REGIONAL impact OF PORTS

Report 101

BUREAU OF TRANSPORT ECONOMICS

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FOREWORD

This report presents the results of a BTE project on the regional impact of ports. It includes a general framework for undertaking port impact studies in Australia and a case study that applies the framework to the Port of Fremantle.

The project was proposed by the Association of Australian Ports and Marine Authorities (AAPMA). The primary purpose was to facilitate the preparation of port impact studies in Australia on a rigorous and consistent basis. Studies of individual ports will potentially contribute to an improved understanding of the contribution of ports, particularly for communities located near port facilities.

The BTE received substantial assistance from a range of individuals and organisations during the study. We would particularly like to thank officers of the Fremantle Port Authority and members of the Fremantle port community who provided data for the case study.

A draft of the report was completed in December 1999. The final report incorporates comments by AAPMA, the Fremantle Port Authority and two external reviewers—Dr Guy West and Dr Julian Morison.

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Canberra
March 2000

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EXECUTIVE SUMMARY

This report presents the results of a BTE study of the regional impact of ports. It comprises two parts:

- a general framework for undertaking port impact studies in Australia;
- a case study of the Port of Fremantle.

The project was proposed by the Association of Australian Ports and Marine Authorities (AAPMA). It was undertaken with the co-operation of AAPMA, the Fremantle Port Authority, and members of the Fremantle port community.

ROLE AND IMPACT OF PORTS

Ports are essential for the operation of the Australian economy. They have a central role in the transport of Australia's exports, which provide income and jobs for many Australians. Imports shipped through Australia's ports supply essential inputs for local producers as well as a wide range of consumer goods. Australia's ports are also used by coastal shipping, which carries large quantities of bulk commodities and most of the cargo moved between Tasmania and the mainland.

The operation of a port generates employment and income for the local community, as well as flow-on effects to other local industries. In addition, all levels of government receive revenue from taxes and other charges on these activities.

Port activities also generate pollution (eg noise and light), and may contribute to traffic and congestion on local roads. As a result of these factors, there have been increased pressures to restrict the scope of port activities in recent years. However, such actions can reduce the efficiency of a port, its capacity to handle trade growth, and the competitiveness of shippers that use the port. There may in turn be adverse effects on local income and employment.

Port impact studies can contribute to a balanced assessment of the role of ports and to informed consideration of issues such as port planning. The results of a port impact study are of interest to the port

authority/corporation, members of the local community, organisations involved in port operations, users of the port, governments and government agencies.

PORT IMPACT STUDIES

The term 'economic impact' refers to the effects of an activity on an economic system (eg a regional economy). The approaches that can be used to analyse economic impact are multiplier analysis (including input-output models), CGE modelling and integrated modelling. The appropriate technique is determined by the characteristics of the activity and the region being analysed, the purpose of the study, data availability, and the time and resources allocated to the study.

A multiplier provides a measure of the overall effects on the regional economy of an initial change in the level of activity. Total impact is the sum of the direct effects (the initial round of output, employment and income) and the subsequent flow-on effects to other sectors of the economy.

Input-output analysis is the preferred approach for economic impact analysis at the regional level as it can be used to analyse a variety of regions ranging from a town or shire to a State. It provides a good combination of relevant activity measures, information on impact components, analytical rigour and cost. The broad processes and results of a study using this approach are relatively easy to understand. In addition, a significant number of Australian academics and consultants have expertise in input-output analysis.

More than 80 economic impact studies of ports have been carried out since the mid-1960s. Most of the studies have been undertaken in the US. Other overseas studies have covered ports in Canada, Europe and New Zealand. The six Australian studies obtained by the BTE have involved Brisbane (two studies), Fremantle, Sydney, Esperance and Bunbury.

Port impact studies have generally used multiplier analysis (particularly input-output analysis). However, there has been significant variation between studies in areas such as the definition of the port industry and the type of region used to estimate the flow-on effects.

GENERAL FRAMEWORK

The terms of reference for the current study required the BTE to develop a general framework for undertaking port impact studies in

Australia. The objective is to facilitate soundly-based studies that are prepared on a consistent basis for Australian ports.

Figure 1 provides an overview of the general framework. Port impact is defined as the output, income and employment that are generated by port-related activities. It does not include the economic benefits of exports and imports handled at the port, or the impact of industrial activities in the port area that are not involved in the transport of cargo.

The general framework is suitable for analysing the impact of a wide range of Australian ports. The standard approach incorporates a detailed survey of organisations involved in port-related activities, and input-output tables that have been modified to provide port-specific multipliers. This approach requires a significant commitment of time and resources by the port community. It is particularly suitable for more complex ports, where information on the major sources of port impact is required, and where rigorous impact estimates are required.

A limited study (eg using interviews or readily-available multipliers that have been appropriately validated) may be adequate for analysing a small or specialised port. It may also be appropriate where data, time or resources for the study are limited or where indicative estimates of port impact are required. However, a limited study will usually be less accurate than a more comprehensive study.

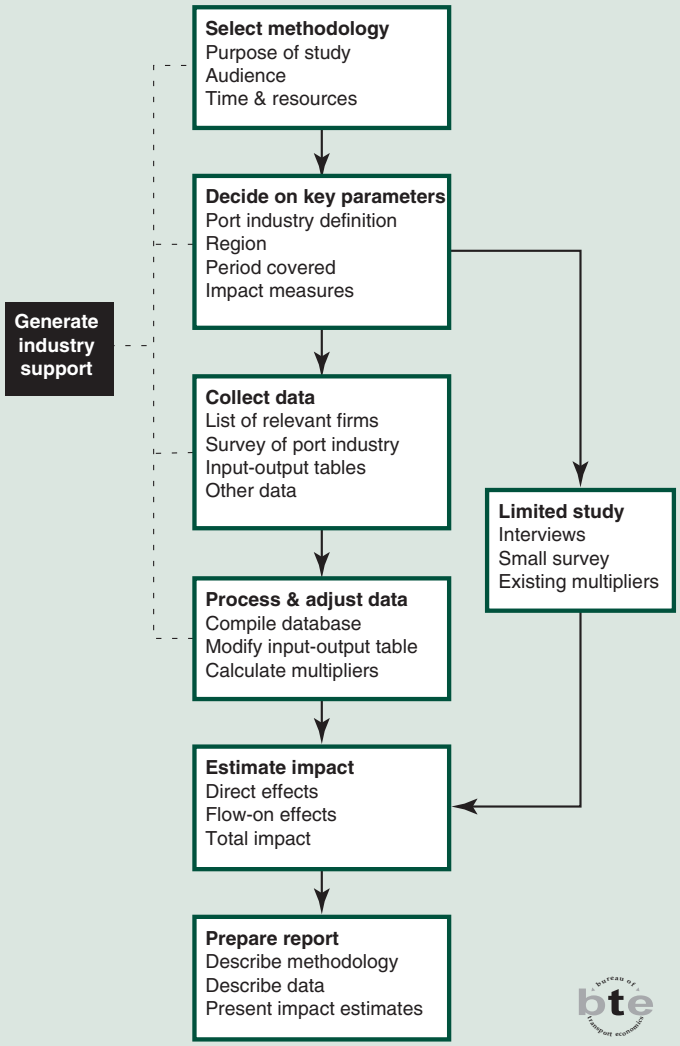
The definition of the port industry in the general framework incorporates all activities that are required for the movement of commercial trading vessels, cargoes and passengers through the port. Local factors may sometimes result in a requirement for additional analysis (eg the impact of visiting naval vessels) in individual port impact studies.

The region used to estimate the flow-on effects should be specified at the beginning of the study. Major options include the city or town where the port is located, the adjacent shire or group of shires, and the State or Territory in which the port is located. The choice will be affected by the interests of the primary audience for the study, the availability of data, and the hinterland served by the port.

The impact measures that are typically reported in a port impact study are output (gross revenue), value added (payments to primary inputs of production), household income and employment. Information on taxes and other payments to governments may also be included.

Detailed measures of port impact provide additional assistance to decision-makers and the local community by indicating the effects of specific aspects of port operations. Impact can be considered in

FIGURE 1 GENERAL FRAMEWORK FOR PORT IMPACT STUDIES



terms of port function (eg ship operations, cargo services), cargo type/commodity, and port area. It is also useful to identify the flow-on effects by industry sector.

The standard approach specified in the general framework is data-intensive. A successful port impact study will therefore require strong support from the port community. A coordinated strategy should generally be used to build industry support prior to, and during, the study.

Even where there is strong support for a port impact study, it is likely that some organisations will be reluctant to provide data due to concerns about the release of commercially sensitive information. In these cases, some of the data used in the study will have to be based on publicly available information or other estimates.

A port impact study will generally be undertaken by an external analyst as specialist skills are required and some firms may be reluctant to provide data to the port authority/corporation. However, the port authority/corporation will need to commit significant resources to activities such as building support for the study, providing data, and assisting with the survey mailing list.

REPORTING THE RESULTS

The results of a port impact study should be presented in a format that meets the requirements of the intended audience.

A study based on the general framework will indicate the output, employment and income generated by port-related activities in a recent year. It will not measure net economic benefits, technical efficiency (ie resources required per unit of output) or competitiveness (eg relative to other ports or other modes of transport). In addition, a port impact study will not indicate trade facilitation effects or the contribution of port infrastructure to regional development. Other techniques should be used to analyse these aspects of a port.

A port impact study will measure the effects of port-related activities on a particular region. It will not indicate the net effects on the broader (eg national) economy, as the impact in the region being studied may be offset by reduced activity in other regions from which resources are drawn.

A port impact study will indicate the general magnitude of the effects associated with a port. It will not provide precise estimates, as only approximate data are available for some parts of the analysis and the

use of input-output tables involves an element of judgement by the analyst.

The results of a port impact study may provide useful data for estimating the impact of increased activity at a port. However, any projections should not be based on a mechanistic application of data from the study. They should take account of factors such as the commodity composition of increased trade flows, economies or diseconomies of scale, and existing capacity utilisation at the port.

PORT OF FREMANTLE

The BTE undertook a study of the Port of Fremantle in order to illustrate the practical issues involved in a port impact study. The case study also provided information for the development of the general framework.

The Port of Fremantle is the largest general cargo port in Western Australia and one of Australia's major bulk cargo ports. It handles around 93 per cent (by value) of seaborne imports into Western Australia and 34 per cent (by value) of the State's seaborne exports. The efficiency of the port has major effects on cost structures, industry competitiveness and living standards in Western Australia.

Total throughput at the Port of Fremantle in 1998–99 was 23.5 million tonnes, with bulk cargoes accounting for 83 per cent of this traffic. Container traffic, which totalled 275 697 teus, has grown at an average annual rate of 11 per cent since 1991–92. A total of 1771 commercial vessels called at the port in 1998–99.

The Port of Fremantle's facilities are located at the Inner Harbour (general cargo and passengers) and the Outer Harbour (bulk cargoes). Facilities and services at the port are provided by the port authority and by private operators.

CONDUCT OF CASE STUDY

The study of the Port of Fremantle was undertaken between June and December 1999, using the standard approach specified in the general framework. It included a co-ordinated strategy to build and maintain industry support for the study.

A survey of 198 organisations involved in port-related activities provided extensive information on the direct effects of the port and on linkages to the rest of the State economy. Flow-on effects were estimated using Western Australian input-output tables, which were modified to provide port-specific multipliers. The BTE also used

publicly available information to prepare estimates of revenue and costs for some port-related activities.

RESULTS OF CASE STUDY

The results of the case study, which are summarised in table 1, focus on the impact of activities required for the operation of the port. They do not include the economic benefits of exports and imports handled at the port, or the effects of industrial activities in the port area that are not involved in the transport of cargo (eg many tenants at Rous Head and small boat industries at the Outer Harbour). The results are not directly comparable with the results of an earlier study undertaken in 1992, as different methods were used in parts of the analysis.

Direct effects

Fremantle port-related activities involved output (ie gross revenue) of $341 million in 1998–99. Value added, which represents payments to the primary inputs of production (ie labour, capital, land), was $215 million.

Port-related activities generated household income of $124 million and 2294 jobs (full-time equivalent) in 1998–99. Household income associated with port-related activities averaged around $54 000 per employee, which was well above the average of $31 000 per annum for all industries in Western Australia.

TABLE 1 ECONOMIC IMPACT (DIRECT AND FLOW-ON EFFECTS) OF THE PORT OF FREMANTLE, 1998–99

Impact measure	Direct effects	Flow-on effects	Total impact
Output ($m)	341	387	728
Value added ($m)	215	225	440
Household income ($m)	124	99	223
Employment (no.)[a]	2 294	3 499	5 792

a. Number of full-time equivalent jobs.
Note Components may not sum to totals due to rounding.
Source BTE analysis.

Flow-on effects

The flow-on effects to other sectors of the Western Australian economy involved output of $387 million, value added of $225 million, household income of $99 million, and 3499 jobs (full-time equivalent).

The two industry sectors most affected by the flow-on effects were wholesale and retail trade etc, and other business services. These sectors each accounted for 26 per cent of the flow-on effects in terms of value added. The proportions for employment were 44 per cent and 12 per cent respectively.

Total impact

The total impact of the Port of Fremantle is the sum of the direct effects (ie Fremantle port-related activities) and the flow-on effects to other sectors of the Western Australian economy.

Output attributable to the operation of the port totalled $728 million in 1998–99. Value added was $440 million, which was equivalent to around 0.9 per cent of Western Australia's Gross State Product.

Household income from port-related and flow-on activities totalled $223 million. The 5792 jobs (full-time equivalent) attributable to the operation of the port represented around 0.8 per cent of total employment in Western Australia.

The results of the case study indicate that, on average, each ship call at the Port of Fremantle involved the following impact on Western Australia:

- $411 000 of output;
- $248 000 of value added;
- $126 000 of household income;
- 3.3 jobs (full-time equivalent).

Taxes and other payments to governments attributable to the operation of the port are estimated at around $125 million in 1998–99. These payments do not include duties and taxes on imports handled at the Port of Fremantle.

Detailed impact measures

Table 2 provides information on the total impact of the port by function, cargo type and port area. The proportion of total impact attributable to individual components sometimes varies significantly depending on the activity measure.

TABLE 2 DETAILED MEASURES OF THE TOTAL IMPACT OF THE PORT OF FREMANTLE, 1998–99

Component	Output ($m)	Value added ($m)	Household income ($m)	Employment (no.)[a]
Function				
Port authority operations	87	48	22	555
Ship operations	162	101	54	1 401
Ship loading/unloading	218	135	72	1 694
Cargo services	99	61	31	897
Land transport & storage	141	82	37	1 033
Government agencies	21	13	8	213
Total	728	440	223	5 792
Cargo type				
Containers	382	240	125	3 195
Other general cargo	96	59	31	800
Liquid bulk	67	38	17	441
Dry bulk	181	100	50	1 339
Other	2	1	1	19
Total	728	440	223	5 792
Port area				
Inner Harbour	470	293	152	3 896
Outer Harbour	258	146	71	1 896
Total	728	440	223	5 792

a. Number of full-time equivalent jobs.
Note Components may not sum to totals due to rounding.
Source BTE analysis.

Port function

Ship loading and unloading (mainly involving stevedoring activities) accounted for 30 per cent of total impact. A further 23 per cent was attributable to ship operations (eg ship's agency, pilotage, towage and bunkering). The other port functions involved land transport and storage (18 per cent), cargo services such as freight forwarding and customs broking (14 per cent), port authority operations (11 per cent) and government agencies (4 per cent).

Cargo type

Containerised cargo generally accounted for around 55 per cent of total impact, although it comprised only 13 per cent of the total

tonnage moved through the port. A further 23 per cent of total impact was attributable to dry bulk cargoes such as grain and alumina.

Other general cargo (break bulk, livestock, motor vehicles), which comprised 3 per cent of the tonnage handled at the port, accounted for 13 per cent of total impact. Liquid bulk cargoes (mainly involving oil and petroleum products) contributed the remaining 9 per cent.

The proportion for each cargo type reflects the characteristics of the cargo, which affect the handling arrangements and associated input requirements per tonne, and the tonnage moved through the port.

Port area

The Inner Harbour accounted for around 67 per cent of total impact but only 18 per cent of the total tonnage moved through the Port of Fremantle. The Outer Harbour contributed around 33 per cent of total impact and 82 per cent of traffic. This impact pattern reflects the concentration of containerised and other general cargo at the Inner Harbour and bulk cargoes at the Outer Harbour.

Impact of foreign naval vessels

The case study focused on commercial trading vessels. However, at the request of the Fremantle Port Authority, the BTE also calculated the impact of foreign naval vessels visiting the Port of Fremantle.

Expenditure by crews from visiting US naval vessels was estimated at about $10 million in 1998–99. Total impact (including flow-on effects) was around $22 million in terms of output and 193 jobs (full-time equivalent). These figures are probably conservative as they exclude some types of local expenditure (eg ship supplies, pilotage) and do not include visits by naval vessels from other countries.

1

INTRODUCTION

Australia's ports are an integral part of the national transport system and trade activities. They handle most of Australia's international merchandise trade, and large quantities of bulk commodities within Australia. Ports also have a major role in the movement of cargo and passengers between Tasmania and the mainland. For many cargoes, shipping provides the only practicable means of transport, in terms of capacity and cost.

Ports are therefore essential for the operation of the Australian economy. The efficiency of the port sector also affects cost structures, industry competitiveness and living standards. As a result of these factors, the efficiency of Australia's ports is an important issue for the community.

AUSTRALIA'S PORTS

Australia has around 70 commercial trading ports (see figure 1.1). They handle a wide range of cargoes (eg coal, crude oil, meat, chemicals, machinery, motor vehicles) and also provide facilities for cruise ships and their passengers. Australia's ports can be broadly divided into several categories on the basis of the cargoes that they handle:

- major multi-cargo ports (eg most of the capital city ports), which handle a mix of containerised, break-bulk and bulk cargoes;
- specialist bulk ports, ranging from large facilities such as Port Hedland to small ports such as Bundaberg;
- other regional ports, which generally handle a mix of bulk and non-bulk cargoes (eg Townsville, Devonport); and
- community ports, which service the domestic and business requirements of small communities (eg Thursday Island).

FIGURE 1.1 AUSTRALIA'S COMMERCIAL TRADING PORTS

Within these categories, there is also significant variation between ports in areas such as traffic levels, port facilities and institutional arrangements.

Most of Australia's ports are owned by State/Territory governments. Port authorities/corporations generally operate on a commercial basis under a corporatised business structure, often within a charter of trade facilitation. Board members are appointed by the relevant State/Territory government.

Many of the services that are required for the operation of a port are typically provided by private operators. Examples include towage, stevedoring, customs broking and bunkering. However, for certain activities such as pilotage, the service is provided by a private operator at some ports and by the port authority/corporation at other ports.

