.6955 |
| 8 | 0.0317 | 0.0025 | 0.0004 | 0.0029 | 0.0138 | 0.0484 | 1.0779 | 1.0901 | 1.5256 |
| 9 | 0.0173 | 0.0020 | 0.0003 | 0.0023 | 0.0138 | 0.0334 | 1.1170 | 1.1345 | 1.9331 |
| 10 | 0.0171 | 0.0111 | 0.0031 | 0.0142 | 0.0201 | 0.0514 | 1.6465 | 1.8276 | 2.9991 |
| 11 | 0.0393 | 0.0017 | 0.0003 | 0.0020 | 0.0205 | 0.0618 | 1.0445 | 1.0517 | 1.5740 |

TABLE 6.20 TOTAL SECTOR OUTPUT MULTIPLIERS — NORTHERN TERRITORY: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1245 | 0.0294 | 0.1539 | 0.1163 | 1.2703 |
| 2 | 1.0000 | 0.3477 | 0.1220 | 0.4698 | 0.3376 | 1.8074 |
| 3 | 1.0000 | 0.1824 | 0.0456 | 0.2279 | 0.0458 | 1.2737 |
| 4 | 1.0000 | 0.3304 | 0.0986 | 0.4290 | 0.2335 | 1.6625 |
| 5 | 1.0000 | 0.0459 | 0.0106 | 0.0565 | 0.2036 | 1.2600 |
| 6 | 1.0000 | 0.2183 | 0.0742 | 0.2924 | 0.2878 | 1.5802 |
| 7 | 1.0000 | 0.1642 | 0.0312 | 0.1954 | 0.1427 | 1.3381 |
| 8 | 1.0000 | 0.1218 | 0.0268 | 0.1486 | 0.3466 | 1.4951 |
| 9 | 1.0000 | 0.1161 | 0.0198 | 0.1359 | 0.3236 | 1.4595 |
| 10 | 1.0000 | 0.4962 | 0.1636 | 0.6598 | 0.4645 | 2.1242 |
| 11 | 1.0000 | 0.0988 | 0.0200 | 0.1188 | 0.4787 | 1.5975 |

TABLE 6.21 TOTAL SECTOR INCOME MULTIPLIERS — NORTHERN TERRITORY: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1151 | 0.0331 | 0.0067 | 0.0398 | 0.0335 | 0.1884 | 1.2872 | 1.3458 | 1.6371 |
| 2 | 0.3412 | 0.0846 | 0.0238 | 0.1083 | 0.0973 | 0.5468 | 1.2478 | 1.3175 | 1.6027 |
| 3 | 0.0317 | 0.0221 | 0.0072 | 0.0292 | 0.0132 | 0.0741 | 1.6955 | 1.9219 | 2.3380 |
| 4 | 0.2335 | 0.0597 | 0.0177 | 0.0775 | 0.0673 | 0.3782 | 1.2559 | 1.3318 | 1.6201 |
| 5 | 0.2551 | 0.0136 | 0.0023 | 0.0160 | 0.0587 | 0.3297 | 1.0534 | 1.0626 | 1.2926 |
| 6 | 0.3210 | 0.0480 | 0.0142 | 0.0622 | 0.0830 | 0.4662 | 1.1495 | 1.1938 | 1.4523 |
| 7 | 0.1438 | 0.0388 | 0.0074 | 0.0462 | 0.0411 | 0.2311 | 1.2700 | 1.3217 | 1.6078 |
| 8 | 0.4203 | 0.0351 | 0.0061 | 0.0412 | 0.0999 | 0.5614 | 1.0836 | 1.0980 | 1.3358 |
| 9 | 0.3928 | 0.0332 | 0.0048 | 0.0380 | 0.0933 | 0.5241 | 1.0846 | 1.0968 | 1.3342 |
| 10 | 0.4021 | 0.1714 | 0.0450 | 0.2163 | 0.1339 | 0.7524 | 1.4262 | 1.5380 | 1.8710 |
| 11 | 0.6069 | 0.0261 | 0.0044 | 0.0306 | 0.1380 | 0.7754 | 1.0430 | 1.0503 | 1.2778 |

TABLE 6.22 TOTAL SECTOR EMPLOYMENT MULTIPLIERS — NORTHERN TERRITORY: 11-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0757 | 0.0033 | 0.0006 | 0.0039 | 0.0067 | 0.0862 | 1.0435 | 1.0510 | 1.1390 |
| 2 | 0.0442 | 0.0059 | 0.0021 | 0.0079 | 0.0193 | 0.0715 | 1.1325 | 1.1797 | 1.6169 |
| 3 | 0.0072 | 0.0023 | 0.0007 | 0.0029 | 0.0026 | 0.0127 | 1.3136 | 1.4043 | 1.7692 |
| 4 | 0.0137 | 0.0052 | 0.0016 | 0.0068 | 0.0134 | 0.0339 | 1.3815 | 1.4977 | 2.4724 |
| 5 | 0.0122 | 0.0010 | 0.0002 | 0.0012 | 0.0117 | 0.0251 | 1.0852 | 1.1009 | 2.0574 |
| 6 | 0.0242 | 0.0036 | 0.0013 | 0.0049 | 0.0165 | 0.0456 | 1.1483 | 1.2007 | 1.8812 |
| 7 | 0.0195 | 0.0037 | 0.0007 | 0.0044 | 0.0082 | 0.0320 | 1.1896 | 1.2239 | 1.6433 |
| 8 | 0.0332 | 0.0030 | 0.0005 | 0.0036 | 0.0198 | 0.0566 | 1.0914 | 1.1072 | 1.7060 |
| 9 | 0.0285 | 0.0028 | 0.0004 | 0.0032 | 0.0185 | 0.0502 | 1.0978 | 1.1124 | 1.7629 |
| 10 | 0.0206 | 0.0120 | 0.0034 | 0.0154 | 0.0266 | 0.0626 | 1.5834 | 1.7468 | 3.0362 |
| 11 | 0.0526 | 0.0021 | 0.0004 | 0.0025 | 0.0274 | 0.0825 | 1.0397 | 1.0469 | 1.5603 |

response to the first round effects. The industrial support output requirements are calculated as the elements of the columns of the Z inverse, less the initial dollar stimulus and the first round effects as shown in Table 6.8. This table shows that the industrial support effects over all sectors of an increase of one dollar in the sales of Sector 1 to final demand is $0.0193. The first round and industrial support effects are together the production induced effect.

(iii) Consumption Induced Effects

The consumption induced effect is that induced by increased HH income associated with the original dollar stimulus in output. The consumption induced income effects are the consumption induced output effects multiplied by the appropriate household coefficients. Employment multipliers are calculated by substituting the employment coefficients for the household coefficients.

The total output multiplier effect is the total of the production induced effect and the consumption induced effect, in addition to the initial $1 increase in sales. For the Darwin region (Table 6.8) the total output response to a dollar increase in output is $1.1967.

The total output multiplier for sector j measures direct, indirect and induced requirements from all sectors for each dollar increase in sales of sector j to final demand. For example, each increase in the sale of output of the Animal Industries sector in the Darwin region produces a total increase in output of $1.1967. The induced effect of the increased sales will be $1.1967 - $0.1199 = $0.0768.

An examination of Tables 6.8 to 6.22 provides some important information with respect to the expected output response of each sector on a regional basis. This may be summarised by three main points. First, we would expect that the regions of the Northern Territory, ranked in size from the metropolitan to rural regions, would display an overall pattern in the size of output multipliers which reflects this ranking. The 'larger' economies would be expected to be more diversified and therefore to contain stronger linkages which would contribute to higher output multipliers. In general terms the output multipliers reflect the expected rankings with the Top End region showing usually the highest regional multipliers and the Katherine-Barkly region showing the lowest. Note that the relative distribution of the sectors within each region alsoplays an important part in determining the multiplier rankings. When the 'size' of the region is measured in terms of the total output of all sectors in the region there is some correspondence between the ranking of the regions and the size of the output multipliers for each sector.

Secondly, it is noticeable that the output mutlipliers relating to each sector in the Northern Territory table areusually larger than those of the corresponding sectors in the regions. As outlined in Section 6.2, the territory tables incorporates all of the linkages of the regional tables. From another point of view, the regional multipliers for each sector should be seen as the disaggregation of the spatial incidence of the territory multiplier effects. However it must be remembered that the total multiplier effects for the territory as a whole and the regions are not directly comparable, as a dollar increase in sales of a sector at the territory level does not correspond to a dollar increase in sales of the same sector at the regional level at the same time. In other words an initial dollar spent in the territory usually means that less than one dollar is spent in each region.

Thirdly, some similarities occur in the rankings of multipliers across the regions. However the individual rankings within each region reflect the relative importance of the industries within the region in terms of the effect on expansion in that sector has on the rest of the economy. In all the regions the Public Administration sector generates the largest total output multiplier. On the other hand, in the Top End and Katherine-Barkly regions, the total output multiplier of the Mining sector is relatively low, and this can be seen to be a result of the consumption induced effect. Very little of the household component of the effect of increased output is fed back into the economy, that is, very little of the increase household income is spent within the region. Most of the effect of increase in output stops at the production induced stage, and over eighty percent of these inputs are imported.

Income Mutlipliers

Tables 6.8 to 6.22 also provide the GRIT II income multipliers for the regions of the Northern Territory. These are provided in three forms namely: (i) the initial impact or direct income effect, indicating the initial effect on household income of an increase in output of each sector. First round income effects are calculated by multiplying the first-round output effects by the appropriate HH income coefficients, as shown in Chapter 2. For instance an increase of one dollar in output of the Animal Industries sector in the Darwin region would increase household income in that sector within the region by $0.0287 (Table 6.9); (ii) the production induced income effect, which is the first round and industrial support effects (excluding the initial impact) in response to an increase in sales of one dollar to final demand by each sector. For instance the production induced income effect of the Animal Industries sector in the Darwin region would be $0.034 as a result of industrial support requirements. Finally

(iii) the initial, production and consumption induced effect is listed; this figure is $0.1646 for the example quoted.

The direct income effects indicate the labour intensity of each sector in each region. These show, as expected, a high degree of similarity between regions with slight variations reflecting the efficiency of labour use in particular sectors. There is, however, within each region a wide disparity in this coefficient between sectors, reflecting the differences in labour intensity. This ranges, for example, from $0.1089 to $0.5691 per dollar of output in the Animal Industries and Community Services and Entertainment in the Darwin Region. These differences have an important effect on the calculation of both direct and indirect, and total income multipliers.

The total income effect shows a consistency between regions in the upper and lower rankings. Those sectors with high direct coefficients, together with large contributions to the personal income of the regions show variable but consistently the highest total income effects over all regions, namely the Community Services sector. Each increase of one dollar in the value of output of the Community Services sector destined for final demand in the Alice Springs region, adds an additional $0.7964 to regional household income; the same dollar increase in the same sector in the Katherine-Barkly region would increase this income by only $0.7296. The sector with the lowest total income effect is usually the Mining sector, as a result of the small contribution made by this sector to the personal income of the regions.

Type I and Type II Income Multipliers

As described above, income multipliers refer to changes in income per dollar initial change in output. Income multipliers are conventionally converted to a "per unit measurement" by the calculation of Type I and Type II multipliers as described in Chapter 2. These were also calculated for all regions (Tables 6.8 to 6.22).

The Type IA income multiplier illustrates, for the Darwin region, that for each dollar of initial income effect, the total initial plus first round income effect in Sector 1 (as a result of increased output) will be $1.2639, for Sector 2, $1.2512 etc.. When industrial support effects are included (Type IB), associated income effects for Sector 1 will be $1.3126 and when consumption induced effects are included (Type II) associated income will be $1.5113.

From Table 6.9: Type I and II Income Multipliers, Darwin Region, 1976-77.

| | | | | |
|---|---|---|---|---|
| Type IA = $\frac{I + F}{I}$ | = | Sector | 1 | 1.2639 |
| | | | 2 | 1.2512 |
| | | | 3 | 1.3522 |
| Type IB = $\frac{I + P}{I}$ | = | Sector | 1 | 1.3126 |
| | | | 2 | 1.3080 |
| | | | 3 | 1.4390 |
| Type II = $\frac{I + P + C}{I}$ | = | Sector | 1 | 1.5113 |
| | | | 2 | 1.5059 |
| | | | 3 | 1.6567 |

where:
- I = Initial effect
- F = First round effect
- P = Production induced effect
- C = Consumption induced effect

<u>Employment Multipliers</u>

Tables 6.8 to 6.22 also present the GRIT II employment multipliers for the regions of the Northern Territory. These also are provided in three forms, parallel to those described above for income multipliers. In general terms, if the wage rate between sectors is constant, employment mutlipliers would be expected to reflect income

multipliers in terms of ranking between sectors and between regions. The extent to which the income multipliers and employment multipliers vary in ranking highlights difference in personal income levels between sectors. For example, in the Alice Springs region, while the Other Agriculture sector shows one of the lowest requirements for the direct income component, its direct requirement in terms of employment is relatively high. This reflects the low incomes earned in the highly labour intensive other crops industry.

The column of initial employment effects show variations both between regions for the same sector and between sectors in the same region. The former is an indication of the differences in technology which exist between regions in the same sector. For example, the Animal Industries sector which varies throughout the territory, requires 0.0849 units of labour per unit[2] of output in the Top End - the same sector in the Katherine-Barkly region requires only 0.0749 employees to produce the same level of output. These differences in technology, both between sectors and between regions produce several changes in the rankings of total employment multipliers when compared overall of the regions of the territory. These sectors, namely the Animal Industries, Other Agriculture, Community Services, and Public Administration and Defence sectors show the highest-ranked employment multipliers, but the ranking of these three sectors changes between regions. For instance the Animal Industries sector shows the highest total employment multiplier in the Katherine-Barkly region, but is replaced in the first rank by the Other Agriculture sector in the Alice Springs region, and the Community Services sector in the Top End region.

---

2. I.e. per thousand dollars of output.

## General Comment on Regional Multipliers

The multipliers assembled in Tables 6.8 to 6.22 provide a wealth of information relating to the response which can be expected within the regions of the Northern Territory to a change in economic circumstances. Several important points need to be established at this stage. First although the uniform tables presented in this chapter enable comparisons of multipliers between regions without difficulty, it should be remembered that the industry content of some sectors will vary substantially between regions in an area like the Northern Territory which encompasses several climatic and physical zones. This is so particularly with respect to the primary industries which vary from mining to animal industries to other agriculture, with different combinations and technologies between regions. This variation is accompanied by variations in the Manufacturing sector, which also differs considerably between the regions. Even normally stable industries like Transport, Public Administration and Trade vary, and it may be necessary to consult the non-uniform tables and multipliers to obtain a sufficient understanding of the response of a particular region to a change in economic circumstances. The analysis of this response should be interpreted in the knowledge of the nature of the industries which comprise the regional economy.

Second, the multipliers offer significant advantages and improvements in the regional planning process or in the formation of regional policy. They provide an opportunity to isolate those sectors which will contribute the highest additional output income and employment in each region and thereby indicate those sectors which might receive special attention if regional economic growth is to be encouraged. They provide also a basis of estimating the likely decrease in economic activity associated with the closure or contraction of an industry.

Comparisons of sector multipliers between regions provide measures of the response which can be expected in each region to the establishment of a new industry or the expansion of any sector, and thereby provide guidance to location policy. For instance, if it was desired to locate an industry to maximise the increase in regional output resulting from the establishment of that industry, the regions showing the highest relevant output multipliers would be considered as the appropriate location.

Third, although the tables of multipliers offer a convenient method of selecting regional economic growth strategies, it should be remembered that the multipliers are relevant only in the context of the transactions table from which they are derived and should be interpreted in this light. It often transpires, for example, that the ranking of multipliers suggests that one or two sectors offer the most promising avenues of regional expansion, but that the linkages shown in the transactions tables suggest that expansion of these sectors is not feasible. The Manufacturing sector in most Northern Territory regions illustrates this point; it shows consistently high output multipliers throughout the regions and appears as a promising sector for expansion of regional output levels. However this sector is closely linked with other manufacturing and primary sectors, and the output of the Manufacturing sector cannot be increased without concurrent increases in these other industries and improvements in the transportation and other service facilities.

Fourth, it is an advantage to consider all of the multipliers for a region in determining regional development strategies, and to consider these multipliers in terms of criteria for regional development.

It is possible that the multipliers can indicate different directions of development according to the development criteria, i.e. that sectors with the highest output multipliers are not necessarily those which would contribute the highest additional employment or income. Also by considering separately the magnitudes of the initial and production induced effects, and the consumption induced effects it is possible to determine whether the expansion of any sector in a region will confer advantages on the local sectors primarily through increased demand for industrial support requirements or through increased household expenditures.

## 6.4 Summary

This chapter, with accompanying appendices, has provided the empirical results of the GRIT II system for the regions of the Northern Territory. The large volume of results has allowed only a highly selective discussion of the input-output tables and multipliers. This discussion has been cast only in explanatory terms; the potential contribution in understanding the structure and spatial response pattern of the Northern Territory economy is enormous, but has not been considered in this report.

# APPENDIX I

## NATIONAL INPUT-OUTPUT CLASSIFICATION IN TERMS OF ASIC

1968-69

| | | |
|---|---|---|
| **00** | **Agriculture, Forestry and Fishing** | |
| 01.01 | Sheep | 0111, 0113 (part) |
| 01.02 | Cereal grains | 0112, 0113 (part) |
| 01.03 | Meat cattle | 0121 |
| 01.04 | Milk cattle and pigs | 0122, 0123 |
| 01.05 | Poultry | 013 |
| 01.06 | Other farming | 014, 015, 016, 017 |
| 02.00 | Services to agriculture | 020 |
| 03.00 | Forestry and logging | 030 |
| 04.00 | Fishing, trapping and hunting | 041, 042 |
| **10** | **Mining** | |
| 11.01 | Iron | 1104 |
| 11.02 | Other metallic minerals | 110 (excl. 1104) |
| 12.00 | Coal and crude petroleum | 120, 130 |
| 14.00 | Non-metallic n.e.c. | 140, 150 |
| 16.00 | Services to mining | 160 |
| **21-22** | **Food, Tobacco** | |
| 21.01 | Meat products | 211 |
| 21.02 | Milk products | 212 |
| 21.03 | Fruit and vegetable products | 213 |
| 21.04 | Margarine, oils and fats | 214 |
| 21.05 | Flour mill and cereal food products | 215 |
| 21.06 | Bread, cakes, and biscuits | 216 |
| 21.07 | Confectionery and cocoa products | 2181 |
| 21.08 | Food products n.e.c. (including fish and sugar) | 2182, 2183, 2184, 217 |
| 21.09 | Soft drinks, cordials and syrups | 2191 |
| 21.10 | Beer and malt | 2192, 2193 |
| 21.11 | Alcholic beverages n.e.c. | 2194, 2195 |
| 22.01 | Tobacco products | 2210 |
| **23-24** | **Textile and Clothing** | |
| 23.01 | Prepared fibres (cotton ginning, wool scouring, top-making) | 2311 to 2313 |
| 23.02 | Man-made fibres, yarns and fabrics | 2314, 2315 |
| 23.03 | Cotton, silk and flax yarns, fabrics and household textiles | 2316, 2319, 2322 |
| 23.04 | Wool and worsted yarns and fabrics | 2317, 2318 |
| 23.05 | Textile finishing | 2321 |
| 23.06 | Textile floor covering, felt and felt products | 2331,2332 |
| 23.07 | Textile products n.e.c. (incl. canvas, rope, etc.) | 2333-2335 |
| 24.01 | Knitting mills | 241 |
| 24.02 | Clothing | 242 |
| 24.03 | Footwear | 243 |

| | | | |
|---|---|---|---|
| 25 | **Wood** | | |
| | 25.01 | Sawmill products | 2511, 2512, 2515 |
| | 25.02 | Plywood, veneers and manufactured boards | 2513 |
| | 25.03 | Joinery and wood products n.e.c. | 2514, 2516 |
| | 25.04 | Furniture, mattresses, brooms and brushes | 252, 3443 |
| 26 | **Paper** | | |
| | 26.01 | Pulp, paper and paperboard | 2611 |
| | 26.02 | Fibreboard and paper containers | 2612-2614 |
| | 26.03 | Paper products n.e.c. | 2615 |
| | 26.04 | Newspapers and books | 2621 |
| | 26.05 | Commercial and job printing and printing trade services | 2622, 2623 |
| 27 | **Chemicals** | | |
| | 27.01 | Chemical fertilisers | 2711 |
| | 27.02 | Industrial chemicals n.e.c. (plastic materials, synthetic resins, industrial gases, synthetic rubber, other basic chemicals) | 2712-2715 |
| | 27.03 | Paints, varnishes and lacquers | 2722 |
| | 27.04 | Pharmaceutical and veterinary products, agricultural chemicals | 2723, 2724 |
| | 27.05 | Soap and other detergents | 2725 |
| | 27.06 | Cosmetiç and toilet preparations | 2726 |
| | 27.07 | Chemical products n.e.c. (incl. ammunition, explosives and fireworks) | 2721, 2727, 2728 |
| | 27.08 | Petroleum and coal products | 273, 274 |
| 28 | **Non-metallic Mineral Products** | | |
| | 28.01 | Glass and glass products | 281 |
| | 28.02 | Clay products | 282 |
| | 28.03 | Cement | 2831 |
| | 28.04 | Ready-mixed concrete | 2832 |
| | 28.05 | Concrete products | 2833, 2834, 2835 |
| | 28.06 | Gypsum, plaster and other non-metallic mineral products | 2841-2843 |
| 29,31 | **Metals, Metal Products** | | |
| | 29.01 | Basic iron and steel | 291 |
| | 29.02 | Non-ferrous metal basic products | 292-295 |
| | 31.01 | Fabricated structural metal products | 311 |
| | 31.02 | Metal containers, sheet metal products | 312 |
| | 31.03 | Cutlery and hand tools, metal coating and finishing and metal products n.e.c. | 313 |

32 Transport Equipment

| | | |
|---|---|---|
| 32.01 | Motor vehicles and parts and transport equipment n.e.c. | 321, 3225 |
| 32.02 | Ship and boat building and repair | 3221, 3222 |
| 32.03 | Locomotives, rolling stock and repair | 3223 |
| 32.04 | Aircraft building and repair | 3224 |

33 Machinery and Household Appliances

| | | |
|---|---|---|
| 33.01 | Photographic, scientific equipment etc. | 331 |
| 33.02 | Television sets, radios, communication and electronic equipment n.e.c. | 3321 |
| 33.03 | Household appliances n.e.c. | 3322, 3323 |
| 33.04 | Electrical machinery and equipment n.e.c. | 3324-3326 |
| 33.05 | Agricultural machinery and equipment | 3331 |
| 33.06 | Construction, earthmoving and materials handling machinery and equipment | 3332, 3333 |
| 33.07 | Other machinery and equipment | 3334-3339 |

34 Leather, Rubber and Plastic Products

| | | |
|---|---|---|
| 34.01 | Leather tanning, leather and leather substitute products n.e.c. | 341 |
| 34.02 | Rubber products | 342 |
| 34.03 | Plastic and related products | 343 |
| 34.04 | Signs, advertising displays, writing and marking equipment | 3444, 3446 |
| 34.05 | Ophthalmic articles, jewellery, silverware and other manufacturing | 3441, 3442, 3445, 3447 |

36,37 Electricity, Gas and Water

| | | |
|---|---|---|
| 36.01 | Electricity generation and distribution | 361 |
| 36.02 | Gas production and distribution | 362 |
| 37.01 | Water, sewerage and drainage | 370 |

41,42 Building and Construction

| | | |
|---|---|---|
| 41.01 | Residential buildings | 411 (part), 42 (part) |
| 41.02 | Other building and construction | 411 (part), 412, 42 (part) |

45-46 Trade, Transport, Storage and Communication

| | | |
|---|---|---|
| 46.01 | Wholesale trade | 46-47 (excl.repairs) |
| 48.01 | Retail trade | 48 (excl.repairs) |
| 48.02 | Motor vehicle repairs | Re-definitions |
| 48.03 | Other repairs | Re-definitions |
| 51.01 | Road transport | 51 |
| 52.01 | Railway transport, other transport and storage | 52, 55 |
| 53.01 | Water transport | 53 |
| 54.01 | Air transport | 54 |
| 55.01 | Communication | 56 |

61-63 Finance etc.

| | | |
|---|---|---|
| 61.01 | Banking | 611 |
| 61.02 | Finance and life insurance | 612, 621 |
| 61.03 | Other insurance | 622 |
| 61.04 | Investment, real estate and leasing | 613, 631, 632 (part), 636 |
| 61.05 | Technical and other business services | 633-635 |
| 61.06 | Ownership of dwellings | 632 (part) and imputed rent |

71-94 Public Administration, Community Services, Entertainment etc.

| | | |
|---|---|---|
| 71.01 | Public administration | 71, 8451-3 |
| 72.01 | Defence | 72 |
| 81.01 | Health | 81 |
| 82.01 | Education, libraries, etc. | 82 |
| 83.01 | Welfare services, religious and community organisations | 83, 841 (part), 842, 843, 844, 8454 |
| 91.01 | Entertainment and recreational services | 91 |
| 92.01 | Restaurants, hotels and clubs | 921, 922 |
| 93.01 | Personal services | 93, 94 |

99 Business Expenses

| | | |
|---|---|---|
| 99.01 | Business expenses | Dummy industry, No ASIC equivalent |

# APPENDIX II

## Sector Classification

| Rural Regions | Metropolitan Region and State | National Sectors Included |
|---|---|---|
| 1. Animal Industries | 1. Animal industries | 01.01 Sheep<br>01.03 Meat cattle<br>01.04 Milk cattle and pigs |
| 2. Other primary industries | 2A. Other agriculture, Forestry | 01.02 Cereal grains<br>01.05 Poultry<br>01.06 Other farming<br>02.00 Services to agriculture<br>03.00 Forestry and logging |
| | 2B. Fishing | 04.00 Fishing, trapping and hunting |
| 3. Mining | 3. Mining | 12.00 Coal and crude petroleum mining<br>11.01 Iron<br>11.02 Other metallic minerals<br>14.00 Non-metallic n.e.c.<br>16.00 Services to mining |
| 4. Manufacturing | 4A. Food manufacturing | 21.01 Meat products<br>21.02 Milk products<br>21.03 Fruit and vegetable products<br>21.04 Margarines, oils and fats<br>21.05 Flour mill and cereal food products<br>21.06 Bread, cakes and biscuits<br>21.07 Confectionary and cocoa products<br>21.08 Food products n.e.c. (including fish and sugar)<br>21.09 Soft drinks, cordials and syrups<br>21.10 Beer and malt<br>21.11 Alcoholic beverages n.e.c.<br>22.01 Tobacco products |

| Rural Regions | Metropolitan Region and State | National Sectors Included |
|---|---|---|
| | 4B. Wood and paper manufacturing | 25.01 Sawmill products |
| | | 25.02 Plywood, veneers and manufactured boards |
| | | 25.03 Joinery and wood products n.e.c. |
| | | 25.04 Furniture, mattresses, brooms and brushes |
| | | 26.01 Pulp, paper and paperboard |
| | | 26.02 Fibreboard and paper containers |
| | | 26.03 Paper products n.e.c. |
| | | 26.04 Newspapers and books |
| | | 26.05 Commercial and job printing and printing trade services |
| | 4C. Machinery, appliances, equipment | 32.01 Motor vehicles and parts and transport equipment n.e.c. |
| | | 32.02 Ship and boat building and repair |
| | | 32.03 Locomotives, rolling stock and repair |
| | | 32.04 Aircraft building and repair |
| | | 33.01 Photographic, scientific equipment etc. |
| | | 33.02 Television sets, radios, communication and electronic equipment n.e.c. |
| | | 33.03 Household appliances n.e.c. |
| | | 33.04 Electrical machinery and equipment n.e.c. |
| | | 33.05 Agricultural machinery and equipment |
| | | 33.06 Construction, earthmoving and materials handling machinery and equipment |
| | | 33.07 Other machinery and equipment |

| Rural Regions | Metropolitan Region and State | National Sectors Included |
|---|---|---|
| | 4DE. Metals, metal products, non-metallic mineral products | 28.01 Glass and glass products |
| | | 28.02 Clay products |
| | | 28.03 Cement |
| | | 28.04 Ready-mixed concrete |
| | | 28.05 Concrete products |
| | | 28.06 Gypsum, plaster and other non-metallic mineral products |
| | | 29.01 Basic iron and steel |
| | | 29.02 Non-ferrous metal basic products |
| | | 31.01 Fabricated structural metal products |
| | | 31.02 Metal containers, sheet metal products |
| | | 31.03 Cutlery and hand tools, metal coating and finishing and metal products n.e.c. |
| | 4F. Other Manufacturing | 23.01 Prepared fibres (cotton ginning, wool scouring, top-making) |
| | | 23.02 Man-made fibres, yarns and fabrics |
| | | 23.03 Cotton, silk and flax yarns, fabrics and household textiles |
| | | 23.04 Wool and worsted yarns and fabrics |
| | | 23.05 Textile finishing |
| | | 23.06 Textile floor covering, felt and felt products |
| | | 23.07 Textile products n.e.c. (inc. canvas, rope, etc.) |
| | | 24.01 Knitting mills |
| | | 24.02 Clothing |
| | | 24.03 Footwear |
| | | 27.01 Chemical fertilisers |

| Rural Regions | Metropolitan Region and State | National Sectors Included |
|---|---|---|
| | | 27.02 Industrial chemicals n.e.c. (plastic materials, synthetic resins, industrial gases, synthetic rubber, other basic chemicals) |
| | | 27.03 Paints, varnishes and lacquers |
| | | 27.04 Pharmaceutical and veterinary products, agricultural chemicals) |
| | | 27.05 Soap and other detergents |
| | | 27.06 Cosmetic and toilet preparations |
| | | 27.07 Chemical products n.e.c. (inc. ammunition, explosives and fireworks) |
| | | 27.08 Petroleum and coal products |
| | | 34.01 Leather tanning, leather and leather substitute products n.e.c. |
| | | 34.02 Rubber products |
| | | 34.03 Plastic and related products |
| | | 34.04 Signs, advertising displays, writing and marking equipment |
| | | 34.05 Ophthalmic articles, jewellery, silverware and other manufacturing |
| 5. Electricity, gas and water | 5. Electricity, gas and water | 27.01 Water, sewerage and drainage |
| | | 36.01 Electricity generation and distribution |
| | | 36.02 Gas production and distribution |
| 6. Building and construction | 6. Building and construction | 41.01 Residential buildings |
| | | 41.02 Other building and construction |

| Rural Regions | Metropolitan Region and State | National Sectors Included | |
|---|---|---|---|
| 7. Trade | 7. Trade | 46.01 | Wholesale trade |
| | | 48.01 | Retail trade |
| | | 48.02 | Motor vehicle repairs |
| | | 48.03 | Other repairs |
| 8. Transport and communication | 8. Transport and communication | 51.01 | Road transport |
| | | 52.01 | Railway transport, other transport and storage |
| | | 53.01 | Water transport |
| | | 54.01 | Air transport |
| | | 55.01 | Communication |
| 9. Finance | 9. Finance | 61.01 | Banking |
| | | 61.02 | Finance and life insurance |
| | | 61.03 | Other insurance |
| | | 61.04 | Investment, real estate and leasing |
| | | 61.05 | Technical and other business services |
| | | 61.06 | Ownership of dwellings |
| 10. Public administration and defence | 10. Public administration and defence | 71.01 | Public administration |
| | | 71.02 | Defence |
| 11. Community services, entertainment | 11. Community services, entertainment | 81.01 | Health |
| | | 82.01 | Education, libraries, etc. |
| | | 83.01 | Welfare services, religious and community organisations |
| | | 91.01 | Entertainment and recreational services |
| | | 92.01 | Restaurants, hotels and clubs |
| | | 93.01 | Personal services |

# APPENDIX III

## TECHNICAL APPENDIX

### Australian Input-Output Table

After consultations with the Australian Bureau of Statistics (ABS) Input-Output Section, the latest national table that could be made available was the 1974-75 preliminary 109 sector absorption matrix. Input is by industry and final demand category and output by commodity group, with transactions measured in basic values, indirect allocation of competing imports, and recording intra-industry flows.

This provided the study team with a dilemna. The methodology required the national table to be in the form of industry by industry, in basic values, and with direct allocation of imports. Several alternatives presented themselves:

(i) The 1968-69 national input-output table could be used. This was the least appropriate alternative.

(ii) The 1968-69 national table could be updated to the 1974-75 output figures by applying an RAS based technique. Although this is part of the procedure used by the ABS in their updates, it was not considered appropriate in this case as the research team lacked substantial superior data to account for the many structural shifts in the economy during the period 1968-69 to 1974-75.

(iii) The 1974-75 preliminary table could be modified to convert it to an industry by industry and direct allocation of imports basis.