IMPACT OF PORTS

As a trading nation, Australia relies on an uninterrupted and competitive flow of exports and imports. The production of exports provides income and jobs for many Australians. Imports supply essential inputs (eg machinery) for use by local producers, as well as a wide range of consumer goods (eg motor vehicles). Cargoes carried by coastal shipping supply key commodities for local producers and consumers.

Ports have a central role in the movement of these cargoes. Their activities also generate direct employment and income in local communities, with purchases from local suppliers resulting in flow-on effects to regional economies. In addition, local, State/Territory and Commonwealth governments receive revenue from taxes and other charges on these activities.

Most of Australia's ports are located near, or within, populated areas. This partly reflects the central role that ports have played in the establishment and growth of many communities. In addition, the attractive environment around many ports (eg proximity to the sea, historic buildings) has contributed to an expansion of residential developments near the ports in recent years.

The operation of a port also generates noise and other forms of pollution, such as light, which may adversely affect local residents. A port may contribute to traffic and congestion on local roads. In addition, there is a perception that port activities result in adverse environmental impacts such as damage to beaches and other sensitive areas.

As a result of these factors, there have been increased pressures to restrict the scope of port activities in recent years. In some cases, these pressures have included proposals to re-locate a port outside populated areas. Ports also face increasing constraints in terms of environmental policies, urbanisation of long-term port areas and limitations on land transport access.

Such restrictions can significantly reduce the efficiency of a port, its capacity to handle trade growth, and the competitiveness of shippers that use the port. There may in turn be adverse effects on local income and employment.

BTE STUDY

In view of these considerations, the Association of Australian Ports and Marine Authorities (AAPMA) approached the BTE to undertake

a study of the regional impact of ports. Detailed terms of reference were agreed with AAPMA in March 1999 (see appendix I).

AAPMA was concerned that there was only limited knowledge, both in industry and in the community, about the role and position of Australia's ports. It considered that, as a result of this limited knowledge, the importance of ports was not acknowledged in policy development or in public discussion. AAPMA therefore wanted to provide port authorities/corporations and other parties with a framework that could be used to quantify the positive effects of port activities.

The project provided an opportunity for the BTE to contribute to a key policy area, to extend its maritime research skills, and to develop additional expertise in regional analysis. The development of regional analysis skills, particularly input-output modelling, was a key feature of the project.

The terms of reference for the study required the BTE to develop a general framework for assessing the regional impact of ports in Australia. The objective was to facilitate the preparation of soundly-based port impact studies on a consistent basis for Australian ports.

The terms of reference also specified a case study. The case study illustrates the practical issues involved in a port impact study, and also contributed to the development of the general framework. The Fremantle Port Authority agreed, in April 1999, to assist with the case study.

General framework

The general framework identifies the major steps, data requirements and technical issues that are likely to arise in a port impact study. It is developed in Part A, which incorporates chapters 2 to 5 of this report.

Chapter 2 provides an overview of economic impact analysis. It covers the concept of economic impact, the analytical techniques that can be used, multipliers and input-output analysis.

A review of existing port impact studies is presented in chapter 3. It discusses the studies that have been undertaken, the treatment of key issues in these studies, and major review articles.

Chapter 4 presents the general framework developed by the BTE. It covers the purpose of the study, industry support, key parameters, data issues, and preparation of the impact estimates. Other issues, such as the impact of capital expenditure, are also considered.

A port impact study based on the general framework will measure the effects of port-related activities on income, output and employment in a particular region. It will not indicate the net effects on the broader (eg national) economy, as the impact in the region being studied may be offset by reduced activity in other regions from which resources are drawn.

Chapter 5 discusses the presentation and interpretation of the results of a port impact study. Key elements include the coverage of the report, interpretation of the results, and the impact of increased port activity.

Case study

The Fremantle case study is presented in Part B, which covers chapters 6 to 9.

Chapter 6 provides an overview of the Port of Fremantle. It describes the infrastructure and facilities, cargo and trade patterns, shipping activity, institutional arrangements, and planning and co-ordination activities.

Chapter 7 covers the method used to estimate the impact of the Port of Fremantle. It describes the general approach, the key parameters, payments flows for port-related activities, and the strategy that was used to build industry support.

Chapter 8 covers data issues in terms of data collection, modification of the input-output tables, and calculation of the multipliers. The approach to estimating the impact of visiting naval vessels is also outlined.

The estimates of the impact of the Port of Fremantle are presented in chapter 9. They involve the overall impact, the major components (eg by cargo type), and other industry sectors affected by the flow-on effects.

Appendixes

Part C contains appendixes for the general framework and the case study. They include the terms of reference for the study, information on CGE models and integrated models, the covering letter and questionnaire for the industry survey used in the case study, input-output sector definitions and disaggregated multipliers.

MAIN POINTS—OVERVIEW OF PORT IMPACT

- Ports are essential for the operation of the Australian economy.
- They also provide employment and income for local communities, as well as regional flow-on effects through purchases from other industries.
- The attractive environment around ports (eg proximity to the sea) has contributed to an expansion of residential developments near ports.
- Ports generate pollution (eg noise and light), and may contribute to traffic and congestion on local roads.
- Restrictions on port operations may significantly reduce the efficiency of a port and affect local employment and earnings.
- Port impact studies can contribute to a balanced assessment of the role of ports and to informed consideration of issues such as port planning.
- The BTE's regional impact of ports study provides a general framework for undertaking port impact studies in Australia and a case study of the Port of Fremantle.

PART A – GENERAL FRAMEWORK

2

ECONOMIC IMPACT ANALYSIS

This chapter provides a general overview of economic impact analysis in terms of the concept of economic impact, techniques for estimating economic impact, multipliers, and input-output analysis. It introduces several major concepts which are further discussed in the review of existing port impact studies (chapter 3) and the general framework for Australian studies (chapter 4).

ECONOMIC IMPACT

The term 'economic impact' refers to the effects of an economic activity (impacting agent) on an economic system (eg a regional economy). These effects are measured in terms of monetary units and the number of jobs.

The effects of an economic activity usually extend beyond the initial round of output, income and employment generated by the activity. For example, stevedoring firms purchase inputs (eg equipment, fuel) from local suppliers. The production of these inputs generates additional output, income and employment in the local economy. The suppliers in turn purchase goods and services from other local firms. There are then further rounds of local re-spending as part of the chain of production.

Similarly, households that receive income from employment in stevedoring and related activities spend some of their income on local goods and services. These purchases result in additional local jobs. Some of the household income from these additional jobs is in turn spent on local goods and services, thereby creating further jobs and income for local households. There are then further rounds of income generation as part of the chain of household expenditure.

As a result of these successive rounds of re-spending (ie local purchases), the overall impact on the economy exceeds the initial round of output, income and employment generated by stevedoring. However, each successive round of re-spending is smaller than the

preceding round as some of the spending involves goods and services that are produced outside the region. These 'leakages' of expenditure eventually limit the number of rounds of re-spending.

The extent of the 'ripple effects' from the initial round of output, income and employment is also affected by the boundaries of the economy that is being analysed. For a particular activity, the flow-on effects to the national economy will generally be larger than the flow-on effects to the regional economy (eg the local shire or city). This reflects a reduction in the size of the leakages associated with a particular activity as the boundaries of the economy being analysed are increased.

The impact of an economic activity becomes more complex if the activity affects macroeconomic variables such as the exchange rate or input costs. For example, the establishment of a major export activity might result in an initial upward movement of the exchange rate, due to increased exports. This movement would reduce the competitiveness of certain export or import-replacement activities, thereby causing a contraction in some industry sectors. This contraction would partly offset the expansion of sectors associated with the export activity. There would be a range of complex adjustments throughout the economy in response to these changes. In addition, these adjustments would be occurring in a dynamic environment affected by a variety of global and local forces.

ANALYTICAL TECHNIQUES

Various approaches can be used to analyse the effects of an economic activity on output, income and employment. The options are:

- multiplier analysis, involving input-output analysis, the economic base method or Keynesian multiplier analysis;
- integrated modelling, which combines input-output analysis and econometric techniques to analyse the economy's response over time to external shocks; and
- computable general equilibrium (CGE) modelling, which estimates the optimal mix of economic variables (eg consumption) in response to an external shock.

The appropriate technique for analysing the economic impact of a particular activity is determined by the characteristics of the activity and the region being analysed, and by the purpose of the analysis. The availability of data is also an important factor. In addition, the

time and resources allocated to a study may affect the choice of analytical technique.

In broad terms, a multiplier is an index (ratio) that indicates the overall change in the level of activity that results from an initial change in activity[1]. It effectively adds up all of the successive rounds of re-spending, assuming that major factors such as input prices are unchanged and that there are no resource limitations. Port impact studies have generally used multiplier analysis, with some studies including elements of cost-benefit analysis and econometric models (see chapter 3).

Integrated modelling and CGE modelling are more sophisticated than multiplier analysis. They incorporate more feedback effects but their use for regional studies is constrained by data limitations and high costs. A range of consultants have skills in CGE modelling, but expertise in integrated modelling in Australia is currently limited to a small number of academics. Appendix II provides some additional information on these models.

Mules (1996) evaluated the suitability of macro-economic, economic base, input-output and CGE models for measuring the economic impact of tourism. He noted that there is a trade-off between cost/ease of use and accuracy. Mules concluded that, for small regions and perhaps even for State economies where domestic tourism is the issue, input-output models are still appropriate.

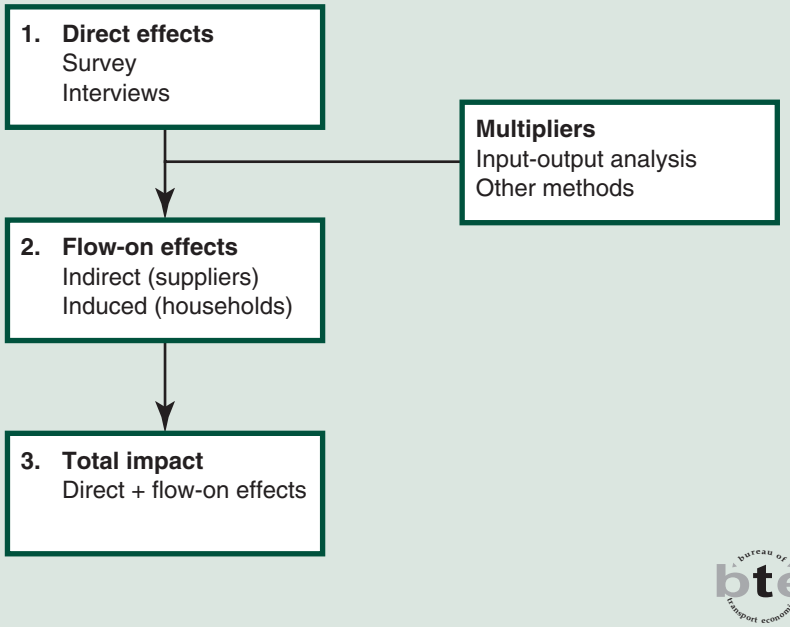
This conclusion is also relevant for port impact studies, which typically focus on a small region or a State. Input-output analysis provides a good combination of relevant activity measures, disaggregated impact measures (eg by cargo type), analytical rigour, and cost. The broad processes and results of a study using this approach are relatively easy to understand, and the expertise required is available from a significant number of consultants and academics. The relative attractiveness of input-output analysis, the economic base method and Keynesian multiplier analysis is considered further in later sections of this chapter.

MULTIPLIER ANALYSIS

Figure 2.1 illustrates the major steps that are involved in a study using multiplier analysis. It indicates that the total impact is the sum

1 For example, Type I multiplier = (direct effect + indirect effect)/direct effect. Type II multiplier = (direct effect + indirect effect + induced effect)/direct effect. For definitions of these terms, see the discussion on page 11 or the glossary at the end of the report.

FIGURE 2.1 BASIC STEPS IN MULTIPLIER ANALYSIS



of the direct effects and the flow-on effects to other sectors of the regional economy.

The direct effects (sometimes called the primary impact) involve the initial round of output, employment and income generated by the activity being studied (eg the port). These effects are generally estimated on the basis of a survey of relevant organisations. An alternative approach (eg interviews) may be used if only a small number of organisations is involved or if the time and resources available for the study are limited.

The flow-on effects (sometimes called secondary effects) are the other activities in the region that are generated by the initial expenditure. There are two components:

- indirect (production) effects, resulting from re-spending by firms that receive income from the sale of goods and services to firms undertaking the primary activity;
- induced (consumption) effects, resulting from re-spending by households that receive income from employment in the primary and indirect activities.

The flow-on effects are calculated using the multipliers, which quantify the relationship with the initial impact[2].

There is significant variation in the magnitude of the multipliers for individual industry sectors in a particular region. This reflects differences in the extent to which each sector uses local labour and the outputs of local producers. Overall multipliers also vary between regions due to differences in industrial structures and linkages to the rest of the national economy.

PREPARATION OF MULTIPLIERS

The basic approaches to the preparation of multipliers for economic impact studies involve input-output analysis, economic base analysis and Keynesian multiplier analysis. There are also hybrid models which combine elements of these approaches. In addition, existing multiplier estimates are sometimes used in economic impact studies. The appropriate approach is affected by the nature of the activity, the resources and data that are available, and the level of accuracy required.

Input-output analysis

Input-output analysis provides the most rigorous and detailed method for the estimation of multipliers. It is the most commonly used approach in Australian and overseas economic impact studies. However, it is also the most expensive and data-intensive method, and requires a higher level of expertise than the economic base method or Keynesian multiplier analysis.

Input-output analysis is based on a set of tables that quantify the linkages and transactions between different sectors of the economy. It can be used to prepare multipliers for a variety of impact measures (eg output, employment, income). Multipliers can also be estimated for major components (eg by cargo type for a port), enabling the analyst to identify the aspects of the activity that have the greatest regional impact. They measure both the indirect and induced effects.

Input-output modelling incorporates various assumptions which potentially affect the rigour of the results (Butler & Mandeville 1981, pp. 109-110; West 1993, pp. 2.19-2.20). It provides a static analysis which assumes that input requirements are directly

2 In a small number of studies, flow-on effects have been estimated using a survey to measure outputs of regional producers that supply firms undertaking the primary activity. However, this approach is resource-intensive and does not capture all of the successive rounds of re-spending.

proportional to output (the linearity assumption) and that relative prices are fixed. Input-output analysis does not incorporate any supply-side constraints (eg labour or foreign exchange shortages), economies or diseconomies of scale, substitution between inputs, synergistic effects, external economies or diseconomies, or changes in technology.

The impact of these assumptions on the accuracy of the analysis depends on the activity and the region being analysed. In many cases, additional resources can be imported into a small region from the rest of the economy and production can be increased without affecting relative prices. Similarly, Mills and Morison (1993, p. 27) noted that the linearity assumption did not pose a significant problem in their Sydney Ports study as port-related activity was a long-established, permanent and integrated part of the regional economy.

Studies using input-output analysis have been undertaken since the 1950s, with the first port impact studies being prepared in the mid-1960s. They have typically reported some or all of the following impact measures:

- output (alternatively called sales or gross revenue);
- value added (the payments to primary inputs of production);
- household income (alternatively called wages and salaries, payroll, earnings or income);
- employment (the number of persons employed);
- taxes generated by the activity.

A significant number of studies have been undertaken in Australia since the 1970s. They have analysed activities such as ports, airports, railway construction, mining, mineral processing, agricultural activities, irrigation water, commercial fishing, national parks, tourism and major events (eg motor racing). The region used in the analysis has typically involved one or more local government areas or statistical divisions, a city or a State.

Economic base analysis

In economic base analysis, the region is divided into export (basic) industries and other (non-basic) industries. Exports comprise goods and services sold outside the region plus expenditures within the region by outsiders. The level of regional economic activity is determined by the level of activity in the export industries. The economic base multiplier is the ratio of total income to basic income, with employment being the most frequently used unit of income measurement.

BOX 2.1 USING INPUT-OUTPUT ANALYSIS

Input-output analysis is a well-established technique for estimating economic impact. It indicates the effect of a given stimulus (activity) on an economy in terms of income, output and employment. The most common applications of input-output analysis involve estimation of:

- the economic significance of an existing activity (eg a port) in a region;
- the impact of expanding an existing activity in a region;
- the impact of establishing a new activity in a region.

The estimates of regional economic impact do not indicate the net effects on the broader (eg national) economy. Impact in the region being studied may be offset by reduced activity in other regions from which resources are drawn. Broader effects of a new or expanded activity (eg exchange rate movements), which are not incorporated in input-output analysis, may also result in offsetting changes in economic activity in other parts of the national economy.

Input-output analysis measures economic impact. It does not indicate whether a particular activity should be undertaken, given the potential benefits from alternative uses of the resources. The assessment of the desirability of an activity from the viewpoint of society should be based on an evaluation technique, such as cost-benefit analysis.

An economic impact study does not measure technical efficiency (resources required per unit of output) or competitiveness (eg relative to other ports or other modes of transport). In addition, it does not indicate trade facilitation effects or the contribution of infrastructure services to regional development. Other analytical techniques should be used to analyse these aspects.

The input-output model has various theoretical and practical limitations. For example, it assumes that relative prices are fixed, input requirements are directly proportional to output, and there are no capacity constraints. Input-output analysis is therefore most suitable for analysing small regional (ie sub-State) economies which can readily draw resources from other regions.

More sophisticated techniques, including integrated input-output/econometric models and computable general equilibrium (CGE) models, will be more appropriate in other circumstances. Examples include situations where there are effects on prices (eg wages) as well as on production, or where impacts on the national economy are being analysed.

The appropriate technique for a particular study will be determined by the characteristics of the activity and the region being analysed, the purpose of the study, data availability, and the costs of applying alternative techniques. The BTE considers that, as a general approach, input-output analysis is the most appropriate technique for estimating the regional impact of port-related activities.

This approach is inexpensive and quick, but there are several conceptual problems. It is invalid in some situations (eg where non-basic industries are a determining factor in an area's level of economic activity). All activities related to imports are considered non-basic, but in some cases (eg a port) these activities may affect economic growth and activity. In addition, accurate estimation of a region's basic and non-basic income can be difficult.

An economic base multiplier measures the induced (ie consumption) effect only (Davis 1983, p. 64). Economic base analysis provides a single multiplier that is a very aggregated average of basic and non-basic goods. It does not enable the analyst to obtain multipliers for individual impact measures (eg value added) or disaggregated estimates of total impact (eg by industry sector).

In his review of alternative models, Mules (1996, p. 358) concluded that the 'economic base method is perhaps best reserved for very small regions where the size of the impact is not large enough to alter the basic multiplier'. This technique has been used in only a small number of port studies (see chapter 3).