Although the study team expresses reservations about the suitability of any of the above options, it was eventually decided to opt for the modification of the 1974-75 table. The conversion to industry by industry format was accomplished by the use of superior data and estimates where available, using the breakdown of the difference between total commodity supply and industry supply supplied with the preliminary table, and the make matrix of the 1968-69 table where it appeared appropriate. To reconcile any remaining differences, an RAS procedure was applied to the altered table, but this produced some unacceptable changes in many coefficients that were considered accurate. As the remaining differences between total outputs and inputs were minimal (all less than one percent), the RAS procedure was dropped.

The next step was to convert the table to direct allocation of competing imports.[1] Imports are said to be directly allocated when recorded in the table as an import to the sector which uses them, and indirectly allocated when recorded as an import to the sector producing similar commodities, i.e. that sector which would have produced the commodities if local production occurred.

When competing imports are indirectly allocated they are usually explicitly assigned in the table as an addition to the output of the sector indirectly importing them; when allocated directly they are incorporated as a direct cost to the sector consuming the commodity. Each intermediate cell of the transactions table includes both locally produced and competitively imported commodities with indirect allocation, and only the former with direct allocation. Thus with indirect allocation, competing imports are counted twice, both explicitly as an import by the 'indirect' sector and implicitly in the value of the commodities distributed from that sector, whereas with direct allocation they are counted only once. It also follows that with indirect allocation sector output totals for each sector are explicitly inclusive of competitive imports, for distribution to

---

1. See Jensen, R.C., 'Some Accounting Procedures and their Effects on Input-Output Multipliers', Annals of Regional Science, forthcoming.

other sectors, but also inclusive of competing imports for use by that sector.

It is necessary, therefore, to identify within each cell that component representing competing imports indirectly allocated through sector i, i.e.

$$X'_{ij} = X_{ij} + m_{ij}$$

where $X'_{ij}$ = transactions with indirect allocation of competing imports,

$X_{ij}$ = transactions with direct allocation of competing imports, and

$m_{ij}$ = competing imports indirectly allocated through sector i.

If $M_i = \sum_j m_{ij}$ is the total competing imports allocated through sector i, then $M_i$ must be disaggregated into its components $m_{ij}$ across row i. This was performed on a proportional basis to the elements of row i. Within each column these were summed to produce $M'_i = \sum_i m_{ij}$ which replaced the appropriate $M_i$ entry in the competitive imports row. The calculated $m_{ij}$'s were subtracted from the transactions with indirect allocation to provide an estimate of transactions with direct allocation. New output totals were then obtained by column addition of the $X_{ij}$'s.

With respect to the national table used, one additional point needs to be mentioned. The resultant 1974-75 table is a gross table in that intrasectoral transactions are recorded, whereas the national table used in the original GRIT system was a net table. The resultant regional tables are therefore fully gross tables, rather than hybrid gross/net tables.

## Superior Data Collection

A major characteristic of the GRIT procedure is the utilization of superior data where this is considered appropriate. Subject to the format of the available data, superior information can be inserted into the system in four stages:

(i) disaggregated superior data - where data is available at the disaggregated 109 sector regional level.

(ii) disaggregated/aggregated ata - where data is available in a form disaggregated by column and aggregated by rows.

(iii) aggregated superior data - where data is available at the non-uniform aggregation level.

(iv) transactions superior data - where data is available in transactions form at the various levels of aggregation.

The study team utilized all four stages of superior data insertion.

Superior data was obtained from various sources. Extensive consultations occurred between the study team and the various ABS departments, both at the regional and national levels. All available standard and non-standard publications were perused, and some detailed information was obtained in the areas of agriculture, manufacturing, retail, mining, and building and construction. The major input at the disaggregated level were wages and salaries, and where possible these were verified from several sources e.g. payroll tax data.

The study team also consulted with various Northern Territory government departments, in order to isolate those industries which are peculiar to the region. This resulted in the drawing up of a list of industries which were considered not to conform to the national 'average', and consequently the active seeking out of information about these industries. Major firms in these various industry groups were surveyed directly in order to obtain representative cost coefficients. The areas surveyed included the mining, fishing and electricity industries. In addition the Treasury Department supplied detailed breakdown of government expenditure in the public authority area. The data thus obtained was utilized at both the disaggretated/aggregated and aggregated stages of the GRIT procedure. A copy of the questionnaire appears at the end of this appendix. The survey and the subsequent follow up was conducted by Northern Territory Chief Minister's Department.

At the transactions stage of the procedure, various superior data sources were utilized. Household consumptions expenditure for the state was obtained from the ABS household expenditure survey 1975-76, and reduced to the sub-territory regional level by the use of location quotients. Export data was obtained with the help of interstate trade statistics supplied by the ABS. In this study other final demand was obtained as a residual.

Other superior transactions data was inserted in the light of additional information obtained after the preliminary and revised preliminary tables were circulated. Members of the various Northern Territory government departments were asked to critically evaluate the preliminary tables. Anomalies discovered in the course of this evaluation occurred primarily in the mining and agricultural sectors and sales to final demand and exports in the Northern Territory table.

CONFIDENTIAL

1. Name of firm ______________________________

Location of activity in N.T. ______________________________

Business address ______________________________

2. Number of persons employed ______________________________

3. Total value of output ex factory ______________________________

4. Year for which information is supplied (preferably 1976/77) ______________________________

5. Percentage (%) Breakdown of Total Expenditure

Total of Columns A + B = 100%

| | Operating Costs (Ongoings) | |
|---|---|---|
| | A<br>% Spent in N.T. | B<br>% Spent Outside N.T. |
| (1) Manufacturing food, drink, tobacco | | |
| (2) Manufactured wood and paper products | | |
| (3) Machinery, equipment, appliances (incl. vehicle parts) | | |
| (4) Other metal products | | |
| (5) Other manufactured products e.g. cement, paint, etc. | | |
| (6) Fuels, oils | | |
| (7) Electricity (only if purchased from electricity authority) | | |
| (8) Building - construction | | |
| (9) Motor vehicle repairs | | |

| | Operating Costs (Ongoings) | |
|---|---|---|
| | A<br>% Spent in N.T. | B<br>% Spent Outside N.T. |
| (10) Payments to transport operators freight and personnel travel | | |
| (11) Communications (telephone, postage, etc.) | | |
| (12) Finance: Bank and insurance charges and business services | | |
| (13) Payments to Governments for services, e.g. water, sewerage, rates, etc. (excluding taxes) | | |
| (14) Community services, entertainment, accommodation expenses, etc. | | |
| (15) Wages, salaries | | |
| (16) Gross operating surplus (including interest, dividends, depreciation and profits, etc.) | | |
| (17) Other (please specify) | | |
| | A | B |
| TOTAL | | |

A + B = 100%

95.

DIRECTOR GENERAL
DEPARTMENT OF THE CHIEF MINISTER
DARWIN

Groote Eylandt Mining Co. P/l
GROOTE EYLANDT

21.9.79

Dear Sirs,

ECONOMIC SURVEY OF THE NORTHERN TERRITORY

The Department of the Chief Minister, in conjunction with the Economics Department, University of Queensland, is embarking on a series of economic studies of the Northern Territory.

It is expected that the studies will prove invaluable in providing detailed information which is essential to successful planning for the economic development of the Northern Territory. Information on the Mining Industry in the Northern Territory is an important requirement for the study. The information required is indicated in the attached questionnaires.

Every effort will be made to keep the information confidential for Northern Territory Government use only. The information obtained will be reduced to a "transaction table" which will not contain the name of any individual company. A transaction table indicates the relative contribution of each sector of the economy in producing the goods and services supplied in the Northern Territory. A sample of a typical transaction table produced for Queensland and its constituent regions is appended by way of illustration.

Your co-operation in providing the information sought by the Northern Territory Government will be appreciated.

Please do not hesitate to contact Bill Price (089 896095) (reverse charges) Department of the Chief Minister, if you have any problems or require any further guidance in supplying the information sought in the questionnaires.

Yours sincerely,

M.R. FINGER

TABLE M1

CONFIDENTIAL

ECONOMIC SURVEY OF THE NORTHERN TERRITORY

MINING AND ASSOCIATED OPERATIONS

Note: Please complete a separate table for each location and for each operation

1. Name of firm ______________________________

2. Nature of business ______________________________

3. Postal address for further contact ______________________________

______________________________

4. Name and telephone number of firm's contact ______________________________

______________________________

5. Location address for this operation ______________________________

______________________________

6. Is the activity at this location continued throughout the year, or does it operate for only part of the year? If for only part of the year, please specify the number of months and for which period.

| | AS AT 30 JUNE: | | |
|---|---|---|---|
| | 1977 | 1978 | 1979 |
| | $'000 | $'000 | $'000 |
| 7. Total value of output for this operation* | ______ | ______ | ______ |

* Total sales or value of goods and services produced at this location

TABLE N.

CONFIDENTIAL

## ECONOMIC STUDY OF THE NORTHERN TERRITORY

### MINING AND ASSOCIATED OPERATIONS

Note: Please complete a separate table for each location and for each operation

NUMBER OF PERSONS EMPLOYED AT THIS LOCATION:

| SKILL CATEGORY * | EMPLOYED AS AT 30 JUNE : | | | | | |
|---|---|---|---|---|---|---|
| | 1977 | | 1978 | | 1979 | |
| | Full time | ** Other | Full time | ** Other | Full time | ** Other |
| a) Professional | | | | | | |
| b) Sub-professional | | | | | | |
| c) Skilled | | | | | | |
| d) Semi-skilled | | | | | | |
| e) Unskilled | | | | | | |
| f) Total number of persons employed | | | | | | |

* The definition of skills categories is as follows:

a. Professional: Personnel with tertiary qualifications in Science, Engineering, Economics, etc. who are employed in a professional capacity or at an executive level

b. Sub-professional: Personnel with tertiary or other qualifications and experience employed in a technical or administrative capacity including senior clerical staff

c. Skilled: Personnel with appropriate trade or other qualifications and experience, such as carpenters, mechanics and mid-range clerical staff

d. Semi-skilled: Personnel with appropriate training and experience such as laboratory assistants and plant and equipment operators, junior clerks and clerical assistants

e. Unskilled: Personnel with no special skills, such as labourers and cleaners

** Other = less than 40 hours per week

CONFIDENTIAL

## ECONOMIC SURVEY OF THE NORTHERN TERRITORY

## NOTES TO TABLE M3

## MINING AND ASSOCIATED OPERATIONS

## BREAKDOWN OF TOTAL EXPENDITURE

1. Item 3A - Mining - Metallic - includes beneficiating ores or other minerals by crushing, milling, screening, washing, flotation, leaching and calcining, etc. as well as mining, for example, beneficiation of bauxite and production of yellow cake are included in mining. Excluded are such processes as bauxite refining and copper smelting, which fall into Category 4D - Manufactured Metals, Minerals and Metal Products. Preliminary smelting of gold is, however, included under Item 3A.

2. Similarly, Item 3B - Non-metallic mining - includes, for example, coal, but not products such as coke, which are included under Item 5 f O.8.

3. For the purposes of allocating costs please treat exploration, development, mining and processing as separate enterprises.

4. Electricity and water supply costs should be allocated to other sectors in Table M3 where electricity is provided by the enterprise as an integral part of a single activity. In this case there should be no entry against sector 5 in Table M3.

5. Expenditure on the electricity supply, and where applicable on other services such as water supply should be allocated to each activity in cases where supply is maintained to more than one activity such as bauxite mining and alumina smelting. In this case, please enter the cost of electricity to each of your activities to sector 5 in Table M3, electricity and water, in the breakdown of capital and operating costs for each of your activities. Please also complete the separate set of tables for electricity supply.

6. Please estimate where information on costs is not available to the extent sought in the tables, and clearly indicate which is estimated data.

7. It is not expected that all columns for each sector will be completed. Please allocate costs only to those sectors appropriate to the costs incurred in manufacturing your firm/organisation's product or in providing services.

8. Sector classifications accord with the Australian Standard Industrial Classifications used by the Australian Bureau of Statistics. These should be adhered to in allocating costs so as to maintain uniformity with information obtained from other sources.

----

CONFIDENTIAL

ECONOMIC SURVEY OF THE NORTHERN TERRITORY

LOCATION ____________________ MINING AND ASSOCIATED OPERATIONS YEAR ________________

BREAKDOWN OF TOTAL COSTS

| SECTORS<br>Please enter payments to following sectors | Exploration<br>Spent in N.T. | <br>Spent Outside N.T. | New development Capital Works<br>Spent in N.T. | <br>Spent Outside N.T. | Mining Current Costs<br>Spent in N.T. | <br>Spent Outside N.T. | Processing<br>New development<br>Spent in N.T. | <br><br>Spent Outside N.T. | <br>Current Costs<br>Spent in N.T. | <br><br>Spent Outside N.T |
|---|---|---|---|---|---|---|---|---|---|---|
| | $'000 | | $'000 | | $'000 | | $'000 | | $'000 | |
| 1. Animal industries | | | | | | | | | | |
| 2. Other primary industries | | | | | | | | | | |
| 3. Mining | | | | | | | | | | |
| a) Metallic | | | | | | | | | | |
| b) Non-metallic | | | | | | | | | | |
| 4. Manufactured | | | | | | | | | | |
| a) Food, drink, tobacco | | | | | | | | | | |
| b) Wood & paper products | | | | | | | | | | |
| c) Machinery, equipment appliances (incl.transport parts) | | | | | | | | | | |
| d) Metals, Minerals & Metal products | | | | | | | | | | |
| e) Non-metallic mineral products | | | | | | | | | | |
| f) Other | | | | | | | | | | |
| 02) Industrial Chemicals, Paints, Varnishes | | | | | | | | | | |
| 08) Petroleum & coal products (incl. fuel oils & coke) | | | | | | | | | | |
| 5. Electricity, water, sewerage & drainage (only if purchased from an external supplier or provided by the enterprise to more than one activity) | | | | | | | | | | |
| 6. Building - construction | | | | | | | | | | |
| 7. Motor vehicle repairs | | | | | | | | | | |

TABLE M3
(continued)

CONFIDENTIAL

ECONOMIC SURVEY OF THE NORTHERN TERRITORY

LOCATION ______________ YEAR ______________

MINING AND ASSOCIATED OPERATIONS

BREAKDOWN OF TOTAL COSTS

| SECTORS<br>ease enter payments to following sectors | Exploration<br>Spent in N.T.<br>$'000 | Spent Outside N.T. | New development Capital Works<br>Spent in N.T.<br>$'000 | Spent Outside N.T. | Mining Current Costs<br>Spent in N.T.<br>$'000 | Spent Outside N.T. | Processing: New development<br>Spent in N.T.<br>$'000 | Spent Outside N.T. | Processing: Current Costs<br>Spent in N.T.<br>$'000 | Spent Outside N.T |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Payments to transport operators freight and personal travel | | | | | | | | | | |
| 2 Communications (telephone postage, etc.) | | | | | | | | | | |
| Finance: Bank & Insurance charges & business services | | | | | | | | | | |
| Payments to Governments for services (excl. taxes, etc.) Not elsewhere included | | | | | | | | | | |
| 12 Community & personal services, entertainment, accommodation expenses, etc.) | | | | | | | | | | |
| Wages, salaries | | | | | | | | | | |
| Gross operating surplus (incl. interest, dividends, depreciation & profits, etc.) | | | | | | | | | | |
| Other (please specify) | | | | | | | | | | |
| TOTAL | | | | | | | | | | |

CONFIDENTIAL

TABLE E1

# ECONOMIC STUDY OF THE NORTHERN TERRITORY

## ELECTRICITY SUPPLY

NOTE: These tables should only be completed where your organisation produces electricity for multiple use, at this location, e.g. mining and processing or education and domestic use, or for sale to a separate organisation.

1. Name of firm/authority ______________________

2. Postal address for further contact ______________________

______________________

3. Name and telephone of firm's contact ______________________

______________________

4. Location address for this operation* ______________________

5. Please list each activity or business supplied with electricity from this source** ______________________

______________________

______________________

6. Is the activity at this location continued throughout the full year, or does it operate for only part of the year? If only for part of the year please specify the number of months and for which period ______________________

______________________

| | YEAR ENDING 30 JUNE | | |
|---|---|---|---|
| | 1977 | 1978 | 1979 |
| | $'000 | $'000 | $'000 |
| 7. a) Total value of electricity distributed | ______ | ______ | ______ |

* Please complete separate tables for each location and for each operation.

** Item 5 does not apply to the Northern Territory Electricity Commission.

CONFIDENTIAL

ECONOMIC STUDY OF THE NORTHERN TERRITORY

ELECTRICITY SUPPLY

Note: Please complete a separate table for each location and for each operation

NUMBER OF PERSONS EMPLOYED AT THIS LOCATION:

| SKILL CATEGORY * | EMPLOYED AS AT 30 JUNE : | | | | | |
|---|---|---|---|---|---|---|
| | 1977 | | 1978 | | 1979 | |
| | Full time | ** Other | Full time | ** Other | Full time | ** Other |
| a) Professional | | | | | | |
| b) Sub-professional | | | | | | |
| c) Skilled | | | | | | |
| d) Semi-skilled | | | | | | |
| e) Unskilled | | | | | | |
| f) Total number of persons employed | | | | | | |

* The definition of skills categories is as follows:

a. Professional: Personnel with tertiary qualifications in Science, Engineering, Economics, etc. who are employed in a professional capacity or at an executive level

b. Sub-professional: Personnel with tertiary or other qualifications and experience employed in a technical or administrative capacity including senior clerical staff

c. Skilled: Personnel with appropriate trade or other qualifications and experience, such as carpenters, mechanics and mid-range clerical staff

d. Semi-skilled: Personnel with appropriate training and experience, such as laboratory assistants and plant and equipment operators, junior clerks and clerical assistants

e. Unskilled: Personnel with no special skills, such as labourers and cleaners

** Other = less than 40 hours per week

CONFIDENTIAL

# ECONOMIC STUDY OF THE NORTHERN TERRITORY

## NOTES TO TABLES E3 AND E4

## ELECTRICITY SUPPLY

## BREAKDOWN OF TOTAL EXPENDITURE

1. Electricity production costs should be allocated to appropriate sectors where electricity is provided by the enterprise to a single activity. In this case, do not complete these tables for electricity supply.

2. Only complete these tables when electricity is supplied to more than one activity such as Bauxite Mining and Alumina Production, or supplied to consumers other than your own enterprise. The electricity supply should then be treated as a separate entity and the breakdown in total expenditure for electricity supply should be entered in the appropriate sectors in these tables.

3. Also costs of supply should be allocated to and entered against sector 5, electricity supply in the "Mining and Associated Operations" tables, for example, for each of your enterprises which are supplied with electricity from this source.

4. Please estimate, where information of costs is notavailable to the extent sought in the tables, and clearly indicate which is estimated data.

5. It is not expected that all columns for each sector will be completed. Please allocate costs only against those sectors appropriate to the costs incurred in manufacturing your firm/organisation's product or in providing service..

6. Sector classifications accord with the Australian Standard Industrial Classifications used by the Australian Bureau of Statistics. These should be adhered to in allocating your costs so as to maintain uniformity with information obtained from other sources.

----

# ECONOMIC STUDY OF THE NORTHERN TERRITORY

## BREAKDOWN OF CURRENT PRODUCTION COSTS

### ELECTRICITY SUPPLY

LOCATION: ______________ YEAR ______________

| SECTORS<br>Please enter payments to following sectors | GENERATION<br>Spent in N.T. | <br>Spent Outside N.T. | DISTRIBUTION<br>Spent in N.T. | <br>Spent Outside N.T. | RETICULATION<br>Spent in N.T. | <br>Spent Outside N.T. |
|---|---|---|---|---|---|---|
| | $'000 | | $'000 | | $'000 | |
| 1. Animal Industries | | | | | | |
| 2. Other Primary Industries | | | | | | |
| 3. Mining | | | | | | |
| a) Metallic | | | | | | |
| b) Non-metallic | | | | | | |
| 4. Manufactured | | | | | | |
| a) Food, drink, tobacco | | | | | | |
| b) Wood & paper products | | | | | | |
| c) Machinery, equipment, appliances (incl. transport parts) | | | | | | |
| d) Metals, Minerals & Metal Products | | | | | | |
| e) Non-metallic mineral products | | | | | | |
| f) Other | | | | | | |
| 02) Industrial chemicals, Paints, Varnishes | | | | | | |
| 08) Petroleum & coal products including fuel, oils & coke. | | | | | | |
| 5. Electricity, Water & Gas, only if purchased from an external supplier or provided by the enterprise to more than one activity | | | | | | |
| 6. Building - construction | | | | | | |
| 7. Motor vehicle repairs | | | | | | |
| 8.1 Payments to transport operators - freight and personnel travel | | | | | | |
| 8.2 Communications, (telephone, postage, etc.) | | | | | | |
| 9. Finance: Bank & insurance charges & business services | | | | | | |
| 10. Payments to Governments for services (excluding taxes, etc.) Not elsewhere included. | | | | | | |

ECONOMIC STUDY OF THE NORTHERN TERRITORY

BREAKDOWN OF CURRENT PRODUCTION COSTS

ELECTRICITY SUPPLY

LOCATION: ______ YEAR ______

| SECTORS<br>Please enter payments to following sectors | GENERATION<br>Spent in N.T. | <br>Spent Outside N.T. | DISTRIBUTION<br>Spent in N.T. | <br>Spent Outside N.T. | RETICULATION<br>Spent in N.T. | <br>Spent Outside N.T. |
|---|---|---|---|---|---|---|
| | $'000 | | $'000 | | $'000 | |
| 11/12 Community & personal services, entertainment, accommodation, expenses etc. | | | | | | |
| 13. Wages, salaries | | | | | | |
| 14. Gross operating surplus (incl. interest, dividends, depreciation and profits, etc.) | | | | | | |
| 15. Other (please specify) | | | | | | |
| TOTAL | | | | | | |

CONFIDENTIAL

TABLE E4

# ECONOMIC STUDY OF THE NORTHERN TERRITORY

## BREAKDOWN OF CAPITAL COSTS

## ELECTRICITY SUPPLY

LOCATION: ____________ YEAR ____________

| SECTORS<br>Please enter payments to following sectors | GENERATION<br>Spent in N.T. | <br>Spent Outside N.T. | DISTRIBUTION<br>Spent in N.T. | <br>Spent Outside N.T. | RETICULATIO[N]<br>Spent in N.T. | <br>Spent Outsi[de] N.T. |
|---|---|---|---|---|---|---|
| | $'000 | | $'000 | | $'000 | |
| 1. Animal Industries | | | | | | |
| 2. Other Primary Industries | | | | | | |
| 3. Mining | | | | | | |
| a) Metallic | | | | | | |
| b) Non-metallic | | | | | | |
| 4. Manufactured | | | | | | |
| a) Food, drink, tobacco | | | | | | |
| b) Wood & paper products | | | | | | |
| c) Machinery, equipment appliances (incl. transport parts) | | | | | | |
| d) Metals, Minerals & Metal Products | | | | | | |
| e) Non-metallic mineral products | | | | | | |
| f) Other | | | | | | |
| 02) Industrial chemicals Paints, Varnishes | | | | | | |
| 08) Petroleum & coal products including fuel, oils & coke | | | | | | |
| 5. Electricity, Water & Gas, only if purchased from an external supplier or provided by the enterprise to more than one activity | | | | | | |
| 6. Building - construction | | | | | | |
| 7. Motor vehicle repairs | | | | | | |
| 8.1 Payments to transport operators - freight and personnel travel | | | | | | |
| 8.2 Communications (telephone postage, etc.) | | | | | | |
| 9. Finance: Bank & insurance charges & business services | | | | | | |
| 10. Payments to Governments for services (excluding taxes, etc.) | | | | | | |

ECONOMIC STUDY OF THE NORTHERN TERRITORY (continued)

## BREAKDOWN OF CAPITAL COSTS

## ELECTRICITY SUPPLY

LOCATION: ________ YEAR ________

| SECTORS<br>Please enter payments to following sectors | GENERATION<br>Spent in N.T. | <br>Spent Outside N.T. | DISTRIBUTION<br>Spent in N.T. | <br>Spent Outside N.T. | RETICULATION<br>Spent in N.T. | <br>Spent Outside N.T. |
|---|---|---|---|---|---|---|
| | $'000 | | $'000 | | $'000 | |
| 11/12 Community & personal services, entertainment accommodation, expenses, etc. | | | | | | |
| 13. Wages, salaries | | | | | | |
| 14. Gross operating surplus (incl. interest, dividends, depreciation and profits, etc.) | | | | | | |
| 15. Other (please specify) | | | | | | |
| TOTAL | | | | | | |

TABLE 7.12 ELEVEN-SECTOR TRANSACTIONS TABLE : QUEENSLAND, 1973-74, (,000)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | House-holds | Other Final Demand | Exports | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 312095 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 10111 | 0 | 183319 | 505529 |
| 2 | 41501 | 61382 | 11322 | 311877 | 120 | 23 | 1 | 1588 | 0 | 9 | 174 | 140640 | 0 | 88879 | 657516 |
| 3 | 1 | 111 | 14804 | 67588 | 13766 | 11884 | 1645 | 2196 | 21 | 61 | 1063 | 0 | 0 | 543733 | 656873 |
| 4 | 60789 | 72830 | 85791 | 420063 | 9253 | 334401 | 37132 | 75589 | 3130 | 42875 | 28133 | 848860 | 89780 | 839402 | 2948028 |
| 5 | 6151 | 9741 | 25764 | 46326 | 6411 | 4793 | 9633 | 5793 | 32798 | 6236 | 30219 | 87448 | 25673 | 0 | 296986 |
| 6 | 7461 | 8102 | 7540 | 24123 | 13642 | 0 | 15024 | 46367 | 28008 | 44375 | 15683 | 24136 | 857362 | 0 | 1091823 |
| 7 | 21512 | 29699 | 47977 | 136475 | 4674 | 99505 | 41522 | 34593 | 43209 | 3606 | 28104 | 625540 | 0 | 0 | 1116416 |
| 8 | 10485 | 20670 | 29268 | 138035 | 13708 | 40517 | 38181 | 14232 | 9542 | 5725 | 5041 | 180514 | 174734 | 41405 | 722057 |
| 9 | 221 | 660 | 19923 | 32921 | 829 | 2750 | 105563 | 5745 | 59842 | 11708 | 9295 | 324634 | 0 | 280210 | 854301 |
| 10 | 0 | 0 | 11 | 163 | 9 | 0 | 2 | 14 | 0 | 0 | 1 | 8381 | 410464 | 0 | 419045 |
| 11 | 1446 | 29 | 476 | 1644 | 124 | 103 | 2360 | 1514 | 1261 | 4404 | 853 | 290400 | 270889 | 39409 | 614912 |
| Households | 28669 | 77514 | 85392 | 621261 | 75983 | 325614 | 427912 | 266711 | 323647 | 249265 | 326882 | 0 | 0 | 0 | 2798850 |
| Other Value Added | 303288 | 345281 | 205746 | 420407 | 154542 | 136021 | 348767 | 193972 | 324300 | 5371 | 124989 | 0 | 0 | 0 | 2562684 |
| Imports | 24005 | 31497 | 122859 | 415050 | 3925 | 136209 | 88674 | 83742 | 28543 | 45410 | 44475 | 908881 | 0 | 0 | 1933270 |
| Total | 505529 | 657516 | 656873 | 2948028 | 296986 | 1091823 | 1116416 | 722057 | 854301 | 419045 | 614912 | 3449545 | 1828902 | 2016357 | - |

# APPENDIX IV

## SOME REFLECTIONS ON INPUT-OUTPUT MULTIPLIERS

G.R. West and R.C. Jensen
University of Queensland

## ABSTRACT

It is possible to identify some important inconsistencies in the definition of the components of input-output multipliers derived in the conventional manner. This paper identifies these inconsistencies which occur in output, income and employment multipliers, with the result that valid comparison of direct and indirect effects between multipliers is not possible. A suggested re-definition of input-output multipliers, considered to be free of these inconsistencies, is provided and illustrated.

This note is concerned with the interpretation of input-output multipliers. Over many years and many empirical applications of input-output analysis, methods of calculating multipliers have been derived and some have been accepted as 'conventional'. They are conventional in that they are taken for granted by most analysts, and within certain limits are accorded the status of both theoretical and empirical legitimacy. Our concern is not with the multiplier concepts, nor with the general methods of multiplier derivation, but rather with the specific meaning of some of the components of the multipliers and some apparent inconsistencies in interpretation. This note briefly reviews the methods of calculation of the conventional input-output multipliers in Part 1; Part 2 illustrates the inconsistencies in interpretation in the components of these multipliers. Part 3 suggests a multiplier format which we believe to be free of these inconsistencies and simpler to interpret.

## 1. THE CONVENTIONAL MULTIPLIERS

It is possible from a study of the input-output literature (particularly at the regional level) to recognise a conventional concensus calculation format and terminology.[1] This conventional format is described below in algebraic terms is illustrated using a 3 x 3 simplified table of the Queensland economy (Table 1), and its attendant A matrix, defined by heavy lines in Table 2.

### Output Multipliers

The multiplier logic is usually cast in terms of response to the stimulus of a dollar increase in output or sales of each sector. Because of the linearity conditions, the arguments apply equally to each dollar of output or a dollar increase or decrease in output. For simplicity

---

1. This is described, for example in the two 'classics' of Chenery and Clark [1] and Miernyk [2] and many other publications.

we follow the convention of assuming an increase in output, and refer as an example to Sector 1. The initial stimulus of a dollar increase in output of Sector 1 calls for first round increases in output of $a_{11}$ (\$0.071) from Sector 1 (in addition to the dollar stimulus), of $a_{21}$ (\$0.133) from Sector 2 and so on. These $a_{i1}$ are the separate industry or disaggregated first round intersectoral effects. The total first round effect from Sector 1 (conventionally termed the direct effect), following the dollar stimulus to Sector 1 is $\sum_i a_{i1}$, (or \$0.327). We should note that the first round effects exclude the initial dollar stimulus.

Now proceed from the A matrix to the general solution $B = (I-A)^{-1}$. Each element $b_{ij}$ of B is a multiplier and indicates the direct and indirect requirement of sector i per dollar (increase) in sales by sector j to final demand. For example, the direct and indirect requirements from Sector 1 (Table 3) per dollar (increase) of sales to final demand by Sector 1 is \$1.116, from Sector 2 is \$0.205 and so on, giving a direct and indirect output multiplier of $\sum_i b_{i1}$ of 1.509. Note that this includes the initial dollar stimulus. The same reasoning applies to the direct, indirect and induced output effects taken from the augmented inverse $B^* = (I-A^*)^{-1}$ (Table 5), obtained after closing A with respect to households to obtain A* (Table 4). The total direct, indirect and induced output multipliers, obtained in this three-sector case as $\sum_{i=1}^{3} b^*_{ij}$ are respectively 1.999, 2.625, and 2.395. Note that these multipliers also include the original dollar stimulus. The sector output multipliers are shown in the conventional format in Table 6; the sectoral incidence of the output effects of Sector 1 are shown through disaggregated output multipliers for Sector 1, in Table 7.

## Income Multipliers

Input-output income multipliers are calculated from output multipliers i.e. income increases in a sector are assumed to be linearly dependent on output. Income, usually defined as household (HH) income is represented via the HH coefficients, in the HH row of Table 4. These coefficients are termed the direct income change associated with an increase of sales of one dollar to final demand by each sector i.e. \$0.105 in the case of Sector 1. The direct and indirect (DI) income effects are calculated by multiplying the elements of each column of the B matrix by the corresponding HH coefficient e.g. for Sector 1 the calculation is given in Table 8. The $b_{ij}\ h_i$ provide the disaggregated income effects, and the $\sum_i b_{ij}\ h_i$, or sum of these, provides the direct and indirect income multiplier, which is parallel in interpretation to the direct and indirect output multiplier from which it is obtained.

The direct, indirect and induced (DII) income multiplier is taken in total from the HH row of the augmented inverse (Table 5) or calculated in a disaggregated form for Sector 1 in Table 9. The $b_{ij}^*\ h_i$ are parallel in interpretation to the output elements of the B* matrix. It is a feature of the input-output matrices that they sum to equal the corresponding entry in the HH row of the B* matrix.

The sector income multipliers for this example are summarised in conventional form in Table 10. The format is similar to that of the output multipliers in Table 6, except that Type I and II multipliers are added. The sectoral incidence of income effects of Sector 1 are illustrated in Table 11; note that the direct income effects are restricted to that sector which incurred the initial increase of sales of one dollar to final demand.

## 2. MULTIPLIER INCONSISTENCY

### Inconsistencies in Output Multipliers

It would be conventional for the output multipliers in the Queensland example to be published in the form similar to that shown in Table 6. The total direct effects (Column 1) and the direct and indirect effects (Column 4) do not have consistent definitions; the former excludes the original dollar stimulus, the latter includes it. The difference, which is conventionally termed the indirect effect (Column 2) therefore includes the actual indirect or industrial support effects, plus the original dollar stimulus. The induced effect obtained from columns (4) and (5), excludes the dollar stimulus since both of these columns contain the stimulus and it is netted out in subtraction. Clearly, to be consistent all three effects should exclude the initial dollar effect.

When considering disaggregated output effects so that the sectoral incidence of the stimulus of the jth sector can be identified, the above inconsistency is true only for the jth sector. For instance, the sectoral incidence of the output stimulus to sector 1 is given in Table 7, where the original dollar stimulus is included in the first row of Column (2). For all other sectors the direct, and direct and indirect effects are consistently defined.

Inconsistencies in Income Multipliers

As mentioned earlier, income multipliers are effectively calculated from output multipliers by multiplication of the disaggregated output multipliers by HH coefficients. There is however a major inconsistency in the terminology used in output and income multipliers. This inconsistency lies in the use of the term 'direct'. In the common usage of output multipliers the term 'direct' refers to the direct or technical coefficients which represent the first round effect on all sectors in the table, in response to an initial stimulus of one dollar increase in final demand. With income multipliers the term 'direct' is confined to the HH income increase in own sector which accompanies the initial stimulus of one dollar increase in sales. For the direct income effect to be defined consistently with the use of the term in output multipliers, it would need to represent the HH income increases in all sectors, associated with the first round output effect, to be obtained by multiplying first round output effects ($a_{ij}$) by the corresponding HH coefficients ($h_i$). This is shown in Table 13 for Sector 1; note that these exclude the initial income effect. This means in effect that although the parallel usage of terms has developed, the inconsistent definition of these terms has become common practice. In effect while columns (1) of Tables 6 and 10 are similarly named, they have quite different meanings. Similarly, columns (1) of Tables 7 and 11 are not symmetrical; the single entry in column (1) of Table 11 represents the own-sector income effect.

The inconsistency is compounded when we consider the direct and indirect income effects shown in column (4) of Tables 10 and 11. These are conventionally obtained, as shown in Table 8, by multiplying the elements of each column of matrix B by the appropriate HH coefficients. The total direct and indirect (DI) income effect from a dollar increase in sales by Sector 1 is $\Sigma\, b_{i1} \,.\, h_i$ (0.243), which now includes the initial effect (0.105) since the unity is retained on the main diagonal of the B matrix during the calculation of DI effects. The subtraction of the conventional direct income effect (own sector) from the conventional DI income effect (which includes the own-sector, first-round and subsequent round effects), provides an indirect effect (in column (2) of Tables 10 and 11) which is actually similar in content to the direct and indirect effect in output multipliers, by including both first round and subsequent-round effects. Consistency in DI output and income multipliers could be obtained only by deleting the unity from the diagonal of B matrix before calculating the DI effects.

The calculation of DII income multipliers, shown in Table 9, and the subsequent calculation of induced effects by subtracting DI from DII multipliers produces no inconsistencies in definition of induced effects between output and income multipliers, provided both are calculated on the same basis, i.e. with the presence or absence of the unity on the main diagonal.

Employment Multipliers

Conventional methods for the calculation of employment multipliers are parallel to those for the calculation of income multipliers. Clearly, the inconsistencies noted in the interpretation of income multipliers will extend also to employment multipliers.

## 3. A CONSISTENT PRESENTATION OF INPUT-OUTPUT MULTIPLIERS

This section provides a re-definition of input-output multipliers, one which is consistent from output to income multipliers, and which retains essence of the conventional multipliers. The discussion below avoids use of the terms "direct" and "indirect" because of the confusion of meaning attached to these terms as evident in Section 2 above.

A multiplier is essentially a measurement of response to an economic stimulus. In the case of input-output multipliers the stimulus is normally assumed to be an increase of one dollar in sales to final demand by a sector, and we are interested in the major categories of response in terms of output and income increases. These major categories of effect/response are listed below and illustrated in Table 12. They are:

(i) The Initial Effect. This refers to the assumed dollar increase in sales; it is the stimulus. It is the unity base for the output multiplier and provides the identity matrix of the Leontief matrix. Associated directly with this dollar increase in output is an own-sector increase in HH income in wages, salaries etc. used in the production of that dollar of output. This is the household coefficient $h_1$ ($0.105 for Sector 1).

(ii) The First-Round Effect. This refers to the effect of the first round of purchases by the sector providing the additional dollar of output. Clearly, in the case of the output multiplier this will be $a_{ij}$ as the individual sectoral effect, and the column sum of the elements of the A matrix, i.e. $\sum_i a_{ij}$ as the total first round effects of a dollar increase in sales to final demand by sector i. In the case of the income multipliers this will be the HH income increases occasioned by the first round requirements, i.e. $a_{ij}\ h_i$ for any individual sectoral effect, or $\sum_i a_{ij}\ h_i$ for the total effect of sector i. (Table 13)

(iii) Industrial Support Effect. This term is applied here to 'second and subsequent round' effects as successive waves of necessary output increases occur in the economy following the first-round impacts. The term specifically excludes household consumption induced effects; it is calculated from the open inverse B, as a measure of industrial support requirements associated with a given set of first-round effects. The industrial support output requirements must be calculated as the elements of the columns of the B matrix, less the initial dollar stimulus and the first-round requirements, i.e. $\sum_i b_{ij} - 1 - \sum_i a_{ij}$. The income effects for each sector will be defined consistently with this, i.e. $\sum_i b_{ij}\ h_i - h_i - \sum_i a_{ij}\ h_i$. The first round and industrial support can together be described as the production induced effect to distinguish them from the consumption induced effect.

(iv) The Consumption Induced Effect. As mentioned in Section 2, no inconsistencies in the definition of the induced effect in output and income multipliers were apparent. The induced effect here is therefore defined in the conventional way.

namely as that induced by increased income associated with increased output. This is recorded as the difference between the columns of the open inverse B and the closed inverse B*, i.e. as $\sum_i b^*_{ij} - \sum_i b_{ij}$ for output effects and $\sum_i b^*_{ij} h_i - \sum_i b_{ij} h_i$ for income effects.

These effect categories avoid inconsistencies between multipliers by defining the income effects symmetrically with output effects.[2] Revised output multipliers for the Queensland example are shown in Tables 14 and 15, and revised income multipliers of consistent definition in Tables 16 and 17. These multipliers indicate for example that a dollar increase in sales of Sector 1 to final demand results in:

(i) an initial income increase to the workers/staff/owners in Sector 1 of $0.105.

(ii) a first-round output effect on all sectors of $0.327 ($0.071 in Sector 1, $0.133 in Sector 2, and $0.123 in Sector 3), accompanied by a first round income increases of $0.089, being $0.007, $0.031, and $0.051 in each sector.

(iii) industrial support output effect of $0.182 (being $0.045, $0.072 and $0.065 in the three sectors), which in turn is accompanied by an income increase of $0.049, (being $0.005, $0.017 and $0.027 respectively).

(iv) consumption induced output effect of $0.490 ($0.049, $0.173 and $0.268 respectively in the sectors) and an accompanying consumption-induced income increase of $0.156, being in each sector $0.005, $0.040, and $0.110 respectively.

---

2. Table 12 provides opportunity for a useful summary of the inconsistencies noted in Section 2. In terms of the nomenclature of Table 12, the conventional system defines the effect as:

| | Output Multipliers | Income Multipliers |
|---|---|---|
| Direct | (ii) | (i) |
| Indirect | (i)&(iii) | (ii)&(iii) |
| Induced | (iv) | (iv) |

Type I and II Multipliers

The question of Type I and Type II multipliers deserves attention. The output multipliers are calculated both in the conventional system and the system suggested in this paper, on a 'per unit of initial effect' basis - i.e. output responses to a dollar change in output. Income multipliers as described above refer to changes in income per dollar initial change in output. Income multipliers are conventionally converted to a 'per unit' measurement by the calculation of Type I and II multipliers as:

$$\text{Type I} = \frac{\text{Direct \& indirect effect}}{\text{Direct effect}}; \quad \text{Type II} = \frac{\text{Direct, indirect \& induced effect}}{\text{Direct effect}}$$

Type I and II multipliers therefore measure the DI and DII income effects per unit of income generated within the sector expanding production, on an 'own-sector' basis, as a result of an increase in sales to final demand. The output multipliers and the Type I and II income multipliers therefore have a common structure, measuring a response per unit of initial effect.

The redefinition of multiplier components to produce consistency suggests a re-examination of Type I and II multipliers. Analysts are likely to be interested in income generated per unit of initial effect - in this case it is probably useful to retain the general Type I-Type II format, but to distinguish between the first-round, industrial support and consumption induced effect in this manner:

$$\text{Type IA Income Multiplier} = \frac{\text{Initial + First Round effect}}{\text{Initial effect (I)}} = \frac{IF}{I}$$

$$\text{Type IB Income Multiplier} = \frac{\text{Initial + Production Induced Effect}}{\text{Initial effect (I)}} = \frac{IP}{I}$$

$$\text{Type II Income Multiplier} = \frac{\text{Initial + Production Induced \& Consumption Induced Effect}}{\text{Initial effects (I)}} = \frac{IPC}{I}$$

These are shown for the Queensland example in Table 18.

## CONCLUDING REMARKS

The suggested multiplier format has two advantages. First, it ensures that the terms used in defining the component effects of multipliers are consistently applied in both output and income multipliers; this is not a feature of the multiplier format in conventional use. Secondly, procedures for income (and employment) multiplier calculation are considerably simplified; output effects can simply be multiplied by appropriate income (or employment) coefficients to obtain corresponding multiplier components. This also is not a feature of the conventional format. The system suggested in this paper has replaced the conventional format in our input-output studies.

REFERENCES

[1] Chenery, H.B. and Clark, P.G. (1962), Interindustry Economics, Wiley.

[2] Miernyk, W.H. (1965), The Elements of Input-Output Analysis, Random House.

TABLE 1: TRANSACTIONS TABLE, QUEENSLAND, 1973-4($m)

| | | Intermediate Sectors 1 | 2 | 3 | Household Consumption | Other Final Demand | Total Output |
|---|---|---|---|---|---|---|---|
| Intermediate Sectors | 1 | 129.1 | 703.5 | 20.6 | 102.4 | 864.3 | 1819.9 |
| | 2 | 242.5 | 778.6 | 359.2 | 762.2 | 1897.3 | 4039.8 |
| | 3 | 224.0 | 503.2 | 536.7 | 1434.2 | 1325.5 | 4023.6 |
| Households | | 191.6 | 946.9 | 1660.4 | - | - | 2798.9 |
| Other Primary Inputs | | 1032.7 | 1107.6 | 1446.7 | 500.1 | 429.2 | 4516.3 |
| Total | | 1819.9 | 4039.8 | 4023.6 | 2798.9 | 4516.3 | 17198.5 |

TABLE 2: DIRECT COEFFICIENTS MATRIX, QUEENSLAND, 1973-4

| | 1 | 2 | 3 |
|---|---|---|---|
| 1 | .071 | .174 | .005 |
| 2 | .133 | .193 | .089 |
| 3 | .123 | .125 | .133 |
| Total Intermediate | .327 | .492 | .227 |
| Households | .105 | .234 | .413 |
| Other Primary Inputs | .568 | .274 | .360 |
| Total | 1.000 | 1.000 | 1.000 |

TABLE 3: $B = (I-A)^{-1}$, QUEENSLAND, 1973-4

| | 1 | 2 | 3 |
|---|---|---|---|
| 1 | 1.116 | .246 | .032 |
| 2 | .205 | 1.304 | .136 |
| 3 | .188 | .222 | 1.178 |
| Total | 1.509 | 1.772 | 1.346 |

TABLE 4: A* MATRIX, CLOSED WITH RESPECT TO HOUSEHOLDS, QUEENSLAND, 1973-4

| | 1 | 2 | 3 | Households |
|---|---|---|---|---|
| 1 | .071 | .174 | .005 | .036 |
| 2 | .133 | .193 | .089 | .273 |
| 3 | .123 | .125 | .133 | .512 |
| Households | .105 | .234 | .413 | - |

TABLE 5: $B^* = (I-A^*)^{-1}$, QUEENSLAND, 1973-4

| | 1 | 2 | 3 | Households |
|---|---|---|---|---|
| 1 | 1.165 | .332 | .138 | .204 |
| 2 | .378 | 1.604 | .505 | .710 |
| 3 | .456 | .689 | 1.752 | 1.102 |
| (Total) | (1.999) | (2.625) | (2.395) | |
| Households | .399 | .695 | .856 | 1.643 |

TABLE 6: SECTOR OUTPUT MULTIPLIERS, QUEENSLAND, 1973-4

| Sector | Direct[(a)] (1) | Indirect[(b)] (2) | Induced[(c)] (3) | Direct[(d)] and Indirect (4) | Direct[(e)] Indirect and Induced (5) |
|---|---|---|---|---|---|
| 1 | .327 | 1.182 | .490 | 1.509 | 1.999 |
| 2 | .492 | 1.280 | .853 | 1.772 | 2.625 |
| 3 | .227 | 1.119 | 1.049 | 1.346 | 2.395 |

(a) From Table 2
(b) Column (4) less column (1)
(c) Column (5) less column (4)
(d) From Table 3
(e) From Table 5

TABLE 7: DISAGGREGATED OUTPUT MULTIPLIERS, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Direct[(a)] (1) | Indirect[(b)] (2) | Induced[(c)] (3) | Direct[(d)] and Indirect (4) | Direct[(e)] Indirect and Induced (5) |
|---|---|---|---|---|---|
| 1 | .071 | 1.045 | .049 | 1.116 | 1.165 |
| 2 | .133 | .072 | .173 | .205 | .378 |
| 3 | .123 | .065 | .268 | .188 | .456 |
| | .327 | 1.182 | .490 | 1.509 | 1.999 |

(a) From Table 2
(b) Column (4) less column (1)
(c) Column (5) less column (4)
(d) From Table 3
(e) From Table 5

TABLE 8: CALCULATION OF DIRECT & INDIRECT INCOME EFFECTS, SECTOR 1

| Sector | $b_{i1}$ (1) | $h_i$ (2) | $b_{i1}\ h_i$ (3) | |
|---|---|---|---|---|
| 1 | 1.116 | .105 | .117 | |
| 2 | .205 | .234 | .048 | ........... (1) |
| 3 | .188 | .413 | .078 | |

DI Income Multiplier = .243

TABLE 9: CALCULATION OF DIRECT, INDIRECT & INDUCED INCOME EFFECTS, SECTOR 1

| Sector | $b^*_{i1}$ (1) | $h_i$ (2) | $b^*_{i1}\ h_i$ (3) | |
|---|---|---|---|---|
| 1 | 1.165 | .105 | .122 | |
| 2 | .378 | .234 | .088 | ........... (2) |
| 3 | .456 | .413 | .188 | |

DII Income Multiplier = .398

TABLE 10: SECTOR INCOME MULTIPLIERS, QUEENSLAND, 1973-4

| Sector | Direct[a] | Indirect[b] | Induced[c] | Direct and Indirect[d] | Direct Indirect & Induced[e] | Type I[f] | Type II[g] |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1 | .105 | .138 | .156 | .243 | .399 | 2.31 | 3.80 |
| 2 | .234 | .189 | .272 | .423 | .695 | 1.81 | 2.97 |
| 3 | .413 | .108 | .335 | .521 | .856 | 1.26 | 2.07 |

(a) From the Households row of Tables 2 or 4
(b) Column (4) less column (1)
(c) Column (5) less column (4)
(d) Calculated as shown in Section 1
(e) Calculated as shown in Section 1 or taken as the HH row of Table 5
(f) Column (4) divided by column (1)
(g) Column (5) divided by column (1)

TABLE 11: DISAGGREGATED INCOME MULTIPLIERS, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Direct | Indirect[a] | Induced[b] | Direct and Indirect | Direct, Indirect & Induced |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1 | .105 | .012 | .005 | .117 | .122 |
| 2 | - | .048 | .040 | .048 | .088 |
| 3 | - | .078 | .110 | .078 | .188 |
| | .105 | .138 | .155 | .243 | .398 |

(a) Column (3) of Table 8, less column (1) of this table.
(b) Column (3) of Table 9, less column (3) of Table 8.

TABLE 12: OUTPUT AND INCOME EFFECTS OF AN INCREASE IN SALES TO FINAL DEMAND

| | Output Multipliers | | Income Multipliers | |
|---|---|---|---|---|
| | General Case | Example | General Case | Example |
| (i) Initial Effect | 1 | 1 | $h_i$ | .105 |
| Production Induced Effect | | | | |
| (ii) First Round Effect | $\sum_i a_{ij}$ | .327 | $\sum_i a_{ij} h_i$ | .089 |
| (iii) Industrial Support Effect | $\sum_i b_{ij} - 1 - \sum_i a_{ij}$ | .182 | $\sum_i b_{ij} h_i - h_i - \sum_i a_{ij} h_i$ | .049 |
| (iv) Consumption Induced Effect | $\sum_i b^*_{ij} - \sum_i b_{ij}$ | .490 | $\sum_i b^*_{ij} h_i - \sum_i b_{ij} h_i$ | .155 |
| Total | $\sum_i b^*_{ij}$ | 1.999 | $\sum_i b^*_{ij} h_i$ | .398 |

TABLE 13: FIRST ROUND INCOME EFFECTS, SECTOR 1, QUEENSLAND, 1973-4

| Sector | $a_{i1}$ | $h_i$ | $a_{i1} h_i$ |
|---|---|---|---|
| 1 | .071 | .105 | .007 |
| 2 | .133 | .234 | .031 |
| 3 | .123 | .413 | .051 |
| First Round Income Effect = | | | .089 |

TABLE 14: SECTOR OUTPUT MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, QUEENSLAND, 1973-4

| Sector | Initial | First Round[a] | Industrial Support[b] | Consumption Induced | Total |
|---|---|---|---|---|---|
| 1 | 1.000 | .327 | .182 | .490 | 1.999 |
| 2 | 1.000 | .492 | .280 | .853 | 2.625 |
| 3 | 1.000 | .227 | .119 | 1.049 | 2.395 |

(a) from Table 2.
(b) from Table 2 & 3, using formula (iii) of Table 12.
(c) from Table 6.

TABLE 15: SECTORAL INCIDENCE OF OUTPUT MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Initial | First Round[a] | Industrial Support | Consumption Induced | Total |
|---|---|---|---|---|---|
| 1 | 1.000 | .071 | .045 | .049 | 1.165 |
| 2 | - | .133 | .072 | .173 | .378 |
| 3 | - | .123 | .065 | .268 | .456 |
| | 1.000 | .327 | .182 | .490 | 1.999 |

(a) from Table 2.

TABLE 16: SECTOR INCOME MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, QUEENSLAND, 1973-4

| Sector | Initial | First Round | Industrial Support | Consumption Induced | Total |
|---|---|---|---|---|---|
| 1 | .105 | .089 | .049 | .156 | .399 |
| 2 | .234 | .115 | .074 | .272 | .695 |
| 3 | .413 | .077 | .032 | .335 | .857 |

TABLE 17: SECTORAL INCIDENCE OF INCOME MULTIPLIERS BY FOUR CATEGORIES OF EFFECT, SECTOR 1, QUEENSLAND, 1973-4

| Sector | Initial | First Round | Industrial Support | Consumption Induced | Total |
|---|---|---|---|---|---|
| 1 | .105 | .007 | .005 | .005 | .122 |
| 2 | - | .031 | .017 | .040 | .088 |
| 3 | - | .051 | .027 | .110 | .188 |
| | .105 | .089 | .049 | .155 | .398 |

TABLE 18: TYPE I AND TYPE II MULTIPLIERS, QUEENSLAND EXAMPLE

| Conventional Multipliers | | Suggested Consistent Multipliers | |
|---|---|---|---|
| Type I = $\frac{DI}{D}$ | | Type IA = $\frac{IF}{I}$ | |
| Sector 1 | 2.31 | Sector 1 | 1.85 |
| 2 | 1.81 | 2 | 1.49 |
| 3 | 1.26 | 3 | 1.19 |
| | | Type IB = IP | |
| | | Sector 1 | 2.31 |
| | | 2 | 1.81 |
| | | 3 | 1.26 |
| Type II | | Type II = $\frac{IPC}{I}$ | |
| Sector 1 | 3.80 | Sector 1 | 3.80 |
| 2 | 2.97 | 2 | 2.97 |
| 3 | 2.07 | 3 | 2.07 |

# APPENDIX V

## A PROCEDURE FOR ACCURACY OPTIMIZATION IN INPUT-OUTPUT COEFFICIENTS

G.R. West

(University of Queensland)

## ABSTRACT

Analysts constructing and applying regional input-output tables will normally have limited budget resources. Once a prototype table has been produced, it would be inefficient for the analyst to spread these resources evenly over every cell in the table, in order to obtain superior or updated estimates. This paper demonstrates that it is possible to rank the coefficients in order of the importance that errors in these coefficients have on the input-output multipliers. A selection of criteria to choose from in determining this ranking is provided. It is then demonstrated how this ranking can be used as an input to an optimization model to determine exactly which coefficients the analyst should concentrate on in order that multiplier accuracy is maximized subject to limited budget resources.

## I Introduction

In both the derivation and application stages of input-output analysis, it would be of interest to the analyst if he could rank the direct coefficients in terms of the relative importance of their effects on the input-output multipliers.

In the construction stage, for example, prototype tables are usually compiled and progressively updated in the 'critical' areas until the analyst is satisfied with the final transactions table. In the application stage, if the analyst is interested in particular sectors, he should give these sectors, together with other strongly interconnected sectors, close scrutiny before proceeding with the impact analysis. Therefore if the analyst can rank the coefficients in order of their relative importance in terms of the magnitude of the effect errors in the direct coefficients have on the final multipliers, he can get some idea as to which coefficients and sectors he should concentrate on in order to minimize the final multiplier errors, subject to the limited resources available.

No previous work has been published on this specific aspect to the author's knowledge. Previous work has been done on some aspects of coefficient error, but the analysis has not been carried through to the extent of explicitly ranking the direct coefficients in order of their importance, nor to the ultimate end of using this ranking in a mathematical optimization model. This paper attempts to fill this gap. In Section II, some background work is presented. Section III develops the mathematical formulation of multiplier errors, and Section IV suggests a possible optimization model. Section V presents an empirical example, and finally Section VI outlines the important conclusions.

## II Background

An analyst compiling regional input-output tables will normally have limited resources available in terms of money and time. It will be very likely not possible for the analyst to give very close scrutiny to all of the coefficients in the prototype table. The question then arises: which coefficients should he give first priority to, and which coefficients should he pay less attention, if any, to. Previous work has provided some hints to the answer of this question.

Evans [2] was concerned with the suspicion that relatively small errors in the direct coefficients ($a_{ij}$) might cumulate to relatively large errors in estimates of sector output. He concludes that two errors opposite in sign could be compensating in their effect on the Leontief inverse, and that the I/O model has an "inherent ability to minimize the undesirable effects of data imperfections" (p. 461). However Evans concerned himself solely with the output vector, and did not consider the effects of errors on multipliers. Similarly, Quandt [6, 7] was concerned with the output vectors and used shocking techniques on the $a_{ij}$'s to test the relationship between the distribution of the errors and the distribution of the solution. Quandt showed that the skewness of the $a_{ij}$ errors tends to be transmitted to the solution vectors, and suggests the lognormal can be used as an approximate distribution of the solution.

More recently, Stevens and Trainer [8] argue that errors in the $a_{ij}$'s do not have serious effects on outputs and multipliers, and that household and regional purchase coefficients exert the most important effects on overall accuracy. Burford and Katz [1] also support this view. They suggest the distribution of coefficients in the columns has a relatively small role in the determination of multiplier values, and that the main determinant of multiplier values is the column totals of the A matrix. However both Stevens and Trainer and Burford and Katz concerned themselves with the specific case of fixed absolute errors in the direct coefficients.

On the other hand, West and Jensen [9] used shocking techniques to examine the effects of proportional error in the $a_{ij}$'s on the multipliers, and conclude "that the instability of output multipliers varies directly with both the size of the multiplier and the extent to which individual coefficients dominate their respective columns in the technology matrix. This suggests that greater attention should be given to sectors showing larger multipliers, particularly if their columns are relatively dominated by a small number of cells" (p. 25).

Jensen and West [5], in an attempt to nail down the effects of coefficient size on the multipliers, performed experiments on 14 empirical tables by progressively removing the coefficients in order of their magnitude, from low to high, both cumulatively and with replacement. They conclude that there is "some empirical support for the notion that the relatively larger coefficients exert relatively more influence on multipliers; it also provides empirical support for an accuracy-maximizing approach to multiplier derivation. This notion, implied in most operational circumstances and probably accepted generally by analysts, is that budget resources available to the analyst should be directed to ensuring accuracy in the relatively large coefficients, and allocated in decreasing amounts to progressively smaller coefficients" (p. 14).

Both the West and Jensen and Jensen and West conclusions are correct, but they do not go far enough. The West and Jensen paper possibly comes closest to the correct answer by claiming that size and distribution of coefficients within columns, together with the size of the corresponding output multiplier, are the main determinants of multiplier values, but do not take account of the distribution of coefficients across columns. The same is true for the income multipliers. The Jensen and West paper acknowledges that coefficient size is important, but does not realize that the internal distribution of the coefficients is also a major factor. That is, neither of the above papers take into account the level of interconnectedness of the table, nor its level of aggregation. The following model explicitly takes account of these factors.

Before the model is presented, one additional point needs to be mentioned. An efficiency optimization technique based on principles similar to the above, depends on the notion of what can be called holistic accuracy, in the sense that the table should be as representatively accurate as possible in the overall sense, i.e. in the operational sense of applying the table. The normal concept of accuracy, partitive accuracy, on the other hand, is where each individual cell, regardless of its relative importance, is deemed accurate. However an input-output table, per se, doesn't mean much; the test is in the empirical application of the table. Thus it is important that the overall picture is representative of the economy, i.e. the major sectors and linkages are reproduced accurately, but the less important cells which exert little influence on the multipliers, etc., need not be reproduced with the same degree of accuracy. This concept of accuracy was explicit in the work of Jensen, Mandeville, and Karunaratne [4], and is a necessary concept in any technique used to develop regional input-output tables within a reasonable time (and money) horizon. For a comprehensive discussion on the concept of accuracy, see Jensen [3].

## III Errors in Multipliers - Mathematical Formulation

Suppose we have an initial estimate of an input-output direct coefficient matrix, A. Then it is likely that all, or some, of the direct coefficients, $a_{ij}$, contain errors, $d_{ij}$, either absolute or proportional. If the errors are absolute errors, what we in fact have are first estimates of the true coefficients $(a_{ij} + d_{ij})$. On the other hand the errors in the coefficients may be proportional errors, in which case

$d_{ij} = a_{ij}p_{ij}$, and we have first estimates of $(a_{ij} + a_{ij}p_{ij})$.

The aim of this section is to find what affect, if any, the coefficient errors have on the various input-output multipliers. The analysis that follows is based on the assumption that the initial coefficient error is proportional, but this does not restrict the analysis in any way. In fact the assumption of absolute coefficient errors is more restrictive, and the following theory can easily be converted to the analysis of absolute errors by substituting $d_{ij}$ for $a_{ij}p_{ij}$. In the empirical sense, there is little to suggest either error format is more likely to occur, and one can find arguments in favour of both propositions. Given that a decision had to be made, however, the author is marginally inclined towards the proportional error theory, primarily on the basis that we would expect, ceteris paribus, larger coefficients to contain larger errors.

All the input-output multipliers are calculated from the Leontief inverse, $B = (I-A)^{-1}$. Therefore we need to know how the error matrix $D = [d_{ij}] = [a_{ij}p_{ij}]$ affects B. In other words, if we apply the usual theory to the coefficient matrix (A), we obtain $(I-A)^{-1}$ which is not equal to the 'true' inverse $(I-A-D)^{-1}$. The question we therefore need to answer is: how is $(I-A-D)^{-1}$ related to $(I-A)^{-1}$?

Let us write:

$$(I-A-D) = (I-A)(I-\theta) \qquad (1)$$

$$= I-A - (I-A)\theta$$

and we have

$$D = (I-A)\theta \qquad (2)$$

From (1):

$$(I-A-D)^{-1} = (I-\theta)^{-1}(I-A)^{-1}$$

$$= (I+\theta+\theta^2+\theta^3+ \dots)(I-A)^{-1}$$

$$= (I-A)^{-1} + \theta(I-A)^{-1} + \theta^2(I-A)^{-1} + \dots$$

$$= B + \theta B + \theta^2 B + \dots \qquad (3)$$

But, from (2):

$$\theta = (I-A)^{-1}D$$

$$= BD$$

and therefore (3) becomes:

$$(I-A-D)^{-1} = B + BDB + (BD)^2B + (BD)^3B + \dots$$

$$= B + BDB + BDBDB + BDBDBDB + \dots$$

$$= B + E1 + E2 + E3 + \dots$$

$$= B + E \qquad (4)$$

where $E = E1 + E2 + E3 + \dots$ is the error induced into $(I-A)^{-1}$ in response to an initial error D introduced into A.

Consider the error component E1 first:

Now the $(i,j)^{th}$ element of BD is $\sum_k b_{ik}a_{kj}p_{kj}$

and the $(i,j)^{th}$ element of $E1 = (BD)B$ is $\sum_\ell(\sum_k b_{ik}a_{k\ell}p_{k\ell})b_{\ell j}$

The error in the $j^{th}$ output or column multiplier is therefore

$$\varepsilon 1(OM_j) = \sum_i\sum_\ell\sum_k b_{ik}a_{k\ell}p_{k\ell}b_{\ell j}$$

$$= \sum_\ell\sum_k OM_k a_{k\ell}p_{k\ell}b_{\ell j} \qquad (5)$$

and the total absolute error over all j output multipliers is

$$\varepsilon 1 = \sum_j \varepsilon 1(OM_j) = \sum_j\sum_\ell\sum_k OM_k a_{k\ell}p_{k\ell}b_{\ell j}$$

$$= \sum_\ell\sum_k OM_k a_{k\ell}p_{k\ell}RM_\ell \qquad (6)$$

where $RM_\ell$ denotes the $\ell^{th}$ row total of B i.e. the $\ell^{th}$ row multiplier, which represents the change in output of the $\ell^{th}$ sector in response to a one dollar change in final demand of all sectors. $\varepsilon 1$ denotes a scalar formed from the summation of elements in the matrix E1.

Equations (5) and (6) throw an interesting light on the coefficient error problem. For example, suppose an error occurs in one cell $a_{k\ell}$. The subsequent error in the $j^{th}$ output multiplier depends not on the size of the $j^{th}$ output multiplier, but the magnitude of the output multiplier corresponding to the <u>row</u> sector where the original error lies i.e. $OM_k$. If errors exist in more than one (but not necessarily all) of the direct coefficients, the error in the $j^{th}$ output multiplier depends on the sum of the output multipliers of the errored row sectors. The error in the $j^{th}$ output multiplier in response to an error in the direct coefficient $a_{k\ell}$ is found by weighting the error in $a_{k\ell}$ by the output multiplier of industry k and the sectoral output multiplier from industry $\ell$ into industry j. The error over all output multipliers is the sum of the errors in $a_{k\ell}$ weighted by the output multiplier from industry k and the row multiplier of industry $\ell$.

Not only does this give an estimate of the total error over all output multipliers, but it also tells us the relative importance of the $a_{ij}$ coefficients in which errors occur. For a given proportional error in any $a_{ij}$, we would want to reduce the error in those cells which correspond to large $a_{ij}$'s, combined with large row and column multipliers.

Equation (6) is a summation of terms, and can be rewritten as

$$e1 = [OM_{k1}a_{k1.\ell 1}p_{k1.\ell 1}RM_{\ell 1} + OM_{k2}a_{k2.\ell 2}p_{k2.\ell 2}RM_{\ell 2} + \dots +$$

$$+ OM_{ki}a_{ki.\ell i}p_{ki.\ell i}RM_{\ell i} + \dots ] \quad (7)$$

where the terms in the series [ ] can be written in sequential order from high to low. We then have a sequential list of cells which contribute, in order of importance, to the overall multiplier error. In terms of relative efficiency, therefore, we should concentrate firstly on reducing the error in the coefficient $a_{k1.\ell 1}$, secondly in the coefficient $a_{k2.\ell 2}$, and so on.

Also note from equation (6) that the total multiplier error is a function of several factors; (a) the size of the original error $p_{k\ell}$, (b) the magnitude of the corresponding direct coefficient $a_{k\ell}$, (c) the level of interconnectedness (the values of $OM_k$ and $RM_\ell$), and (d) the level of aggregation (the range of values of k and $\ell$). Thus errors in the coefficients give rise to relatively larger multiplier errors in more interconnected tables and more disaggregated tables. Within any given table, cells which contain large direct coefficients and also correspond to large row and column multipliers have a larger effect on multiplier error than other cells.[1]

In an operational sense, we need to make the broad assumption that the proportional error in each coefficient is roughly of the same magnitude. We need not specify a particular value. In situations where more detailed knowledge of the local economy is available, one may be able to obtain rough ratios of these errors e.g. one may be led to believe that the error in one particular coefficient is approximately twice as large as in other coefficients. Remember, the above model does not aim to tell us what the errors are (although in some circumstances it can provide a rough estimate). It only gives us a pointer which indicates which cells we should be concentrating on, in the light of all the prior available information.