Keynesian multiplier analysis

The Keynesian multiplier is derived from a macroeconomic model that expresses regional income as a function of consumption, investment, government expenditure, exports and imports. The estimation process involves a solution for the following relationship: $k=[1/(1-t)(c-m)]$, where k is the multiplier, t is the tax rate, c is the marginal propensity to consume and m is the marginal propensity to import[3] (Villaverde-Castro & Coto-Millan 1998, p. 164).

Keynesian multiplier analysis has been used in a number of economic impact studies. It is more flexible than the economic base method as it enables the analyst to treat import-replacement activities as an income generator (Davis 1983, p. 64). However, Keynesian multiplier analysis generates a single income multiplier for all industries in the region, and does not enable the analyst to obtain multipliers for individual impact measures or disaggregated estimates of total impact. It provides an estimate of the induced (ie consumption) effect only.

The level of expertise required for this approach is considerably higher than that required for the economic base method. Data

3 The marginal propensity to consume is the amount by which consumption increases when income rises by a dollar. The marginal propensity to import is the amount by which imports increase when income increases by a dollar.

constraints and other problems mean that it can be difficult to estimate the system of equations required to calculate Keynesian multipliers at the regional level.

Existing multiplier estimates

In some economic impact studies, existing multiplier estimates are used to calculate the flow-on effects. The sources of these multipliers include earlier studies of the same activity (eg another port impact study) or multipliers for broader industry groupings.

This approach is quick, requires minimal resources and provides an indication of the magnitude of the figures to expect in a more comprehensive study of economic impact. However, existing multiplier estimates may not accurately reflect the underlying multipliers for the activity being studied as there are differences in the characteristics of individual ports (eg mix of cargo types). Economic linkages (and therefore multipliers) also vary between regions and between industry sectors. In addition, the underlying multipliers may change over time, meaning that older estimates may not reflect current conditions.

It should be noted that the use of multipliers prepared for earlier studies means that any methodological weaknesses, which may not be apparent from the published material, will be incorporated in the analysis.

INPUT-OUTPUT ANALYSIS

Input-output analysis was initially developed in the 1930s in relation to the US economy (Butler & Mandeville 1981, pp. 129-130). National input-output tables were subsequently developed for many other countries, including Australia.

The technique was first applied to smaller regions (in the US) during the 1950s. Studies were initially based on unadjusted coefficients from national tables. Regional tables, incorporating local data on linkages between industry sectors, were produced from the late 1950s. Survey techniques were initially used to develop the regional tables but they were subsequently replaced by non-survey and hybrid techniques. The first regional input-output tables for Australia were completed in 1967.

Input-output analysis initially focused on single-region models. Economic impacts were estimated for the study region, with the rest of the world being aggregated into one other region. Multi-regional and inter-regional models were subsequently developed.

Key concepts

The fundamental component of input-output analysis is the transactions table. This table records the production and disposal of goods and services in an economy over a one-year period. It does not include purely financial transactions or transfers (eg purchases or sale of land and buildings). A simplified transactions table is presented in table 2.1.

The transactions table is constructed as a matrix. It consists of four sub-matrices which cover intermediate usage (flows between industries), final demand (disposition of output into categories of final demand), primary inputs to production, and primary inputs to final demand.

Each row of a transactions table indicates the distribution of an industry's output to other local industries and to final demand. For example, in table 2.1 sales of agriculture's products involve $5 million for its own use[4], $112 million to manufacturing, $1 million to service industries, and $168 million to final demand.

TABLE 2.1 SIMPLIFIED INPUT-OUTPUT TRANSACTIONS TABLE

($ million)

Inputs \ Outputs	Agr.	Min.	Man.	Ser.	Household consumption	Other final demand [b]	Total output
Agriculture	5	-	112	1	46	122	286
Mining	-	4	74	1	-	40	119
Manufacturing	19	10	1 395	622	1 116	2 497	5 659
Services	16	10	689	1026	3 036	2 183	6 960
Wages & salaries	120	52	999	3161	-	-	4 332
Other value added & imports[a]	126	43	2 390	2149	1 456	182	6 346
Total inputs	286	119	5 659	6960	5 654	5 024	23 702

a. Interest, depreciation, taxes, profits and imports.
b. Government expenditure, investment and exports.

Source Morison & Jensen (1987, p. 20).

4 An example is the acquisition of grain by producers of lot-fed beef.

Each column shows the amounts of inputs that are purchased from other industries and the amounts of primary inputs that are purchased. For example, in table 2.1 purchases of inputs by agriculture include $5 million of its own output, $19 million from manufacturing, $16 million from service industries and $246 million of primary inputs.

There are two other important tables in the input-output system (Butler & Mandeville 1981, pp. 121-122). The table of direct requirements coefficients is calculated from the transactions table by dividing each column entry by the associated column total. For example, in table 2.1 all entries in the agriculture column would be divided by 286. The table of total requirements coefficients (sometimes called the table of interdependence coefficients) is calculated by obtaining the inverse matrix, of the identity matrix[5] minus the direct requirements coefficients matrix. This inverse matrix can be used to calculate the multipliers for economic impact studies.

Regional input-output tables

Multipliers should ideally be calculated from input-output tables for the relevant region as there is significant inter-regional variation in economic structures (and multipliers). Regional economies generally have a higher degree of specialisation, and rely more heavily on external suppliers, than the national economy. This means that the multipliers for regional economies are often lower than the corresponding multipliers for the national economy.

The national input-output tables for Australia are updated over a five-year period. The latest tables, for 1994–95, were published by the Australian Bureau of Statistics (ABS) in 1999. At the most disaggregated level they contain 107 industry sectors. The national tables provide the basis for State input-output tables which are generally prepared by universities or private consultants for State government agencies. These agencies also support the production of tables for some smaller regions (eg in New South Wales) on a regular basis.

In many cases, regional input-output tables are not readily available and must be developed specifically for an economic impact study. An existing national or State table may be modified by incorporating regional data on employment and production. Alternatively, older regional tables may be updated using more recent data.

5 The identity matrix is a square matrix, with 1's as elements on the diagonal and 0's as the off-diagonal elements.

Preparation of reliable input-output tables for a region within an urban area (ie a group of suburbs within a city) involves significant difficulties. For example, a port authority/corporation in a major city may be interested in the flow-on effects to the community located adjacent to the port. However, accurate input-output tables for such a region may not be obtainable due to insufficient data on port industry expenditure patterns (ie between the region and other regions).

Preparation of multipliers

In some economic impact studies, the flow-on effects of an activity are estimated using industry-wide multipliers or multipliers prepared for similar industries. However, the preferred and most rigorous approach in practice is to calculate the multipliers using input-output tables that incorporate a specific row and column for the activity being analysed.

Published input-output tables separately identify only a limited number of industry sectors. Activities that are analysed in an economic impact study are often combined with other activities in these broader industry sectors. For example, the 1992–93 Western Australian input-output tables include most of the port industry in the 'services to transport and storage' sector. As this sector incorporates activities for several ports as well as various non-port activities, a separate row and column should ideally be estimated for the relevant port industry (eg Fremantle port-related activities).

Estimation of the specific row and column requires detailed information on income and expenditure patterns. This information is usually collected through a survey of organisations undertaking the activity, supplemented with data from other sources. After the new row and column have been inserted, the table is balanced and adjusted in order to ensure that it is internally consistent.

Multipliers are estimated from the inverse matrix using mathematical techniques. Software programs such as GRIMP[6] or Excel can be used to adjust the tables and to calculate the multipliers.

6 GRIMP is an interactive input-output software package.

MAIN POINTS—ECONOMIC IMPACT ANALYSIS

- The term 'economic impact' refers to the effects of an economic activity (eg a port) on an economic system (eg a regional economy).
- The major measures of economic impact are output (including value added), income and employment.
- Total impact exceeds the initial impact as there are flow-on effects to other sectors of the regional economy, due to local purchases by firms and households.
- Input-output analysis is the preferred approach for economic impact analysis at the regional level as it provides a good combination of relevant activity measures, information on impact components, analytical rigour and cost.
- A significant number of Australian academics and consultants have expertise in input-output analysis.
- The direct effects are generally estimated using a survey of relevant organisations, and the flow-on effects are calculated with multipliers that quantify the changes in economic activity that flow from the initial effects.
- The multipliers should be obtained from input-output tables for the relevant region, with specific rows and columns for the activity being analysed.

3

STUDIES OF PORTS

The results of several port impact studies have been published in economic journals. However, many of the reports have not been widely distributed beyond the local communities and agencies for which they were primarily intended. Summary information on some of these unpublished studies has been included in several review articles.

As part of the current study, the BTE undertook an extensive review of the economic journals covering ports, shipping and regional issues. Contact was made with a range of academics involved in port impact studies and maritime economics, and with local and overseas port authorities/corporations. Other sources of information included specialist maritime libraries, international agencies (eg the World Bank) and relevant Internet sites.

This chapter reviews the literature on port impact studies in terms of the studies that have been undertaken, the treatment of key issues in these studies, and major review articles.

PORT IMPACT STUDIES

More than 80 port impact studies have been prepared since the mid-1960s. Most of the studies identified by the BTE have been undertaken in the US. Studies have also been carried out in Canada, Europe, Australia and New Zealand.

United States

An unpublished bibliography prepared by DeSalvo and other literature identified by the BTE indicate that at least 60 US port impact studies have been prepared since 1964. Some of the ports covered by these studies have included New York, Seattle, Los Angeles, Portland, Tacoma, Oakland and Port Canaveral. Most of the US studies were completed in the 1970s or 1980s.

A port economic impact kit was published in 1979 by the Maritime Administration of the US Department of Transportation. The kit was developed to facilitate the preparation of economic impact studies for small and medium-size ports. It provided a step-by-step manual and was intended to enhance the credibility, clarity and comparability of the studies.

A revised version of the port economic impact kit was released in 1985 (Maritime Administration 1985). It attempted to simplify some of the requirements of the original kit and to provide a more practical, less data-intensive method. The revised kit also included an interactive computer model to organise and facilitate the study and provide key input data. The main features of the model were standardised relationships to provide key data, a 30-sector regional input-output model, and a spreadsheet package for the calculations and reports. By 1991, 22 port impact studies had been undertaken using the revised port economic impact kit (DeSalvo 1994, p. 41).

In September 1999, the Maritime Administration announced that it would be updating the port economic impact kit (Maritime Administration 1999). Release of the revised version is scheduled for mid-2000.

Canada

At least 11 port impact studies have been undertaken in Canada since 1975. The studies identified by the BTE have covered Vancouver, Montreal, Halifax, Fraser Port, North Fraser Harbour, the ports under the jurisdiction of the Ports Canada Corporation, and a group of small and medium-size ports in Quebec. Several studies have been undertaken for Vancouver, the latest report being published in 1996.

Europe

The available literature indicates that only a small number of port impact studies have been undertaken in Europe. Studies covering Dublin, Santander, Plymouth and Rotterdam were published between 1988 and 1997. In addition, Verbeke and Debisschop (1996, pp. 261-265) refer to port economic impact studies performed in Belgium (the Flemish Region). A recent study of the Dutch maritime cluster included estimates of the economic impact of Dutch ports as a whole (Dickey 1999, pp. 19-21).

The small number of studies may reflect a limited requirement for information about port impact due to strong community recognition

of the role of ports in Europe. However, some studies undertaken in Europe may not have been identified in the BTE's literature search.

Australia

At least six studies of the effects of individual ports have been undertaken in Australia. They have covered the Port of Brisbane (Morison & Jensen 1987, ACIL Consulting 1999), the Sydney Ports (Mills & Morison 1993), the Port of Fremantle (McLeod & McGinley 1992), the Port of Esperance (The Rowland Company 1995) and the Port of Bunbury (Price Waterhouse 1997).

There have also been several studies of the economic impact of airports in Australia. The most recent reports have included Sydney International Airport (Institute of Transport Studies 1996), Brisbane Airport (Ernst & Young 1997), Perth Airport (Economic Research Associates 1997) and Canberra International Airport (ACIL 1998). The operational similarities between ports and airports mean that similar analytical techniques are used to assess economic impact in these two sectors.

Other studies

Information on port impact studies undertaken in other countries is limited. The BTE is aware of a study of the Ports of Auckland which was completed in 1989. This study was being updated in late 1999.

APPROACHES TO KEY ISSUES

The port impact studies identified by the BTE have generally been undertaken using multiplier analysis. However, there has been significant variation in the details of individual studies due to differences in the primary purpose, the resources available, data availability, and the characteristics of the port and associated region. Individual studies have often contained methodological innovations intended to improve accuracy or to provide an acceptable trade-off between resources and analytical detail.

The key issues in these studies can be considered in terms of the method, port industry definition, region, estimation of multipliers, and impact measures.

Method

Port impact studies have generally quantified both the direct effects and the flow-on effects, although several early studies covered the direct effects only (Davis 1983, p. 69). The more comprehensive

studies have usually included a detailed survey of organisations involved in port-related activities and the use of modified input-output tables to estimate the multipliers.[7]

The analysis has typically been based on the 'estimation of the economic impact as it is produced'. This approach, which reflects the predominant approach in the broader literature on economic impact analysis, was used in the Brisbane, Sydney and Fremantle port studies. The alternative approach, involving a comparison with expected levels of economic activity in the absence of the port, is not widely used due to difficulties in accurately identifying alternative economic structures and activity levels (see chapter 5).

The 1995 Esperance study involved an analysis of economic benefits (mainly defined as cost savings) rather than economic impact, as the analysts considered that the port's importance to the region was reflected in cost reductions for inputs. The effects assessed in the study involved port operations (employment, payroll and purchases), fuel and freight cost savings, and investment attracted by the port. Flow-on effects were calculated using industry output multipliers.

The 1997 Bunbury study was reportedly based on the general principles of cost-benefit analysis. It compared the value added that was generated by the port in a recent year with an estimate of the value added that would have been generated without the port. The estimates covered cessation of port activities, additional transport costs, and loss of construction work on offshore structures. Some other impacts which could not be readily quantified were also identified.

The literature identified by the BTE indicates that CGE modelling has not been used to a significant extent in overseas or Australian port impact studies.

Port industry definition

The estimation of the direct effects of a port requires a definition of the activities that comprise the port industry. There has been significant variation in the definitions used in existing studies, partly

7 The major exceptions include a 1994 study of the Port of Seattle which used detailed interviews with nearly 600 firms to estimate the direct and flow-on effects (Martin O'Connell Associates 1994). In this study, re-spending models were developed using actual consumption patterns of Seattle residents. The authors of the study noted that their impact estimates were conservative by design. For purchases by firms, their methodology only estimated the indirect effects associated with the first round of purchases.

reflecting differences in the characteristics of individual ports and in the objectives of the studies. This variation limits the comparability of the results of port impact studies, particularly between ports but also for individual ports over time.

Components

In all of the port impact studies examined by the BTE, the definition of the port industry has incorporated the activities that are required to move ships and their cargoes and passengers through the port. These activities typically involve organisations such as the port authority/corporation, stevedores, tug operators, pilots, and road and rail transport operators.

Some studies have incorporated other ship-related and boating activities. For example, a 1988 Vancouver study included ship building and repair, consulting engineering and naval architecture, fishing and fish processing, marinas, yacht charters, and water taxi and seabus services (Vancouver Port Corporation 1988, p. 9).

Many US port impact studies have analysed the effects on shippers, although there has been significant variation in the definitions used. Examples include all shippers using the port, shippers' activities that would cease if the port did not exist, and firms using land owned by the port authority/corporation. Yochum and Argwal (1987, pp. 74-76) distinguished between firms that had been able to expand their markets as a result of lower transport costs facilitated by the port and firms that were attracted to a region due to the presence of a port.

Capital spending on port facilities and/or local manufacturing facilities has also been included in some port impact studies.

Port economic impact kit

The port economic impact kit published by the US Maritime Administration noted that, depending on the objectives, the following types of activities could be analysed in a port impact study:

- port industry (services associated with moving cargo through the port);
- local port user industries (activities of shippers and receivers making heavy use of the port, such as exporters and shipbuilders);
- port capital spending (new construction, expansion or rehabilitation).

The kit stated that inclusion of port users in a study required a clear link to the port in order to be compelling (Maritime Administration 1985, p. 19, p. 44). It noted that inclusion of local port users was particularly relevant when large facilities shipping or receiving goods were located within or near the port area. Such industries were called port dependent, as the firm in question would go out of business without the port. The kit concluded that easily-identified major users located close to the port should normally be included in a port impact study.

Australian studies

There has been some variation in the definition of the port industry in Australian studies.

The Brisbane, Sydney and Fremantle studies focused on firms involved in the movement of ships, cargoes and passengers through the port. A small number of additional activities (eg aquaculture, coastal water transport) were included in the Fremantle study. The 1997 Brisbane study also incorporated some capital works and construction activities (ie improvement of the existing capital stock).

The coverage of the other Australian studies was broader, reflecting the features of the ports and the objectives of the studies. The Esperance study incorporated firms involved in port-related activities, shippers and consumers. The Bunbury study covered the port authority, providers of ancillary port services, exporters, importers, firms involved in offshore structures construction, new investment in the port, and land transport operators.

Region

The region used to estimate the flow-on effects of a port has typically been specified or approved by the agency that initiated the study. Factors affecting this decision have included the decision-makers and community affected by the port, the available input-output tables, and the time and resources for the study.

The region has generally involved a discrete area with distinct political or geographic boundaries. The US Maritime Administration (1985, p. 20) noted, in relation to US studies, that the region was typically related to the tax-base area of other local hinterland closely connected with the port. Davis (1983, p. 63) commented that port impact studies had focused on political jurisdictions that contained and immediately surrounded the study port.

It appears that most overseas studies have measured flow-on effects in terms of a county, group of counties, city or State. In Australia, the approaches have involved:

- the surrounding city (Sydney and 1987 Brisbane studies);
- the regional centre containing the port, and a group of adjacent shires (Bunbury and Esperance studies);
- the State (Fremantle study);
- the State, its major regions, and the national economy (1999 Brisbane study).

Australian airport impact studies have adopted various approaches including a region within a city, a city, a broad region of a State/Territory, and a State.

Multipliers

Input-output analysis has been the preferred method of preparing multipliers for port impact studies since the mid-1970s. The application of this technique has varied between studies, with the approaches including:

- estimation of multipliers from regional input-output tables modified to include a row and column for the relevant port industry;
- weighted average multipliers, derived by allocating individual port-related activities to existing components of the input-output tables;
- multipliers for the most similar component of the existing input-output tables (eg services to water transport);
- multipliers prepared in an earlier study for a similar port;
- industry multipliers for the State as a whole.

The port impact studies of Brisbane (1987) and Sydney used input-output tables that had been modified to incorporate a row and column for the relevant port industry. This approach is likely to provide the most accurate multipliers.