If we assume that $p_{k\ell} \simeq p$ for all k, $\ell$, then equation (6) (and (7)), becomes[2]

$$e1 = p\sum_{\ell}\sum_{k} OM_k a_{k\ell} RM_\ell \qquad (8)$$

1. These cells need not necessarily correspond to cells containing just large $a_{ij}$'s. In the case of the five sector Queensland input-output Table [4] the rank correlation coefficient between the rankings of the $a_{ij}$'s and the $OM_k a_{k\ell} RM_\ell$'s listed in order of magnitude from high to low is 0.97. The slight difference between the rankings can be accounted for by the level of interconnectedness (i.e. the positioning of the large $a_{ij}$'s relative to each other in the table) which is not taken into account when simply ranking the $a_{ij}$'s from high to low.

2. The assumption of constant coefficient error (either absolute or proportional) is also implicit in the partitive accuracy concept, i.e. looking at each cell in turn without any prior ranking procedure.

Each term in the summation can be arranged in a matrix format, and these elements can easily be calculated. All that is required are the matrices A and B.

$$E1' = p \begin{bmatrix} OM_1 a_{11} RM_1 & OM_2 a_{21} RM_1 & \cdots & \\ OM_1 a_{12} RM_2 & & & \\ \vdots & & & \\ OM_1 a_{1n} RM_n & \cdots & & OM_n a_{nn} RM_n \end{bmatrix} \qquad (9)$$

where E1´ denotes the matrix of absolute multiplier error components, as distinct from E1 which is the matrix of errors in the elements of B. Once the error matrix E1´has been obtained, the elements can simply be ranked. The transpose of these elements in the A matrix then gives the relatively important coefficients.

In the simple case where $a_{k\ell} \cdot p_{k\ell} = d_{k\ell}$ is assumed to be constant, i.e. there is a constant absolute coefficient error, equation (8) reduces to

$$\epsilon 1 = d \sum_{\ell} \sum_{k} OM_k RM_\ell$$

$$= dT^2 \qquad (10)$$

Where T denotes the sum of the elements of the Leontief inverse, B

i.e. $T = \sum_i \sum_j b_{ij}$

In this case, all that is required to rank the coefficients is the matrix B.

The analysis so far has concentrated on absolute multiplier error. This may not be a satisfactory criterion, as multiplier size is not taken into account. A more appropriate measure would be average proportional multiplier error.

Proportional output multiplier error can be measured in two ways: (a) the error as a proportion of the total multiplier, or (b) the error as a proportion of that portion of the multiplier above unity. Again there are advantages and disadvantages in each approach, and the analysis can easily accommodate either method. For the sake of consistency with previous analysis and uniformity across multipliers, we will use the former approach, stressing that it is not necessarily more correct.

The proportional multiplier error in the $j^{th}$ output multiplier is, from equation (5):[3]

$$\frac{\varepsilon 1(OM_j)}{OM_j} = \sum_{\ell} \sum_{k} OM_k \, a_{k\ell} p_{k\ell} \left(\frac{b_{\ell j}}{OM_j}\right) \tag{12}$$

and the average proportional multiplier error is thus

$$\frac{1}{n} \sum_{j} \left(\frac{\varepsilon 1(OM_j)}{OM_j}\right) = \frac{1}{n} \sum_{\ell} \sum_{k} OM_k \, a_{k\ell} \, p_{k\ell} \sum_{j} \left(\frac{b_{\ell j}}{OM_j}\right) \tag{13}$$

where $\frac{b_{\ell j}}{OM_j}$ is the proportion of the column total which lies in cell $(\ell, j)$ of B, and n is the number of intermediate sectors.

Again using the broad assumption that $p_{k\ell}$ is constant for all k, $\ell$ we have

$$\frac{1}{n} \sum_{j} \left(\frac{\varepsilon 1(OM_j)}{OM_j}\right) = \frac{p}{n} \sum_{\ell} \sum_{k} OM_k \, a_{k\ell} \sum_{j} \left(\frac{b_{\ell j}}{OM_j}\right) \tag{14}$$

and each term in the series can be compiled into an error matrix as previously,[4] viz:

---

3. Using the second measure, we would have

$$\frac{\varepsilon 1(OM_j)}{(OM_j - 1)} = \sum_{\ell} \sum_{k} OM_k \, a_{k\ell} \, p_{k\ell} \left(\frac{b_{\ell j}}{OM_j - 1}\right)$$

Also note that we need to measure the error relative to the estimated multiplier.

4. Average proportional multiplier error is the criterion used by Jensen and West [5]. As noted previously, their results imply that the $a_{ij}$ coefficients should be ranked from high to low. Comparing this simple ranking with the ranking obtained from equation (14) for the Queensland table, results in a rank correlation coefficient of 0.98.

$$\overline{E1} = \frac{p}{n}\begin{bmatrix} OM_1\ a_{11}\ \sum_j\left(\frac{b_{1j}}{OM_j}\right) & OM_2\ a_{21}\ \sum_j\left(\frac{b_{1j}}{OM_j}\right) & \cdots \\ OM_1\ a_{12}\ \sum_j\left(\frac{b_{2j}}{OM_j}\right) & & \\ OM_1\ a_{1n}\ \sum_j\left(\frac{b_{nj}}{OM_j}\right) & & OM_n\ a_{nn}\ \sum_j\left(\frac{b_{nj}}{OM_j}\right) \end{bmatrix} \quad (15)$$

where $\overline{E1}$ is used to distinguish the error matrix from $E1'$, as now each element is a measure of an error component in the average proportional multiplier error, rather than the absolute multiplier error.

Simplifing further by assuming constant absolute coefficient errors reduces equation (5) to

$$\begin{aligned} \varepsilon 1(OM_j) &= d \sum_k OM_k \sum_\ell b_{\ell j} \\ &= d\ T\ OM_j \end{aligned} \quad (16)$$

and thus

$$\frac{\varepsilon 1(OM_j)}{OM_j} = dT \quad (17)$$

i.e. the proportional output multiplier error is constant, irrespective of the sector number. The average proportional multiplier error is thus also

$$\frac{1}{n} \sum_j\left(\frac{\varepsilon 1(OM_j)}{OM_j}\right) = dT \quad (18)$$

It should be noted that the above analysis is equally applicable to income and employment multipliers. Income multipliers are obtained by the scalar multiplication of B by the household coefficients, i.e. $h_i$ B; the employment multipliers by the employment coefficients, i.e. $e_i$ B. (The output multipliers involve scalar multiplication by 1.) Summing the columns, of course, gives the multipliers. Equation (4) thus becomes, for example,

$$h_i(I-A-D)^{-1} = h_iB + h_iE .$$

Let us now consider briefly the error component E2: Now from equation (4) we have

$$E2 = (BD)(BDB) = (BD)E1$$

and therefore the (i, j)$^{th}$ element of E2 is $\sum_m (\sum_q b_{iq}\ a_{qm}\ p_{qm})(\sum_{\ell k} b_{mk}\ a_{k\ell}\ p_{k\ell}\ b_{\ell j})$

The error in the j$^{th}$ output multiplier is then

$$\varepsilon 2(OM_j) = \sum_i \sum_m (\sum_q b_{iq}\ a_{qm}\ p_{qm})\ (\sum_\ell \sum_k b_{mk}\ a_{k\ell}\ p_{k\ell}\ b_{\ell j})$$

$$= \sum_m(\sum_q OM_q\ a_{qm}\ p_{qm})(\sum_\ell \sum_k b_{mk}\ a_{k\ell}\ p_{k\ell}\ b_{\ell j}) \qquad (19)$$

Again summing over the j multipliers gives

$$\varepsilon 2 = \sum_j \varepsilon 2(OM_j) = \sum_m(\sum_q OM_q\ a_{qm}\ p_{qm})(\sum_\ell \sum_k b_{mk}\ a_{k\ell}\ p_{k\ell}\ RM_\ell) \qquad (20)$$

Assuming $p_{k\ell}$ is constant for all k and $\ell$ gives

$$\varepsilon 2 = p^2 \sum_m(\sum_q OM_q\ a_{qm})(\sum_\ell \sum_k b_{mk}\ a_{k\ell}\ RM_\ell) \qquad (21)$$

and under the further assumption of constant absolute errors,

$$\varepsilon 2 = d^2 \sum_m (\sum_q OM_q)(\sum_\ell \sum_k b_{mk}\ RM_\ell)$$

$$= d^2\ T^3 \qquad (22)$$

In a similar manner, we can show that

$$\varepsilon 3 = d^3\ T^4 \qquad (23)$$

and the total multiplier error over all multipliers under the assumption of constant coefficient error is

$$\varepsilon = \varepsilon 1 + \varepsilon 2 + \varepsilon 3 + \ldots\ldots$$

$$= dT^2 + d^2T^3 + d^3T^4 + \ldots\ldots$$

$$= dT\ [1 + dT + (dT)^2 + (dT)^3 + \ldots\ldots] \qquad (24)$$

i.e. in terms of the total multiplier sum we can write:

A gives rise to T

and (A+D) gives rise to $T + dT^2 + d^2T^3 + \ldots\ldots$

$$= T[1 + dT + (dT)^2 + \ldots\ldots] \qquad (25)$$

This may give us a very rough estimate of total multiplier error.

Getting back to the more realistic situation of proportional multiplier error, we get from equation (19):

$$\frac{\varepsilon 2(OM_j)}{OM_j} = \sum_m \left(\sum_q OM_q \; a_{qm} \; p_{qm}\right)\left(\sum_\ell \sum_k b_{mk} \; a_{k\ell} \; p_{k\ell} \; \left(\frac{b_{\ell j}}{OM_j}\right)\right) \tag{26}$$

and the average proportional multiplier error is

$$\frac{1}{n} \sum_j \left(\frac{\varepsilon 2(OM_j)}{OM_j}\right) = \frac{1}{n} \sum_m \left(\sum_q OM_q \; a_{qm} \; p_{qm}\right)\left(\sum_\ell \sum_k b_{mk} \; a_{k\ell} \; p_{k\ell} \; \sum_j \left(\frac{b_{\ell j}}{OM_j}\right)\right) \tag{27}$$

$$= \frac{p^2}{n} \sum_m \left(\sum_q OM_q \; a_{qm}\right)\left(\sum_\ell \sum_k b_{mk} \; a_{k\ell} \; \sum_j \left(\frac{b_{\ell j}}{OM_j}\right)\right) \tag{28}$$

under the assumption of constant proportional error. The terms in this equation can also be expressed in the form of an error matrix.:

$$\overline{E2} = \frac{p^2}{n} \begin{bmatrix} \left(\sum_m \sum_q OM_q \; a_{qm} \; b_{m1}\right) a_{11} \sum_j \left(\frac{b_{1j}}{OM_j}\right) & \left(\sum_m \sum_q OM_q \; a_{qm} \; b_{m2}\right) a_{21} \sum_j \left(\frac{b_{1j}}{OM_j}\right) \cdots \\ \left(\sum_m \sum_q OM_q \; a_{qm} \; b_{m1}\right) a_{12} \sum_j \left(\frac{b_{2j}}{OM_j}\right) & \\ \vdots & \\ \left(\sum_m \sum_q OM_q \; a_{qm} \; b_{m1}\right) a_{1n} \sum_j \left(\frac{b_{nj}}{OM_j}\right) & \end{bmatrix} \tag{29}$$

In a similar manner it can be shown that, under the same conditions, the $(i,j)^{th}$ cell of the third error matrix has the following form.

$$E3 = \frac{p^3}{n} \left[\left(\sum_r \sum_s \sum_m \sum_q OM_r \; a_{rs} \; b_{sm} \; a_{mq} \; b_{qj}\right) a_{ji} \sum_k \left(\frac{b_{ik}}{OM_k}\right)\right] \tag{30}$$

Because we are primarily interested in the ranking of the coefficients, we can let p = 1 to obtain the complete error matrix:

$$\bar{E} = \bar{E}1 + \bar{E}2 + \bar{E}3 + \ldots = [\bar{E}_{ij}]$$

$$= \frac{1}{n} [(OM_j + \sum_m \sum_q OM_q \; a_{qm} \; b_{mj} + \ldots.) \; a_{ji} \sum_k (\frac{b_{ik}}{OM_k}) ] \qquad (31)$$

As the average proportional multiplier error is the sum of all the elements of $\bar{E}$, we simply need to rank the elements in order of magnitude from high to low to find which coefficients contribute relatively more to the average multiplier error. We should obviously look at those $a_{ji}$ 's corresponding to large $\bar{E}_{ij}$'s. This leads to a more efficient process of reducing multiplier error.

## IV Application to a Possible Optimization Scheme

Analysts, in compiling regional input-output tables, have usually proceeded to estimate the table coefficient by coefficient, on the assumption that overall accuracy will be maximized. However, this is not necessarily the most efficient approach in that no consideration is given (except implicitly) to maximizing accuracy <u>and</u> minimizing cost. The majority of analysts involved in such an exercise will have very limited resources available (e.g. money and/or time, etc.), and the analyst will probably ask himself the question as to whether he should attempt to get superior estimates of all the coefficients, or whether his time and money would be better spent concentrating on a smaller subset of coefficients.

Section III above has already answered part of that question, by ranking the coefficients in relative order of importance. The second part of the question then becomes: how far along the sequence should we continue until we reach a point where the reduction in average multiplier error is not worth the trouble and effort of superior estimation?

Given the conditions described earlier, and these restrictions can easily be relaxed if, for some reason, we think we know what the relative errors in the various coefficients are, including those cells which we think contain no error (i.e. if we can assign weights to the cells reflecting the possible size of the proportional error in that cell), the elements in the matrix $\bar{E}$ can be summed to obtain the total average proportional multiplier error.

$$\bar{\varepsilon} = \frac{1}{n}(\bar{E}_{k1.\ell 1} + \bar{E}_{k2.\ell 2} + \ldots + \bar{E}_{ki.\ell i} + \ldots) \quad (32)$$

If the terms in the series are listed in sequential order from high to low, we have a sequential list of direct coefficients which contribute, in order of importance, to the average multiplier error. This implies that we should concentrate firstly on reducing the error in the coefficient $a_{\ell 1.k1}$, secondly in element $a_{\ell 2.k2}$, and so on.

The first step is to derive an error function.

Let X = Number of cells with an error, and Y = average proportional multiplier error resulting from X cells in error $= \frac{1}{n}\sum_{i=1}^{X} \bar{E}_{ki.\ell i}$.

We can then plot Y against X for X = 1, 2, 3, ...., n, where the cells are numbered in order of magnitude. As each subsequent term is smaller than the previous term, the curve will have a shape similar to Figure 1.

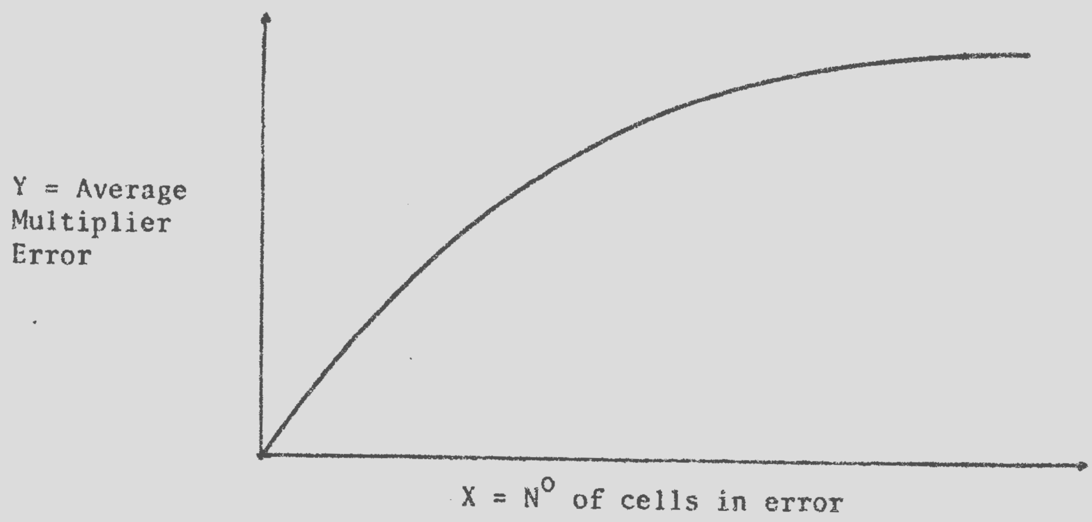



FIGURE 1

A possible mathematical function which fits this curve[5] is

$$Y = \alpha X^{\beta} \; ; \quad \alpha \geq 0 < \beta < 1 \tag{33}$$

Now if we progressively re-estimate the direct coefficients in the order specified, we can obtain the function relating the average multiplier error remaining after X cells have been re-estimated i.e.

$$\begin{aligned} Y^1 &= Y_{max} - Y_X \\ &= Y_{max} - \alpha X^{\beta} \\ &= \alpha(X_{\eta}^{\beta} - X^{\beta}) \end{aligned} \tag{34}$$

where $\eta$ refers to the number of cells in A which contain an error (which may or may not equal $n^2$, all the cells in the table).

In many situations, (e.g. in some Baynesian and Operations Research problems) it is common to specify a value, subjective or otherwise, to the cost of making an incorrect decision. Similarly, in input-output model estimation, it may be possible for the analyst to set a value to the cost of a certain level of error occuring. This cost will, of course, depend upon a large number of factors e.g. the relative importance of the particular region in question, the primary use for which the final table is to be put, and even the experience and personality of the analyst himself.

---

5. The reason for estimating the error function in this form rather than in another form was that this form returned consistently superior regression results in empirical tests. However, this function does make several assumptions, e.g. continuity. Also note that the error function need not be specified mathematically in practice; the final results can be derived with greater accuracy by an iterative technique by the computer. We will come back to this point later.

Suppose we can specify (implicitly or otherwise) the cost of making a unit average proportional error in the multipliers, $C_1$.[6] Then after we re-estimate the first X cells, the total cost of the remaining multiplier error is

$$TC_1 = C_1Y^1 = C_1(Y_{max} - \alpha X^{\beta}) \quad (35)$$

If $C_2$ is the average re-estimation cost per cell, the total cost of re-estimating those first X cells is[7]

$$TC_2 = C_2X \quad (36)$$

These two cost functions are represented in Figure 2.

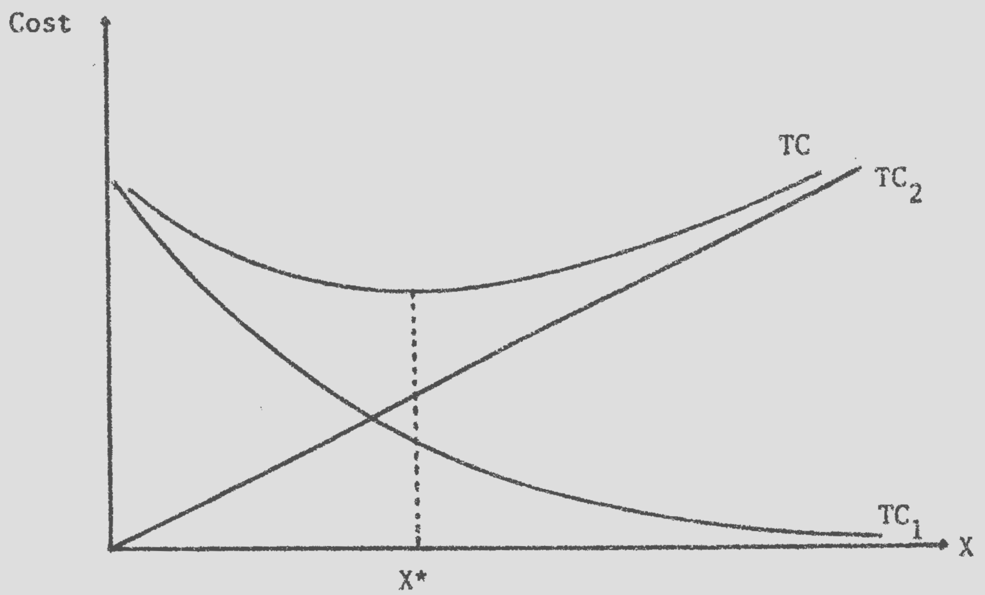



FIGURE 2

---

6. A proportional error of one unit is equivalent to a 100% error.

7. It may be desirable to assign a relatively higher cost per cell to the more important coefficients, in which case equation (36) should be modified accordingly.

Note that the larger the number of cells re-estimated, the lower is the cost associated with the multiplier error, but the higher is the re-estimation cost. At the point where the marginal increase in cost of estimation equals the marginal savings in reduced error, the total cost will be minimized.

Now

$$TC = TC_1 + TC_2$$

$$= C_1 Y^1 + C_2 X$$

$$= C_1 (Y_{max} - \alpha X^{\beta}) + C_2 X \qquad (37)$$

To find the value of X which minimizes total cost, we differentiate (37) w.r.t. X and equate to zero:

$$\frac{dTC}{dX} = -C_1 \alpha \beta X^{\beta - 1} + C_2$$

$$= 0 \text{ when } X^{\beta - 1} = \frac{C_2}{C_1 \alpha \beta}$$

or

$$X^* = \left[ \frac{C_2}{C_1 \alpha \beta} \right]^{\frac{1}{\beta - 1}} \qquad (38)$$

which is the optimal number of cells to re-estimate.[8]

There are a couple of points to note about equation (38). In all cases tested, it was found that $\alpha \geq 0$ and $0 < \beta < 1$. Thus the minimization conditions are fulfilled, and the larger the value of $C_2$, the cost of estimation per cell, the smaller is the number of cells that should be re-estimated. Conversely, the larger the cost per unit error $C_1$, the larger the number of cells which should be re-estimated.

Secondly, we do not need the actual values of $C_1$ and $C_2$, only the ratio. We can thus find the range of values of this ratio which will return a value of X* between 0 and $\eta$ i.e.

---

8. $\frac{d^2TC}{d\,X^2} = -C_1 \alpha \beta (\beta - 1) X^{\beta - 2} > 0$ when $\alpha \geq 0$, $0 < \beta < 1$ which indicates the second order condition for minimization holds.

$$\text{if} \quad \frac{C_2}{C_1} > \alpha\beta \quad : \text{re-estimate no cells.}$$

$$\text{if} \quad \frac{C_2}{C_1} < \alpha\beta\eta^{\beta-1} \quad : \text{re-estimate all } \eta \text{ cells.} \qquad (39)$$

However, this ratio may be fairly difficult to visualize, since they refer to different units. $C_1$ is the error cost <u>per unit error</u>, whilst $C_2$ is the estimation cost <u>per cell</u>. The analyst may prefer to set the cost of making an error in terms of the original cells. Then let $C_1^1$ be the cost of an individual cell (direct coefficient) being incorrect. $C_1$ and $C_2$ are now both expressed in terms of cost per cell, and we get

$$\begin{aligned} TC &= TC_1 + TC_2 \\ &= C_1^{1\beta}(Y_{max} - \alpha X^{\beta}) + C_2 X \end{aligned} \qquad (40)$$

and

$$X^* = \left[ \frac{C_2}{C_1^{1\beta}\ \alpha\beta} \right]^{\frac{1}{\beta-1}} \qquad (41)$$

Thus:

$$\text{if} \quad \frac{C_2}{C_1^{1\beta}} > \alpha\beta \quad : \text{re-estimate no cells}$$

$$\text{if} \quad \frac{C_2}{C_1^{1\beta}} < \alpha\beta\eta^{\beta-1} \quad : \text{re-estimate all } \eta \text{ cells} \qquad (42)$$

## V <u>An Empirical Example</u>

The above procedures have been applied to several Queensland GRIT [4] tables, as well as the South Australian regional tables currently being compiled, comprising various levels of interconnectedness and aggregation. For the sake of simplicity, however, the results derived from the five-sector Queensland state table will be presented here.

The transactions table, direct coefficients table, inverse matrix and various error matrices are presented in Attachment 1. Also for ease of presentation, the results refer only to the output multipliers, but the analysis is equally applicable to income and employment multipliers. Obviously in a practical situation, income and employment multipliers are relatively more important than output multipliers.

The simplest criteria in terms of ease of calculation to apply is absolute coefficient error/absolute multiplier error. In this case the error matrix E1′ is formed simply from the product of the row and column totals of the B matrix (Table 3). This error matrix is given in Table 4, together with the ranking of the elements. The ranking of the direct coefficients using Table 4 compared with the ranking derived just from the A matrix results in a rank correlation of 0.14. This is understandable as the magnitude of the $a_{ij}$ 's are not explicitly taken into account (since the error in each $a_{ij}$ is assumed to be the same, irrespective of coefficient size), but only implicitly in the size of the multipliers.

A more realistic criterion is proportional coefficient error/average proportional multiplier error, and we will refer mainly to this criterion, acknowledging that other criteria could easily be applied.

The error matrix $\overline{E1}$ (equation (15)) is shown in Table 5. As noted previously, the rank correlation coefficient derived from comparing the rankings from $\overline{E1}$ and A is 0.98. When $\overline{E2}$ is added, there is a marginal change in the ranking, with a rank correlation coefficient between $\overline{E1}$ and ($\overline{E1}$ + $\overline{E2}$) of 0.998. In no cases did the ranking change with the addition of additional error matrices, $\overline{E3}$, $\overline{E4}$, etc. Results indicate that it is of marginal value proceeding past $\overline{E2}$, but nevertheless all calculations were taken to three terms in the expansion. Remember we are primarily interested in the ranking of the coefficients; if the actual value of the error component is of interest, more terms may be required.

It is of interest to note that the error components decline dramatically with each additional error matrix. For example, it would require a coefficient error of at least 3 percent before the largest element in $\overline{E2}$ becomes non-zero, and a coefficient error of at least 32 percent would be required before any element of $\bar{E}3$ becomes non-zero. In addition, this decline is accelerated the less aggregated the table. Note, however, that these comments refer primarily to the criterion in question; absolute multiplier error would normally require additional terms in the error expansion.

From Table 8 we can now draw up a list of coefficients in order of priority, i.e. $a_{33}$, $a_{13}$, $a_{35}$, $a_{31}$, .... . This is shown in Table 9. We should therefore concentrate on these coefficients, in sequence, in order to reduce average multiplier error by the largest amount in the shortest possible time, given that we normally have limited budget resources.

The next step to decide on is how far along this sequence should we proceed before it becomes uneconomical to proceed any further. We therefore need to compute the cumulative sum of elements $\bar{E}_{ij}$ listed in order of their rank. This is also done in Table 9. To derive the error function we regress Y against X. If we use the form in equation (33), we obtain:

$$Y = \alpha X^{\beta}$$

or

$$\text{Ln } Y = \text{Ln } \alpha + \beta \text{Ln } X$$

$$= \underset{(0.31)}{0.01762} + \underset{(22.00)}{0.51223} \text{ Ln } X \qquad r^2 = 0.96$$

(the values in brackets are t-values). This gives estimated values of $\alpha$ and $\beta$ as $\hat{\alpha} = 1.01777$, $\hat{\beta} = 0.51223$.

We now need to specify the ratio $C_2/C_1$. Suppose, for example, we let $C_2/C_1 = 0.2$. This could mean, for example, that the cost of obtaining superior data for each cell is set at about $200, and the cost of making a 100% error in the multipliers at about $1000. Applying equation (38), we obtain

$$X^* = \left[\frac{C_2}{C_1 \hat{\alpha} \hat{\beta}}\right]^{\frac{1}{\hat{\beta}-1}}$$

$$\simeq 7$$

This means we should obtain superior estimates (if possible) of the first 7 coefficients listed above. From equation (39) we also see that if $C_2/C_1 > 0.52$ we should re-estimate no cells, or if $C_2/C_1 < 0.11$ re-estimate all 25 cells.

The above result depends on how accurately the error function can be estimated. The regression equation above would not be considered a 'good' fit in these circumstances (some error functions have returned $r^2$ values of 0.999). In practice therefore, it is recommended that the total cost be computed iteratively for consecutative values of $Y^1$ and X (from equation (37)) until the minimum value of TC is obtained. This is, in fact, a more efficient approach since values of TC can be computed as each $Y^1$ is computed, and these values are also shown in Table 9. It can be seen in this example that X* = 7 which coinsides with the result obtained above. Actually, the difference in cost for any value of X between 6 and 9 is so small $28) that for practical purposes one might choose any X in this interval.

This also raises an additional interesting point. The ratio $C_2/C_1$ is very close to its lower limit, yet only a small number of cells require re-estimation. This supports the conclusions of Jensen and West, who suggest that the lower 50 percent of coefficients have a marginal effect on multiplier values.

## VI Summary

Analysts constructing and applying regional input-output tables will normally have limited resources (time and money) at their disposal. It would be extremely unlikely that these resources would allow the analyst to give very close scrutiny to every cell in the table. He will normally have to be satisfied with concentrating his attention on the more important sections (however he defines important) of the table, with less attention to the cells which he considers to have little or no effect on the multipliers and output vectors.

Up to now there have only been vague rules of thumb in this regard, the majority of which have been derived from shocking and simulation techniques. This paper has shown that there is a simple mathematical relationship between coefficient error and multiplier error. Furthermore, this relationship allows us to rank the coefficients in order of their importance (with respect to error in the coefficients affecting the multiplier values), subject to a wide range of criteria from which the analyst can choose.

This paper developed the analysis with particular attention to one of these criteria viz. proportional coefficient error/average proportional multiplier error, but explains how various other criteria can be used. It was shown that the proportional $j^{th}$ output multiplier error is largely determined by the magnitude of the direct coefficient in which the error occurs $a_{k\ell}$, the size of the corresponding row sector output multiplier $OM_k$, and the sectoral output multiplier from sector $\ell$ to sector j as a proportion of the $j^{th}$ output multiplier.

Once the optimal ranking of the coefficients has been obtained, the analyst should proceed to work his way down the list, removing errors, if possible, from the coefficients. The optimal point in the list to stop because the improvement in multiplier accuracy resulting from the re-estimation of an additional coefficient does not warrant the additional cost involved, can be determined by allocating values to the costs of re-estimation and making of error. Empirical evidence suggests that, as a rough guide, only the first 50 percent of the coefficients exert any significent effect on the multipliers. The error function levels off at about this point, and any additional effort to re-estimate more cells is probably not worth the resultant improvement in accuracy.

## ATTACH MENT 1

The following tables are derived from the five-sector transactions table for Queensland, 1973-74, ($m). The table was adapted from Jensen, Mandeville and Karunaratne [4]. Numbers in brackets after the coefficients denote the rank of that coefficient from high to low.

TABLE 1: TRANSACTIONS TABLE

| Sectors | 1 | 2 | 3 | 4 | 5 | H.H | O.F.D. | Exports | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 102.9 | 11.3 | 624.0 | 0 | 1.9 | 130.8 | 230.8 | 61.3 | 1163.1 |
| 2 | 0.1 | 14.8 | 79.5 | 1.6 | 17.1 | 0 | 506.9 | 36.8 | 656.8 |
| 3 | 149.2 | 93.3 | 778.6 | 52.2 | 307.0 | 973.7 | 839.4 | 846.4 | 4039.8 |
| 4 | 51.2 | 48.0 | 236.0 | 41.5 | 114.2 | 572.0 | 0 | 53.5 | 1116.4 |
| 5 | 49.4 | 75.4 | 267.2 | 155.7 | 225.3 | 1260.3 | 361.0 | 512.9 | 2907.2 |
| H.H | 106.2 | 85.4 | 946.9 | 427.9 | 1232.5 | 0 | 0 | 0 | 2798.9 |
| O.V.A. | 55.5 | 122.9 | 551.2 | 88.7 | 206.1 | 458.3 | 47.1 | 222.9 | 1752.7 |
| Imports | 648.6 | 205.7 | 556.4 | 348.7 | 803.1 | 180.6 | 6.9 | 13.5 | 2763.5 |
| Total | 1163.1 | 656.8 | 4039.8 | 1116.4 | 2907.2 | 3575.7 | 1992.1 | 1747.3 | |

TABLE 2: DIRECT COEFFICIENTS MATRIX; A

| | | | | |
|---|---|---|---|---|
| 0.0885 (8) | 0.0172 (20) | 0.1545 (2) | 0.0000 (25) | 0.0007(23) |
| 0.0001 (24) | 0.0225 (18) | 0.0197 (19) | 0.0014 (22) | 0.0059 (21) |
| 0.1283 (5) | 0.1421 (3) | 0.1927 (1) | 0.0468 (13) | 0.1056 (7) |
| 0.0440 (14) | 0.0731 (10) | 0.0584 (12) | 0.0372 (17) | 0.0393 (16) |
| 0.0425 (15) | 0.1148 (6) | 0.0661 (11) | 0.1395 (4) | 0.0775 (9) |

TABLE 3: INVERSE MATRIX; $B = (I-A)^{-1}$

| | | | | | Row Total |
|---|---|---|---|---|---|
| 1.1301 | 0.0563 | 0.2209 | 0.0148 | 0.0271 | 1.4492 |
| 0.0046 | 1.0285 | 0.0271 | 0.0043 | 0.0098 | 1.0743 |
| 0.1943 | 0.2168 | 1.3000 | 0.0858 | 0.1540 | 1.9509 |
| 0.0669 | 0.1004 | 0.0960 | 1.0516 | 0.0565 | 1.3714 |
| 0.0766 | 0.1613 | 0.1213 | 0.1663 | 1.1061 | 1.6316 |
| 1.4725 | 1.5634 | 1.7652 | 1.3228 | 1.3534 | |

TABLE 4: ERROR MATRIX E1´

(d)

| | | | | |
|---|---|---|---|---|
| 2.1339 (15) | 2.2657 (11) | 2.5581 (7) | 1.9170 (18) | 1.9613 (17) |
| 1.5819 (23) | 1.6796 (22) | 1.8964 (19) | 1.4211 (25) | 1.4539 (24) |
| 2.8727 (3) | 3.0500 (2) | 3.4437 (1) | 2.5806 (6) | 2.6403 (5) |
| 2.0194 (16) | 2.1440 (14) | 2.4208 (9) | 1.8141 (21) | 1.8560 (20) |
| 2.4025 (10) | 2.5508 (8) | 2.8801 (4) | 2.1583 (13) | 2.2082 (12) |

TABLE 5: ERROR MATRIX $\overline{E1}$

$(\frac{p}{5})$

| | | | | |
|---|---|---|---|---|
| 0.1251 | 0.0001 | 0.2174 | 0.0559 | 0.0552 |
| 0.0174 | 0.0242 | 0.1723 | 0.0664 | 0.1067 |
| 0.2698 | 0.0365 | 0.4033 | 0.0916 | 0.1061 |
| 0.0000 | 0.0022 | 0.0827 | 0.0492 | 0.1889 |
| 0.0012 | 0.0108 | 0.2175 | 0.0607 | 0.1224 |

TABLE 6: ERROR MATRIX $\overline{E2}$

$(\frac{p}{5})^2$

| | | | | |
|---|---|---|---|---|
| 0.0624 | 0.0001 | 0.1463 | 0.0200 | 0.0222 |
| 0.0087 | 0.0133 | 0.1160 | 0.0237 | 0.0430 |
| 0.1344 | 0.0201 | 0.2716 | 0.0328 | 0.0428 |
| 0.0000 | 0.0013 | 0.0556 | 0.0176 | 0.0761 |
| 0.0006 | 0.0059 | 0.1464 | 0.0217 | 0.0493 |

TABLE 7: ERROR MATRIX $\overline{E3}$

$(\frac{p}{5})^3$

| | | | | |
|---|---|---|---|---|
| 0.0342 | 0.0000 | 0.0805 | 0.0098 | 0.0121 |
| 0.0047 | 0.0071 | 0.0637 | 0.0117 | 0.0233 |
| 0.0740 | 0.0107 | 0.1493 | 0.0160 | 0.0232 |
| 0.0000 | 0.0006 | 0.0306 | 0.0086 | 0.0413 |
| 0.0003 | 0.0032 | 0.0806 | 0.0106 | 0.0268 |

TABLE 8: ERROR MATRIX $\bar{E} = \overline{E1} + \overline{E2} + \overline{E3}$ (p=1)

$(\frac{1}{5})$

| | | | | |
|---|---|---|---|---|
| 0.2216 (7) | 0.0002 (24) | 0.4441 (4) | 0.0857 (16) | 0.0895 (15) |
| 0.0308 (20) | 0.0446 (19) | 0.3519 (5) | 0.1018 (13) | 0.1730 (9) |
| 0.4781 (2) | 0.0673 (18) | 0.8243 (1) | 0.1404 (12) | 0.1721 (10) |
| 0.0000 (25) | 0.0041 (22) | 0.1688 (11) | 0.0754 (17) | 0.3063 (6) |
| 0.0020 (23) | 0.0198 (21) | 0.4445 (3) | 0.0929 (14) | 0.1985 (8) |

TABLE 9: CUMULATIVE SUM OF COEFFICIENTS FROM $\bar{E}$

| Rank X | $a_{ij}$ | $\tilde{E}_{ij}$ | $\Sigma \tilde{E}_{ij}$ Y | TC ($C_2/C_1$=0.2) |
|---|---|---|---|---|
| 1 | .1927 | .8243 | .8243 | 3913.4 |
| 2 | .1545 | .4781 | 1.3024 | 3435.3 |
| 3 | .1056 | .4445 | 1.7469 | 3390.8 |
| 4 | .1283 | .4441 | 2.1910 | 3146.7 |
| 5 | .1421 | .3519 | 2.5429 | 2994.8 |
| 6 | .1395 | .3063 | 2.8492 | 2888.5 |
| 7 | .0885 | .2216 | 3.0708 | 2866.9* |
| 8 | .0775 | .1985 | 3.2693 | 2868.4 |
| 9 | .1148 | .1730 | 3.4423 | 2895.4 |
| 10 | .0661 | .1721 | 3.6144 | 2923.3 |
| 11 | .0468 | .1688 | 3.7832 | 2954.5 |
| 12 | .0584 | .1404 | 3.9236 | 3014.1 |
| 13 | .0731 | .1018 | 4.0254 | 3112.3 |
| 14 | .0393 | .0929 | 4.1183 | 3219.4 |
| 15 | .0425 | .0895 | 4.2078 | 3329.9 |
| 16 | .0440 | .0857 | 4.2935 | 3444.2 |
| 17 | .0372 | .0754 | 4.3689 | 3568.8 |
| 18 | .0197 | .0673 | 4.4362 | 3701.5 |
| 19 | .0225 | .0446 | 4.4808 | 3856.9 |
| 20 | .0172 | .0308 | 4.5116 | 4026.1 |
| 21 | .0059 | .0198 | 4.5314 | 4206.3 |
| 22 | .0014 | .0041 | 4.5355 | 4402.2 |
| 23 | .0007 | .0020 | 4.5375 | 4600.2 |
| 24 | .0001 | .0002 | 4.5377 | 4800.0 |
| 25 | .0000 | .0000 | 4.5377 | 5000.0 |

(* denotes minimum)

REFERENCES:


[1] Burford, R.L. and Katz, J.L. (1977), "Regional Input-Output Multipliers Without a Full I/O Table", Annals of Regional Science XI(3): 21-38.

[2] Evans, W.D. (1954), "The Effect of Structural Matrix Errors on Interindustry Relations Estimates", Econometrica 22: 461-480.

[3] Jensen, R.C. (1979), The Concept of Accuracy in Regional Input-Output, Proceedings, Input-Output Workshop of the Fourth Meeting of the Australia and New Zealand Section of the Regional Science Association, Wodonga.

[4] Jensen, R.C., Mandeville, T.D. and Karunaratne, N.D. (1979), Regional Economic Planning - Generation of Regional Input-Output Analysis, Croom Helm, London.

[5] Jensen, R.C., and West, G.R. (1978), The Effect of Relative Coefficient Size on Input-Output Multipliers, Proceedings, Input-Output Workshop of the Third Meeting of the Australian and New Zealand Section of the Regional Science Association, Melbourne, (forthcoming), Environment and Planning A.

[6] Quandt, R.C. (1958), "Probabilistic Errors in the Leontief System", Naval Research Logistics Quarterly 5 (2): 155-170.

[7] Quandt, R.E. (1959), "On the Solution of Probabilistic Leontief Systems", Naval Research Logistics Quarterly 6(4): 295-305.

[8] Stevens, B.H. and Trainer, G.A. (1976), The Generation of Error in Regional Input-Output Impact Models. Regional Science Research Institute Working Paper A1-76.

[9] West, G.R. and Jensen, R.C. (1977), Some Effects of Errors in Coefficients on Input-Output Multipliers. Proceedings, Input-Output Workshop of the Second Meeting of the Australian and New Zealand Section of the Regional Science Association, Sydney.

# APPENDIX VI

## NON UNIFORM (16-SECTOR) TRANSACTIONS TABLES

TABLE VI-1 16-SECTOR TRANSACTIONS TABLE: DARWIN REGION, 1976-77 ($'000)

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | G.F.B. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 101 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 104 | 0 | 0 | 0 | 241 | 606 |
| 2A | 10 | 2 | 0 | 0 | 115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 51 | 2 | 0 | 0 | 86 | 267 |
| 2B | 0 | 0 | 0 | 0 | 9 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 4 | 106 | 0 | 8220 | 8467 |
| 3 | 0 | 0 | 0 | 382 | 0 | 0 | 0 | 994 | 15 | 0 | 105 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 2893 | 4403 |
| 4A | 2 | 0 | 84 | 0 | 198 | 0 | 0 | 1 | 6 | 0 | 0 | 6 | 0 | 0 | 1 | 65 | 703 | 4435 | 2868 | 8441 |
| 4B | 0 | 0 | 26 | 0 | 2 | 48 | 2 | 13 | 2 | 0 | 1999 | 120 | 1 | 10 | 75 | 121 | 177 | 101 | 449 | 3146 |
| 4C | 0 | 0 | 464 | 503 | 1 | 0 | 7 | 14 | 1 | 29 | 120 | 138 | 298 | 2 | 240 | 15 | 18 | 0 | 193 | 2045 |
| 4DE | 0 | 0 | 0 | 0 | 207 | 47 | 99 | 5981 | 51 | 20 | 24017 | 163 | 196 | 3 | 208 | 2871 | 130 | 8643 | 244 | 40261 |
| 4F | 1 | 1 | 1205 | 196 | 7 | 2 | 1 | 70 | 41 | 8 | 161 | 203 | 128 | 11 | 56 | 71 | 25 | 6 | 250 | 2511 |
| 5 | 5 | 1 | 40 | 20 | 70 | 12 | 10 | 559 | 29 | 119 | 257 | 655 | 177 | 534 | 7917 | 1432 | 1193 | 3519 | 0 | 16507 |
| 6 | 11 | 2 | 0 | 0 | 79 | 22 | 0 | 402 | 27 | 461 | 0 | 1776 | 1476 | 698 | 36008 | 1966 | 1743 | 125740 | 7 | 170506 |
| 7 | 22 | 11 | 403 | 35 | 114 | 63 | 19 | 479 | 39 | 57 | 2999 | 8455 | 1336 | 1192 | 4143 | 1130 | 19378 | 95075 | 0 | 135229 |
| 8 | 4 | 2 | 42 | 103 | 140 | 35 | 11 | 1053 | 21 | 86 | 1582 | 1186 | 1399 | 315 | 3130 | 102 | 1025 | 35054 | 9209 | 54659 |
| 9 | 0 | 0 | 341 | 11 | 19 | 13 | 5 | 147 | 14 | 6 | 857 | 4375 | 163 | 931 | 6260 | 322 | 6424 | 13467 | 2658 | 38015 |
| 10 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 28254 | 0 | 662 | 101437 | 43202 | 165601 |
| 11 | 6 | 6 | 9 | 7 | 0 | 0 | 0 | 0 | 0 | 10 | 16 | 317 | 314 | 369 | 3602 | 383 | 5976 | 53104 | 13339 | 77532 |
| H-H | 46 | 50 | 2940 | 1030 | 1664 | 998 | 876 | 1'489 | 679 | 4492 | 34550 | 19392 | 23191 | 14062 | 67196 | 44127 | 0 | 0 | 0 | 247610 |
| G.V.A. | 286 | 114 | 1500 | 835 | 865 | 333 | 125 | 4298 | 211 | 9560 | 22772 | 45563 | 9102 | 13831 | 3002 | 11200 | 0 | 0 | 0 | 123773 |
| IMPORTS | 193 | 84 | 1195 | 1277 | 4778 | 1551 | 886 | 14761 | 1375 | 1651 | 68991 | 52903 | 16073 | 5253 | 13668 | 16137 | 53313 | 0 | 0 | 248283 |
| TOTAL | 606 | 267 | 8467 | 4403 | 8441 | 3146 | 2045 | 40261 | 2511 | 16507 | 170506 | 135229 | 54659 | 38015 | 165601 | 77532 | 93233 | 442575 | 83858 | 0 |

TABLE VI-2 16-SECTOR TRANSACTIONS TABLE: TOP END REGION, 1976-77 ($'000)

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | O.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 517 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 917 | 0 | 0 | 0 | 203 | 1637 |
| 2A | 25 | 2 | 0 | 0 | 127 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 69 | 2 | 0 | 0 | 121 | 349 |
| 2B | 0 | 0 | 0 | 0 | 14 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 62 | 8 | 209 | 0 | 9347 | 9642 |
| 3 | 0 | 0 | 0 | 17331 | 0 | 0 | 0 | 11809 | 125 | 0 | 657 | 2 | 5 | 0 | 0 | 10 | 0 | 0 | 113527 | 143466 |
| 4A | 5 | 0 | 95 | 172 | 229 | 0 | 0 | 1 | 7 | 0 | 0 | 7 | 0 | 0 | 1 | 139 | 840 | 6451 | 3446 | 11393 |
| 4B | 0 | 0 | 29 | 57 | 2 | 40 | 2 | 14 | 1 | 0 | 2075 | 123 | 1 | 10 | 75 | 123 | 209 | 466 | 222 | 3458 |
| 4C | 0 | 1 | 464 | 552 | 1 | 0 | 7 | 15 | 1 | 29 | 130 | 147 | 336 | 3 | 266 | 21 | 31 | 2 | 125 | 2139 |
| 4DE | 0 | 0 | 0 | 0 | 207 | 125 | 133 | 16862 | 224 | 21 | 26666 | 118 | 203 | 3 | 214 | 290 | 157 | 44191 | 3442 | 92857 |
| 4F | 3 | 1 | 1980 | 408 | 11 | 4 | 2 | 166 | 69 | 13 | 250 | 410 | 189 | 18 | 82 | 120 | 126 | 0 | 327 | 4266 |
| 5 | 6 | 1 | 45 | 29 | 77 | 13 | 11 | 1177 | 38 | 130 | 290 | 630 | 181 | 592 | 10657 | 1402 | 1308 | 2976 | 0 | 19644 |
| 6 | 32 | 3 | 0 | 5667 | 106 | 24 | 0 | 715 | 39 | 527 | 0 | 1702 | 1610 | 750 | 40577 | 2682 | 1989 | 126361 | 74 | 190354 |
| 7 | 102 | 26 | 550 | 172 | 454 | 214 | 73 | 3079 | 172 | 147 | 11770 | 13818 | 2479 | 1757 | 5376 | 2754 | 21983 | 63440 | 7000 | 135573 |
| 8 | 10 | 2 | 49 | 459 | 142 | 36 | 13 | 1769 | 25 | 88 | 1645 | 1191 | 1461 | 317 | 4213 | 183 | 2890 | 38567 | 6100 | 58360 |
| 9 | 1 | 0 | 382 | 14 | 19 | 14 | 5 | 166 | 17 | 5 | 872 | 4388 | 149 | 942 | 8427 | 336 | 12562 | 12890 | 581 | 40996 |
| 10 | 0 | 0 | 40 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 27263 | 0 | 733 | 135824 | 60945 | 224837 |
| 11 | 10 | 0 | 11 | 316 | 0 | 1 | 0 | 6 | 0 | 9 | 10 | 319 | 346 | 376 | 4957 | 431 | 6595 | 28210 | 46158 | 79769 |
| H-H | 186 | 66 | 3414 | 2782 | 2272 | 1070 | 914 | 20470 | 1230 | 5853 | 60776 | 17454 | 24886 | 15901 | 90266 | 40075 | 0 | 0 | 0 | 296923 |
| G.V.A. | 758 | 144 | 1803 | 875 | 1147 | 371 | 125 | 11506 | 442 | 11790 | 25445 | 45679 | 9517 | 14924 | 3070 | 11304 | 0 | 0 | 0 | 139796 |
| IMPORTS | 491 | 103 | 759 | 114552 | 6067 | 1530 | 843 | 24994 | 1092 | 1823 | 59743 | 47497 | 16969 | 5320 | 19337 | 12409 | 55858 | 0 | 0 | 370186 |
| TOTAL | 1637 | 349 | 9642 | 143466 | 11393 | 3438 | 2139 | 92857 | 4266 | 19644 | 190354 | 135573 | 58360 | 40996 | 224837 | 79770 | 104682 | 45858. | 231637 | 0 |

TABLE VI-3 16-SECTOR TRANSACTIONS TABLE: NORTHERN TERRITORY, 1976-77 ($'000)

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H | D.F.D. | EXPORTS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 1088 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1066 | 0 | 0 | 0 | 22807 | 24961 |
| 2A | 350 | 7 | 0 | 0 | 130 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 72 | 5 | 1 | 0 | 0 | 567 |
| 2B | 0 | 0 | 0 | 0 | 25 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 72 | 19 | 288 | 0 | 10945 | 11352 |
| 3 | 1 | 0 | 0 | 20369 | 0 | 0 | 0 | 12155 | 137 | 0 | 889 | 5 | 7 | 0 | 0 | 24 | 0 | 0 | 104982 | 226769 |
| 4A | 80 | 1 | 114 | 392 | 262 | 1 | 0 | 1 | 8 | 0 | 0 | 12 | 0 | 0 | 1 | 200 | 1239 | 6688 | 4045 | 14043 |
| 4B | 0 | 0 | 35 | 66 | 3 | 63 | 2 | 19 | 2 | 0 | 2514 | 251 | 1 | 14 | 82 | 224 | 287 | 1024 | 0 | 4686 |
| 4C | 13 | 1 | 556 | 899 | 1 | 0 | 13 | 21 | 1 | 37 | 285 | 249 | 541 | 4 | 285 | 75 | 112 | 4 | 1 | 3097 |
| 4DE | 1 | 0 | 0 | 313 | 215 | 164 | 177 | 16970 | 244 | 26 | 31685 | 216 | 242 | 5 | 247 | 544 | 209 | 51084 | 58 | 102400 |
| 4F | 40 | 1 | 2097 | 844 | 11 | 8 | 3 | 170 | 70 | 13 | 303 | 578 | 231 | 33 | 145 | 326 | 172 | 0 | 0 | 5053 |
| 5 | 138 | 3 | 55 | 50 | 115 | 22 | 19 | 1565 | 46 | 200 | 495 | 1537 | 293 | 1278 | 12392 | 3702 | 1913 | 5874 | 0 | 29697 |
| 6 | 510 | 5 | 0 | 7937 | 128 | 32 | 12 | 836 | 49 | 698 | 0 | 3372 | 2278 | 1195 | 36487 | 4275 | 2754 | 169286 | 145 | 249999 |
| 7 | 1469 | 34 | 647 | 290 | 537 | 276 | 102 | 3424 | 190 | 195 | 14401 | 24652 | 3582 | 2955 | 6484 | 5607 | 35253 | 156759 | 230 | 256576 |
| 8 | 203 | 4 | 57 | 1152 | 217 | 62 | 27 | 2764 | 42 | 173 | 2034 | 2852 | 2383 | 516 | 4399 | 448 | 1617 | 54034 | 10270 | 84554 |
| 9 | 9 | 0 | 457 | 14 | 21 | 15 | 6 | 174 | 10 | 7 | 1135 | 7756 | 170 | 1440 | 9799 | 495 | 22744 | 25193 | 0 | 69468 |
| 10 | 0 | 0 | 57 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 31702 | 0 | 1043 | 228158 | 0 | 261001 |
| 11 | 287 | 0 | 13 | 578 | 1 | 1 | 0 | 6 | 0 | 14 | 24 | 641 | 561 | 614 | 5764 | 921 | 9445 | 115959 | 30554 | 165383 |
| H-H | 2873 | 116 | 3950 | 7191 | 2813 | 1423 | 1324 | 23151 | 1453 | 7575 | 80246 | 36884 | 35535 | 27289 | 104752 | 100364 | 0 | 0 | 0 | 437140 |
| G.V.A. | 11364 | 255 | 2128 | 1227 | 1417 | 494 | 177 | 12609 | 527 | 10054 | 33351 | 86372 | 14326 | 25265 | 4586 | 22814 | 0 | 0 | 0 | 235137 |
| IMPORTS | 7416 | 139 | 1186 | 176991 | 7659 | 2045 | 1233 | 28535 | 2236 | 2705 | 81837 | 91199 | 24395 | 8846 | 21966 | 25868 | 70362 | 0 | 0 | 554029 |
| TOTAL | 24961 | 567 | 11352 | 226769 | 14043 | 4686 | 3097 | 102400 | 5053 | 29697 | 249999 | 256576 | 84554 | 69463 | 261091 | 165393 | 147439 | 814063 | 264833 | 0 |

# APPENDIX VII

## MULTIPLIERS: NON-UNIFORM TABLES

TABLE VII-1 TOTAL SECTOR OUTPUT MULTIPLIERS DARWIN REGION: 16 SECTOR TABLES

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1007 | 0.0138 | 0.1145 | 0.0742 | 1.1886 |
| 2A | 1.0000 | 0.0712 | 0.0100 | 0.0811 | 0.1097 | 1.1908 |
| 2B | 1.0000 | 0.3231 | 0.0412 | 0.3643 | 0.2434 | 1.6077 |
| 3 | 1.0000 | 0.2864 | 0.0460 | 0.3324 | 0.1862 | 1.5185 |
| 4A | 1.0000 | 0.1343 | 0.0219 | 0.1563 | 0.1260 | 1.2822 |
| 4B | 1.0000 | 0.0839 | 0.0147 | 0.0986 | 0.1848 | 1.2835 |
| 4C | 1.0000 | 0.0802 | 0.0190 | 0.0992 | 0.2447 | 1.3439 |
| 4DE | 1.0000 | 0.2413 | 0.0619 | 0.3032 | 0.2002 | 1.5034 |
| 4F | 1.0000 | 0.0980 | 0.0177 | 0.1156 | 0.1620 | 1.2777 |
| 5 | 1.0000 | 0.0482 | 0.0089 | 0.0571 | 0.1552 | 1.2123 |
| 6 | 1.0000 | 0.1888 | 0.0488 | 0.2376 | 0.2076 | 1.4452 |
| 7 | 1.0000 | 0.1285 | 0.0184 | 0.1469 | 0.0975 | 1.2444 |
| 8 | 1.0000 | 0.1005 | 0.0160 | 0.1165 | 0.2469 | 1.3634 |
| 9 | 1.0000 | 0.1070 | 0.0147 | 0.1218 | 0.2293 | 1.3510 |
| 10 | 1.0000 | 0.4972 | 0.1466 | 0.6438 | 0.3346 | 1.9783 |
| 11 | 1.0000 | 0.0772 | 0.0120 | 0.0893 | 0.3187 | 1.4080 |

TABLE VII-2 TOTAL SECTOR OUTPUT MULTIPLIERS TOP END REGION: 16-SECTOR TABLES

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'M INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1235 | 0.0243 | 0.1478 | 0.0977 | 1.2455 |
| 2A | 1.0000 | 0.1018 | 0.0204 | 0.1222 | 0.1401 | 1.2623 |
| 2B | 1.0000 | 0.3803 | 0.0760 | 0.4563 | 0.3172 | 1.7736 |
| 3 | 1.0000 | 0.1760 | 0.0417 | 0.2177 | 0.0307 | 1.2485 |
| 4A | 1.0000 | 0.1674 | 0.0358 | 0.2031 | 0.1573 | 1.3604 |
| 4B | 1.0000 | 0.1387 | 0.0382 | 0.1769 | 0.2286 | 1.4055 |
| 4C | 1.0000 | 0.1198 | 0.0427 | 0.1626 | 0.3037 | 1.4662 |
| 4DE | 1.0000 | 0.3800 | 0.1305 | 0.5105 | 0.2005 | 1.7111 |
| 4F | 1.0000 | 0.1647 | 0.0496 | 0.2142 | 0.2158 | 1.4300 |
| 5 | 1.0000 | 0.0494 | 0.0122 | 0.0616 | 0.1803 | 1.2419 |
| 6 | 1.0000 | 0.2332 | 0.0891 | 0.3223 | 0.2529 | 1.5752 |
| 7 | 1.0000 | 0.1692 | 0.0326 | 0.2018 | 0.1254 | 1.3271 |
| 8 | 1.0000 | 0.1197 | 0.0259 | 0.1456 | 0.3071 | 1.4527 |
| 9 | 1.0000 | 0.1164 | 0.0211 | 0.1375 | 0.2815 | 1.4190 |
| 10 | 1.0000 | 0.4953 | 0.1704 | 0.6657 | 0.4059 | 2.0716 |
| 11 | 1.0000 | 0.1001 | 0.0210 | 0.1211 | 0.4160 | 1.5371 |

TABLE VII-3 TOTAL SECTOR OUTPUT MULTIPLIERS NORTHERN TERRITORY: 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.1245 | 0.0233 | 0.1478 | 0.1134 | 1.2613 |
| 2A | 1.0000 | 0.1004 | 0.0184 | 0.1187 | 0.1718 | 1.2905 |
| 2B | 1.0000 | 0.3601 | 0.0699 | 0.4300 | 0.3517 | 1.7817 |
| 3 | 1.0000 | 0.1824 | 0.0430 | 0.2254 | 0.0460 | 1.2714 |
| 4A | 1.0000 | 0.1961 | 0.0386 | 0.2347 | 0.1836 | 1.4183 |
| 4B | 1.0000 | 0.1398 | 0.0369 | 0.1767 | 0.2606 | 1.4373 |
| 4C | 1.0000 | 0.1172 | 0.0390 | 0.1562 | 0.3456 | 1.5019 |
| 4DE | 1.0000 | 0.3721 | 0.1232 | 0.4954 | 0.2338 | 1.7292 |
| 4F | 1.0000 | 0.1617 | 0.0462 | 0.2079 | 0.2456 | 1.4535 |
| 5 | 1.0000 | 0.0459 | 0.0103 | 0.0562 | 0.2027 | 1.2590 |
| 6 | 1.0000 | 0.2183 | 0.0794 | 0.2976 | 0.2870 | 1.5847 |
| 7 | 1.0000 | 0.1642 | 0.0302 | 0.1943 | 0.1422 | 1.3365 |
| 8 | 1.0000 | 0.1218 | 0.0246 | 0.1464 | 0.3457 | 1.4922 |
| 9 | 1.0000 | 0.1161 | 0.0196 | 0.1358 | 0.3221 | 1.4578 |
| 10 | 1.0000 | 0.4962 | 0.1641 | 0.6603 | 0.4625 | 2.1228 |
| 11 | 1.0000 | 0.0988 | 0.0191 | 0.1179 | 0.4765 | 1.5944 |

TABLE VII-4 TOTAL SECTOR INCOME MULTIPLIERS DARWIN REGION: 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1089 | 0.0259 | 0.0038 | 0.0296 | 0.0208 | 0.1594 | 1.2376 | 1.2722 | 1.4633 |
| 2A | 0.1873 | 0.0149 | 0.0027 | 0.0176 | 0.0308 | 0.2357 | 1.0797 | 1.0941 | 1.2585 |
| 2B | 0.3482 | 0.0948 | 0.0117 | 0.1065 | 0.0683 | 0.5230 | 1.2723 | 1.3060 | 1.5023 |
| 3 | 0.2339 | 0.0992 | 0.0146 | 0.1138 | 0.0523 | 0.4030 | 1.4242 | 1.4866 | 1.7099 |
| 4A | 0.1971 | 0.0321 | 0.0061 | 0.0382 | 0.0354 | 0.2707 | 1.1631 | 1.1938 | 1.3732 |
| 4B | 0.3172 | 0.0238 | 0.0042 | 0.0281 | 0.0519 | 0.3972 | 1.0751 | 1.0885 | 1.2520 |
| 4C | 0.4284 | 0.0232 | 0.0055 | 0.0288 | 0.0687 | 0.5258 | 1.0542 | 1.0671 | 1.2275 |
| 4DE | 0.2854 | 0.0701 | 0.0185 | 0.0886 | 0.0562 | 0.4302 | 1.2456 | 1.3106 | 1.5076 |
| 4F | 0.2704 | 0.0270 | 0.0052 | 0.0322 | 0.0455 | 0.3481 | 1.1000 | 1.1192 | 1.2873 |
| 5 | 0.2721 | 0.0153 | 0.0026 | 0.0179 | 0.0436 | 0.3336 | 1.0563 | 1.0657 | 1.2258 |
| 6 | 0.3199 | 0.0536 | 0.0142 | 0.0678 | 0.0583 | 0.4460 | 1.1676 | 1.2121 | 1.3942 |
| 7 | 0.1434 | 0.0336 | 0.0052 | 0.0388 | 0.0274 | 0.2096 | 1.2344 | 1.2706 | 1.4615 |
| 8 | 0.4243 | 0.0323 | 0.0046 | 0.0369 | 0.0693 | 0.5305 | 1.0762 | 1.0871 | 1.2504 |
| 9 | 0.3910 | 0.0331 | 0.0042 | 0.0373 | 0.0643 | 0.4926 | 1.0846 | 1.0954 | 1.2600 |
| 10 | 0.4058 | 0.1729 | 0.0464 | 0.2192 | 0.0939 | 0.7189 | 1.4261 | 1.5403 | 1.7718 |
| 11 | 0.5691 | 0.0228 | 0.0034 | 0.0262 | 0.0895 | 0.6848 | 1.0490 | 1.0460 | 1.2032 |

TABLE VII-5 TOTAL SECTOR INCOME MULTIPLIERS TOP END REGION: 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1136 | 0.0297 | 0.0055 | 0.0352 | 0.0284 | 0.1773 | 1.2615 | 1.3097 | 1.5599 |
| 2A | 0.1893 | 0.0193 | 0.0047 | 0.0240 | 0.0408 | 0.2541 | 1.1021 | 1.1268 | 1.3421 |
| 2B | 0.3541 | 0.1128 | 0.0162 | 0.1290 | 0.0923 | 0.5753 | 1.3186 | 1.3643 | 1.6249 |
| 3 | 0.0194 | 0.0209 | 0.0065 | 0.0274 | 0.0089 | 0.0557 | 2.0774 | 2.4129 | 2.8739 |
| 4A | 0.1994 | 0.0325 | 0.0076 | 0.0401 | 0.0458 | 0.2853 | 1.1632 | 1.2012 | 1.4307 |
| 4B | 0.3094 | 0.0310 | 0.0076 | 0.0386 | 0.0665 | 0.4145 | 1.1001 | 1.1248 | 1.3396 |
| 4C | 0.4275 | 0.0271 | 0.0078 | 0.0348 | 0.0883 | 0.5507 | 1.0634 | 1.0815 | 1.2881 |
| 4DE | 0.2227 | 0.0615 | 0.0212 | 0.0827 | 0.0583 | 0.3637 | 1.2761 | 1.3714 | 1.6334 |
| 4F | 0.2883 | 0.0315 | 0.0088 | 0.0403 | 0.0628 | 0.3914 | 1.1091 | 1.1398 | 1.3575 |
| 5 | 0.2572 | 0.0147 | 0.0026 | 0.0173 | 0.0524 | 0.3270 | 1.0572 | 1.0673 | 1.2712 |
| 6 | 0.3193 | 0.0501 | 0.0157 | 0.0658 | 0.0736 | 0.4586 | 1.1570 | 1.2061 | 1.4365 |
| 7 | 0.1435 | 0.0396 | 0.0077 | 0.0474 | 0.0365 | 0.2273 | 1.2762 | 1.3301 | 1.5842 |
| 8 | 0.4264 | 0.0353 | 0.0058 | 0.0411 | 0.0893 | 0.5569 | 1.0828 | 1.0965 | 1.3059 |
| 9 | 0.3898 | 0.0338 | 0.0050 | 0.0388 | 0.0819 | 0.5105 | 1.0866 | 1.0995 | 1.3096 |
| 10 | 0.4015 | 0.1798 | 0.0457 | 0.2166 | 0.1181 | 0.7361 | 1.4255 | 1.5394 | 1.6335 |
| 11 | 0.6027 | 0.0262 | 0.0046 | 0.0308 | 0.1210 | 0.7545 | 1.0434 | 1.0511 | 1.2519 |

TABLE VII-6 — TOTAL SECTOR INCOME MULTIPLIERS — NORTHERN TERRITORY: 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1151 | 0.0312 | 0.0054 | 0.0367 | 0.0328 | 0.1846 | 1.2715 | 1.3185 | 1.6036 |
| 2A | 0.2051 | 0.0204 | 0.0043 | 0.0247 | 0.0497 | 0.2796 | 1.0996 | 1.1206 | 1.3629 |
| 2B | 0.3480 | 0.1071 | 0.0155 | 0.1226 | 0.1017 | 0.5723 | 1.3077 | 1.3522 | 1.6446 |
| 3 | 0.0317 | 0.0238 | 0.0069 | 0.0299 | 0.0133 | 0.0749 | 1.7239 | 1.9418 | 2.3616 |
| 4A | 0.2003 | 0.0366 | 0.0087 | 0.0453 | 0.0531 | 0.2987 | 1.1827 | 1.2261 | 1.4913 |
| 4B | 0.3089 | 0.0319 | 0.0077 | 0.0397 | 0.0754 | 0.4240 | 1.1034 | 1.1284 | 1.3724 |
| 4C | 0.4275 | 0.0274 | 0.0076 | 0.0350 | 0.1000 | 0.5625 | 1.0641 | 1.0818 | 1.3157 |
| 4DE | 0.2261 | 0.0652 | 0.0215 | 0.0868 | 0.0676 | 0.3805 | 1.2885 | 1.3838 | 1.6830 |
| 4F | 0.2876 | 0.0324 | 0.0088 | 0.0411 | 0.0711 | 0.3997 | 1.1125 | 1.1430 | 1.3901 |
| 5 | 0.2551 | 0.0139 | 0.0023 | 0.0162 | 0.0587 | 0.3299 | 1.0545 | 1.0635 | 1.2935 |
| 6 | 0.3210 | 0.0481 | 0.0150 | 0.0631 | 0.0830 | 0.4671 | 1.1499 | 1.1965 | 1.4552 |
| 7 | 0.1438 | 0.0392 | 0.0073 | 0.0465 | 0.0411 | 0.2314 | 1.2726 | 1.3236 | 1.6098 |
| 8 | 0.4203 | 0.0365 | 0.0058 | 0.0423 | 0.1000 | 0.5626 | 1.0868 | 1.1006 | 1.3386 |
| 9 | 0.3928 | 0.0333 | 0.0048 | 0.0381 | 0.0932 | 0.5241 | 1.0847 | 1.0969 | 1.3341 |
| 10 | 0.4021 | 0.1716 | 0.0451 | 0.2167 | 0.1338 | 0.7527 | 1.4267 | 1.5390 | 1.8718 |
| 11 | 0.6069 | 0.0263 | 0.0043 | 0.0307 | 0.1379 | 0.7754 | 1.0434 | 1.0505 | 1.2777 |