The other approaches are less resource-intensive but the resulting multipliers are potentially less accurate. Weighted average multipliers were calculated for the Fremantle study and the 1999 Brisbane study, by assigning components of the port industry to relevant industry sectors (eg other transport, public administration). Industry multipliers for the State were used in the Esperance study. In the Bunbury study, industry multipliers for the State were adjusted to

reflect relative levels of value added in industry sectors in the local region.

A 1983 review of overseas studies identified six port impact studies (undertaken between 1964 and 1976) which had used economic base multipliers (Davis 1983, p. 69). A further three studies, prepared between 1976 and 1982, had used Keynesian income multipliers. The BTE is not aware of any subsequent studies that have used these approaches[8].

Impact measures

The measures used in port impact studies have included output, value added, household income, employment, and taxes and other payments to governments. These are the measures that are generally of primary interest to decision-makers and local communities. Output, value added and household income can be estimated using survey data and multipliers obtained from input-output tables. Employment effects are calculated with the assistance of supplementary data on the relationship between output and employment.

Estimation of taxes and other payments to governments requires some additional information. For example, a 1988 Vancouver study used a government revenue model to estimate certain direct and indirect payments (including taxes) to provincial and federal governments. These data supplemented information collected through the survey. Reasonable order-of-magnitude figures were reportedly obtained using this approach (Vancouver Port Corporation 1988, p. 3).

Port impact studies have often identified the major components contributing to the overall impact. The approach is affected by the audience for the report, data availability and the features of the port. Several major Australian studies have provided details of port impact using some or all of following features:

- port function (eg ship services, inland transport);
- cargo type (eg containerised, break bulk, liquid bulk, dry bulk);
- commodity type (eg grain, oil);
- port area.

8 An economic impact study of Vancouver International Airport reportedly constructed a total expenditure multiplier by combining an economic base model with econometric techniques.

In addition, the flow-on effects in the Brisbane, Sydney and Fremantle studies were identified by industry sector (eg business services, finance).

Some overseas studies have also included details of port impact. However, the BTE has not been able to draw general conclusions about the basis of disaggregation due to the limited number of reports that are available for detailed analysis.

REVIEW ARTICLES

Several review articles have discussed the limitations of port impact studies and the appropriate interpretation of the results. They have also included proposals to improve the method used in these studies.

Waters article

Waters (1977) criticised the use of port impact studies as a planning tool and argued that the existing studies suffered from major limitations. In particular, he stated that they could not measure incremental effects or the benefits of new investment, ignored the impact of imports, assumed that transportation expenditures were fixed, ignored changes in technology and assumed that the price level remained constant. In addition, the multiplier employed in such studies was too simplistic.

Waters proposed the use of cost-benefit analysis to determine the direct effects, with regional input-output models being used to estimate the flow-on effects.

Chang article

In defending port impact studies, Chang (1978) conceded that most of Waters' criticisms were valid. However, he considered that the criticisms were irrelevant as they were based on a misunderstanding of the objectives of the studies. In Chang's view, the studies measured the economic impact of a port in a particular year and were not intended to measure the incremental impact of port investments.

Chang also noted that Waters had correctly pointed out many limitations involved in the use of port impact studies. He proposed a model that linked capacity expansion to existing profitability, capacity utilisation and expected growth in the demand for port services.

Davis article

Davis (1983) noted that existing port impact studies had three principal weaknesses. First, there was no commonly accepted definition of the port industry. Secondly, the existing studies used at least four alternative methods to estimate the flow-on effects—economic base analysis, income-expenditure analysis, input-output analysis, and application of a multiplier from a previous study. Thirdly, the studies had several weaknesses if they were to be used for evaluating the economic effects of changes in the volume of port services.

Davis proposed a method for relating changes in demand and supply conditions for both exports and imports as a means of improving the consideration of the differential effects of various economic conditions.

DeSalvo article

DeSalvo (1994) noted that the method of port impact studies had improved over the years. Major improvements had included the use of multipliers generated from input-output models and efforts to ensure that the direct effects were not overestimated by the inclusion of economic activity unrelated to the port. However, he considered that economic impact was still mis-estimated due to the failure to consider induced price changes, and the resulting effects on local production, if the port was unavailable.

DeSalvo recommended the use of conventional supply and demand analysis to estimate the cost effects of the port's absence and changes in the demand for exports and imports. However, it appears that his recommended approach has not been applied in any subsequent studies, due mainly to data limitations.

Assessment

The review articles indicate that port impact studies are affected by the general limitations of the analytical techniques that are used. Some of the early criticisms are no longer valid as further development of input-output analysis has improved the process of estimating multipliers. However, there is still significant variation between studies in areas such as the definition of the port industry.

The articles show that the results of a port impact study should be interpreted and used with caution. Major problems include the confusion of concepts such as economic impact and benefits.

Chapter 5 provides more detailed information about appropriate interpretation of the results of port impact studies.

MAIN POINTS—STUDIES OF PORTS

- More than 80 port impact studies have been undertaken since the mid-1960s, with six of these studies involving Australian ports.
- Port impact studies have generally used multiplier analysis (particularly input-output analysis) but there has been significant variation in the details of individual studies.
- The definition of the port industry has varied between studies, although it has typically incorporated the activities required to move ships, cargoes and passengers through the port.
- The type of region used to estimate the flow-on effects has also varied, with the region ranging from a town or shire to a State.
- The impact measures reported in the studies have included output, value added, household income, employment, and payments to governments.
- Impact has been identified by port function, cargo type/commodity, port area and industry sector (flow-on effects only).
- Several review articles have highlighted the general limitations of port impact studies and the need to interpret the results appropriately.

4

FRAMEWORK FOR PORT IMPACT STUDIES

This chapter presents a general framework for undertaking port impact studies in Australia. The objective is to facilitate soundly-based studies that are prepared on a consistent basis for Australian ports.

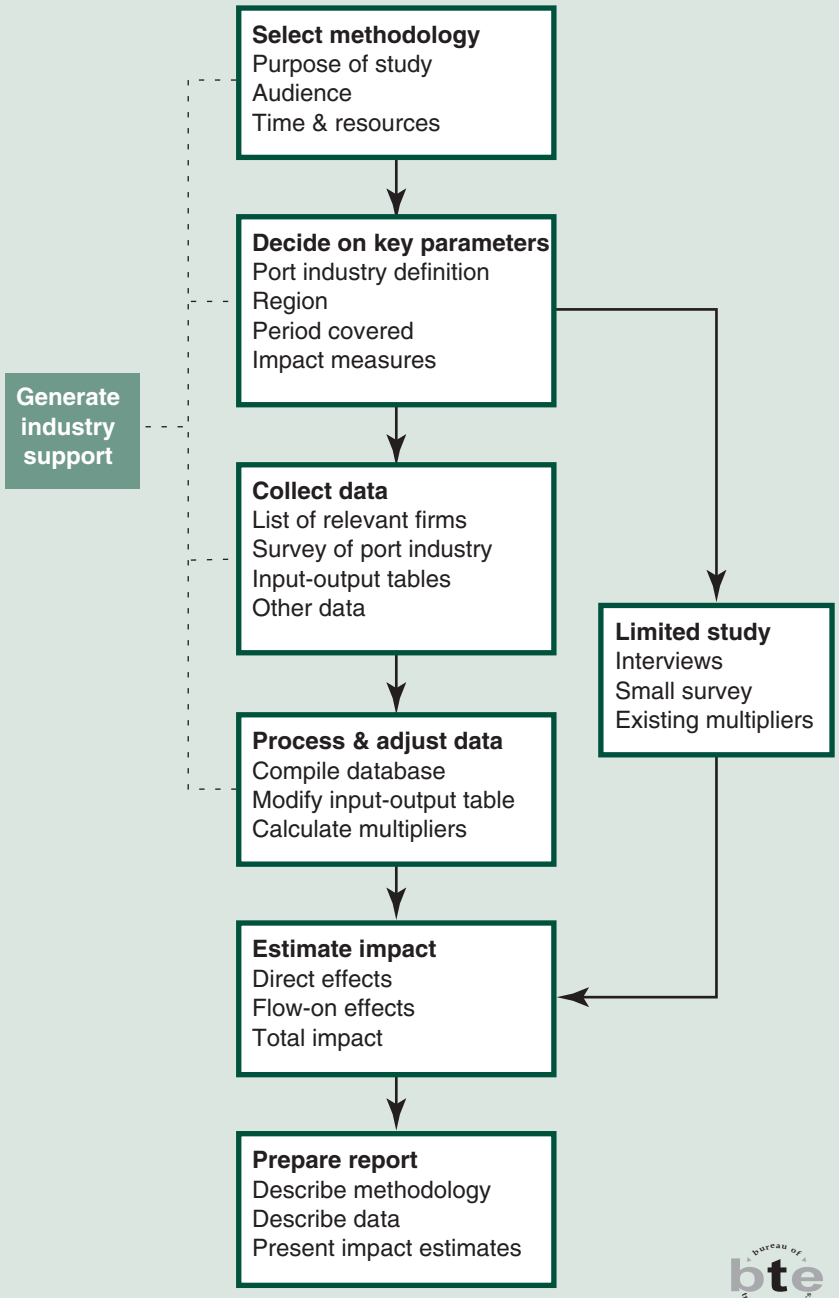
An overview of the general framework is presented in figure 4.1. The standard approach incorporates a detailed survey of organisations involved in port-related activities, and input-output tables that have been modified to provide port-specific multipliers. This approach requires a significant commitment of time and resources by the port community. It is particularly suitable for more complex ports (eg large ports that handle multiple commodities), where information on the major sources of port impact (eg cargo type) is required, and where rigorous impact estimates are required.

A limited study (eg using interviews or readily-available multipliers that have been appropriately validated) may be adequate for analysing a small or specialised port. This approach may also be appropriate where data, time or resources for the study are limited or where indicative estimates of port impact are required. However, a limited study will usually be less accurate than a more comprehensive study.

The general framework does not incorporate standardised values for estimating port impact (eg average employment per tonne of cargo shipped through a port). The use of standardised values would enable impact studies to be undertaken quickly and with minimal resources. However, this approach would often result in mis-estimation of port impact due to the substantial variation in the characteristics of individual ports and regions. In addition, little data are available as only a small number of port impact studies have been undertaken in Australia and they cover a period of more than 10 years. As a result of these factors, the BTE does not recommend the use of standardised values for port impact studies.

A port impact study will generally be undertaken by an external

FIGURE 4.1 GENERAL FRAMEWORK FOR PORT IMPACT STUDIES



analyst as specialist skills are required and some firms may be reluctant to provide detailed data to the port authority/corporation. However, the port authority/corporation will need to commit significant resources to activities such as providing data and assisting with the survey mailing list.

PURPOSE

Economic impact analysis is used to estimate the output, income and employment generated by an activity such as the operation of a port. It should be noted that other methods may be more appropriate when other port-related effects are being analysed. For example, cost-benefit analysis should generally be used when there is a requirement to assess the economic benefits associated with new port investment.

The purpose of a port impact study should therefore be clearly identified at an early stage. The general framework is intended to facilitate studies that provide relevant decision-makers and communities with information about the importance of a port to the regional economy.

The general framework focuses on the 'estimation of economic impact as it is produced'. It does not incorporate a comparison with the expected levels of economic activity in the absence of the port. The method used in the general framework is consistent with the usual approach in economic impact analysis which effectively assumes that, in the absence of the activity, the outputs would be fully provided by imports from outside the region.

INDUSTRY SUPPORT

A port impact study includes the collection of a substantial amount of information from organisations in the port industry. A successful study is therefore dependent on strong support from these organisations. However, such support may not be provided by some key members of the port community if they:

- do not view a port impact study as a useful exercise;
- have major concerns about commercial confidentiality;
- consider that their resources should be focused on their own activities.

The reluctance of individual organisations to contribute to a port impact study may reflect company policy (eg a directive by head office) or local issues (eg involvement in a local tendering process at the time of the study).

As a result of these factors, a coordinated strategy is generally required to build industry support prior to the commencement of a port impact study and to maintain support during the study. The port authority/corporation, which is often in the best position to promote the interests of the port as a whole, will generally have a central role in this process. The activities to build support should emphasise the benefits of a successful study to the port community and to individual organisations.

The components of the support-building strategy may vary between ports in response to factors such as the size and composition of the port community. However, they are likely to include most or all of the following activities:

- promotion of the study by the port authority/corporation at meetings of port liaison committees and through informal contacts with relevant firms and associations;
- a supportive letter from a senior executive of the port authority/corporation to members of the port community at an early stage of the study;
- approaches to supportive individuals in the port community to promote the study through informal contacts and at meetings of industry associations;
- use of follow-up interviews during the survey to encourage supportive activities by influential members of the port industry;
- a covering letter for the survey questionnaire which emphasises the benefits of a successful study;
- a concise, readable survey questionnaire which balances the requirement for adequate data with attractiveness to potential respondents;
- procedures to ensure adequate protection of commercially sensitive data provided by individual organisations; and
- an undertaking to make the results of the study available to all survey respondents.

The timing of activities to build support for a port impact study is also a key consideration. The activities should be coordinated with major stages of the study (eg the survey) so that long delays are avoided and the momentum of support is maintained.

If strong support within the port community cannot be obtained prior to commencement of the survey, it may be appropriate to consider other methods. Alternatively, the study might be deferred until external circumstances (eg industry restructuring) are more favourable or until longer-term initiatives to build support have been successfully implemented.

Even where there is strong support for a port impact study, it is likely that some organisations will be reluctant to provide data due to concerns about the release of commercially sensitive information. In these cases, some of the data used in the study will have to be based on publicly available information or other estimates.

KEY PARAMETERS

Decisions about several key parameters should be made at the beginning of a port impact study. They involve the definition of the port industry, the region for estimating flow-on effects, the time period covered by the study, and the impact measures.

Port industry definition

The definition of the port industry (ie port-related activities) provides the basis for estimating the direct effects of a port (and the multipliers). It also determines the organisations that will be approached to provide data. Adoption of a consistent definition in Australian port impact studies will promote comparable estimates, both between ports and over time for individual ports.

The definition in the general framework incorporates all activities that are required for the movement of ships and their cargoes and passengers through the port. Ships comprise commercial trading vessels and passenger vessels (excluding intra-port ferries), which are the primary focus of Australian ports. Naval ships, fishing vessels and recreational boating activities are excluded from the general definition.

Table 4.1 identifies the port-related activities covered by the general definition. The list was developed for the Port of Fremantle case study and may need to be amended for studies of other ports which have different institutional arrangements and cargo patterns. For example, certain activities such as container stevedoring are not undertaken on a significant scale at some Australian ports. Other activities, such as expenditure by cruise ship passengers or crews from visiting naval vessels, may be included in a port impact study in response to local requirements.[9]

9 Airport impact studies often include, as a direct effect, estimated expenditure by passengers who are normally resident outside the region. A similar approach is not usually adopted in port impact studies as many ports do not handle significant numbers of passengers. However, cruise ship activities (and associated passenger expenditure) are significant at several Australian ports.

TABLE 4.1 TYPICAL COMPONENTS OF THE PORT INDUSTRY

Categories	Activities/components
Port authority/corporation operations	Planning, co-ordination and promotion
	Land and property management
	Safety and emergency response
	Shipping channels and navigation aids
	Port authority wharves, berths, jetties, etc[a]
	Infrastructure for roads and utilities
Ship operations	Shipping lines/agents
	Pilotage
	Towage
	Line boats
	Mooring/unmooring
	Bunkering
	Ship supplies[b]
	Ship repairs and maintenance[c]
	Container repairs[d]
	Container maintenance and servicing
Ship loading and unloading	Private wharves, berths, jetties etc[a]
	Container and break bulk stevedoring
	Livestock stevedoring
	Bulk cargo loading/unloading
	Passenger terminals
Cargo services	Customs brokers
	Freight forwarders
	Container packing/unpacking
	Cargo surveyors
	Wool dumping
	Fumigation
Land transport and storage[e]	Road transport
	Rail transport
	Transfer between road/rail and storage facilities
	Storage
Government agencies	Customs
	Quarantine
	Ship safety
	Port safety
	Environmental management
	Port policy administration

a. Operation and maintenance.
b. Sometimes called chandlering or providoring. Excludes supplies to commercial fishing and recreational boating.
c. Only for vessels in the port for the purpose of bringing in or taking out cargo or passengers.
d. Includes container parks/depots.
e. Involves movement of cargo within the port, movement of cargo between the port and closest inland points (eg warehouses, bonded storage, other storage facilities), and port-related storage.

Source BTE analysis.

Some of the activities identified in table 4.1 involve firms that are located outside the physical boundaries of the port (eg road transport operators). The activities of these firms may comprise a significant component of the port industry.

The definition developed for the general framework is consistent with the broad approach used in the major Australian port impact studies (Sydney, Brisbane and Fremantle). It focuses on the impact of activities required for the operation of the port and does not include the effects on shippers. Inclusion of shippers would substantially increase the size and complexity of port impact studies. In addition, it is difficult to accurately estimate the effects of a major port on the transport costs and outputs of local shippers (see chapter 5).

Region

The region for assessing the flow-on effects of a port should be specified at the beginning of the study. Major options include the city or town where the port is located, the adjacent shire or group of shires, or the State/Territory in which the port is located.

The region used in the analysis will reflect the interests of the primary audience for the study and the availability of data (eg input-output tables). The hinterland served by the port will also be a relevant factor. As input-output tables are not available for all regions of Australia, additional time and resources will be required if tables have to be prepared for a particular study.

Period covered by study

The estimates of port impact typically cover a period of one year. It is generally desirable to use the most recent year for which key data are available. Firms should be able to provide data about their operations for the previous financial year if the survey or interviews are conducted from September onwards. Input-output tables are often at least several years old, but can be adjusted so that they are consistent with the survey data (see later discussion).

If the year covered by the study is atypical (eg due to a large but temporary surge in trade), this factor should be mentioned prominently in the report.

Impact measures

The impact measures should be decided at the beginning of a port impact study as they will affect the structure of the survey

questionnaire and the process of modifying the input-output tables. The decision will be affected by the objectives of the study, the interests of the primary audience and data availability.

Measures

The terms of reference for this study specified that economic impact should be reported in terms of five measures of activity. All of these measures are potentially of interest to decision-makers and local communities. They are regularly included in Australian and overseas port impact studies.

Output is the gross revenue of the sector being analysed. This measure should be interpreted with some caution as it includes inputs produced inside the region and inputs produced outside the region. As a result, output does not indicate the net contribution of port-related activities to a regional economy.

Value-added represents the payments to the primary inputs of production (ie land, labour, capital). It is generally equal to gross revenue minus the cost of intermediate inputs into production and imported goods and services. Value added is of particular use because it can be directly compared to gross regional product, thereby providing an indicator of the port's relative contribution to the regional economy.

Household income provides a measure of wages, salaries and other payments to people working in the sector being analysed. It typically includes income tax and overtime payments but excludes payroll tax.

Employment indicates the number of working proprietors, managers, directors and other employees in the sector being analysed. It is usually expressed in terms of the number of full-time equivalent jobs.

Payments to governments include taxes and other payments such as local government rates and charges. It may be appropriate to focus on payments to levels of government that are consistent with the region being studied.

Impact components

Information on the major components of port impact can provide additional assistance to decision-makers and the local community. For example, estimates of the impact of container traffic may be useful if there is community debate about road transport of containers through urban areas.

A study of a major port will typically identify some or all of the following components of port impact:

- port functions (eg ship operations, land transport and storage);
- commodities (eg wheat, alumina, oil);
- cargo types (eg containers, other general cargo, liquid bulk);
- major areas of the port.

Most studies will also provide information on the major industry sectors that are affected by the flow-on effects.

The extent and basis of the disaggregation of port impact will reflect the characteristics of the port, the requirements of the intended audience for the study, and data availability. A lower level of disaggregation will often be appropriate for smaller ports or for ports that handle only one or two commodities.

DATA COLLECTION

A port impact study based on the standard approach in the general framework incorporates data on port-related activities, a set of input-output tables, and other information.

Survey

Data on port-related activities are required for the estimation of the direct effects and to modify the input-output tables so that port-specific multipliers can be calculated. The key source of these data is a survey of all significant organisations involved in port-related activities.

One of the questionnaires developed by the BTE for the Fremantle case study is contained in appendix III. The major data collected through the survey include:

- number of employees;
- current operating expenses, by major expenditure item and location;
- total revenue attributable to port-related and other activities;
- port-related revenue attributable to customers inside and outside the region;
- port-related revenue by port function, cargo type, commodity and areas of the port.

Data on fixed capital expenditure should also be collected if the study is to include information on the impact of capital works projects.

As the survey is used to collect sensitive and detailed data (eg on firms' costs and revenues), there is always a risk of a low response

rate. If the response rate is low, less accurate data (eg industry averages obtained from public documents) will have to be used for large parts of the study.[10]

Survey design and administration are therefore key components of a port impact study, and should be carefully planned in the early stages of the study. The survey questionnaire must be concise and readable. If possible, a pilot survey should be undertaken to obtain industry comments on the clarity of the questionnaire and on the likely availability of data. The questionnaire should be accompanied by a covering letter that emphasises the confidentiality of individual returns. Given the detailed (and confidential) nature of the questionnaire, telephone follow-up and some on-site interviews will generally be necessary to obtain a satisfactory response rate.

Questionnaires should be sent to all organisations that have significant port-related activities. The port authority/corporation will generally have a major role in developing the mailing list, both in terms of identifying the relevant organisations and keeping the list to a manageable size. Alternative sources of names and addresses include relevant industry associations, trade journals, industry participants and telephone directories. Resource constraints will usually mean that some smaller operators (eg owner-drivers who occasionally provide road transport services to or from the port area) will not be included in the survey.

As a survey requires significant resources, a simpler approach to data collection may be considered in some circumstances. Examples include small ports, ports that handle only one or two commodities, and situations where the time and resources for the study are limited. In these cases, data on direct effects might be obtained through alternative approaches such as interviews with a small number of key stakeholders (eg the port authority/corporation and major shippers).

Input-output tables

If recent input-output tables are available for the region, these tables can be used to obtain the multipliers. As noted in chapter 2, input-output tables are available for all Australian States and for some smaller regions.

10 The response rates reported in previous Australian port impact studies have ranged from 36 per cent to 76 per cent (McLeod & McGinley 1992, p. 29; Morison & Jensen 1987, p. 27).

In some cases, the available tables may be relatively old. As the structure of a regional economy (and therefore the underlying multipliers) may change over time, use of an older table may result in over- or under-estimates of the flow-on effects. There are two options for obtaining more recent tables:

- Generate new regional tables, by modifying the national input-output tables or by using survey methods to construct completely new tables.
- Update the existing regional tables, using more recent data on production and employment in the region.

The approach adopted in each situation will be affected by the time and resources available for the study. Generation of new tables is the more expensive and time-consuming option. Alternatively, it may be acceptable to use older tables if the analyst considers that economic relationships in the region have not changed significantly since the tables were prepared.

Other data sources

In most studies, the survey data will not cover all of the organisations undertaking port-related activities (eg some road transport operators). It may therefore be necessary to adjust the survey data so that total revenue and total expenditure can be estimated. One approach is to use market share estimates provided by firms that respond to the survey, with the survey totals being multiplied by the inverse of the market shares. Alternatively, total revenue may be calculated using estimates of total traffic for the activity (eg tonnages carried by road transport) and average charges.

Information on port-related revenue by function, cargo type, commodity and/or port area is required for the preparation of disaggregated impact measures. The survey typically provides these data for some firms. However, it will also be necessary to obtain additional information from sources such as the ABS.

As there is usually a lag of several years in the publication of input-output tables, data collected through the survey will typically cover a later year than the input-output tables. Appropriate price indexes are therefore used to align the tables with the port data.

DATA PROCESSING AND ADJUSTMENT

After the data have been collected, they are systematically recorded and processed.

Database

The port industry data are entered into a database using a standard computer spreadsheet or database program. The database should be designed so that it can be easily manipulated, checked and used to modify the input-output tables. The data management strategy should also incorporate measures (eg secure storage of completed forms and coding of data entries) to protect confidential data provided by individual organisations.

Modification of input-output tables

As noted in chapter 2, input-output tables, incorporating rows and columns for the relevant port industry, provide the most rigorous multipliers. They also facilitate calculation of multipliers for individual port functions, cargo types, commodities and port areas. This is the preferred approach for impact studies.

Modification of the existing input-output tables is usually required as they do not separately identify the relevant port industry. Figure 4.2 summarises the major steps required to modify input-output tables so that they can be used to generate port-specific multipliers.

The survey data, and other information such as financial statistics and rates for fuel taxes, are used to estimate the transactions between sub-sectors of the port industry and between the port industry and other industries. The transactions data are then incorporated into the input-output tables. A modified transactions table is prepared for each form of disaggregation. For example, one of the transactions tables will have a separate row and column for each function (port authority/corporation operations, ship loading and unloading, etc). In addition, there is an aggregated table that includes a single row and column for the port industry.

The modified tables should be checked to ensure that they are correct and internally consistent.

Calculation of multipliers

The modified input-output tables are used to calculate the port-specific multipliers. Additional data (eg revenue per employee) are required for the estimation of the employment multipliers.

Figure 4.3 indicates the major steps involved in calculating and applying the multipliers. The modified transactions tables are first converted to tables of direct requirements coefficients by dividing each column entry by the associated column total. The inverse matrix for each table is then estimated, using the open model for indirect

FIGURE 4.2 MODIFICATION OF INPUT-OUTPUT TABLES

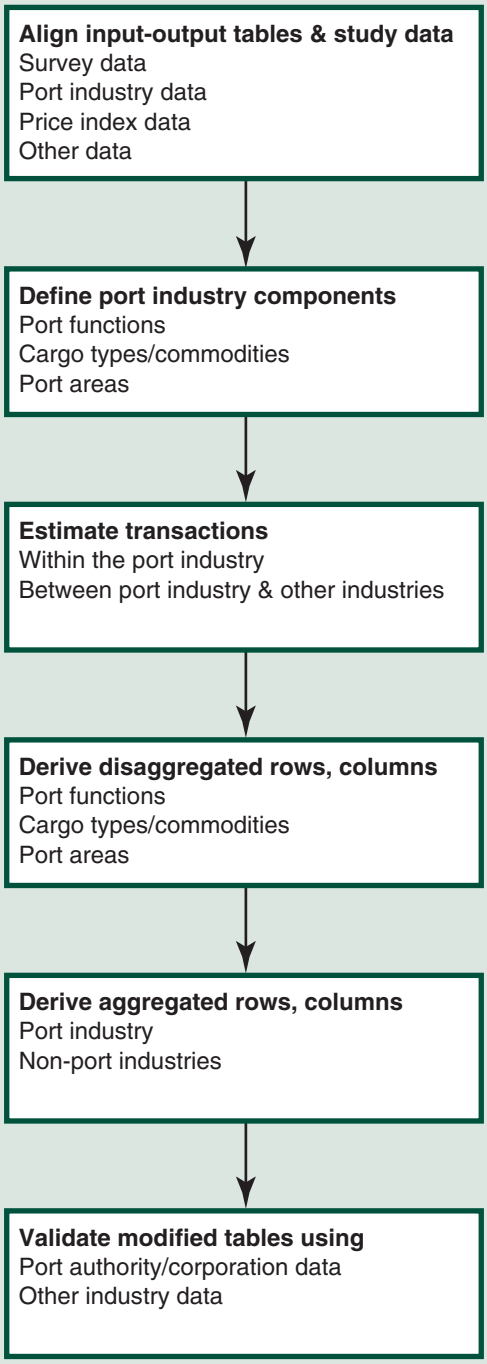
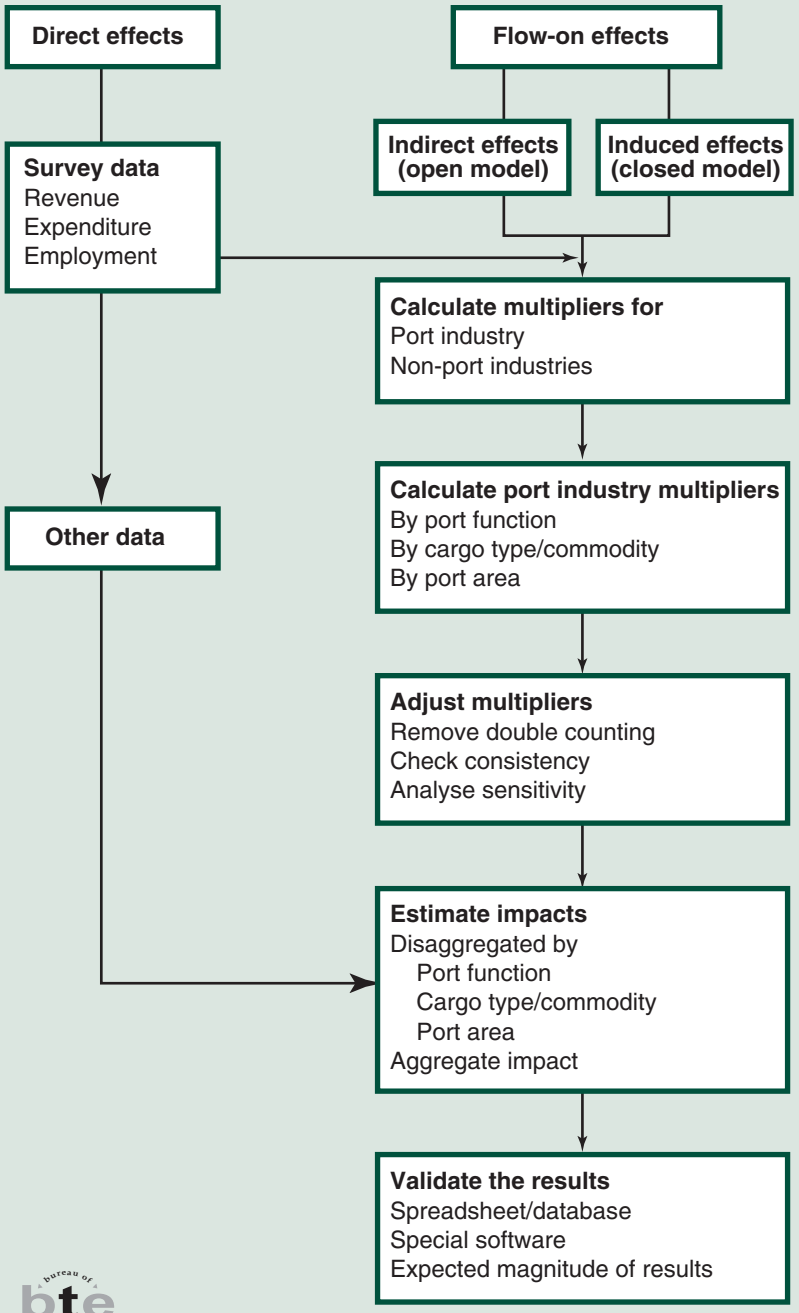


FIGURE 4.3 CALCULATION OF MULTIPLIERS AND PORT IMPACT



effects and the closed model for induced effects[11]. Tables of multiplier coefficients are derived from these inverse matrix tables, using vector analysis.

Less resource-intensive methods (eg multipliers from other port impact studies or for broader industry sectors) may be appropriate in some circumstances. These methods potentially involve significant mis-estimation of economic impact as actual multipliers can differ considerably between ports and between industries.

The port industry survey provides data on payroll tax, local council rates, charges for water and sewerage, and motor vehicle registration. Indirect methods are generally required to calculate other payments to governments. For example, personal income tax payments can be estimated using the survey data on average earnings and total port-related employment, and official tables for average tax rates. Alternatively, total payments to governments can be calculated by combining the estimates of port impact with published data on ratios of aggregate government revenue to gross regional product.

PREPARATION OF IMPACT ESTIMATES

The multipliers are applied to the estimates of direct effects to calculate the flow-on effects of the port[12]. Total impact is the sum of the direct and flow-on effects.

Multipliers calculated from modified input-output tables enable the analyst to provide disaggregated measures of port impact. The flow-on effects can also be identified by industry sector.

The multipliers and the estimates of port impact should be checked to ensure that they are internally consistent and of the correct magnitude. Methods that can be used include comparison with multipliers and impact estimates obtained in other port impact studies. Survey data (eg average employment and earnings in specific

11 In the 'closed' model, the household row (wages, salaries and supplements) and the household column (consumption expenditure) are transferred to the intermediate usage quadrant and counted as part of the productive system. In the 'open' model, households are treated as being independent of production.

12 The multipliers for a pre-existing activity, such as an established port, are estimated from the input-output tables on the basis that there is no expansion in final demand. This approach was used by the BTE in the Fremantle case study. Use of traditional multipliers, which assume an increase in final demand, would result in over-estimation of the flow-on effects. For further discussion of this issue, see West (1999, pp. 3-9).

activities) will also provide some insights into the likely magnitude of aspects of the impact estimates.

OTHER IMPACTS

Local factors may sometimes result in a requirement for information about the impact of capital expenditure, cruise ships or naval vessels. This analysis will be additional to the requirements of the general framework.

Capital expenditure

Projects such as the construction of new berths at a port may have substantial effects on employment and income in a regional economy. The initial effects involve contractors and materials during the construction phase. There will also be effects during the operating phase, particularly if increased capacity provided by the capital expenditure is used to move additional cargo through the port.

Capital expenditure at individual ports tends to vary significantly from year to year. This type of expenditure is not usually included in an economic impact study, as input-output tables focus on recurrent expenditure.

The direct and flow-on effects of capital expenditure will be affected by the characteristics of each project. For example, with a particular amount of expenditure, construction of a berth using local labour and materials would typically have a larger impact on the regional economy than the installation of portainer cranes manufactured outside the region.

The impact of new capital expenditure at a port should therefore be assessed on an individual project basis. The analysis will ideally be based on cost and employment estimates provided by contractors involved in the project or by the organisation undertaking the expenditure (eg the port authority/corporation). Project-specific multipliers can be prepared using data on the major expenditure items.

This approach focuses on the impact of the construction phase only. As noted earlier, capital expenditure may result in increased capacity which in turn will facilitate a higher level of trade through the port. Estimation of the on-going impact of increased port activity, which would be additional to the temporary impact of the construction phase, is discussed in chapter 5.

Visiting cruise ships

Expenditure by passengers from visiting cruise ships may also have a significant impact on the regional economy. This is most likely to occur where the port has relatively frequent visits by cruise ships or the region is small.

Detailed data on the annual number of passengers, average expenditure per passenger and typical expenditure patterns are required to develop rigorous impact estimates[13]. This information would enable the analyst to accurately estimate the direct effects and to prepare relevant multipliers.

In practice, data and resource limitations mean that the analysis will usually be based on general expenditure patterns by cruise ship passengers. Multipliers can be estimated from the input-output tables for the region, using weighted averages for the major items of passenger expenditure.

Visiting naval vessels

The general framework described in this chapter focuses on commercial trading vessels. Activities associated with naval bases are therefore excluded.

Visits by foreign or Australian naval vessels may have significant effects on a regional economy. The significance of the effects will depend on the frequency of the visits, crew numbers and the size of the region.

The major impacts on the regional economy are likely to involve acquisition of fuel and provisions, and expenditure by ships' crews while they are ashore. The regional impact will therefore be estimated using an approach similar to that proposed for visiting cruise vessels.

Information on crew numbers and typical expenditure can be obtained from the relevant naval authorities[14]. Multipliers can be estimated from the input-output tables for the region, using weighted averages for the major items of crew expenditure.

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13 The data need to be converted from purchasers' prices to producers' prices. This involves adjustments for indirect taxes, imports, and retail and transport margins. If the data are not converted to producers' prices, the impact of the expenditure will be over-estimated.

14 The data need to be converted from purchasers' prices to producers' prices. If this is not done, the impact of the expenditure will be over-estimated.

MAIN POINTS—GENERAL FRAMEWORK

- The general framework is intended to facilitate soundly-based port impact studies that are prepared on a consistent basis for Australian ports.
- The standard approach incorporates a detailed survey of organisations involved in port-related activities, and input-output tables that have been modified to provide port-specific multipliers.
- A limited study may be appropriate for analysing a small or specialised port, for obtaining indicative impact estimates, or where data or resources for the study are limited.
- A port impact study will generally be undertaken by an external analyst, but the port authority/corporation will also need to commit significant resources to the study.
- The definition of the port industry in the general framework incorporates all activities that are required for the movement of commercial ships, cargoes and passengers through the port.
- The region and the impact measures to be used in the analysis should be specified at the beginning of the study.
- The impact measures will generally include output, value added, household income and employment.
- Information on payments to governments may also assist decision-makers and the local community.
- Local factors may sometimes result in a requirement for additional analysis (eg the impact of visiting naval vessels) that is not included in the general framework.

5

REPORTING THE RESULTS

Various organisations and community groups are potentially interested in the results of a port impact study. They include:

- the port authority/corporation, which often commissions the study;
- members of the local community, particularly people living adjacent to port areas;
- investors;
- users of the port;
- organisations involved in port operations;
- governments; and
- government agencies.

The results of a port impact study should be reported in a format that meets the requirements of the intended audience. The published information should also facilitate correct interpretation of the results.

COVERAGE OF REPORT

A written report is generally used to present the results of a port impact study. Other material, such as a separate summary of the key findings, may also be used to disseminate the results to interested organisations and community groups.