TABLE VII-7 TOTAL SECTOR EMPLOYMENT MULTIPLIERS DARWIN REGION:
************************************ 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0822 | 0.0124 | 0.0004 | 0.0128 | 0.0021 | 0.0972 | 1.1506 | 1.1558 | 1.1814 |
| 2A | 0.6194 | 0.0061 | 0.0003 | 0.0064 | 0.0031 | 0.6289 | 1.0099 | 1.0103 | 1.0154 |
| 2B | 0.0094 | 0.0105 | 0.0011 | 0.0115 | 0.0069 | 0.0279 | 2.1071 | 2.2192 | 2.9514 |
| 3 | 0.0207 | 0.0115 | 0.0014 | 0.0129 | 0.0053 | 0.0388 | 1.5548 | 1.6216 | 1.8775 |
| 4A | 0.0248 | 0.0123 | 0.0010 | 0.0133 | 0.0036 | 0.0416 | 1.4981 | 1.5371 | 1.6817 |
| 4B | 0.0667 | 0.0024 | 0.0003 | 0.0028 | 0.0053 | 0.0747 | 1.0367 | 1.0414 | 1.1202 |
| 4C | 0.0626 | 0.0014 | 0.0004 | 0.0018 | 0.0070 | 0.0713 | 1.0228 | 1.0284 | 1.1395 |
| 4DE | 0.0101 | 0.0038 | 0.0013 | 0.0051 | 0.0037 | 0.0189 | 1.3748 | 1.5013 | 2.0627 |
| 4F | 0.0247 | 0.0021 | 0.0004 | 0.0025 | 0.0046 | 0.0318 | 1.0853 | 1.1024 | 1.2899 |
| 5 | 0.0142 | 0.0012 | 0.0002 | 0.0014 | 0.0044 | 0.0200 | 1.0838 | 1.0956 | 1.4054 |
| 6 | 0.0238 | 0.0032 | 0.0009 | 0.0041 | 0.0059 | 0.0338 | 1.1341 | 1.1712 | 1.4186 |
| 7 | 0.0220 | 0.0035 | 0.0005 | 0.0039 | 0.0028 | 0.0287 | 1.1580 | 1.1789 | 1.3049 |
| 8 | 0.0332 | 0.0029 | 0.0004 | 0.0033 | 0.0070 | 0.0435 | 1.0874 | 1.0980 | 1.3091 |
| 9 | 0.0351 | 0.0030 | 0.0003 | 0.0033 | 0.0065 | 0.0449 | 1.0842 | 1.0942 | 1.2797 |
| 10 | 0.0234 | 0.0127 | 0.0033 | 0.0160 | 0.0095 | 0.0489 | 1.5448 | 1.6849 | 2.0919 |
| 11 | 0.0477 | 0.0019 | 0.0003 | 0.0021 | 0.0091 | 0.0589 | 1.0391 | 1.0445 | 1.2343 |

TABLE VII-8 TOTAL SECTOR EMPLOYMENT MULTIPLIERS TOP END REGION:
************************************ 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0849 | 0.0129 | 0.0007 | 0.0135 | 0.0031 | 0.1015 | 1.1516 | 1.1593 | 1.1958 |
| 2A | 0.6397 | 0.0061 | 0.0005 | 0.0066 | 0.0044 | 0.6507 | 1.0095 | 1.0104 | 1.0173 |
| 2B | 0.0111 | 0.0135 | 0.0016 | 0.0151 | 0.0101 | 0.0363 | 2.2150 | 2.3618 | 3.2679 |
| 3 | 0.0069 | 0.0025 | 0.0006 | 0.0031 | 0.0010 | 0.0110 | 1.3558 | 1.4487 | 1.5897 |
| 4A | 0.0213 | 0.0134 | 0.0014 | 0.0148 | 0.0050 | 0.0411 | 1.6263 | 1.6942 | 1.9279 |
| 4B | 0.0552 | 0.0033 | 0.0007 | 0.0040 | 0.0072 | 0.0665 | 1.0597 | 1.0726 | 1.2039 |
| 4C | 0.0668 | 0.0021 | 0.0006 | 0.0027 | 0.0096 | 0.0792 | 1.0308 | 1.0405 | 1.1845 |
| 4DE | 0.0079 | 0.0042 | 0.0018 | 0.0060 | 0.0064 | 0.0202 | 1.5315 | 1.7563 | 2.5625 |
| 4F | 0.0326 | 0.0029 | 0.0008 | 0.0037 | 0.0068 | 0.0431 | 1.0889 | 1.1135 | 1.3234 |
| 5 | 0.0126 | 0.0012 | 0.0002 | 0.0014 | 0.0057 | 0.0197 | 1.0964 | 1.1138 | 1.5684 |
| 6 | 0.0236 | 0.0038 | 0.0013 | 0.0051 | 0.0080 | 0.0366 | 1.1603 | 1.2150 | 1.5553 |
| 7 | 0.0240 | 0.0046 | 0.0008 | 0.0054 | 0.0040 | 0.0334 | 1.1924 | 1.2265 | 1.3920 |
| 8 | 0.0329 | 0.0036 | 0.0006 | 0.0041 | 0.0097 | 0.0467 | 1.1083 | 1.1252 | 1.4212 |
| 9 | 0.0349 | 0.0033 | 0.0005 | 0.0038 | 0.0089 | 0.0476 | 1.0959 | 1.1102 | 1.3662 |
| 10 | 0.0209 | 0.0129 | 0.0037 | 0.0165 | 0.0129 | 0.0503 | 1.6154 | 1.7904 | 2.4055 |
| 11 | 0.0667 | 0.0025 | 0.0005 | 0.0029 | 0.0132 | 0.0828 | 1.0374 | 1.0442 | 1.2420 |

TABLE VII-9 TOTAL SECTOR EMPLOYMENT MULTIPLIERS NORTHERN TERRITORY: 16-SECTOR TABLE

| SECTOR | INITIAL IMPACT | FIRST ROUND | INDUSTRIAL SUPPORT | PROD'N INDUCED | CONS'N INDUCED | TOTAL | TYPE IA | TYPE IB | TYPE II |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0757 | 0.0114 | 0.0006 | 0.0120 | 0.0030 | 0.0907 | 1.1502 | 1.1584 | 1.1977 |
| 2A | 0.0138 | 0.0093 | 0.0005 | 0.0098 | 0.0045 | 0.0281 | 1.0152 | 1.0160 | 1.0233 |
| 2B | 0.0158 | 0.0129 | 0.0014 | 0.0143 | 0.0092 | 0.0393 | 1.8168 | 1.9074 | 2.4931 |
| 3 | 0.0072 | 0.0026 | 0.0007 | 0.0032 | 0.0012 | 0.0116 | 1.3582 | 1.4523 | 1.6206 |
| 4A | 0.0215 | 0.0138 | 0.0017 | 0.0155 | 0.0048 | 0.0418 | 1.6404 | 1.7203 | 1.9446 |
| 4B | 0.0558 | 0.0031 | 0.0006 | 0.0037 | 0.0068 | 0.0663 | 1.0549 | 1.0664 | 1.1891 |
| 4C | 0.0668 | 0.0020 | 0.0006 | 0.0026 | 0.0091 | 0.0784 | 1.0296 | 1.0383 | 1.1742 |
| 4DE | 0.0081 | 0.0043 | 0.0017 | 0.0060 | 0.0061 | 0.0202 | 1.5270 | 1.7373 | 2.4978 |
| 4F | 0.0356 | 0.0028 | 0.0007 | 0.0035 | 0.0065 | 0.0456 | 1.0775 | 1.0980 | 1.2792 |
| 5 | 0.0122 | 0.0011 | 0.0002 | 0.0013 | 0.0053 | 0.0188 | 1.0910 | 1.1057 | 1.5427 |
| 6 | 0.0242 | 0.0034 | 0.0011 | 0.0045 | 0.0075 | 0.0363 | 1.1398 | 1.1865 | 1.4978 |
| 7 | 0.0195 | 0.0038 | 0.0007 | 0.0045 | 0.0037 | 0.0277 | 1.1967 | 1.2309 | 1.4226 |
| 8 | 0.0332 | 0.0034 | 0.0005 | 0.0039 | 0.0091 | 0.0461 | 1.1032 | 1.1181 | 1.3920 |
| 9 | 0.0285 | 0.0028 | 0.0004 | 0.0032 | 0.0085 | 0.0402 | 1.0986 | 1.1132 | 1.4102 |
| 10 | 0.0206 | 0.0123 | 0.0034 | 0.0156 | 0.0122 | 0.0484 | 1.5944 | 1.7577 | 2.3466 |
| 11 | 0.0526 | 0.0022 | 0.0004 | 0.0026 | 0.0125 | 0.0677 | 1.0421 | 1.0492 | 1.2873 |

# APPENDIX VIII

## MATRICES OF DIRECT COEFFICIENTS: 11-SECTOR TABLES

### TABLE VIII-1 DIRECT COEFFICIENTS, 11-SECTOR TABLE: DARWIN REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0032 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0011 | 0.0000 | 0.0090 |
| 2 | 0.0165 | 0.0002 | 0.0000 | 0.0022 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0006 | 0.0001 | 0.0020 |
| 3 | 0.0000 | 0.0000 | 0.0686 | 0.0179 | 0.0000 | 0.0011 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0080 |
| 4 | 0.0050 | 0.2038 | 0.1578 | 0.1268 | 0.0035 | 0.1542 | 0.0048 | 0.0114 | 0.0007 | 0.0035 | 0.0072 | 0.0122 |
| 5 | 0.0083 | 0.0047 | 0.0064 | 0.0121 | 0.0072 | 0.0015 | 0.0045 | 0.0032 | 0.0140 | 0.0478 | 0.0185 | 0.0128 |
| 6 | 0.0182 | 0.0002 | 0.0000 | 0.0095 | 0.0279 | 0.0000 | 0.0131 | 0.0270 | 0.0184 | 0.2179 | 0.0254 | 0.0187 |
| 7 | 0.0363 | 0.0566 | 0.0079 | 0.0127 | 0.0035 | 0.0176 | 0.0625 | 0.0244 | 0.0314 | 0.0250 | 0.0146 | 0.2100 |
| 8 | 0.0066 | 0.0056 | 0.0416 | 0.0223 | 0.0052 | 0.0093 | 0.0088 | 0.0256 | 0.0083 | 0.0189 | 0.0023 | 0.0110 |
| 9 | 0.0000 | 0.0390 | 0.0025 | 0.0035 | 0.0004 | 0.0050 | 0.0324 | 0.0030 | 0.0245 | 0.0378 | 0.0042 | 0.0689 |
| 10 | 0.0000 | 0.0048 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1223 | 0.0000 | 0.0071 |
| 11 | 0.0099 | 0.0010 | 0.0016 | 0.0000 | 0.0006 | 0.0001 | 0.0023 | 0.0057 | 0.0097 | 0.0222 | 0.0049 | 0.0641 |
| H-H | 0.1389 | 0.3433 | 0.2339 | 0.2785 | 0.2721 | 0.3199 | 0.1434 | 0.4243 | 0.3910 | 0.4058 | 0.5691 | 0.0000 |

### TABLE VIII-2 DIRECT COEFFICIENTS, 11-SECTOR TABLE: TOP END REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0046 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0041 | 0.0000 | 0.0000 |
| 2 | 0.0153 | 0.0002 | 0.0000 | 0.0013 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0006 | 0.0001 | 0.0020 |
| 3 | 0.0000 | 0.0000 | 0.1298 | 0.1053 | 0.0000 | 0.0035 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0500 |
| 4 | 0.0048 | 0.2580 | 0.0088 | 0.1529 | 0.0032 | 0.1530 | 0.0060 | 0.0125 | 0.0000 | 0.0028 | 0.0087 | 0.0130 |
| 5 | 0.0033 | 0.0046 | 0.0002 | 0.0115 | 0.0066 | 0.0016 | 0.0046 | 0.0031 | 0.0144 | 0.0474 | 0.0186 | 0.0125 |
| 6 | 0.0195 | 0.0003 | 0.0395 | 0.0079 | 0.0268 | 0.0000 | 0.0131 | 0.0277 | 0.0183 | 0.2161 | 0.0261 | 0.0190 |
| 7 | 0.0623 | 0.0576 | 0.0012 | 0.0352 | 0.0075 | 0.0618 | 0.1019 | 0.0425 | 0.0429 | 0.0248 | 0.0345 | 0.2100 |
| 8 | 0.0061 | 0.0051 | 0.0032 | 0.0175 | 0.0045 | 0.0086 | 0.0088 | 0.0250 | 0.0077 | 0.0187 | 0.0023 | 0.0200 |
| 9 | 0.0006 | 0.0388 | 0.0001 | 0.0020 | 0.0003 | 0.0046 | 0.0324 | 0.0029 | 0.0230 | 0.0375 | 0.0042 | 0.1200 |
| 10 | 0.0000 | 0.0048 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1213 | 0.0000 | 0.0070 |
| 11 | 0.0110 | 0.0011 | 0.0022 | 0.0001 | 0.0005 | 0.0001 | 0.0023 | 0.0059 | 0.0092 | 0.0220 | 0.0054 | 0.0630 |
| H-H | 0.1136 | 0.3483 | 0.0194 | 0.2293 | 0.2572 | 0.3193 | 0.1435 | 0.4264 | 0.3898 | 0.4015 | 0.6027 | 0.0000 |

TABLE VIII-3 DIRECT COEFFICIENTS, 11-SECTOR TABLE: KATHERINE-BARKLY REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0430 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0041 | 0.0000 | 0.0000 |
| 2 | 0.0050 | 0.0006 | 0.0000 | 0.0008 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0001 | 0.0021 |
| 3 | 0.0000 | 0.0000 | 0.0656 | 0.0181 | 0.0000 | 0.0021 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 |
| 4 | 0.0043 | 0.0729 | 0.0000 | 0.0205 | 0.0000 | 0.0433 | 0.0010 | 0.0033 | 0.0000 | 0.0010 | 0.0042 | 0.0276 |
| 5 | 0.0064 | 0.0028 | 0.0000 | 0.0109 | 0.0013 | 0.0028 | 0.0069 | 0.0042 | 0.0252 | 0.0471 | 0.0317 | 0.0140 |
| 6 | 0.0204 | 0.0006 | 0.0000 | 0.0093 | 0.0114 | 0.0000 | 0.0112 | 0.0350 | 0.0130 | 0.2148 | 0.0288 | 0.0070 |
| 7 | 0.0362 | 0.0361 | 0.0000 | 0.0196 | 0.0032 | 0.0259 | 0.0527 | 0.0283 | 0.0307 | 0.0247 | 0.0183 | 0.1030 |
| 8 | 0.0060 | 0.0039 | 0.0000 | 0.0153 | 0.0057 | 0.0079 | 0.0047 | 0.0105 | 0.0069 | 0.0186 | 0.0024 | 0.0650 |
| 9 | 0.0002 | 0.0000 | 0.0000 | 0.0005 | 0.0002 | 0.0022 | 0.0079 | 0.0002 | 0.0071 | 0.0373 | 0.0012 | 0.0660 |
| 10 | 0.0000 | 0.0000 | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1206 | 0.0000 | 0.0079 |
| 11 | 0.0109 | 0.0011 | 0.0000 | 0.0000 | 0.0004 | 0.0001 | 0.0022 | 0.0037 | 0.0065 | 0.0219 | 0.0034 | 0.0730 |
| H-H | 0.1150 | 0.3079 | 0.0577 | 0.2547 | 0.2484 | 0.3288 | 0.1440 | 0.4394 | 0.4028 | 0.3998 | 0.6006 | 0.0000 |

TABLE VIII-4 DIRECT COEFFICIENTS, 11-SECTOR TABLE: ALICE SPRINGS REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0036 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0041 | 0.0000 | 0.0000 |
| 2 | 0.0136 | 0.0077 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 |
| 3 | 0.0000 | 0.0000 | 0.3634 | 0.0245 | 0.0000 | 0.0040 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0002 | 0.0000 |
| 4 | 0.0040 | 0.0000 | 0.0276 | 0.0852 | 0.0015 | 0.1049 | 0.0032 | 0.0117 | 0.0005 | 0.0021 | 0.0074 | 0.0120 |
| 5 | 0.0044 | 0.0077 | 0.0001 | 0.0083 | 0.0047 | 0.0018 | 0.0060 | 0.0021 | 0.0174 | 0.0476 | 0.0202 | 0.0142 |
| 6 | 0.0197 | 0.0077 | 0.0000 | 0.0099 | 0.0189 | 0.0000 | 0.0132 | 0.0263 | 0.0139 | 0.2169 | 0.0224 | 0.0227 |
| 7 | 0.0580 | 0.0519 | 0.0011 | 0.0405 | 0.0062 | 0.0548 | 0.0969 | 0.0467 | 0.0438 | 0.0249 | 0.0284 | 0.2100 |
| 8 | 0.0003 | 0.0077 | 0.0015 | 0.0268 | 0.0071 | 0.0117 | 0.0064 | 0.0199 | 0.0061 | 0.0188 | 0.0030 | 0.0560 |
| 9 | 0.0003 | 0.0000 | 0.0000 | 0.0009 | 0.0002 | 0.0048 | 0.0319 | 0.0004 | 0.0194 | 0.0376 | 0.0016 | 0.1630 |
| 10 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1217 | 0.0000 | 0.0069 |
| 11 | 0.0116 | 0.0000 | 0.0013 | 0.0000 | 0.0005 | 0.0001 | 0.0028 | 0.0097 | 0.0086 | 0.0221 | 0.0063 | 0.0638 |
| H-H | 0.1155 | 0.2515 | 0.0221 | 0.2670 | 0.2531 | 0.3250 | 0.1441 | 0.3957 | 0.3963 | 0.4122 | 0.6132 | 0.0000 |

TABLE VIII-3  DIRECT COEFFICIENTS, 11-SECTOR TABLE: NORTHERN TERRITORY

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0084 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0041 | 0.0000 | 0.0000 |
| 2 | 0.0140 | 0.0006 | 0.0000 | 0.0012 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0006 | 0.0001 | 0.0028 |
| 3 | 0.0000 | 0.0000 | 0.1260 | 0.0951 | 0.0000 | 0.0036 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0000 |
| 4 | 0.0057 | 0.2353 | 0.0121 | 0.1426 | 0.0026 | 0.1391 | 0.0051 | 0.0120 | 0.0008 | 0.0029 | 0.0083 | 0.0137 |
| 5 | 0.0055 | 0.0048 | 0.0082 | 0.0137 | 0.0067 | 0.0020 | 0.0060 | 0.0035 | 0.0184 | 0.0475 | 0.0224 | 0.0130 |
| 6 | 0.0204 | 0.0004 | 0.0352 | 0.0082 | 0.0235 | 0.0000 | 0.0131 | 0.0269 | 0.0172 | 0.2164 | 0.0258 | 0.0187 |
| 7 | 0.0589 | 0.0372 | 0.0013 | 0.0351 | 0.0066 | 0.0576 | 0.0961 | 0.0424 | 0.0425 | 0.0248 | 0.0308 | 0.2391 |
| 8 | 0.0081 | 0.0051 | 0.0051 | 0.0241 | 0.0058 | 0.0113 | 0.0111 | 0.0282 | 0.0074 | 0.0188 | 0.0027 | 0.0110 |
| 9 | 0.0004 | 0.0384 | 0.0001 | 0.0018 | 0.0002 | 0.0045 | 0.0302 | 0.0021 | 0.0208 | 0.0375 | 0.0030 | 0.1543 |
| 10 | 0.0000 | 0.0048 | 0.0082 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1215 | 0.0000 | 0.0671 |
| 11 | 0.0115 | 0.0011 | 0.0025 | 0.0001 | 0.0005 | 0.0001 | 0.0025 | 0.0066 | 0.0000 | 0.0221 | 0.0056 | 0.0641 |
| H-H | 0.1151 | 0.3412 | 0.0317 | 0.2335 | 0.2551 | 0.3210 | 0.1438 | 0.4203 | 0.3928 | 0.4021 | 0.6069 | 0.0000 |

# APPENDIX IX

## MATRICES OF DIRECT COEFFICIENTS: NON-UNIFORM TABLES

TABLE IX-1 DIRECT COEFFICIENTS, 16-SECTOR TABLE: DARWIN REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | N-N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0214 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0011 | 0.0000 | 0.0000 |
| 2A | 0.0163 | 0.0075 | 0.0000 | 0.0000 | 0.0134 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0000 |
| 2B | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0011 | 0.0000 | 0.0010 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0001 | 0.0020 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0404 | 0.0000 | 0.0000 | 0.0000 | 0.0247 | 0.0000 | 0.0000 | 0.0011 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0000 |
| 4A | 0.0033 | 0.0000 | 0.0099 | 0.0000 | 0.0223 | 0.0000 | 0.0000 | 0.0000 | 0.0024 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0030 | 0.0000 | 0.0000 | 0.0084 |
| 4B | 0.0000 | 0.0000 | 0.0031 | 0.0000 | 0.0032 | 0.0153 | 0.0010 | 0.0003 | 0.0000 | 0.0000 | 0.0117 | 0.0009 | 0.0000 | 0.0003 | 0.0005 | 0.0014 | 0.0019 |
| 4C | 0.0000 | 0.0000 | 0.0548 | 0.1147 | 0.0001 | 0.0000 | 0.0034 | 0.0003 | 0.0004 | 0.0010 | 0.0007 | 0.0010 | 0.0055 | 0.0001 | 0.0014 | 0.0002 | 0.0002 |
| 4DE | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0245 | 0.0213 | 0.0454 | 0.1466 | 0.0283 | 0.0012 | 0.1409 | 0.0000 | 0.0036 | 0.0001 | 0.0013 | 0.0037 | 0.0014 |
| 4F | 0.0317 | 0.0037 | 0.1423 | 0.0432 | 0.0000 | 0.0064 | 0.0005 | 0.0017 | 0.0163 | 0.0003 | 0.0009 | 0.0021 | 0.0023 | 0.0003 | 0.0003 | 0.0009 | 0.0003 |
| 5 | 0.0003 | 0.0037 | 0.0047 | 0.0064 | 0.0003 | 0.0030 | 0.0049 | 0.0139 | 0.0113 | 0.0072 | 0.0015 | 0.0045 | 0.0032 | 0.0149 | 0.0470 | 0.0105 | 0.0120 |
| 6 | 0.0102 | 0.0575 | 0.0000 | 0.0000 | 0.0094 | 0.0070 | 0.0039 | 0.0108 | 0.0108 | 0.0279 | 0.0000 | 0.0131 | 0.0270 | 0.0104 | 0.2179 | 0.0254 | 0.0187 |
| 7 | 0.0363 | 0.0412 | 0.0570 | 0.0079 | 0.0135 | 0.0200 | 0.0093 | 0.0119 | 0.0155 | 0.0035 | 0.0176 | 0.0625 | 0.0244 | 0.0314 | 0.0250 | 0.0146 | 0.2100 |
| 8 | 0.0464 | 0.0075 | 0.0050 | 0.0416 | 0.0144 | 0.0111 | 0.0054 | 0.0262 | 0.0004 | 0.0052 | 0.0093 | 0.0000 | 0.0256 | 0.0003 | 0.0109 | 0.0023 | 0.0110 |
| 9 | 0.0000 | 0.0000 | 0.0403 | 0.0023 | 0.0023 | 0.0040 | 0.0024 | 0.0037 | 0.0554 | 0.0004 | 0.0050 | 0.0324 | 0.0030 | 0.0245 | 0.0378 | 0.0042 | 0.0009 |
| 10 | 0.0000 | 0.0000 | 0.0030 | 0.0000 | 0.0003 | 0.0002 | 0.0000 | 0.0000 | 0.0006 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1223 | 0.0000 | 0.0071 |
| 11 | 0.5099 | 0.0000 | 0.0011 | 0.0016 | 0.0060 | 0.0066 | 0.0000 | 0.0000 | 0.0000 | 0.0064 | 0.0001 | 0.0023 | 0.0057 | 0.0097 | 0.0222 | 0.0049 | 0.0441 |
| N-N | 0.1009 | 0.1872 | 0.3402 | 0.2339 | 0.1971 | 0.3172 | 0.4204 | 0.2054 | 0.2704 | 0.2721 | 0.3199 | 0.1434 | 0.4243 | 0.3910 | 0.4058 | 0.5491 | 0.0000 |

TABLE IX-2 DIRECT COEFFICIENTS, 16-SECTOR TABLE: TOP END REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | N-N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0454 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0041 | 0.0000 | 0.0000 |
| 2A | 0.0153 | 0.0057 | 0.0000 | 0.0000 | 0.0112 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0000 |
| 2B | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0012 | 0.0000 | 0.0059 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0053 | 0.0061 | 0.0023 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.1200 | 0.0000 | 0.0000 | 0.0000 | 0.1293 | 0.0293 | 0.0000 | 0.0035 | 0.0002 | 0.0011 | 0.0000 | 0.0000 | 0.0051 | 0.0000 |
| 4A | 0.0027 | 0.0000 | 0.0097 | 0.0012 | 0.0201 | 0.0000 | 0.0000 | 0.0000 | 0.0017 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0017 | 0.0000 |
| 4B | 0.0000 | 0.0000 | 0.0039 | 0.0064 | 0.0002 | 0.0140 | 0.0009 | 0.0002 | 0.0003 | 0.0000 | 0.0109 | 0.0009 | 0.0000 | 0.0002 | 0.0003 | 0.0015 | 0.0020 |
| 4C | 0.0002 | 0.0020 | 0.0431 | 0.0030 | 0.0001 | 0.0000 | 0.0032 | 0.0002 | 0.0002 | 0.0013 | 0.0007 | 0.0011 | 0.0030 | 0.0061 | 0.0012 | 0.0003 | 0.0003 |
| 4DE | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0182 | 0.0361 | 0.0422 | 0.1745 | 0.0525 | 0.0011 | 0.1401 | 0.0009 | 0.0035 | 0.0001 | 0.0010 | 0.0036 | 0.0015 |
| 4F | 0.0010 | 0.0027 | 0.2062 | 0.0034 | 0.0019 | 0.0012 | 0.0009 | 0.0918 | 0.0141 | 0.0007 | 0.0013 | 0.0031 | 0.0032 | 0.0004 | 0.0004 | 0.0015 | 0.0012 |
| 5 | 0.0039 | 0.0029 | 0.0047 | 0.0002 | 0.0060 | 0.0030 | 0.0051 | 0.0120 | 0.0070 | 0.0064 | 0.0016 | 0.0046 | 0.0031 | 0.0144 | 0.0474 | 0.0106 | 0.0125 |
| 6 | 0.0195 | 0.0004 | 0.0000 | 0.0393 | 0.0093 | 0.0009 | 0.0039 | 0.0070 | 0.0091 | 0.0260 | 0.0000 | 0.0131 | 0.0277 | 0.0163 | 0.2161 | 0.0261 | 0.0190 |
| 7 | 0.0623 | 0.0740 | 0.0570 | 0.0012 | 0.0399 | 0.0619 | 0.0342 | 0.0334 | 0.0492 | 0.0575 | 0.0610 | 0.1019 | 0.0425 | 0.0429 | 0.0248 | 0.0345 | 0.2100 |
| 8 | 0.0061 | 0.0057 | 0.0051 | 0.0032 | 0.0125 | 0.0104 | 0.0061 | 0.0192 | 0.0059 | 0.0045 | 0.0006 | 0.0000 | 0.0250 | 0.0077 | 0.0197 | 0.0023 | 0.0200 |
| 9 | 0.0056 | 0.0000 | 0.0402 | 0.0001 | 0.0017 | 0.0041 | 0.0023 | 0.0019 | 0.0040 | 0.0003 | 0.0046 | 0.0324 | 0.0029 | 0.2230 | 0.0375 | 0.0042 | 0.1200 |
| 10 | 0.0000 | 0.0000 | 0.0050 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0001 | 0.1213 | 0.0000 | 0.0070 |
| 11 | 0.0110 | 0.0000 | 0.0011 | 0.0322 | 0.0000 | 0.0003 | 0.0000 | 0.0001 | 0.0000 | 0.0003 | 0.0001 | 0.0023 | 0.0059 | 0.0092 | 0.0223 | 0.0054 | 0.0630 |
| N-N | 0.1136 | 0.1893 | 0.3541 | 0.0194 | 0.1994 | 0.3094 | 0.4275 | 0.2227 | 0.2003 | 0.2372 | 0.3193 | 0.1435 | 0.4204 | 0.3898 | 0.4013 | 0.4027 | 0.0000 |

TABLE IX-3 DIRECT COEFFICIENTS, 16-SECTOR TABLE: NORTHERN TERRITORY

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | N-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0775 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0341 | 0.0000 | 0.0002 |
| 2A | 0.0140 | 0.0120 | 0.0000 | 0.0000 | 0.0093 | 0.0030 | 0.0000 | 0.0000 | 0.0002 | 0.0040 | 0.0000 | 0.0000 | 0.0005 | 0.0000 | 0.0353 | 0.0000 | 0.0080 |
| 2B | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0018 | 0.0000 | 0.0006 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0003 | 0.0001 | 0.0029 |
| 3 | 0.0056 | 0.0394 | 0.0000 | 0.1260 | 0.0000 | 0.0000 | 0.0000 | 0.1107 | 0.0271 | 0.0000 | 0.0036 | 0.0008 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0000 |
| 4A | 0.0032 | 0.0016 | 0.0100 | 0.0026 | 0.0107 | 0.0002 | 0.0000 | 0.0000 | 0.0016 | 0.0300 | 0.0000 | 0.0000 | 0.0050 | 0.0000 | 0.0000 | 0.0012 | 0.0084 |
| 4B | 0.0000 | 0.0000 | 0.0031 | 0.0004 | 0.0002 | 0.0137 | 0.0006 | 0.0002 | 0.0004 | 0.0008 | 0.0101 | 0.0010 | 0.0000 | 0.0002 | 0.0003 | 0.0014 | 0.0019 |
| 4C | 0.0003 | 0.0012 | 0.0496 | 0.0040 | 0.0001 | 0.0000 | 0.0042 | 0.0002 | 0.0002 | 0.0012 | 0.0011 | 0.0010 | 0.0064 | 0.0051 | 0.0011 | 0.0005 | 0.0008 |
| 4DE | 0.0000 | 0.0000 | 0.0000 | 0.0014 | 0.0153 | 0.0356 | 0.0572 | 0.1657 | 0.0483 | 0.0009 | 0.1267 | 0.0000 | 0.0029 | 0.0001 | 0.0009 | 0.0033 | 0.0014 |
| 4F | 0.0319 | 0.0019 | 0.1847 | 0.0037 | 0.0000 | 0.0017 | 0.0010 | 0.0017 | 0.0139 | 0.0004 | 0.0012 | 0.0023 | 0.0027 | 0.0005 | 0.0006 | 0.0028 | 0.0012 |
| 5 | 0.0055 | 0.0055 | 0.0040 | 0.0002 | 0.0082 | 0.0049 | 0.0061 | 0.0153 | 0.0091 | 0.0067 | 0.0020 | 0.0060 | 0.0035 | 0.0104 | 0.0475 | 0.0224 | 0.0130 |
| 6 | 0.0204 | 0.0088 | 0.0000 | 0.0359 | 0.0091 | 0.0069 | 0.0039 | 0.0082 | 0.0097 | 0.0235 | 0.0000 | 0.0131 | 0.0269 | 0.0172 | 0.2164 | 0.0258 | 0.0187 |
| 7 | 0.0589 | 0.0637 | 0.0570 | 0.0013 | 0.0382 | 0.0599 | 0.0329 | 0.0334 | 0.0392 | 0.0066 | 0.0576 | 0.0961 | 0.0424 | 0.0425 | 0.0248 | 0.0300 | 0.2391 |
| 8 | 0.0081 | 0.0074 | 0.0050 | 0.0051 | 0.0155 | 0.0135 | 0.0007 | 0.0270 | 0.0083 | 0.0058 | 0.0113 | 0.0111 | 0.0202 | 0.0074 | 0.0100 | 0.0027 | 0.0110 |
| 9 | 0.0004 | 0.0002 | 0.0403 | 0.0001 | 0.0015 | 0.0033 | 0.0019 | 0.0017 | 0.0036 | 0.0002 | 0.0045 | 0.0302 | 0.0521 | 0.0200 | 0.0375 | 0.0038 | 0.1543 |
| 10 | 0.0009 | 0.0000 | 0.0050 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.1215 | 0.0000 | 0.0071 |
| 11 | 0.0115 | 0.0007 | 0.0012 | 0.0025 | 0.0003 | 0.0092 | 0.0000 | 0.0001 | 0.0000 | 0.0005 | 0.0001 | 0.0025 | 0.0066 | 0.0050 | 0.0221 | 0.0056 | 0.0641 |
| N-H | 0.1151 | 0.2051 | 0.3480 | 0.0317 | 0.2003 | 0.3099 | 0.4275 | 0.2261 | 0.2876 | 0.2551 | 0.3210 | 0.1438 | 0.4203 | 0.3920 | 0.4521 | 0.6969 | 0.0000 |