The report should be written in a clear style and the content should be easily understood by the intended audience. It should include detailed data on port impact as well as relevant technical material (which may involve technical appendixes or separate technical reports). Transparency is a key requirement as readers should be able to assess the rigour of the estimates.

The structure of a report for a port impact study will be affected by the terms of reference and by the requirements of the intended audience. However, a report should generally include:

- an executive summary that presents the main findings;
- an overview of the port (eg location, facilities, institutional arrangements, trade patterns) and its links to the regional economy;
- a clear description of the method used to estimate economic impact;
- key definitions, including the port industry and the region;
- a description of the major data and assumptions used in the study;
- details of the survey of organisations involved in port-related activities (eg the questionnaire, number of organisations contacted, response rates);
- an overview of the process used to obtain the multipliers (including the input-output tables and how they were modified);
- separate estimates of the direct effects, flow-on effects and total impact;
- disaggregated impact estimates, as specified in the terms of reference; and
- information to facilitate correct interpretation of the results.

It will often be appropriate to provide a broader context for the study results. For example, the value added and employment associated with a port may be compared with the corresponding State or national totals for these impact measures.

In many cases, a draft report should be circulated to key stakeholders for comment. This provides an opportunity to check the accuracy of the material and to incorporate appropriate amendments or additional information.

The case study for the Port of Fremantle in chapters 6 to 9 illustrates one possible structure for reporting the results of a port impact study. However, as the case study uses supporting material from chapters 2 to 4, it may be less detailed in some areas than a typical stand-alone port impact study.

INTERPRETING THE RESULTS

One approach to port impact analysis involves the net reduction in activity that would occur if the port did not exist. This approach

would take into account the output, income and employment that would be produced by port resources if they were used in other activities. Montalvo (1998, p. 183) calls this the 'differential estimation approach'.

In principle, this approach could be implemented by assuming that the port had never been established or by hypothetically removing the port from the region's existing economy (and reallocating the resources to other uses). However, as a region's development typically relies heavily on its port, it is not possible to accurately identify the economic structure that would have developed in the absence of the port. Estimating the effects that would result from removal of the port is also difficult as the associated changes in transport costs, industry location decisions and output would be complex.

Economic impact studies therefore focus on what Montalvo (1998, p. 184) calls the 'estimation of the economic impact as it is produced'. This approach is adopted in the general framework. A port impact study will therefore measure the output, employment and income that are generated by organisations undertaking port-related activities. It will not include the impact of the services provided by the port (eg the effects on shippers that use the port).

The estimates of regional economic impact do not indicate the net effects on the broader (eg national) economy. Impact in the region being studied may be offset by reduced activity in other regions from which resources are drawn. Broader effects (eg exchange rate movements), which are not incorporated in the analysis, may also result in offsetting changes in economic activity in other parts of the national economy.

It is important to accurately identify the relationship between economic impact and other concepts that are sometimes used to describe the effects of a port. The following sections discuss these concepts in terms of benefits, efficiency, competitiveness, trade facilitation, regional development and inter-port comparisons. Techniques other than economic impact analysis should be used to measure these effects, although in some cases the effects cannot be reliably quantified due to data limitations.

Benefits

A port impact study does not indicate the net economic benefits attributable to the operation of the port. Economic impact involves effects on output, income and employment, whereas economic benefits are measured in terms of changes in consumer surplus

and producer surplus[15]. Burns and Mules (1985, p. 74) cite the example of an increase in the level of road accidents, which would result in a higher economic impact (through increased use of hospital services, panel beaters, etc) but no increase in economic benefits to the community.

The assessment of the economic benefits associated with a particular activity is usually undertaken using cost-benefit analysis. This involves the estimation of the current monetary value of all social welfare effects (ie benefits and costs from the viewpoint of society) that would be associated with the activity over time. The potential benefits of alternative projects that would be undertaken if the resources were available for other uses (ie the opportunity cost of these resources) are also incorporated in a cost-benefit study.

Efficiency and competitiveness

The technical efficiency of an activity increases if the amount of resources required per unit of output declines. Typical measures of efficiency include output per hour and the average time taken to produce a unit of output.

A port impact study does not measure efficiency. On the contrary, a large economic impact may be indicative of inefficiency. For example, a study of an inefficient port, that uses excess amounts of labour and capital, would indicate a larger regional impact than a study of the same port if it was more efficient. Alternatively, increased efficiency may result in a reduction in the economic impact of a port over time, as measured by port impact studies.

It should also be noted that a port impact study does not indicate the competitiveness of a port relative to other modes of transport or other ports. An assessment of competitiveness would incorporate performance measures for the port and competing facilities. Potential measures include charges per ship visit, ship turnaround times, and cargo dwell times.

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15 Consumer surplus is the difference between the amount that a consumer would be prepared to pay for a particular good (rather than go without it) and the amount that the consumer actually pays for the good. It is measured by the area between the demand curve and the current price.

Producer surplus is the amount by which the total earnings of a supplier exceed the payment that would be required to induce the supplier to maintain the current level of supply. It is measured by the area between the supply curve and the current price.

Trade facilitation

The results of a port impact study do not indicate the extent to which the port facilitates trade. Estimation of these effects involves a comparison of trade flows with the port and without it. Such an analysis requires detailed information about the impact on shippers that use the port.

In practice, it is difficult to accurately estimate the level of trade that would occur if a particular port did not exist. In the absence of the port, there would be an alternative economic structure and at least some of the existing trade might be re-directed through other ports. The effects on trade would reflect factors such as the availability of alternative ports, changes in overall transport costs (including land transport access), and the impact of transport costs on location decisions and the competitiveness of shippers.

Contribution to regional development

The contribution of a port to regional development can be considered in terms of the difference between the level of activity with the port and the level of activity that would occur without the port.

The availability of a port will generally provide transport cost savings and other advantages to producers in the surrounding region. The resulting improvement in transport access, compared with the use of an alternative port, may attract new industries to the region and facilitate an expansion of output by existing producers. In addition, the output, income and employment generated by port-related activities will provide flow-on effects to other industry sectors in the region.

Regional development will therefore be promoted through increased local production (stimulated by the availability of port infrastructure) and the flow-on effects of port-related activities. A port impact study based on the general framework will measure only the second of these effects.

Inter-port comparisons

Caution should be used in comparing the results of individual port impact studies. As noted in chapter 3, there is significant variation in the approaches that are used in individual studies, and this will affect the validity of any comparisons that are made. Areas where major differences can occur include the definition of the port industry, whether shippers are included in the analysis, and the method used to estimate the multipliers.

Even where two studies are based on the general framework, there may be significant differences in aspects such as the size of the region used to estimate the flow-on effects. Comparability may also be affected by differences in data sources, survey response rates, and the years covered by the studies.

Adding the results of individual port impact studies is unlikely to involve double counting if each study focuses on port-related activities only and covers a single port. Summing the figures for all ports in Australia would result in a compendium of the impact of individual ports on their regions. A rigorous estimate of the national impact of ports would require national data and a national model (eg input-output tables).

ACCURACY OF THE RESULTS

A port impact study indicates the general magnitude of the effects associated with a port. It does not provide precise estimates, as only approximate data are available for parts of the analysis and the use of input-output tables involves an element of judgement by the analyst.

The results are also affected by the assumptions incorporated in input-output analysis (see chapter 2) and by the analyst's decisions in areas such as the conduct of the survey, the modification of the input-output tables and the estimation of the multipliers. A limited study, involving approximations such as multipliers taken from other studies, will generally have a lower level of accuracy than a more comprehensive study.

IMPACT OF INCREASED PORT ACTIVITY

An increase in the level of activity at a port will potentially lead to a higher economic impact. For example, a significant increase in trade will generally result in a requirement for more resources to provide port-related services, with flow-on effects to the regional economy.

The results of a port impact study may provide useful data for estimating the impact of increased activity. However, such estimates should not be based on a mechanistic application of relationships from the study.

The multipliers obtained from regional input-output tables effectively represent average relationships between port-related and other activities. They are not the same as the marginal relationships that should ideally be used to estimate the potential impact of changes in the level of port activity.

A given increase in activity will result in a less than proportionate rise in port impact in many cases, particularly where there are economies of scale or excess capacity. However, if the port is congested or there are insufficient quantities of some factors of production (eg cranes), increased activity may lead to a more than proportionate increase in port impact.

There is also significant variation in the impact per unit for individual cargo types. This reflects differences in handling methods which in turn require different amounts of labour, materials and service inputs. Information on the composition of increased trade flows is therefore required for a rigorous estimate of the impact of increased port activity.

In practice, estimation of the impact of a particular increase in port activity should include the views of the suppliers of port-related services about the effects on their activities. This will provide information about the likely direct effects. Estimation of the flow-on effects will probably be based on the multipliers (for relevant commodities) calculated in the port impact study, with adjustments being made to incorporate any other information available to the analyst (ie marginal relationships relative to average relationships).

MAIN POINTS—REPORTING THE RESULTS

- The results of a port impact study should be presented in a format that meets the requirements of the intended audience.
- A study based on the general framework will indicate the output (including value added), employment and income generated by port-related activities in a recent year.
- It will not measure net economic benefits, technical efficiency, competitiveness, trade facilitation effects or the contribution of port infrastructure to regional development.
- A port impact study indicates the general magnitude of the effects associated with a particular port, and does not provide precise estimates.
- The estimates of regional economic impact will not indicate the net effects on the broader (eg national) economy, as there may be offsetting reductions in activity in other regions from which resources are drawn.
- The results of a port impact study may provide useful data for estimating the impact of increased port activity, but the analysis should also take account of factors such as the commodities involved and existing capacity utilisation.

PART B – FREMANTLE CASE STUDY

6

THE PORT OF FREMANTLE

The Port of Fremantle is located on the west coast of Australia, about 20 kilometres from central Perth. It is the largest general cargo port in the State of Western Australia and is one of Australia's major bulk cargo ports. Around 23.5 million tonnes of cargo were shipped through the Port of Fremantle in 1998–99.

The port handles around 93 per cent (by value) of seaborne imports into Western Australia and 34 per cent (by value) of the State's seaborne exports (FPA 1999c, p. 2). Traffic comprises overseas cargoes, with a total value estimated at $11.3 billion in 1997–98, and coastal cargoes. The efficiency of the port has major effects on cost structures, industry competitiveness and living standards in Western Australia.

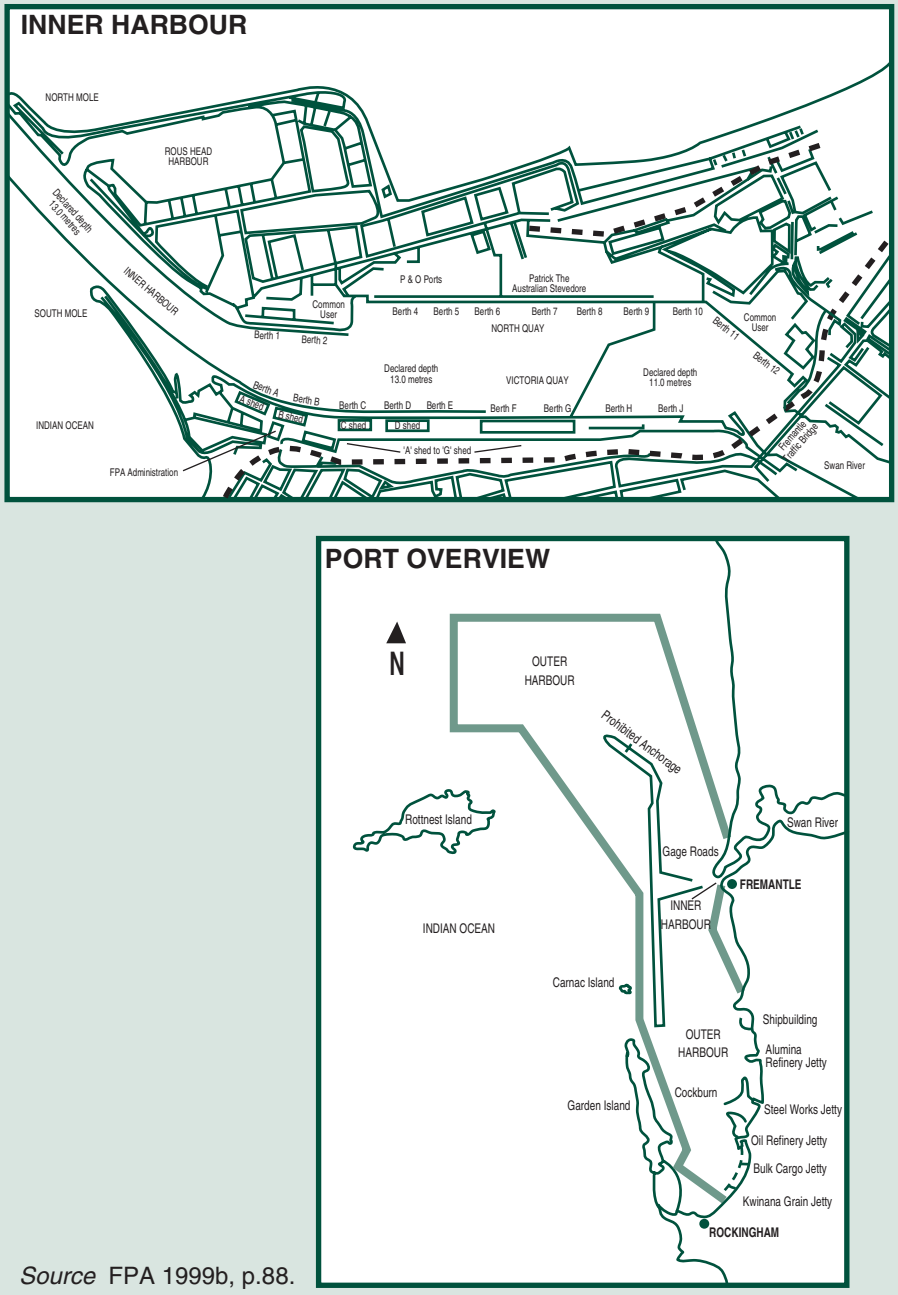
Containerised traffic shipped through the Port of Fremantle involves origins and destinations in many parts of Western Australia. Bulk cargoes exported through the port are generally sourced from the south-west region of the State. Many bulk cargo imports are processed in areas adjacent to the port, either for subsequent shipment to other parts of Western Australia or for export.

The Port of Fremantle competes with several other ports in Western Australia, mainly for bulk cargoes. It also handles some overseas containers that have an interstate destination, as landbridging can provide significant transit time savings for certain high-value commodities.

INFRASTRUCTURE AND FACILITIES

The Port of Fremantle comprises two areas, the Inner Harbour and the Outer Harbour. Figure 6.1 provides an overview of the major facilities at the port.

FIGURE 6.1 MAJOR FACILITIES AT THE PORT OF FREMANTLE



Source FPA 1999b, p.88.

Inner Harbour

The Inner Harbour, which was initially established in 1897, is located within the entrance waters of the Swan River. It contains facilities for handling containers, break bulk cargoes, livestock and motor vehicles.

There are seven heavy-duty container berths and ten common user berths at the Inner Harbour (FPA 1998, p. 2). Facilities are also provided for cruise ships, visiting naval vessels and commercial fishing boats.

The Inner Harbour handled 4.3 million tonnes of cargo in 1998–99 (FPA 1999b, p. 86). This represented 18 per cent of the total tonnage moved through the port in that year.

The proportion based on cargo value would have been substantially greater, due to the relatively high average value per tonne of many non-bulk cargoes. Using average cargo values derived from the ABS international cargo statistics, the BTE estimates that the Inner Harbour handled around 60 per cent of the port's cargo (by value) in 1998–99.

The Inner Harbour accounted for 62 per cent of visits by commercial ships (ie excluding naval vessels) at the Port of Fremantle in 1998–99.

Outer Harbour

The Outer Harbour is located at Kwinana/Cockburn Sound, 20 kilometres south of the Inner Harbour. It comprises five jetties and associated facilities for the storage and handling of bulk cargoes. The major traffics include crude oil and petroleum, grain, alumina, caustic soda, mineral sands and fertilisers.

The Outer Harbour handled 19.2 million tonnes of cargo in 1998–99 (FPA 1999b, p. 86). This represented 82 per cent of the total tonnage moved through the Port of Fremantle.

The proportion based on cargo value would have been significantly smaller, reflecting the relatively low average value per tonne for bulk cargoes. Using average cargo values derived from the ABS international cargo statistics, the BTE estimates that the Outer Harbour handled around 40 per cent of the port's cargo (by value) in 1998–99.

The Outer Harbour accounted for 38 per cent of visits by commercial ships (ie excluding naval vessels) at the Port of Fremantle in 1998–99.

Other facilities

The Inner Harbour and the Outer Harbour are serviced by road links to Perth and to other parts of Western Australia. They are also connected to the interstate and intrastate rail networks.

The port area includes various facilities that are used for activities other than the movement of ships and cargo. Some of these facilities are located on land that is controlled by the Fremantle Port Authority.

The Rous Head area near the Inner Harbour contains a commercial boat harbour and industrial land. The land is used by various marine-related businesses and light industry (eg boat building, aquaculture). Other facilities near the Inner Harbour include a yacht marina and a fishing boat harbour, which are administered by the Department of Transport.

Major storage and processing facilities are located on industrial land near the Outer Harbour. The activities undertaken in this area include oil refining, alumina refining, grain storage, ship building, and production of chemicals.

CARGO AND TRADE PATTERNS

Table 6.1 presents information on shipments of cargo through the Port of Fremantle over the 10 years to 1998–99. Total traffic

TABLE 6.1 CARGO SHIPPED THROUGH THE PORT OF FREMANTLE, 1989–90 TO 1998–99

('000 tonnes)

Year	Bulk cargoes	Non-bulk cargoes	Total
1989–90	15 696	1 926	17 622
1990–91	14 595	1 737	16 332
1991–92	15 235	1 964	17 199
1992–93	16 135	2 154	18 289
1993–94	17 460	2 548	20 008
1994–95	17 563	2 796	20 359
1995–96	17 125	2 937	20 062
1996–97	18 753	3 183	21 936
1997–98	18 195	3 606	21 801
1998–99	19 588	3 901	23 489

Source FPA (1999b, pp. 25-28) and earlier issues. FPA (pers. com. Sep. 1999).

increased at an average rate of 3.2 per cent per annum over this period. The increase in 1998–99, compared with the previous year, was 7.7 per cent.

Major commodities

Table 6.2 provides information on major commodities handled at the port over the five years to 1998–99. It indicates that, in tonnage terms, around 70 per cent of the traffic involved crude oil and petroleum products, grain and alumina.