TABLE XII-1 INVERSE MATRIX, 16-SECTOR OPEN MODEL: DARWIN REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0000 | 0.0002 | 0.0000 | 0.0219 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0013 | 0.0000 |
| 2A | 0.0167 | 1.0075 | 0.0002 | 0.0000 | 0.0144 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0000 |
| 2B | 0.0003 | 0.0000 | 1.0001 | 0.0001 | 0.0011 | 0.0000 | 0.0010 | 0.0000 | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0053 | 0.0001 |
| 3 | 0.0001 | 0.0001 | 0.0012 | 1.0742 | 0.0009 | 0.0007 | 0.0015 | 0.0312 | 0.0072 | 0.0002 | 0.0056 | 0.0002 | 0.0004 | 0.0001 | 0.0015 | 0.0004 |
| 4A | 0.0034 | 0.0000 | 0.0165 | 0.0001 | 1.0231 | 0.0000 | 0.0000 | 0.0000 | 0.0025 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0009 |
| 4B | 0.0003 | 0.0001 | 0.0034 | 0.0002 | 0.0004 | 1.0156 | 0.0011 | 0.0006 | 0.0010 | 0.0003 | 0.0120 | 0.0012 | 0.0054 | 0.0006 | 0.0036 | 0.0019 |
| 4C | 0.0001 | 0.0001 | 0.0553 | 0.1239 | 0.0004 | 0.0002 | 1.0038 | 0.0042 | 0.0014 | 0.0019 | 0.0015 | 0.0012 | 0.0057 | 0.0002 | 0.0023 | 0.0063 |
| 4DE | 0.0033 | 0.0016 | 0.0060 | 0.0009 | 0.0315 | 0.0269 | 0.0300 | 1.1772 | 0.0265 | 0.0063 | 0.1664 | 0.0030 | 0.0095 | 0.0036 | 0.0442 | 0.0089 |
| 4F | 0.0019 | 0.0040 | 0.1450 | 0.0474 | 0.0013 | 0.0000 | 0.0009 | 0.0036 | 1.0171 | 0.0006 | 0.0014 | 0.0023 | 0.0026 | 0.0004 | 0.0010 | 0.0011 |
| 5 | 0.0089 | 0.0041 | 0.0002 | 0.0085 | 0.0095 | 0.0045 | 0.0059 | 0.0170 | 0.0125 | 1.0075 | 0.0042 | 0.0053 | 0.0039 | 0.0150 | 0.0573 | 0.0191 |
| 6 | 0.0196 | 0.0086 | 0.0054 | 0.0029 | 0.0113 | 0.0083 | 0.0051 | 0.0135 | 0.0122 | 0.0205 | 1.0027 | 0.0153 | 0.0236 | 0.0203 | 0.2532 | 0.0245 |
| 7 | 0.0404 | 0.0443 | 0.0662 | 0.0127 | 0.0176 | 0.0220 | 0.0112 | 0.0167 | 0.0101 | 0.0046 | 0.0219 | 1.0686 | 0.0278 | 0.0352 | 0.0398 | 0.0166 |
| 8 | 0.3077 | 0.0083 | 0.0083 | 0.0474 | 0.0109 | 0.0127 | 0.0074 | 0.0334 | 0.0102 | 0.0059 | 0.0147 | 0.0103 | 1.0272 | 0.0095 | 0.0270 | 0.0033 |
| 9 | 0.0015 | 0.0016 | 0.0448 | 0.0040 | 0.0032 | 0.0059 | 0.0032 | 0.0053 | 0.0066 | 0.0007 | 0.0066 | 0.0356 | 0.0043 | 1.0265 | 0.0472 | 0.0050 |
| 10 | 0.0000 | 0.0000 | 0.0057 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1394 | 0.0000 |
| 11 | 0.0101 | 0.0002 | 0.0018 | 0.0021 | 0.0004 | 0.0002 | 0.0001 | 0.0003 | 0.0002 | 0.0007 | 0.0003 | 0.0029 | 0.0060 | 0.0102 | 0.0262 | 1.0051 |

TABLE XII-2 INVERSE MATRIX, 16-SECTOR OPEN MODEL: TOP END REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0000 | 0.0003 | 0.0001 | 0.0463 | 0.0000 | 0.0000 | 0.0090 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0046 | 0.0001 |
| 2A | 0.0154 | 1.0058 | 0.0002 | 0.0000 | 0.0122 | 0.0000 | 0.0000 | 0.0005 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0000 |
| 2B | 0.0030 | 0.0000 | 1.0001 | 0.0000 | 0.0013 | 0.0000 | 0.0009 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0001 |
| 3 | 0.0008 | 0.0005 | 0.0097 | 1.1309 | 0.0537 | 0.0060 | 0.0113 | 0.1775 | 0.0437 | 0.0010 | 0.0299 | 0.0000 | 0.0010 | 0.0007 | 0.0076 | 0.0017 |
| 4A | 0.0028 | 0.0000 | 0.0105 | 0.0014 | 1.0206 | 0.0006 | 0.0000 | 0.0002 | 0.0010 | 0.0000 | 0.0005 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0010 |
| 4B | 0.0003 | 0.0002 | 0.0033 | 0.0010 | 0.0004 | 1.0144 | 0.0011 | 0.0005 | 0.0005 | 0.0003 | 0.0112 | 0.0012 | 0.0004 | 0.0005 | 0.0033 | 0.0019 |
| 4C | 0.0004 | 0.0022 | 0.0485 | 0.0045 | 0.0004 | 0.0302 | 1.0034 | 0.0511 | 0.0005 | 0.0016 | 0.0010 | 0.0013 | 0.0060 | 0.0002 | 0.0019 | 0.0004 |
| 4DE | 0.0041 | 0.0023 | 0.0186 | 0.0054 | 0.0249 | 0.0462 | 0.5760 | 1.2150 | 0.0669 | 0.0062 | 0.1713 | 0.0043 | 0.0102 | 0.0038 | 0.0447 | 0.0095 |
| 4F | 0.0022 | 0.0032 | 0.2096 | 0.0040 | 0.0017 | 0.0016 | 0.0015 | 0.0031 | 1.0148 | 0.0008 | 0.0021 | 0.0036 | 0.0036 | 0.0007 | 0.0013 | 0.0010 |
| 5 | 0.0047 | 0.0034 | 0.0002 | 0.3306 | 0.0079 | 0.0059 | 0.0065 | 0.0161 | 0.0084 | 1.0069 | 0.0044 | 0.0050 | 0.0039 | 0.0135 | 0.0568 | 0.0193 |
| 6 | 0.0214 | 0.0102 | 0.0064 | 0.0454 | 0.0123 | 0.0093 | 0.0060 | 0.0104 | 0.0120 | 0.0274 | 1.0042 | 0.0168 | 0.0297 | 0.0204 | 0.2512 | 0.0277 |
| 7 | 0.0733 | 0.0044 | 0.0794 | 0.0050 | 0.0524 | 0.0733 | 0.0423 | 0.3405 | 0.3498 | 0.0109 | 0.0775 | 1.1175 | 0.0519 | 0.0515 | 0.0561 | 0.0410 |
| 8 | 0.0074 | 0.0049 | 0.0087 | 0.0045 | 0.0146 | 0.0126 | 0.0083 | 0.9253 | 0.0082 | 0.0051 | 0.0133 | 0.0107 | 1.0268 | 0.0090 | 0.0263 | 0.0034 |
| 9 | 0.0033 | 0.0029 | 0.0451 | 0.0004 | 0.0037 | 0.0060 | 0.0041 | 0.0041 | 0.0661 | 0.0005 | 0.0077 | 0.0372 | 0.0059 | 1.0254 | 0.0470 | 0.0039 |
| 10 | 0.0000 | 0.0000 | 0.0057 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0030 | 0.0000 | 0.0000 | 0.0009 | 0.0001 | 1.1380 | 0.0000 |
| 11 | 0.0113 | 0.0003 | 0.0019 | 0.0026 | 0.0000 | 0.0006 | 0.0002 | 0.0000 | 0.0003 | 0.0005 | 0.0005 | 0.0031 | 0.0063 | 0.0056 | 0.0261 | 1.0056 |

TABLE X-3 INVERSE MATRIX, 11-SECTOR OPEN MODEL: KATHERINE-BARKLY REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0003 | 0.0032 | 0.0094 | 0.0440 | 0.0000 | 0.0019 | 0.0001 | 0.0002 | 0.0000 | 0.0052 | 0.0002 |
| 2 | 0.0058 | 1.0006 | 0.0000 | 0.0011 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0001 |
| 3 | 0.0002 | 0.0015 | 1.0704 | 0.0198 | 0.0000 | 0.0031 | 0.0001 | 0.0002 | 0.0000 | 0.0008 | 0.0002 |
| 4 | 0.0060 | 0.0747 | 0.0087 | 1.0220 | 0.0005 | 0.0444 | 0.0026 | 0.0050 | 0.0008 | 0.0125 | 0.0056 |
| 5 | 0.0072 | 0.0040 | 0.0001 | 0.0117 | 1.0014 | 0.0036 | 0.0077 | 0.0047 | 0.0259 | 0.0568 | 0.0322 |
| 6 | 0.0216 | 0.0029 | 0.0002 | 0.0114 | 0.0117 | 1.0012 | 0.0124 | 0.0360 | 0.0150 | 0.2478 | 0.0297 |
| 7 | 0.0396 | 0.0400 | 0.0002 | 0.0237 | 0.0039 | 0.0287 | 1.0565 | 0.0314 | 0.0335 | 0.0397 | 0.0205 |
| 8 | 0.0066 | 0.0053 | 0.0002 | 0.0164 | 0.0059 | 0.0089 | 0.0053 | 1.0112 | 0.0075 | 0.0245 | 0.0031 |
| 9 | 0.0006 | 0.0004 | 0.0000 | 0.0007 | 0.0003 | 0.0024 | 0.0004 | 0.0006 | 1.0074 | 0.0436 | 0.0014 |
| 10 | 0.0000 | 0.0000 | 0.0006 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.1371 | 0.0000 |
| 11 | 0.0111 | 0.0013 | 0.0000 | 0.0006 | 0.0004 | 0.0002 | 0.0024 | 0.0038 | 0.0067 | 0.0256 | 1.0035 |

TABLE X-4 INVERSE MATRIX, 11-SECTOR OPEN MODEL: ALICE SPRINGS REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0000 | 0.0002 | 0.0039 | 0.0000 | 0.0004 | 0.0000 | 0.0001 | 0.0000 | 0.0048 | 0.0000 |
| 2 | 0.0139 | 1.0078 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0000 |
| 3 | 0.0005 | 0.0001 | 1.5727 | 0.0423 | 0.0003 | 0.0108 | 0.0004 | 0.0009 | 0.0002 | 0.0028 | 0.0009 |
| 4 | 0.0002 | 0.0014 | 0.0477 | 1.0964 | 0.0040 | 0.1157 | 0.0058 | 0.0159 | 0.0028 | 0.0324 | 0.0111 |
| 5 | 0.0054 | 0.0003 | 0.0006 | 0.0097 | 1.0049 | 0.0034 | 0.0074 | 0.0029 | 0.0184 | 0.0569 | 0.0208 |
| 6 | 0.0213 | 0.0090 | 0.0007 | 0.0124 | 0.0194 | 1.0025 | 0.0156 | 0.0219 | 0.0156 | 0.2509 | 0.0236 |
| 7 | 0.0677 | 0.0591 | 0.0043 | 0.0521 | 0.0087 | 0.0673 | 1.1108 | 0.0553 | 0.0514 | 0.0532 | 0.0341 |
| 8 | 0.0096 | 0.0086 | 0.0038 | 0.0307 | 0.0077 | 0.0156 | 0.0079 | 1.0214 | 0.0071 | 0.0269 | 0.0040 |
| 9 | 0.0027 | 0.0020 | 0.0002 | 0.0020 | 0.0006 | 0.0072 | 0.0362 | 0.0023 | 1.0216 | 0.0468 | 0.0029 |
| 10 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1386 | 0.0000 |
| 11 | 0.0120 | 0.0003 | 0.0022 | 0.0006 | 0.0006 | 0.0005 | 0.0035 | 0.0102 | 0.0091 | 0.0263 | 1.0065 |

TABLE X-5 INVERSE MATRIX, 11-SECTOR OPEN MODEL: NORTHERN TERRITORY

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0024 | 0.0002 | 0.0099 | 0.0001 | 0.0014 | 0.0001 | 0.0002 | 0.0000 | 0.0050 | 0.0001 |
| 2 | 0.0141 | 1.0009 | 0.0000 | 0.0016 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0002 |
| 3 | 0.0017 | 0.0302 | 1.1468 | 0.1277 | 0.0009 | 0.0219 | 0.0011 | 0.0023 | 0.0006 | 0.0061 | 0.0019 |
| 4 | 0.0148 | 0.2771 | 0.0229 | 1.1721 | 0.0071 | 0.1648 | 0.0095 | 0.0196 | 0.0047 | 0.0462 | 0.0146 |
| 5 | 0.0067 | 0.0103 | 0.0008 | 0.0168 | 1.0070 | 0.0049 | 0.0076 | 0.0045 | 0.0196 | 0.0575 | 0.0232 |
| 6 | 0.0223 | 0.0074 | 0.0407 | 0.0162 | 0.0241 | 1.0038 | 0.0159 | 0.0290 | 0.0193 | 0.2513 | 0.0274 |
| 7 | 0.0691 | 0.0777 | 0.0056 | 0.0493 | 0.0095 | 0.0717 | 1.1101 | 0.0514 | 0.0504 | 0.0543 | 0.0371 |
| 8 | 0.0100 | 0.0138 | 0.0071 | 0.0307 | 0.0066 | 0.0168 | 0.0134 | 1.0305 | 0.0089 | 0.0275 | 0.0041 |
| 9 | 0.0032 | 0.0424 | 0.0005 | 0.0039 | 0.0007 | 0.0072 | 0.0344 | 0.0040 | 1.0230 | 0.0468 | 0.0044 |
| 10 | 0.0001 | 0.0054 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1383 | 0.0000 |
| 11 | 0.0110 | 0.0021 | 0.0030 | 0.0009 | 0.0006 | 0.0005 | 0.0032 | 0.0071 | 0.0093 | 0.0261 | 1.0058 |

## APPENDIX XI

### INVERSE MATRICES FOR 11 SECTOR TABLES (CLOSED MODEL)

TABLE XI-1 INVERSE MATRIX, 11-SECTOR CLOSED MODEL: DARWIN REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0008 | 0.0007 | 0.0037 | 0.0001 | 0.0006 | 0.0009 | 0.0001 | 0.0001 | 0.0015 | 0.0001 | 0.0001 |
| 2 | 0.0169 | 1.0018 | 0.0012 | 0.0034 | 0.0007 | 0.0013 | 0.0005 | 0.0012 | 0.0010 | 0.0023 | 0.0015 | 0.0024 |
| 3 | 0.0004 | 0.0047 | 1.0776 | 0.0222 | 0.0004 | 0.0048 | 0.0003 | 0.0007 | 0.0003 | 0.0016 | 0.0007 | 0.0005 |
| 4 | 0.0169 | 0.2455 | 0.2033 | 1.1533 | 0.0162 | 0.1866 | 0.0133 | 0.0300 | 0.0154 | 0.0658 | 0.0279 | 0.0246 |
| 5 | 0.0118 | 0.0177 | 0.0162 | 0.0212 | 1.0132 | 0.0115 | 0.0091 | 0.0130 | 0.0234 | 0.0695 | 0.0307 | 0.0196 |
| 6 | 0.0242 | 0.0203 | 0.0145 | 0.0236 | 0.0377 | 1.0149 | 0.0211 | 0.0433 | 0.0340 | 0.2731 | 0.0455 | 0.0319 |
| 7 | 0.0785 | 0.1842 | 0.1023 | 0.1094 | 0.0810 | 0.1233 | 1.1167 | 0.1494 | 0.1483 | 0.2036 | 0.1738 | 0.2640 |
| 8 | 0.0103 | 0.0198 | 0.0566 | 0.0337 | 0.0110 | 0.0208 | 0.0135 | 1.0354 | 0.0170 | 0.0378 | 0.0137 | 0.0175 |
| 9 | 0.0153 | 0.0843 | 0.0348 | 0.0369 | 0.0271 | 0.0416 | 0.0522 | 0.0463 | 1.0655 | 0.1041 | 0.0593 | 0.0912 |
| 10 | 0.0014 | 0.0097 | 0.0031 | 0.0033 | 0.0027 | 0.0036 | 0.0017 | 0.0043 | 0.0041 | 1.1452 | 0.0056 | 0.0093 |
| 11 | 0.0210 | 0.0359 | 0.0277 | 0.0269 | 0.0227 | 0.0295 | 0.0168 | 0.0410 | 0.0427 | 0.0737 | 1.0503 | 0.0760 |
| H-H | 0.1646 | 0.3169 | 0.3076 | 0.4023 | 0.3335 | 0.4425 | 0.2097 | 0.5302 | 0.4930 | 0.7184 | 0.6854 | 1.1513 |

TABLE XI-2 INVERSE MATRIX, 11-SECTOR CLOSED MODEL: TOP END REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0015 | 0.0001 | 0.0055 | 0.0001 | 0.0009 | 0.0001 | 0.0002 | 0.0001 | 0.0050 | 0.0002 | 0.0002 |
| 2 | 0.0157 | 1.0017 | 0.0001 | 0.0023 | 0.0007 | 0.0012 | 0.0005 | 0.0012 | 0.0011 | 0.0023 | 0.0017 | 0.0024 |
| 3 | 0.0024 | 0.0305 | 1.1402 | 0.1433 | 0.0022 | 0.0272 | 0.0021 | 0.0044 | 0.0023 | 0.0093 | 0.0045 | 0.0036 |
| 4 | 0.0195 | 0.3209 | 0.0216 | 1.1951 | 0.0169 | 0.1937 | 0.0166 | 0.0346 | 0.0178 | 0.0688 | 0.0342 | 0.0290 |
| 5 | 0.0080 | 0.0193 | 0.0016 | 0.0206 | 1.0127 | 0.0123 | 0.0100 | 0.0138 | 0.0245 | 0.0698 | 0.0327 | 0.0211 |
| 6 | 0.0268 | 0.0242 | 0.0471 | 0.0275 | 0.0371 | 1.0177 | 0.0228 | 0.0462 | 0.0355 | 0.2729 | 0.0500 | 0.0352 |
| 7 | 0.1184 | 0.2159 | 0.0194 | 0.1393 | 0.0917 | 0.1906 | 1.1736 | 0.1894 | 0.1777 | 0.2380 | 0.2284 | 0.2946 |
| 8 | 0.0121 | 0.0259 | 0.0059 | 0.0315 | 0.0133 | 0.0244 | 0.0164 | 1.0407 | 0.0217 | 0.0446 | 0.0222 | 0.0296 |
| 9 | 0.0279 | 0.1159 | 0.0078 | 0.0520 | 0.0439 | 0.0681 | 0.0671 | 0.0783 | 1.0928 | 0.1441 | 0.1055 | 0.1572 |
| 10 | 0.0015 | 0.0599 | 0.0004 | 0.0029 | 0.0026 | 0.0037 | 0.0018 | 0.0044 | 0.0042 | 1.1439 | 0.0060 | 0.0095 |
| 11 | 0.0232 | 0.0330 | 0.0062 | 0.0245 | 0.0219 | 0.0305 | 0.0179 | 0.0427 | 0.0431 | 0.0743 | 1.0550 | 0.0780 |
| H-H | 0.1819 | 0.5502 | 0.0540 | 0.3620 | 0.3267 | 0.4577 | 0.2279 | 0.5557 | 0.5105 | 0.7358 | 0.7545 | 1.1913 |

TABLE XI-3 INVERSE MATRIX, 11-SECTOR CLOSED MODEL, KATHERINE-BARKLY REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0005 | 0.0037 | 0.0005 | 0.0444 | 0.0004 | 0.0024 | 0.0004 | 0.0009 | 0.0007 | 0.0061 | 0.0012 | 0.0015 |
| 2 | 0.0061 | 1.0015 | 0.0002 | 0.0018 | 0.0006 | 0.0009 | 0.0004 | 0.0012 | 0.0011 | 0.0019 | 0.0016 | 0.0025 |
| 3 | 0.0003 | 0.0017 | 1.0704 | 0.0200 | 0.0002 | 0.0033 | 0.0002 | 0.0005 | 0.0004 | 0.0012 | 0.0007 | 0.0007 |
| 4 | 0.0109 | 0.0064 | 0.0110 | 1.0319 | 0.0094 | 0.0566 | 0.0083 | 0.0212 | 0.0157 | 0.0334 | 0.0274 | 0.0347 |
| 5 | 0.0105 | 0.0119 | 0.0016 | 0.0184 | 1.0073 | 0.0117 | 0.0116 | 0.0156 | 0.0359 | 0.0708 | 0.0468 | 0.0233 |
| 6 | 0.0243 | 0.0084 | 0.0014 | 0.0168 | 0.0166 | 1.0078 | 0.0155 | 0.0448 | 0.0231 | 0.2592 | 0.0415 | 0.0189 |
| 7 | 0.0589 | 0.0857 | 0.0089 | 0.0621 | 0.0385 | 0.0761 | 1.0789 | 0.0943 | 0.0914 | 0.1211 | 0.1051 | 0.1349 |
| 8 | 0.0179 | 0.0320 | 0.0052 | 0.0389 | 0.0261 | 0.0366 | 0.0184 | 1.0479 | 0.0413 | 0.0721 | 0.0525 | 0.0789 |
| 9 | 0.0119 | 0.0271 | 0.0051 | 0.0232 | 0.0205 | 0.0302 | 0.0215 | 0.0374 | 1.0414 | 0.0913 | 0.0510 | 0.0790 |
| 10 | 0.0015 | 0.0035 | 0.0013 | 0.0030 | 0.0027 | 0.0037 | 0.0017 | 0.0049 | 0.0045 | 1.1434 | 0.0066 | 0.0105 |
| 11 | 0.0235 | 0.0306 | 0.0056 | 0.0253 | 0.0226 | 0.0306 | 0.0168 | 0.0442 | 0.0439 | 0.0779 | 1.0578 | 0.0867 |
| H-H | 0.1662 | 0.3937 | 0.0731 | 0.3315 | 0.2982 | 0.4805 | 0.1931 | 0.5420 | 0.4999 | 0.7026 | 0.7296 | 1.1640 |



TABLE XI-4 INVERSE MATRIX, 11-SECTOR CLOSED MODEL: ALICE SPRINGS REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0000 | 0.0002 | 0.0040 | 0.0000 | 0.0005 | 0.0000 | 0.0001 | 0.0001 | 0.0049 | 0.0001 | 0.0001 |
| 2 | 0.0138 | 1.0078 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0302 | 0.0000 | 0.0009 |
| 3 | 0.0006 | 0.0004 | 1.5728 | 0.0427 | 0.0006 | 0.0112 | 0.0006 | 0.0015 | 0.0007 | 0.0036 | 0.0017 | 0.0012 |
| 4 | 0.0118 | 0.0079 | 0.0489 | 1.1041 | 0.0104 | 0.1248 | 0.0103 | 0.0263 | 0.0131 | 0.0475 | 0.0264 | 0.0240 |
| 5 | 0.0093 | 0.0153 | 0.0020 | 0.0180 | 1.0118 | 0.0132 | 0.0123 | 0.0142 | 0.0296 | 0.0732 | 0.0375 | 0.0260 |
| 6 | 0.0276 | 0.0203 | 0.0029 | 0.0258 | 0.0305 | 1.0182 | 0.0234 | 0.0399 | 0.0336 | 0.2770 | 0.0503 | 0.0416 |
| 7 | 0.1147 | 0.1434 | 0.0203 | 0.1519 | 0.0914 | 0.1842 | 1.1692 | 0.1891 | 0.1852 | 0.2479 | 0.2320 | 0.3102 |
| 8 | 0.0211 | 0.0293 | 0.0077 | 0.0552 | 0.0280 | 0.0444 | 0.0222 | 1.0543 | 0.0400 | 0.0747 | 0.0529 | 0.0762 |
| 9 | 0.0356 | 0.0611 | 0.0114 | 0.0727 | 0.0585 | 0.0892 | 0.0771 | 0.0961 | 1.1153 | 0.1832 | 0.1422 | 0.2174 |
| 10 | 0.0015 | 0.0027 | 0.0007 | 0.0032 | 0.0026 | 0.0037 | 0.0018 | 0.0042 | 0.0043 | 1.1447 | 0.0063 | 0.0098 |
| 11 | 0.0246 | 0.0230 | 0.0065 | 0.0274 | 0.0229 | 0.0320 | 0.0192 | 0.0462 | 0.0451 | 0.0787 | 1.0600 | 0.0835 |
| H-H | 0.1882 | 0.3377 | 0.0641 | 0.3999 | 0.3314 | 0.4685 | 0.2338 | 0.5362 | 0.5359 | 0.7800 | 0.7964 | 1.2428 |

TABLE XI-5 INVERSE MATRIX, 11-SECTOR CLOSED MODEL, NORTHERN TERRITORY

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0002 | 0.0025 | 0.0002 | 0.0100 | 0.0001 | 0.0015 | 0.0001 | 0.0003 | 0.0002 | 0.0052 | 0.0003 | 0.0003 |
| 2 | 0.0144 | 1.0020 | 0.0202 | 0.0023 | 0.0007 | 0.0012 | 0.0005 | 0.0012 | 0.0011 | 0.0023 | 0.0017 | 0.0024 |
| 3 | 0.0023 | 0.0317 | 1.1470 | 0.1287 | 0.0010 | 0.0232 | 0.0018 | 0.0039 | 0.0020 | 0.0081 | 0.0040 | 0.0034 |
| 4 | 0.0194 | 0.2903 | 0.0247 | 1.1812 | 0.0151 | 0.1753 | 0.0151 | 0.0332 | 0.0174 | 0.0644 | 0.0334 | 0.0295 |
| 5 | 0.0105 | 0.0214 | 0.0023 | 0.0244 | 1.0137 | 0.0143 | 0.0123 | 0.0158 | 0.0302 | 0.0727 | 0.0389 | 0.0246 |
| 6 | 0.0280 | 0.0238 | 0.0430 | 0.0275 | 0.0340 | 1.0177 | 0.0228 | 0.0450 | 0.0350 | 0.2738 | 0.0506 | 0.0364 |
| 7 | 0.1216 | 0.2302 | 0.0263 | 0.1547 | 0.1014 | 0.2016 | 1.1745 | 0.2079 | 0.1966 | 0.2640 | 0.2533 | 0.3392 |
| 8 | 0.0132 | 0.0232 | 0.0084 | 0.0372 | 0.0123 | 0.0248 | 0.0174 | 1.0402 | 0.0179 | 0.0405 | 0.0174 | 0.0209 |
| 9 | 0.0347 | 0.1337 | 0.0129 | 0.0671 | 0.0557 | 0.0851 | 0.0730 | 0.0977 | 1.1105 | 0.1724 | 0.1339 | 0.2031 |
| 10 | 0.0016 | 0.0099 | 0.0008 | 0.0031 | 0.0027 | 0.0038 | 0.0019 | 0.0045 | 0.0043 | 1.1443 | 0.0063 | 0.0098 |
| 11 | 0.0245 | 0.0386 | 0.0080 | 0.0262 | 0.0226 | 0.0317 | 0.0187 | 0.0446 | 0.0444 | 0.0765 | 1.0577 | 0.0814 |
| H-H | 0.1884 | 0.5468 | 0.0741 | 0.3782 | 0.3297 | 0.4662 | 0.2311 | 0.5614 | 0.5241 | 0.7524 | 0.7754 | 1.2165 |

TABLE X-1 INVERSE MATRIX, 11-SECTOR OPEN MODEL: DARWIN REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0008 | 0.0096 | 0.0037 | 0.0000 | 0.0006 | 0.0000 | 0.0001 | 0.0000 | 0.0014 | 0.0000 |
| 2 | 0.0165 | 1.0008 | 0.0004 | 0.0026 | 0.0008 | 0.0004 | 0.0060 | 0.0001 | 0.0000 | 0.0008 | 0.0001 |
| 3 | 0.0003 | 0.0045 | 1.0774 | 0.0220 | 0.0002 | 0.0046 | 0.0002 | 0.0005 | 0.0001 | 0.0013 | 0.0004 |
| 4 | 0.0134 | 0.2345 | 0.1950 | 1.1447 | 0.0091 | 0.1771 | 0.0098 | 0.0187 | 0.0048 | 0.0504 | 0.0132 |
| 5 | 0.0090 | 0.0089 | 0.0096 | 0.0143 | 1.0075 | 0.0040 | 0.0055 | 0.0039 | 0.0150 | 0.0573 | 0.0191 |
| 6 | 0.0196 | 0.0060 | 0.0038 | 0.0125 | 0.0285 | 1.0026 | 0.0153 | 0.0296 | 0.0203 | 0.2532 | 0.0265 |
| 7 | 0.0407 | 0.0657 | 0.0134 | 0.0171 | 0.0046 | 0.0219 | 1.0686 | 0.0278 | 0.0352 | 0.0388 | 0.0166 |
| 8 | 0.0078 | 0.0119 | 0.0507 | 0.0276 | 0.0059 | 0.0141 | 0.0103 | 1.0273 | 0.0095 | 0.0269 | 0.0033 |
| 9 | 0.0022 | 0.0434 | 0.0041 | 0.0050 | 0.0007 | 0.0066 | 0.0356 | 0.0043 | 1.0265 | 0.0472 | 0.0050 |
| 10 | 0.0001 | 0.0055 | 0.0000 | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1394 | 0.0000 |
| 11 | 0.0101 | 0.0010 | 0.0021 | 0.0003 | 0.0007 | 0.0003 | 0.0029 | 0.0060 | 0.0102 | 0.0262 | 1.0051 |

TABLE X-2 INVERSE MATRIX, 11-SECTOR OPEN MODEL: TOP END REGION

| SECTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0014 | 0.0081 | 0.0054 | 0.0000 | 0.0008 | 0.0001 | 0.0001 | 0.0000 | 0.0049 | 0.0001 |
| 2 | 0.0153 | 1.0086 | 0.0000 | 0.0016 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0001 |
| 3 | 0.0019 | 0.0369 | 1.1400 | 0.1422 | 0.0012 | 0.0258 | 0.0014 | 0.0027 | 0.0007 | 0.0071 | 0.0021 |
| 4 | 0.0150 | 0.3675 | 0.0203 | 1.1863 | 0.0089 | 0.1825 | 0.0111 | 0.0210 | 0.0054 | 0.0508 | 0.0158 |
| 5 | 0.0048 | 0.0096 | 0.0086 | 0.0142 | 1.0069 | 0.0042 | 0.0060 | 0.0039 | 0.0155 | 0.0568 | 0.0193 |
| 6 | 0.0214 | 0.0079 | 0.0455 | 0.0168 | 0.0274 | 1.0041 | 0.0161 | 0.0298 | 0.0204 | 0.2512 | 0.0277 |
| 7 | 0.0735 | 0.0799 | 0.0058 | 0.0498 | 0.0109 | 0.0774 | 1.1175 | 0.0520 | 0.0515 | 0.0561 | 0.0418 |
| 8 | 0.0076 | 0.0122 | 0.0046 | 0.0225 | 0.0051 | 0.0131 | 0.0107 | 1.0269 | 0.0090 | 0.0263 | 0.0034 |
| 9 | 0.0039 | 0.0433 | 0.0086 | 0.0043 | 0.0008 | 0.0077 | 0.0372 | 0.0050 | 1.0254 | 0.0470 | 0.0059 |
| 10 | 0.0001 | 0.0035 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1380 | 0.0000 |
| 11 | 0.0113 | 0.0020 | 0.0026 | 0.0007 | 0.0005 | 0.0005 | 0.0031 | 0.0063 | 0.0096 | 0.0261 | 1.0056 |