TABLE 6.2 MAJOR COMMODITIES HANDLED AT THE PORT OF FREMANTLE, 1994–95 TO 1998–99

('000 tonnes)

Commodity	1994–95	1995–96	1996–97	1997–98	1998–99
Exports					
Grain	3 966	4 306	4 000	3 977	5 166
Alumina	2 667	2 669	2 715	2 825	2 952
Refined petroleum	2 529	2 164	2 831	2 501	2 538
Silica sands	479	412	326	399	357
Sulphuric acid	–	–	234	388	207
Animal feeds	225	226	215	242	300
Metal scrap	154	193	196	201	183
Sheep	194	221	198	180	207
Other	1 653	1 522	1 862	2 069	2 088
Total exports	11 867	11 713	12 577	12 782	13 998
Imports					
Crude petroleum	4 763	4 066	4 858	4 563	4 932
Refined petroleum	794	1 357	1 142	1 102	886
Phosphate	357	364	539	458	461
Caustic soda	428	505	491	385	521
Cement clinker	329	285	366	321	146
Chemicals & related products	153	155	199	229	204
Urea	150	114	175	171	227
Manufactures of metal	35	43	63	158	137
Other	1 486	1 460	1 526	1 632	1 977
Total imports	8 495	8 349	9 359	9 019	9 491

– Separate figure not available.

Source FPA (1999b, pp. 26-28) and earlier issues. FPA (pers. com. Sep. 1999).

Tonnages for most commodities have increased since 1994–95. In addition, the Port of Fremantle has attracted some new traffics, such as sulphur and sulphuric acid. However, there have been declines in shipments of cement clinker and silica sands, and little change in exports of refined petroleum.

Bulk cargoes

Bulk cargoes account for the majority of traffic (on a tonnage basis) at the Port of Fremantle. Shipments in 1998–99 totalled 19.6 million tonnes, which was equivalent to 83 per cent of the total tonnage handled at the port in that year. Over 80 per cent of the bulk traffic involved three commodities:

- crude oil and petroleum products (43 per cent);
- grain (26 per cent); and
- alumina (15 per cent).

Non-bulk cargoes

Table 6.3 provides information on non-bulk cargoes shipped through the Port of Fremantle over the last five years.

Shipments of non-bulk cargoes totalled 3.9 million tonnes in 1998–99. Containerised cargo (3.2 million tonnes) accounted for 81 per cent of this traffic. Non-containerised cargoes handled at

TABLE 6.3 NON-BULK CARGOES HANDLED AT THE PORT OF FREMANTLE, 1994–95 TO 1998–99

Cargo type	1994–95	1995–96	1996–97	1997–98	1998–99
Containers					
Teus ('000)	189	198	210	251	276
Tonnes ('000)	2 231	2 263	2 451	2 794	3 156
Livestock					
Number ('000)	3 909	4 476	4 023	3 689	4 100
Tonnes ('000)	207	250	228	222	261
New motor vehicles					
Tonnes ('000)	53	49	53	70	64
Other non-bulk cargoes					
Tonnes ('000)	305	375	358	520	421

Source FPA (1999b, pp. 26-29) and earlier issues. FPA (pers. com. Sep. 1999).

the port included metal scrap, live sheep and cattle, metal manufactures and new motor vehicles.

Container traffic at the Port of Fremantle reached 275 697 teus in 1998–99, a rise of 9.9 per cent compared with the previous year. Growth in container traffic has averaged 10.9 per cent per annum over the period since 1991–92. In 1998–99, the Port of Fremantle handled around 10 per cent of the containers shipped through Australia's mainland capital city ports (BTE 1999, p. 15).

Cargo origin and destination

Table 6.4 provides information on the origins and destinations of cargo shipped through the port in 1998–99. Around 84 per cent of the cargo involved the overseas trades, with the major origins/destinations being Asia and the Middle East. Coastal traffic was evenly divided between intrastate and interstate cargo.

TABLE 6.4 ORIGINS AND DESTINATIONS OF CARGO HANDLED AT THE PORT OF FREMANTLE, 1998–99

(per cent)

Country/region	Outbound	Inbound	Total traffic
Asia			
Indonesia	4.3	13.1	7.9
Japan	9.5	3.8	7.0
Korea	7.7	0.9	4.9
Singapore	3.8	2.6	3.3
China	6.2	1.8	4.4
Malaysia	3.1	2.8	3.0
Other	10.4	19.0	14.5
Total Asia	45.0	44.0	45.0
Middle East	18.0	24.0	20.0
United States	5.0	6.0	5.0
Europe	6.0	3.0	5.0
Africa	7.0	2.0	5.0
Other overseas	5.0	3.0	4.4
Australia			
Intrastate	5.4	11.0	7.8
Interstate	8.6	7.0	7.8

Source FPA (1999b, pp. 83-84) and earlier issues. FPA (pers. com. Sep. 1999).

SHIPPING ACTIVITY

The total number of ship calls at the Port of Fremantle increased from 1724 in 1993–94 to 1887 in 1998–99 (FPA 1999b, p. 16). The average growth rate over this period was 1.8 per cent per annum. Increased calls by commercial vessels outweighed reductions for fishing tenders and naval vessels.

There was a decline of about 1 per cent in the number of ship calls in 1998–99 compared with the previous year. This mainly reflected a fall in activity by fishing vessels, which offset increased calls by commercial vessels.

There were 1771 calls at the Port of Fremantle by commercial vessels in 1998–99. They comprised:

- container vessels (674 calls);
- bulk carriers (420 calls);
- tankers (217 calls);
- livestock carriers (136 calls);
- break bulk/general carriers (107 calls); and
- other ships[16] (217 calls).

In addition, there were 78 calls by non-trading vessels (eg fishing tenders) and 38 calls by naval vessels (including 22 foreign naval vessels) at the Port of Fremantle in 1998–99.

INSTITUTIONAL ARRANGEMENTS

Facilities and services at the Port of Fremantle are provided by the Fremantle Port Authority (FPA) and by private operators. Various other organisations are also involved in activities that affect the operation of the port.

Fremantle Port Authority

The FPA is the strategic port manager. It has responsibility for ensuring that port services and facilities are provided in a reliable, competitive and efficient manner. Its mission is to add value for customers and stakeholders by facilitating trade in a commercial and efficient manner.

16 Vehicle carriers, roll-on/roll-off vessels, multi-purpose ships, passenger vessels, and bunkering only.

The FPA is a Western Australian government trading enterprise. It is constituted as a statutory authority which operates under the Port Authorities Act 1999. This legislation replaced the Fremantle Port Authority Act 1902 and the Ports (Functions) Act 1993.

Since 1991–92, the FPA has undergone a major restructuring aimed at improving its operational and financial performance. Key initiatives have included outsourcing of non-core activities, debt reduction, and a move to a commercially orientated approach. Prices for port services provided by the FPA declined by 22 per cent in real terms between 1993–94 and 1998–99 (FPA 1999b, p. 31).

The FPA is responsible for an area of land and water covering 383 square kilometres. This area includes the Inner Harbour, the Outer Harbour and associated channels but excludes the naval base at Garden Island. The total land area controlled by the FPA is approximately 183 hectares (FPA 1999a, p. 2).

The FPA provides and maintains the following facilities at the port:

- shipping channels;
- navigation aids;
- common user cargo wharves;
- cargo wharves at leased terminals;
- the Fremantle Passenger Terminal;
- road and rail transport infrastructure within the port area;
- moles and seawalls; and
- other port infrastructure such as buildings, water, power and public amenities.

The Bulk Cargo Jetty at Kwinana is owned and operated by the FPA. This facility provides common-user access for the handling of various bulk products including rock phosphate, caustic soda, sulphuric acid, sulphur and petroleum products.

The FPA provides the following services in the port:

- overall port planning and co-ordination;
- ship scheduling and berthing allocation;
- port communications;
- mooring/unmooring services for the Inner Harbour, the Bulk Cargo Jetty and the Kwinana Grain Jetty;
- security services;
- safety, emergency response and hazardous cargo services;
- quarantine and waste disposal services;
- pilot transport; and

- customer information and advice, trade facilitation, marketing and property services.

Revenue earned by the FPA totalled $54.9 million in 1998–99 (FPA 1999b, p. 46). The principal revenue sources were charges on cargo (45 per cent), charges on ships (17 per cent), rentals and leases (15 per cent), shipping services (12 per cent) and charges for port utilities and services (7 per cent).

Operating profit (after income tax equivalent) was $8.4 million in 1998–99. This reflected a rate of return on assets of 8.8 per cent. A dividend of $0.8 million was paid to the State Government for the 1998–99 financial year.

Private operators

Four jetties and associated cargo handling facilities at the Outer Harbour are privately owned and operated. They involve the:

- Alumina Refinery Jetty (Alcoa World Alumina Australia), handling alumina and caustic soda;
- Oil Refinery Jetty (BP Refinery (Kwinana) Pty Ltd), handling crude oil and petroleum products;
- Kwinana Grain Jetty (Co-operative Bulk Handling Ltd), handling grain; and
- Steelworks Jetty (BHP Transport), handling silica sands, liquefied petroleum gas, cement clinker, mineral sands, fertilisers, limestone and other cargoes.

Private operators provide a range of services to shipping lines/agents and shippers at the Port of Fremantle. Some of the major services and operators are:

- stevedoring (Patrick the Australian Stevedore, P&O Ports, Western Stevedores, BHP Transport);
- towage (Stirling Harbour Services);
- pilotage (Fremantle, Kwinana and Cockburn Sound Pilots under contract to the FPA);
- line boats (Harbour Launch Company);
- mooring/unmooring services for some jetties at the Outer Harbour (Stirling Marine Services, Alcoa, BHP Transport);
- bunkering (Fremantle Bunkering Service); and
- ship supplies.

Other organisations

Several Commonwealth agencies undertake port-related activities at the Port of Fremantle. The Australian Customs Service is involved in cargo examination, clearance of ships and cargoes, and enforcement activities. The functions of the Australian Maritime Safety Authority (AMSA) include survey and certification of ships, safety standards and inspection of foreign ships. The Australian Quarantine and Inspection Service (AQIS) undertakes quarantine inspection and related activities.

Various State Government organisations have Fremantle port-related activities, although the direct expenditure involved is generally small. The Department of Transport develops, administers and monitors ports policy in Western Australia. The Department of Environmental Protection is involved in environmental issues. The Department of Minerals and Energy administers public safety legislation for dangerous goods, and provides advice on these matters to the FPA.

PLANNING AND COORDINATION

Several issues, such as urban encroachment and changes in rail access arrangements, will potentially affect the future operation of the Port of Fremantle. Various planning and liaison activities, involving the FPA and members of the port community, provide mechanisms to consider these issues and to facilitate the efficient operation of the port.

Issues affecting the port

Urban encroachment has been identified as one of the major issues facing the Port of Fremantle (FPA 1999a, p. 4). The FPA has therefore been examining land options to help cater for future trade growth and to assist with a buffer for urban encroachment. A Buffer Zone Definition Study, which was started in mid-1999, will identify and assess the impact of port activities on surrounding land uses.

The State Government has released a draft master plan for the redevelopment of the western end of Victoria Quay in the Inner Harbour. Key features of the draft plan include a maritime museum, a waterfront park and promenade, a new ferry terminal, an enhanced technical and further education precinct, and possible commercial developments. Several studies have been undertaken with a view to ensuring that the proposed museum is consistent with a growing and efficient port.

Continued provision of efficient road and rail access is a key issue for the Port of Fremantle. Potential rail loops to replace existing marshalling yards were considered in two studies undertaken in 1998–99.

In May 1999, the State Government announced that it had selected a preferred proponent to develop a private port near James Point in Cockburn Sound. The Government's announced intention was to encourage direct, entirely private, local competition with the Port of Fremantle.

Planning

A comprehensive Port Development Plan is currently being prepared for the FPA. The preparation of the Plan has incorporated traffic forecasts, estimates of existing capacity, and options to increase capacity. The Plan will set the framework for the development of the Port of Fremantle over the next 30 years.

The Inner Harbour component of the Port Development Plan was released in September 1999 as a draft for public comment (FPA 1999c). It indicated that the Inner Harbour could handle two to three times the existing level of trade, with ultimate capacity likely to be reached between 2015 and 2020. Work on the Outer Harbour component of the Port Development Plan is proceeding.

A five-year Strategic Plan for the FPA was released in August 1999. The Plan identified strategies to achieve goals such as lower prices for port services, increased trade through the port, and improved land transport access to the Inner Harbour.

Liaison and consultation

The FPA has developed several forums for on-going liaison and consultation with members of the port industry and the local community. They include the:

- Port Client Council, which comprises representatives of the FPA, shipping lines, WA Shippers' Council, Road Transport Association, Australian Chamber of Shipping and service providers in the port;
- Inner Harbour Community Liaison Group; and
- Outer Harbour Community Liaison Group.

The FPA is a member of the Sea Freight Council of WA which has the objective of removing impediments to adequate, reliable and competitive seaborne trade for WA industry. It also participates in

broader transport planning initiatives, such as the Perth Metropolitan Freight Strategy, which affect the role and operation of the port.

MAIN POINTS—THE PORT OF FREMANTLE

- The Port of Fremantle is the largest general cargo port in Western Australia and one of Australia's major bulk cargo ports.
- The efficiency of the port has major effects on cost structures, industry competitiveness and living standards in Western Australia.
- Total throughput at the port in 1998–99 was 23.5 million tonnes, with bulk cargoes accounting for 83 per cent of this traffic.
- The Port of Fremantle handles around 10 per cent of the containers shipped through Australia's mainland capital city ports.
- There were 1887 ship calls at the port in 1998–99, with 1771 of these calls involving commercial trading vessels.
- Port facilities are located at the Inner Harbour (general cargo and passengers) and the Outer Harbour (bulk cargoes).
- Facilities and services at the port are provided by the Fremantle Port Authority and by private operators.
- Issues that will potentially affect the future operation and efficiency of the Port of Fremantle include urban encroachment and changes in rail access arrangements.

7

METHOD FOR CASE STUDY

An economic impact analysis of the Port of Fremantle was prepared for the FPA in late 1992 (McLeod & McGinley 1992). The study, which was based on 1991–92 data, incorporated a survey of firms involved in port-related activities. Flow-on effects were calculated using the 1982–83 Western Australian input-output tables. The study also included estimates of expenditure by cruise ship passengers and by crews from visiting naval vessels.

By early 1999 the FPA required updated information on the economic impact of the port. Following discussions with AAPMA and the BTE in May 1999, it was agreed that the BTE would include the Port of Fremantle as the case study for the regional impact of ports project.

The Port of Fremantle was particularly suitable for the case study as it handles a range of bulk and non-bulk cargoes. In addition, the FPA was willing to provide extensive data and other support for the study.

APPROACH

The FPA required information about the contribution of the Port of Fremantle to the local community and to the State of Western Australia. Senior executives of the FPA indicated that the results of the study would be used in the consideration of issues such as future port development, financial strategies and land use planning. The general framework described in chapter 4 therefore provided an appropriate method for the study.

The BTE estimated the direct effects of the port on the basis of a survey of organisations involved in Fremantle port-related activities. Multipliers derived from input-output tables were used to calculate the flow-on effects. As the survey and input-output tables provided only limited information on taxes and other payments to governments, other methods were used to estimate some of these payments.

The study focused on commercial trading vessels. However, at the request of the FPA, the BTE also obtained some data on the impact of visiting foreign naval vessels.

The study of the Port of Fremantle was undertaken between June and December 1999. The major components involved:

- specifying the key parameters;
- identifying the organisations involved in port-related activities;
- generating industry support for the study;
- collecting the data;
- processing the data; and
- preparing the estimates of port impact.

The first three components are discussed in this chapter. Data collection and processing are covered in chapter 8, and the results of the study are presented in chapter 9.

KEY PARAMETERS

The key parameters for the study involved the definition of the port industry, the region, the period covered and the impact measures.

Port industry definition

The definition of the port industry was based on the standard approach specified in the general framework. It incorporated all activities required for the movement of ships and their cargoes and passengers through the Port of Fremantle. The study did not include activities related to naval ships based at Garden Island, fishing vessels or recreational boating.

Table 7.1 lists the port-related activities covered by the definition. The activities were grouped into six categories in order to protect commercially sensitive information and to facilitate the processing of the data. The port industry included some firms (eg road transport operators) that operated outside the physical boundaries of the port. It did not include manufacturing or processing activities, either in the port area or at other locations.

Many organisations that participated in the study were able to clearly distinguish their port-related and other activities. However, in some cases (eg road transport and storage) the identification of the port-related component involved an element of judgement. For the purposes of the study, the BTE defined port-related land transport as road or rail movement between the port and the nearest

TABLE 7.1 COMPONENTS OF FREMANTLE PORT INDUSTRY

Categories	Activities/components
Port authority operations	Planning, co-ordination and promotion
	Land and property management
	Safety and emergency response
	Shipping channels and navigation aids
	Port authority wharves, berths, jetties, etc[a]
	Infrastructure for roads and utilities
Ship operations	Shipping lines/agents
	Pilotage
	Towage
	Line boats
	Mooring/unmooring
	Bunkering
	Ship supplies[b]
	Ship repairs and maintenance[c]
	Container repairs[d]
	Container maintenance and servicing
Ship loading and unloading	Private wharves, berths, jetties etc[a]
	Container and break bulk stevedoring
	Livestock stevedoring
	Bulk cargo loading/unloading
	Passenger terminals
Cargo services	Customs brokers
	Freight forwarders
	Container packing/unpacking
	Cargo surveyors
	Wool dumping
	Fumigation
Land transport and storage[e]	Road transport
	Rail transport
	Transfer between road/rail and storage facilities
	Storage
Government agencies	Customs
	Quarantine
	Ship safety
	Port safety
	Environmental management
	Port policy administration

a. Operation and maintenance.

b. Sometimes called chandlering or providoring. Excludes supplies to commercial fishing and recreational boating.

c. Only for vessels in the port for the purpose of bringing in or taking out cargo or passengers.

d. Includes container parks/depots.

e. Involves movement of cargo within the port, movement of cargo between the port and closest inland points (eg warehouses, bonded storage, processing plant, other storage facilities), and port-related storage.

Source BTE analysis.

warehouse, terminal, processing plant or customer premises in the Perth region (excluding retail distribution).

Region

In discussions with the BTE, the FPA indicated that it required information about the impact of the port on the Fremantle community and on the State of Western Australia.

As a result of data and resource limitations, the BTE was not able to prepare input-output tables for the Fremantle area. The estimates of the flow-on effects and total impact therefore focused on the State of Western Australia.

Period covered by study

The study covered the impact of the Port of Fremantle in 1998–99. This was the most recent, full financial year at the time the study was undertaken.

The data presented in chapter 6 indicate that traffic in 1998–99 was broadly representative of recent activity levels at the port.