TABLE XII-3 INVERSE MATRIX, 16-SECTOR OPEN MODEL: NORTHERN TERRITORY

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0003 | 0.0001 | 0.0008 | 0.0002 | 0.0790 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0047 | 0.0001 |
| 2A | 0.0142 | 1.0122 | 0.0002 | 0.0000 | 0.0107 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0050 | 0.0000 | 0.0004 | 0.0000 |
| 2B | 0.0000 | 0.0000 | 1.0001 | 0.0000 | 0.0018 | 0.0000 | 0.0006 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0063 | 0.0001 |
| 3 | 0.0007 | 0.0008 | 0.0089 | 1.1456 | 0.0030 | 0.0062 | 0.0096 | 0.1634 | 0.0398 | 0.0008 | 0.0250 | 0.0007 | 0.0015 | 0.0005 | 0.0065 | 0.0015 |
| 4A | 0.0033 | 0.0016 | 0.0105 | 0.0031 | 1.0193 | 0.0002 | 0.0000 | 0.0005 | 0.0017 | 0.0000 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0013 |
| 4B | 0.0003 | 0.0002 | 0.0034 | 0.0009 | 0.0004 | 1.0140 | 0.0008 | 0.0005 | 0.0006 | 0.0003 | 0.0103 | 0.0013 | 0.0004 | 0.0005 | 0.0030 | 0.0017 |
| 4C | 0.0007 | 0.0014 | 0.0494 | 0.0047 | 0.0004 | 0.0002 | 1.0044 | 0.0012 | 0.0005 | 0.0013 | 0.0015 | 0.0012 | 0.0067 | 0.0002 | 0.0019 | 0.0006 |
| 4DE | 0.0038 | 0.0020 | 0.0157 | 0.0008 | 0.0209 | 0.0450 | 0.0699 | 1.2021 | 0.0610 | 0.0049 | 0.1533 | 0.0039 | 0.0007 | 0.0032 | 0.0401 | 0.0085 |
| 4F | 0.0022 | 0.0022 | 0.1877 | 0.0044 | 0.0016 | 0.0021 | 0.0014 | 0.0029 | 1.0145 | 0.0005 | 0.0018 | 0.0026 | 0.0031 | 0.0007 | 0.0014 | 0.0022 |
| 5 | 0.0066 | 0.0062 | 0.0089 | 0.0007 | 0.0097 | 0.0062 | 0.0077 | 0.0191 | 0.0107 | 1.0070 | 0.0051 | 0.0076 | 0.0044 | 0.0196 | 0.0575 | 0.0232 |
| 6 | 0.0224 | 0.0104 | 0.0061 | 0.0407 | 0.0120 | 0.0093 | 0.0059 | 0.0177 | 0.0131 | 0.0241 | 1.0039 | 0.0159 | 0.0290 | 0.0193 | 0.2513 | 0.0274 |
| 7 | 0.0690 | 0.0695 | 0.0776 | 0.0056 | 0.0519 | 0.0707 | 0.0405 | 0.0480 | 0.0482 | 0.0095 | 0.0717 | 1.1101 | 0.0513 | 0.0504 | 0.0543 | 0.0372 |
| 8 | 0.0098 | 0.0088 | 0.0094 | 0.0069 | 0.0184 | 0.0164 | 0.0116 | 0.0352 | 0.0114 | 0.0066 | 0.0172 | 0.0134 | 1.0303 | 0.0089 | 0.0276 | 0.0040 |
| 9 | 0.0027 | 0.0024 | 0.0446 | 0.0005 | 0.0034 | 0.0057 | 0.0034 | 0.0038 | 0.0054 | 0.0007 | 0.0072 | 0.0344 | 0.0040 | 1.0230 | 0.0467 | 0.0044 |
| 10 | 0.0000 | 0.0000 | 0.0057 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 1.1383 | 0.0000 |
| 11 | 0.0118 | 0.0010 | 0.0020 | 0.0030 | 0.0013 | 0.0006 | 0.0002 | 0.0009 | 0.0004 | 0.0006 | 0.0005 | 0.0032 | 0.0070 | 0.0093 | 0.0261 | 1.0050 |

# APPENDIX XIII

## INVERSE MATRICES, NON-UNIFORM TABLES (CLOSED) MODEL

TABLE XIII-1 INVERSE MATRIX, 16-SECTOR CLOSED MODEL: DARWIN REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | N-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0001 | 0.0000 | 0.0003 | 0.0001 | 0.0225 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0014 | 0.0002 | 0.0002 |
| 2A | 0.0167 | 1.0076 | 0.0002 | 0.0001 | 0.0144 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0005 | 0.0001 | 0.0001 |
| 2B | 0.0003 | 0.0005 | 1.0011 | 0.0009 | 0.0016 | 0.0008 | 0.0020 | 0.0009 | 0.0007 | 0.0007 | 0.0009 | 0.0004 | 0.0011 | 0.0010 | 0.0018 | 0.0014 | 0.0023 |
| 3 | 0.0002 | 0.0001 | 0.0013 | 1.0743 | 0.0009 | 0.0008 | 0.0017 | 0.0314 | 0.0073 | 0.0003 | 0.0057 | 0.0002 | 0.0005 | 0.0002 | 0.0017 | 0.0006 | 0.0003 |
| 4A | 0.0048 | 0.0021 | 0.0151 | 0.0036 | 1.0255 | 0.0035 | 0.0046 | 0.0038 | 0.0055 | 0.0029 | 0.0239 | 0.0019 | 0.0046 | 0.0043 | 0.0063 | 0.0068 | 0.0100 |
| 4B | 0.0007 | 0.0008 | 0.0040 | 0.0013 | 0.0011 | 1.0167 | 0.0025 | 0.0017 | 0.0019 | 0.0012 | 0.0132 | 0.0017 | 0.0018 | 0.0018 | 0.0055 | 0.0037 | 0.0030 |
| 4C | 0.0002 | 0.0003 | 0.0057 | 0.1242 | 0.0006 | 0.0005 | 1.0041 | 0.0046 | 0.0016 | 0.0021 | 0.0010 | 0.0013 | 0.0061 | 0.0006 | 0.0029 | 0.0008 | 0.0008 |
| 4DE | 0.0047 | 0.0033 | 0.0110 | 0.0110 | 0.0335 | 0.0297 | 0.0610 | 1.1003 | 0.0290 | 0.0087 | 0.1696 | 0.0053 | 0.0133 | 0.0072 | 0.0493 | 0.0139 | 0.0003 |
| 4F | 0.0021 | 0.0043 | 0.1456 | 0.0479 | 0.0016 | 0.0013 | 0.0015 | 0.0041 | 1.0175 | 0.0010 | 0.0022 | 0.0026 | 0.0032 | 0.0011 | 0.0019 | 0.0019 | 0.0014 |
| 5 | 0.0116 | 0.0001 | 0.0171 | 0.0153 | 0.0141 | 0.0113 | 0.0140 | 0.0243 | 0.0104 | 1.0131 | 0.0118 | 0.0091 | 0.0129 | 0.0234 | 0.0695 | 0.0307 | 0.0155 |
| 6 | 0.0241 | 0.0131 | 0.0199 | 0.0140 | 0.0190 | 0.0193 | 0.0197 | 0.0254 | 0.0219 | 0.0372 | 1.0150 | 0.0211 | 0.0433 | 0.0339 | 0.2731 | 0.0455 | 0.0318 |
| 7 | 0.0769 | 0.0989 | 0.1061 | 0.1045 | 0.0797 | 0.1130 | 0.1310 | 0.1153 | 0.0979 | 0.0010 | 0.1242 | 1.1167 | 0.1495 | 0.1482 | 0.2037 | 0.1737 | 0.2638 |
| 8 | 0.0101 | 0.0119 | 0.0162 | 0.0534 | 0.0230 | 0.0107 | 0.0153 | 0.0399 | 0.0155 | 0.0109 | 0.0214 | 0.0134 | 1.0352 | 0.0169 | 0.0370 | 0.0136 | 0.0174 |
| 9 | 0.0142 | 0.0202 | 0.0862 | 0.0356 | 0.0247 | 0.0374 | 0.0440 | 0.0393 | 0.0342 | 0.0271 | 0.0420 | 0.0522 | 0.0463 | 1.0655 | 0.1041 | 0.0593 | 0.0911 |
| 10 | 0.0013 | 0.0019 | 0.0099 | 0.0032 | 0.0022 | 0.0032 | 0.0043 | 0.0035 | 0.0028 | 0.0027 | 0.0036 | 0.0017 | 0.0043 | 0.0041 | 1.1452 | 0.0056 | 0.0093 |
| 11 | 0.0206 | 0.0157 | 0.0364 | 0.0285 | 0.0183 | 0.0264 | 0.0348 | 0.0287 | 0.0232 | 0.0227 | 0.0298 | 0.0168 | 0.0411 | 0.0427 | 0.0737 | 1.0503 | 0.0759 |
| N-M | 0.1594 | 0.2357 | 0.5230 | 0.4000 | 0.2707 | 0.3972 | 0.5258 | 0.4302 | 0.3481 | 0.3336 | 0.4460 | 0.2096 | 0.5305 | 0.4926 | 0.7189 | 0.6048 | 1.1503 |

TABLE XIII-2 INVERSE MATRIX, 16-SECTOR CLOSED MODEL: TOP END REGION

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | N-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0002 | 0.0001 | 0.0007 | 0.0001 | 0.0464 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0002 | 0.0001 | 0.0002 | 0.0002 | 0.0049 | 0.0004 | 0.0005 |
| 2A | 0.0154 | 1.0050 | 0.0002 | 0.0000 | 0.0122 | 0.0000 | 0.0001 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0005 | 0.0001 | 0.0001 |
| 2B | 0.0004 | 0.0005 | 1.0012 | 0.0001 | 0.0010 | 0.0008 | 0.0020 | 0.0007 | 0.0008 | 0.0007 | 0.0009 | 0.0005 | 0.0011 | 0.0010 | 0.0018 | 0.0016 | 0.0024 |
| 3 | 0.0010 | 0.0008 | 0.0105 | 1.1390 | 0.0041 | 0.0074 | 0.0121 | 0.1780 | 0.0442 | 0.0015 | 0.0296 | 0.0012 | 0.0026 | 0.0014 | 0.0006 | 0.0020 | 0.0017 |
| 4A | 0.0043 | 0.0021 | 0.0153 | 0.0019 | 1.0230 | 0.0035 | 0.0046 | 0.0033 | 0.0051 | 0.0027 | 0.0039 | 0.0020 | 0.0047 | 0.0043 | 0.0062 | 0.0081 | 0.0099 |
| 4B | 0.0008 | 0.0009 | 0.0049 | 0.0011 | 0.0012 | 1.0155 | 0.0026 | 0.0015 | 0.0016 | 0.0012 | 0.0125 | 0.0018 | 0.0019 | 0.0019 | 0.0053 | 0.0040 | 0.0032 |
| 4C | 0.0006 | 0.0024 | 0.0491 | 0.0045 | 0.0006 | 0.0006 | 1.0039 | 0.0014 | 0.0009 | 0.0019 | 0.0015 | 0.0015 | 0.0065 | 0.0007 | 0.0026 | 0.0011 | 0.0011 |
| 4DE | 0.0055 | 0.0043 | 0.0232 | 0.0009 | 0.0272 | 0.0496 | 0.0813 | 1.2179 | 0.0701 | 0.0000 | 0.1750 | 0.0062 | 0.0147 | 0.0379 | 0.0506 | 0.0156 | 0.0096 |
| 4F | 0.0027 | 0.0039 | 0.2111 | 0.0042 | 0.0025 | 0.0027 | 0.0630 | 0.0041 | 1.0150 | 0.0017 | 0.0033 | 0.0042 | 0.0051 | 0.0021 | 0.0033 | 0.0039 | 0.0033 |
| 5 | 0.0078 | 0.0079 | 0.0183 | 0.0016 | 0.0129 | 0.0122 | 0.0142 | 0.0225 | 0.0153 | 1.0126 | 0.0124 | 0.0100 | 0.0137 | 0.0244 | 0.0690 | 0.0326 | 0.0210 |
| 6 | 0.0267 | 0.0177 | 0.0234 | 0.0471 | 0.0207 | 0.0215 | 0.0223 | 0.0291 | 0.0243 | 0.0371 | 1.0170 | 0.0227 | 0.0462 | 0.0355 | 0.2729 | 0.0500 | 0.0352 |
| 7 | 0.1174 | 0.1473 | 0.2210 | 0.0196 | 0.1230 | 0.1759 | 0.1786 | 0.1385 | 0.1466 | 0.0910 | 0.1910 | 1.1737 | 0.1897 | 0.1770 | 0.2382 | 0.2285 | 0.2947 |
| 8 | 0.0110 | 0.0132 | 0.0229 | 0.0058 | 0.0214 | 0.0229 | 0.0220 | 0.0343 | 0.0179 | 0.0132 | 0.0246 | 0.0163 | 1.0405 | 0.0216 | 0.0445 | 0.0220 | 0.0295 |
| 9 | 0.0266 | 0.0364 | 0.1210 | 0.0079 | 0.0414 | 0.0615 | 0.0767 | 0.0520 | 0.0577 | 0.0440 | 0.0682 | 0.0672 | 0.0705 | 1.0920 | 0.1442 | 0.1055 | 0.1572 |
| 10 | 0.0014 | 0.0020 | 0.0103 | 0.0004 | 0.0023 | 0.0033 | 0.0044 | 0.0029 | 0.0031 | 0.0026 | 0.0037 | 0.0018 | 0.0045 | 0.0042 | 1.1439 | 0.0060 | 0.0095 |
| 11 | 0.0229 | 0.0169 | 0.0396 | 0.0062 | 0.0195 | 0.0270 | 0.0363 | 0.0246 | 0.0260 | 0.0220 | 0.0305 | 0.0179 | 0.0420 | 0.0431 | 0.0743 | 1.0556 | 0.0780 |
| N-M | 0.1773 | 0.2541 | 0.5753 | 0.0557 | 0.2853 | 0.4145 | 0.5587 | 0.3637 | 0.3914 | 0.3270 | 0.4506 | 0.2273 | 0.5569 | 0.5105 | 0.7361 | 0.7545 | 1.1911 |

TABLE XIII-3 INVERSE MATRIX, 16-SECTOR CLOSED MODEL: NORTHERN TERRITORY

| SECTOR | 1 | 2A | 2B | 3 | 4A | 4B | 4C | 4DE | 4F | 5 | 6 | 7 | 8 | 9 | 10 | 11 | H-H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0004 | 0.0003 | 0.0012 | 0.0003 | 0.0792 | 0.0003 | 0.0064 | 0.0003 | 0.0004 | 0.0002 | 0.0003 | 0.0002 | 0.0004 | 0.0004 | 0.0052 | 0.0006 | 0.0009 |
| 2A | 0.0142 | 1.0122 | 0.0002 | 0.0000 | 0.0167 | 0.0000 | 0.0001 | 0.0000 | 0.0003 | 0.0000 | 0.0008 | 0.0000 | 0.0001 | 0.0001 | 0.0005 | 0.0001 | 0.0051 |
| 2B | 0.0004 | 0.0006 | 1.0012 | 0.0002 | 0.0024 | 0.0000 | 0.0018 | 0.0008 | 0.0010 | 0.0007 | 0.0009 | 0.0005 | 0.0011 | 0.0010 | 0.0018 | 0.0017 | 0.0024 |
| 3 | 0.0010 | 0.0011 | 0.0007 | 1.1457 | 0.0033 | 0.0067 | 0.0103 | 0.1639 | 0.0403 | 0.0012 | 0.0255 | 0.0010 | 0.0022 | 0.0012 | 0.0074 | 0.0024 | 0.0015 |
| 4A | 0.0049 | 0.0041 | 0.0155 | 0.0037 | 1.0219 | 0.0039 | 0.0049 | 0.0038 | 0.0052 | 0.0029 | 0.0041 | 0.0021 | 0.0049 | 0.0046 | 0.0066 | 0.0080 | 0.0106 |
| 4B | 0.0008 | 0.0069 | 0.0049 | 0.0011 | 0.0012 | 1.0152 | 0.0023 | 0.0015 | 0.0017 | 0.0011 | 0.0116 | 0.0019 | 0.0019 | 0.0019 | 0.0051 | 0.0038 | 0.0033 |
| 4C | 0.0069 | 0.0018 | 0.0502 | 0.0049 | 0.0008 | 0.0008 | 1.0052 | 0.0017 | 0.0011 | 0.0018 | 0.0021 | 0.0015 | 0.0075 | 0.0009 | 0.0029 | 0.0016 | 0.0017 |
| 4DE | 0.0052 | 0.0040 | 0.0199 | 0.0093 | 0.0231 | 0.0481 | 0.0741 | 1.2049 | 0.0639 | 0.0073 | 0.1568 | 0.0056 | 0.0128 | 0.0071 | 0.0457 | 0.0142 | 0.0090 |
| 4F | 0.0027 | 0.0029 | 0.1092 | 0.0046 | 0.0023 | 0.0032 | 0.0028 | 0.0038 | 1.0155 | 0.0014 | 0.0039 | 0.0032 | 0.0045 | 0.0020 | 0.0033 | 0.0042 | 0.0031 |
| 5 | 0.0103 | 0.0118 | 0.0204 | 0.0022 | 0.0158 | 0.0147 | 0.0190 | 0.0268 | 0.0188 | 1.0137 | 0.0145 | 0.0122 | 0.0157 | 0.0301 | 0.0726 | 0.0388 | 0.0244 |
| 6 | 0.0279 | 0.0187 | 0.0232 | 0.0429 | 0.0217 | 0.0219 | 0.0227 | 0.0291 | 0.0250 | 0.0339 | 1.0170 | 0.0228 | 0.0458 | 0.0349 | 0.2738 | 0.0505 | 0.0363 |
| 7 | 0.1205 | 0.1475 | 0.2372 | 0.0265 | 0.1352 | 0.1089 | 0.1974 | 0.1542 | 0.1597 | 0.1015 | 0.2020 | 1.1746 | 0.2082 | 0.1966 | 0.2642 | 0.2534 | 0.3392 |
| 8 | 0.0129 | 0.0136 | 0.0191 | 0.0082 | 0.0235 | 0.0236 | 0.0212 | 0.0417 | 0.0182 | 0.0122 | 0.0251 | 0.0173 | 1.0399 | 0.0178 | 0.0404 | 0.0172 | 0.0207 |
| 9 | 0.0335 | 0.0491 | 0.1402 | 0.0130 | 0.0533 | 0.0765 | 0.0974 | 0.0673 | 0.0721 | 0.0558 | 0.0852 | 0.0731 | 0.0979 | 1.1105 | 0.1724 | 0.1339 | 0.2031 |
| 10 | 0.0015 | 0.0023 | 0.0103 | 0.0008 | 0.0024 | 0.0034 | 0.0046 | 0.0031 | 0.0032 | 0.0027 | 0.0038 | 0.0019 | 0.0045 | 0.0043 | 1.1443 | 0.0063 | 0.0098 |
| 11 | 0.0242 | 0.0197 | 0.0403 | 0.0085 | 0.0213 | 0.0290 | 0.0379 | 0.0264 | 0.0271 | 0.0226 | 0.0318 | 0.0187 | 0.0447 | 0.0444 | 0.0765 | 1.0577 | 0.0814 |
| H-H | 0.1046 | 0.2796 | 0.5723 | 0.0749 | 0.2987 | 0.4240 | 0.5623 | 0.3005 | 0.3997 | 0.3299 | 0.4671 | 0.2314 | 0.5626 | 0.5241 | 0.7527 | 0.7754 | 1.2162 |

# BIBLIOGRAPHY


Australian Bureau of Statistics, (1978) Australian National Accounts - Input-Output Tables 1974-75 (Preliminary), Canberra.

Australian Bureau of Statistics, (1976) Australian National Accounts - 1975-76, Canberra.

Bacharach, M., (1970) Biproportional Matrices and Input-Output Change, Cambridge University Press.

Barker, T.S., (1975) "An Analysis of the Updated 1963 Input-Output Transactions Tables", in Allen, R.I.G. and Gossling, W.F. (eds.), Estimating and Projecting Input-Output Coefficients, Input-Output Publishing Company.

Blin, J. and Cohen, C., (1976) "Technological Similarity and Aggregation in Input-Output Systems: A Cluster-Analytic Approach", Discussion Paper No. 163, Graduate School of Management, Northwestern University, Evanston, Illinois.

Boster, R.S. and Martin, W.E., (1972) "The Value of Primary versus Secondary Data in Interindustry Analysis: A Study in the Economics of the Economic Models", Annals of Regional Science, 6,2: 35-43.

Bourque, P.J., et al., (1967) The Washington Economy: An Input-Output Study, University of Washington.

Brownrigg, M., (1971) "The Regional Income Multiplier: An Attempt to Complete the Model", Scottish Journal of Political Economy XVIII, 3: 281-297.

Brownrigg, M., (1974) A Study of Economic Impact: The University of Stirli, Scottish Academic Press.

Burford, R.L. and Katz, J.L. (1977), "Regional Input-Output Multipliers Without a Full I/O Table", Annals of Regional Science XI(3): 21-38.

Cambridge Department of Applied Economics, (1963), Input-Output Relationship 1954-66, Chapman and Hall, London.

Chenery, H.B. and Clark, P.G. (1962), Interindustry Economics, Wiley.

Central Statistical Office (UK), (1971), Provisional Input-Output Tables for 1968.

Commonwealth Bureau of Census and Statistics, (1973), Australian National Accounts - Input-Output Tables 1962-63, Canberra.

Consad Research Corp., (1967), Research Federal Procurement Study, Office of Economic Regional, U.S. Department of Commerce, Wash., D.C..

Cutbush, G.C., (1973), Input-Output Analysis and Regional Economic Planning, M.Ec. Dissertation, University of New England, Armidale.

Czamanski, S. and Malizia, E., (1969), "Applicability and Limitations in the Use of National Input-Output Tables for Regional Studies", Papers and Proceedings of the Regional Science Association, 23: 65-77.

Department of Economic Affairs (UK), (1967), Use of an Input-Output Model in the Preparation of the British National Plan, in Economic Commission for Europe, Macroeconomic Models for Planning and Policy Making, UN, Geneva.

Dickinson, J., (1977), An Interindustry Model of the Northern Region of Queensland, paper presented to the Input-Output Workshop, of the Second Meeting of the Australian and New Zealand Section of the Regional Science Association, Sydney.

Edwards, G.C., (1977), An Input-Output Model of the Tasmanian Economy, paper presented to the Input-Output Workshop of the Second Meeting of the Australian and New Zealand Section of the Regional Science Association, Sydney.

Evans, W.D. and Hoffenberg, M. (1952), "The Interindustry Relations Study for 1947", Review of Economics and Statistics, XXXIV, 2: 97-142.

Evans, W.D. (1954), "The Effect of Structural Matrix Errors on Interindustry Relations Estimates", Econometrica 22: 461-480.

Friedlander, D., (1961), "A Technique for Estimating a Contingency Table Given the Marginal Totals and Some Supplementary Data", Journal of The Royal Statistical Society, Series A, 412-420.

Goldman, M.R., (1969), Comment on Czamanski and Malizia (1969), Papers and Proceedings of the Regional Science Association, 23: 79-80.

Government Gas Engineer and Chief Gas Examiner, (1975), Annual Report, Brisbane.

Greig, M.A., (1971), "The Regional Income and Employment Effects of a Pulp and Paper Mill", Scottish Journal of Political Economy.

Hansen, W.L. and Tiebout, C.M., (1963), "An Intersectoral Flows Analysis of the California Economy", Review of Economics and Statistics, 45,4: 409-418.

Harvey, M.E., (1976), The Impact of the Wool Crisis on the Bourke Economy Between 1968/69 and 1970/71: A Regional Input-Output Study. Department of Agricultural Economics and Business Management. Miscellaneous Publication No. 2, University of New England, Armidale.

Hewings, G.J.D., (1969), "Regional Input-Output Models Using National Data: The Structure of the West Midlands Economy", Annals of Regional Science 3: 179-191.

Hewings, G.J.D., (1971a), "Regional Input-Output Models in the UK: Some Problems and Prospects for the Use of Nonsurvey Techniques", Regional Studies 5: 11-22.

Hewings, G.J.D., (1971b), "Nonsurvey Input-Output Tables for S.E. Kent Using 1963 and 1968 UK Input-Output Data", Discussion Paper 5, S.E. Kent Regional Input-Output Study, Center for Research in the Social Sciences, University of Kent at Canterbury.

Hirsch, W.Z., (1959), "Interindustry Relations of a Metropolitan Area", Review of Economics and Statistics, 41,3: 360-9.

Huxley, S.J., (1973), Interregional Trade Flows in Queensland 1970-71, Vols. I and II, Co-ordinator General's Department, Brisbane.

Isard, W., (1953), "Regional Commodity Balances and Interregional Commodity Flows", American Economic Review, XLIII, 167-180.

Isard, W. and Keunne, R., (1953), "The Impact of Steel upon the Greater New York - Philadelphia Industrial Region", Review of Economics and Statistics, 34, 289-301.

Isard, W. and Langford, T.W., (1971), Regional Input-Output Study, Recollections, Reflections and Diverse Notes on the Philadelphia Experience, MIT Press, Cambridge, Mass.

Jensen, R.C., (1976a), "An Interindustry Study of the Central Queensland Economy", Economic Record, 52, 39 : 315-338.

Jensen, R.C., (1976b), An Interindustry Study of the Central Queensland Economy. Unpublished Ph.D. thesis, University of Queensland.

Jensen, R.C., (1977), Some Procedural Conventions and Their Effects on Input-Output Multipliers, paper presented to the Input-Output Workshop of the Second Meeting of the Australian and New Zealand Section of the Regional Science Association, Sydney.

Jensen, R.C. and McGaurr, D., (1976), "Reconciliation of Purchases and Sales Estimates in an Input-Output Tables", Urban Studies, 13, 59-65.

Jensen, R.C. and McGaurr, D., (1977), "Reconciliation Techniques in Input-Output Analysis: Some Comparisons and Implications", Urban Studies, 14: 327-337.

Jensen, R.C., Mandeville, T.D., and Karunaratne, N.D. (1977), Generation of Regional Input-Output Tables for Queensland. Report to the Co-ordinator General's Department and the Department of Commercial and Industrial Development, Department of Economics, University of Queensland.
Published (1979) as Regional Economic Planning: Generation of Regional Input-Output Analysis, Croom Helm.

Jensen, R.C., and West, G.R. (1978), The Effect of Relative Coefficient Size on Input-Output Multipliers, Proceedings, Input-Output Workshop of the Third Meeting of the Australian and New Zealand Section of the Regional Science Association, Melbourne, (forthcoming), Environment and Planning A.

Jensen, R.C. (1979), The Concept of Accuracy in Regional Input-Output, Proceedings, Input-Output Workshop of the Fourth Meeting of the Australian and New Zealand Section of the Regional Science Association, Wodonga.

Jones, L.L., Sporleder, T.L. and Mustafa, G., (1973), "A Source of Bias in Regional Input-Output Models Estimated from National Coefficients", Annals of Regional Science, 7,1: 67-74.

Kokat, R., (1966), The Economic Component of a Regional Socioeconomic Model, IBM Technical Report, 17-210.

Lecomber, R., (1971), "A Critique of Methods of Adjusting, Updating and Projecting Matrices, Together with Some New Proposals", Discussion Paper in Economics No. 40, Conference on Input-Output and Throughput, Norwich.

Malizia, E.E. and Bond, D.L., (1974), "Empirical Tests of the RAS Method of Interindustry Coefficient Adjustment", Journal of Regional Science, 14.

Mandeville, T.D., (1975), Linking APMAA to Representative Regional Input-Output Models, Aggregative Programming Model for Australian Agriculture Research Report No. 8, Department of Agricultural Economics, University of New England, Armidale.

Mandeville, T.D. and Powell, R.A. (1976), Structural Interrelationships in a NSW Wheat-Sheep Region, Department of Agricultural Economics and Business Management. Bulletin 22, University of New England, Armidale.

Mandeville, T.D. and Jensen, R.C. (1978), The Impact of Major Development Projects on the Gladstone/Calliope, Fitzroy, Queensland, and Australian Economies: An Application of Input-Output Analysis. Report to the Department of Commercial and Industrial Development and Comalco Limited, Department of Economics, University of Queensland.

Matuszewski, T.I., Pitts, P.R., and Sawyer, J.A., (1964), "Linear Programming EStimates of Changes in Input Coefficients", The Canadian Journal of Economics and Political Science, 30: 203-10.

McGaurr, D., (1976a), Measuring a City's Dependence on Its Region: An Input-Output Study of the City of Toowoomba, Paper presented to the First Meeting of the Australian and New Zealand Section of the Regional Science Association, Brisbane.

McGaurr, D., (1976b), Personal communication on work in progress.

McMenamin, D.G. and Haring, J.E., (1974), "An Appraisal of Non survey Techniques for Estimating Regional Input-Output Models", Journal of Regional Science, 14(2), 191-205.

Miernyk, W.H. (1965), Elements of Input-Output Analysis, Random House.

Miernyk, W.H., (1969), "Comments on Czamanski and Malizia", Papers and Proceedings of the Regional Science Association, 23: 81-82.

Miernyk, W.H., (1975), The Projection of Technical Coefficients for Medium Term Forecasting, MR-20, Regional Research Institute, West Virginia University.

Miernyk, W.H., (1976), "Comment on Recent Developments in Regional Input-Output Analysis", International Regional Science Review 1,2: 47-55.

Miernyk, W.H. et al., (1970), Simulating Regional Economic Development: An Interindustry Analysis of the West Virginia Economy, Heath Lexington.

Miller, R., (1957), "The Impact of the Aluminum Industry on the Pacific Northwest: A Regional Input-Output Analysis", Review of Economic and Statistics, 34: 200-209.

Moore, F.T. and Petersen, J., (1955), "Regional Analysis: An Interindustry Model of Utah", Review of Economics and Statistics, 37: 368-383.

Morrison, W.I. and Smith, P., (1974), "Nonsurvey Input-Output Techniques at the Small Area Level: An Evaluation", Journal of Regional Science 14(1), 1-14.

Mules, T.J., (1967), Interindustry Analysis and the South Australian Wool Industry, M.Ec. thesis, University of Adelaide.

O'Connor, R. and Henry, E.W., (1975), Input-Output Analysis and Its Applications, Charles Griffin.

Parker, M.L., (1967), An Interindustry Study of the Western Australian Economy, Agricultural Economic Research Report No. 6, University of Western Australia Press.

Quandt, R.C. (1958), "Probabilistic Errors in the Leontief System", Naval Research Logistics Quarterly 5 (2): 155-170.

Quandt, R.E. (1959), "On the Solution of Probabilistic Leontief Systems", Naval Research Logistics Quarterly 6(4): 295-305.

Richardson, H., (1972), Input-Output and Regional Economics, Weidenfeld and Nicolson, London.

Schaffer, W., (1970), "Estimating Regional Input-Output Coefficients", Georgia Institute of Technology, Discussion Paper 16.

Schaffer, W.A. (ed.), (1976), On the Use of Input-Output Models for Regional Planning, Studies in Applied Regional Science, Volume 1, Martinus Nijhoff, Leiden.

Schaffer, W. and Chu, K., (1969a), "Non Survey Techniques for Constructing Regional Interindustry Models", Papers and Proceedings of the Regional Science Association, 23: 83-101.

Schaffer, W.A. and Chu, K., (1969b), "Simulating Regional Interindustry Models for Western States", A Program on Regional Industrial Development, Discussion Paper 14, Georgia Institute of Technology, Georgia.

Shen, T.Y., (1960), "An Input-Output Table with Regional Weights", Papers and Proceedings of the Regional Science Association, 6: 113-119.

Smith, P.S. and Morrison, W.I., (1974), Simulating the Urban Economy, Pion, London.

State Electricity Commission of Queensland, (1975), Annual Report, Brisbane.

Stevens, B.H. and Trainer, G.A. (1976), The Generation of Error in Regional Input-Output Impact Models. Regional Science Research Institute Working Paper A1-76.

Stone, R. and Leicester, C.S., (1966), "An Exercise in Projecting Industrial Needs for Labour", Cambridge.

Su, T.T., (1970), "A Note on Regional Input-Output Models", Southern Economic Journal, 36: 325-327.

Tiebout, C.M., (1969), "An Empirical Regional Input-Output Projection Model", Review of Economics and Statistics, 51, 334-340.

Theil, H., (1967), Economics and Information Theory, North Holland Publishing Co., Amsterdam.

United Nations, (1968), A System of National Accounts, Studies in Methods, Series F, No. 2, Rev. 3, New York.

Walderhaug, A., (1972), "State Input-Output Tables Derived from National Data", 1971 Proceedings of the Business and Economic Statistics Section of the American Statistical Association, Washington, 77-86.

West, G. and Jensen, R.C. (1977), "Some Effects of Errors in Coefficients on Input-Output Multipliers", paper presented to the Input-Output Workshop of the Second Meeting of the Australian and New Zealand Section of the Regional Science Association, Sydney.