Impact measures

The impact of the Port of Fremantle was primarily measured in terms of output, value added, household income and employment. Some information on taxes and other payments to governments was also obtained.

The impact measures were disaggregated on the basis of port function, cargo type and port area. Port functions comprised port authority operations, ship operations, ship loading and unloading, cargo services, land transport and storage, and government agencies. Cargo types were considered in terms of containers, other general cargo, liquid bulk, dry bulk and other traffics. Port areas comprised the Inner Harbour and the Outer Harbour.

The flow-on effects of the port were identified for individual industry sectors. The structure of the Western Australian input-output tables determined the sectors used in this part of the analysis.

PAYMENTS FLOWS

An understanding of payments flows for organisations undertaking port-related activities was a key factor in analysing the economic impact of the Port of Fremantle. This information facilitated the

identification of individual firms and government agencies that were subsequently approached to participate in the survey (see chapter 8).

The flows can be broadly considered in terms of payments by shippers and payments by shipping lines/agents. Local shippers pay the providers of some port-related services (eg freight forwarders). In other cases (eg towage operators), the payments are made by shipping lines/agents that in turn recover the costs from shippers through freight rates and other charges.

Shippers

Figure 7.1 indicates the major payments by shippers for Fremantle port-related activities in 1998–99. It identifies payments by the majority of importers and exporters as a group, and payments by several major bulk shippers that operate facilities at the Outer Harbour.

Many smaller shippers use freight forwarders to arrange port-related activities such as container packing and unpacking, warehousing, and land transport to and from the port. Larger shippers may deal directly with some or all of the organisations that undertake these activities.

There are close links between freight forwarding and customs broking. Freight forwarders often provide customs broking services, either directly or through associated companies. Firms that are predominantly customs brokers may also arrange related activities, such as road transport, for their clients.

Several large bulk shippers that use the Port of Fremantle have their own jetties, ship loading or unloading equipment, and port-related storage facilities. The firms include Alcoa, BP and Co-operative Bulk Handling. They use their own employees and/or contractors to undertake activities such as mooring/ unmooring, loading or unloading of cargoes, and transfer of cargoes between the wharf and storage or processing facilities.

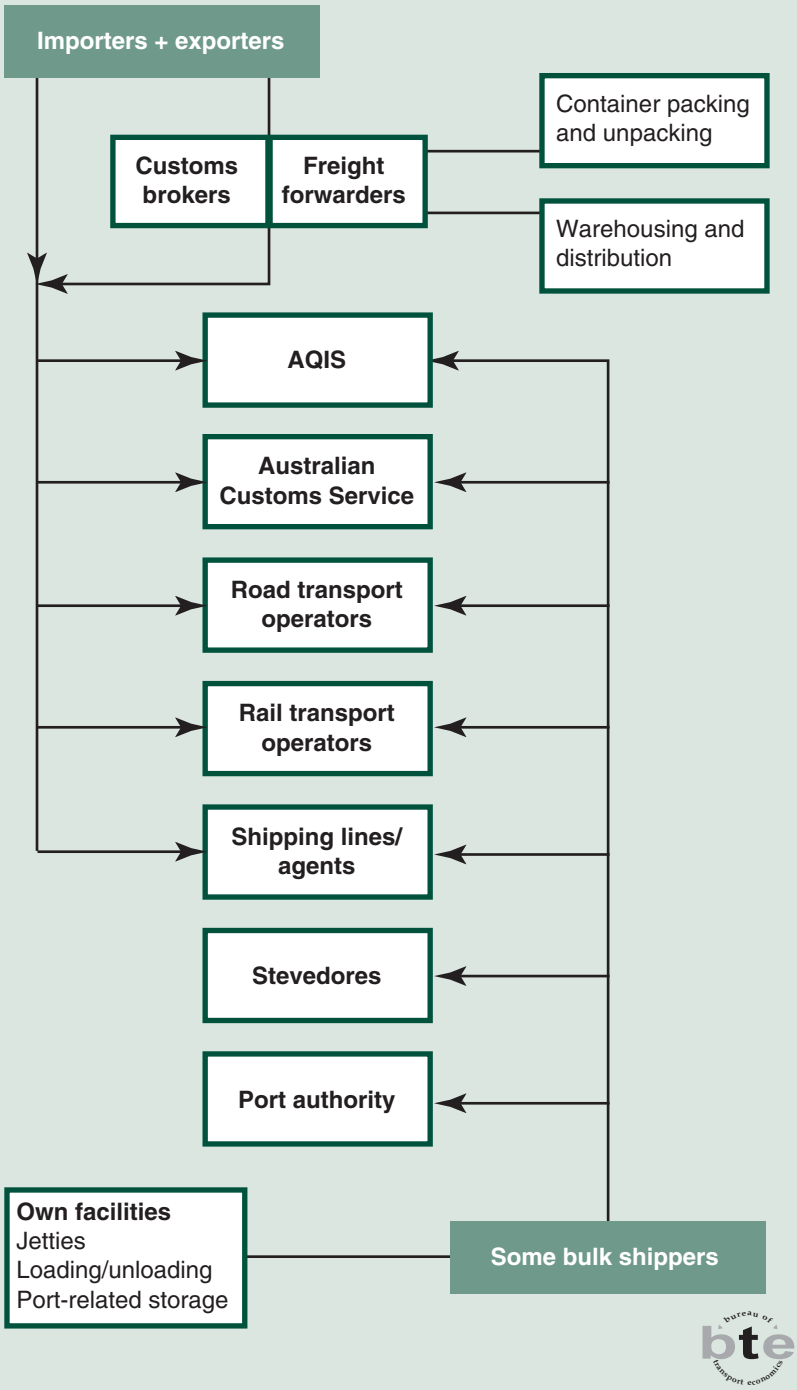
Other organisations that are paid by shippers, but not identified in figure 7.1, include wool dumpers (excluding the Japan trade) and cargo surveyors.

Shipping lines/agents

Figure 7.2 illustrates the major payments by shipping lines/agents for Fremantle port-related activities in 1998–99.

Shipping lines/agents pay the FPA for certain infrastructure and port services. The FPA also receives payments from some providers

FIGURE 7.1 MAJOR FREMANTLE PORT-RELATED PAYMENTS BY SHIPPERS, 1998–99



of port services (eg stevedores) that lease port authority land or rent other port authority facilities.

The Australian Customs Service collects payments from shipping lines/agents on behalf of several Commonwealth agencies. The payments involve:

- the Marine Navigation Levy, the Marine Navigation (Regulatory Functions) Levy and the Protection of the Sea Levy, for AMSA; and
- the Ballast Water Levy, for AQIS.

AQIS also collects various payments direct from the shipping lines/agents. They include the AQIS container fee and charges for quarantine inspection of vessels, de-ratting certificates, and other fee-for-service activities.

The State Government collected conservancy dues from commercial shipping in Western Australian waters during the year covered by the study. A proportion of the revenue was passed to the FPA for the provision, operation and maintenance of navigational aids in the Port of Fremantle. Conservancy dues were abolished from 1 October 1999.

Other organisations that are paid by shipping lines/agents, but not identified in figure 7.2, include wool dumpers (Japan trade only) and cargo surveyors.

INDUSTRY SUPPORT

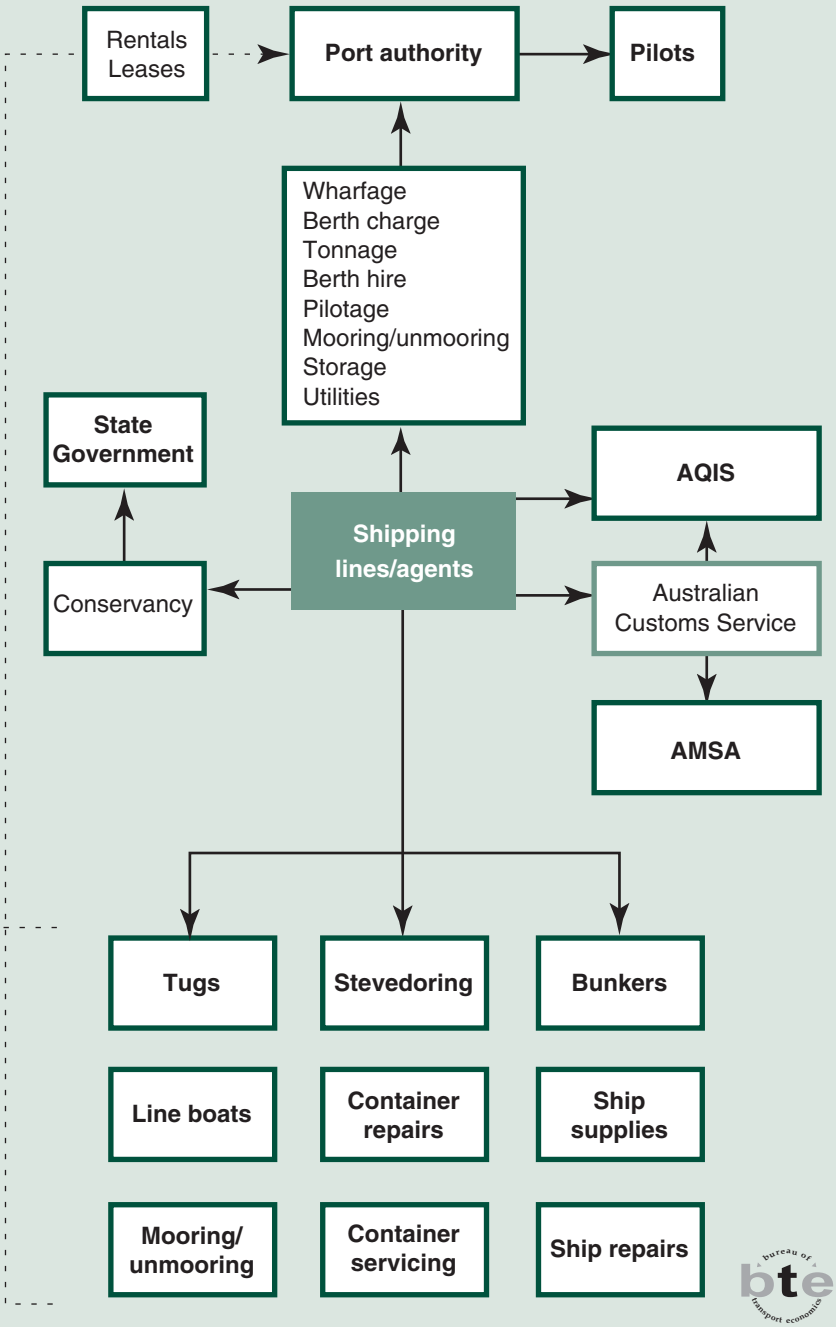
A coordinated strategy was used to build and maintain support for the port impact study.

FPA activities

Senior executives of the FPA announced the study at meetings of the Port Client Council and the WA Shippers' Council. They outlined the potential benefits of the study for the port community, and encouraged individual firms to participate. FPA executives also made the initial contacts with firms that were selected for the pilot survey.

The Chief Executive Officer of the FPA wrote to all of the organisations on the mailing list for the main survey. She indicated the potential benefits of the information being collected, particularly in relation to port planning and operations. The letter was sent out several days prior to the distribution of the survey questionnaire by the BTE.

FIGURE 7.2 MAJOR FREMANTLE PORT-RELATED PAYMENTS BY SHIPPING LINES/AGENTS, 1998–99



Senior executives of the FPA directly approached several major providers of port services to encourage them to participate in the survey. These approaches were particularly helpful, as the firms were initially reluctant to provide detailed information due to concerns about the security of commercially sensitive data.

BTE activities

As the survey was a key component of the study, it was important to obtain a good response rate. The BTE therefore placed considerable emphasis on developing concise and readable questionnaires for the survey. The final questionnaires incorporated detailed comments provided by a consultant with extensive experience in input-output analysis (including port impact studies), the FPA, AAPMA and members of the Fremantle port community.

The covering letter for the questionnaire encouraged individual organisations to participate in the survey. It outlined the background and objectives of the study, explained why the survey was required, described the BTE, and indicated that all survey data would be treated in confidence. The covering letter is contained in appendix IV.

The BTE undertook detailed follow-up activities to ensure that all organisations on the mailing list had received the questionnaire and to encourage their participation. These activities included three rounds of telephone calls over a period of five weeks (see chapter 8). They involved a total of more than 500 telephone calls.

MAIN POINTS—METHOD FOR FREMANTLE STUDY

- The study of the Port of Fremantle was undertaken using the standard approach specified in the general framework.
- The region (Western Australia), time period (1998–99) and impact measures (all major measures and components) were selected at the beginning of the study.
- The BTE estimated the direct effects of the port on the basis of a survey of organisations involved in Fremantle port-related activities, together with some publicly available information.
- Flow-on effects were calculated using the Western Australian input-output tables, which were modified to provide port-specific multipliers.
- Information on payments flows for port-related activities facilitated the identification of organisations that were subsequently approached to participate in the survey.
- The BTE and the FPA used a coordinated strategy to build and maintain industry support for the study.

8

DATA COLLECTION AND PROCESSING

The major data sources for the study of the Port of Fremantle were a survey of organisations involved in port-related activities and a set of input-output tables for Western Australia. The input-output tables were modified to incorporate specific rows and columns for the Fremantle port industry. Port-specific multipliers, estimated from the modified tables, were then used to calculate the flow-on effects associated with the port.

The assessment of the impact of visiting foreign naval vessels was less comprehensive. It incorporated an estimate of local expenditure by crew members and multipliers for relevant industry sectors (based on expenditure patterns of foreign tourists).

SURVEY

The survey provided the following data for organisations involved in Fremantle port-related activities:

- number of employees;
- current operating expenses, by major expenditure item and location;
- total revenue attributable to port-related and other activities;
- port-related revenue attributable to customers inside and outside Western Australia;
- port-related revenue by function, cargo type/commodity and port area; and
- fixed capital expenditure.

The key components of the survey were questionnaire design, the pilot survey, and the main survey.

Questionnaire design

A draft questionnaire was prepared by the BTE, in consultation with members of the port community, during May and June 1999. Four alternative versions of the questionnaire were subsequently developed. Each version focused on a major group of organisations that would be included in the survey:

- port-related firms, whose activities were wholly or primarily Fremantle port-related (eg pilots);
- organisations with port-related activities, whose operations included only a small Fremantle port-related component (eg Department of Transport);
- importers and exporters, whose Fremantle port-related activities (eg operation of private jetties) were an internal cost centre rather than a source of external revenue; and
- stevedoring firms, that were prepared to provide some data (eg percentages of total costs attributable to individual cost components) but would not supply absolute figures on revenue or costs.

The questionnaire for port-related firms is presented in appendix III.

Pilot survey

A pilot survey of 17 firms with major Fremantle port-related activities was undertaken in August 1999. The firms, which were identified with the assistance of the FPA, comprised:

- the towage operator;
- the pilot company;
- two shipping lines/agents;
- two stevedores;
- two suppliers (bunkers, provisions);
- two repairers (containers, ships);
- a container depot operator;
- three bulk shippers with major loading and unloading facilities;
- a freight forwarder;
- a customs broker; and
- a road transport operator.

The primary purpose of the pilot survey was to assess the effectiveness of the draft questionnaires. It also enabled the BTE to

obtain detailed information on major port-related activities at an early stage of the study.

A total of 12 firms responded to the pilot survey. BTE officers had discussions with eight of these firms during a visit to Fremantle in August 1999, and telephone comments were obtained from several other firms. The results of the pilot survey enabled the BTE to significantly improve the design of the questionnaires.

The other five firms that were approached to participate in the pilot survey returned their completed questionnaires during the main survey period.

Main survey

The objective of the main survey was to contact all organisations with significant Fremantle port-related activities. The mailing list, which comprised 181 organisations, was mainly developed by the FPA. It also included some organisations that were identified by the BTE during discussions with firms that participated in the pilot survey.

The questionnaires for the main survey were mailed out in early September 1999. The covering letter requested each organisation to return the completed questionnaire to the BTE, using an enclosed self-addressed envelope, by the end of September 1999. Firms which had been approached to participate in the pilot survey were not included in the main survey, as they had already provided (or undertaken to provide) the required data or had indicated that they would not participate in the study.

BTE officers telephoned each organisation one week after the mail-out, to check whether the questionnaire had been received. Additional questionnaires were sent to 20 organisations which indicated that they had not received a questionnaire.

By the end of September 1999, the BTE had received completed questionnaires from 47 organisations. A second round of follow-up telephone calls was then made to the organisations that had not responded. Additional questionnaires were sent by fax to 22 of these organisations as they were unable to locate the questionnaire that was initially sent to them.

A final round of follow-up telephone calls was made in mid-October 1999. These calls encouraged several more organisations to provide completed questionnaires. Where organisations indicated that they were unlikely to complete the questionnaire, the BTE obtained some basic data (eg port-related employment, revenue) over the telephone.

The data collection stage of the main survey was effectively completed at the beginning of November 1999. However, one completed questionnaire was returned to the BTE in the second half of November.

Outcome of the survey

Questionnaires for the port impact study were sent to a total of 198 organisations (pilot survey and main survey). Table 8.1 summarises the overall outcome.

TABLE 8.1 RESPONSES TO FREMANTLE PORT INDUSTRY SURVEY

Outcome	Number of organisations
Detailed response	71
Partial response	70
Not relevant	57
Total	198

Note Data cover pilot survey and main survey.
Source BTE analysis.

Detailed responses

A total of 71 organisations submitted detailed responses, involving full or substantial completion of the questionnaire. The activities covered by these responses accounted for around 70 per cent of the Fremantle port-related employment identified by the BTE through the survey process.

Partial responses

A further 70 organisations provided partial responses, either by telephone or in the form of a partly completed questionnaire. All of these responses included information on employment. In many cases, they also contained some other data (eg total revenue, proportion of total revenue by cargo type, total costs). The activities covered by these responses accounted for around 30 per cent of the Fremantle port-related employment identified by the BTE through the survey process.

Each organisation which provided only a limited response to the survey was matched with one or more comparable organisations

that had provided a fully or substantially completed questionnaire. For example, a freight forwarder was matched with a group of freight forwarders that had supplied detailed information about their operations. In this way, the BTE was able to obtain revenue and cost estimates for all of the relevant firms on the mailing list.

Other organisations

The remaining 57 organisations advised the BTE that they had not been involved in Fremantle port-related activities in 1998–99. Some of these organisations provided services to sectors other than commercial shipping (eg to fishing or recreational boating) or were shippers that had not used the port in 1998–99.

A significant group of shippers included in the survey indicated that they had no direct involvement in Fremantle port-related activities, as their transport services were organised by contractors. It seems likely that these services would have been included in the responses of port-related service providers (eg freight forwarders, road transport operators).

All of the major bulk shippers that operated loading or unloading facilities at the Outer Harbour responded to the survey. These firms generally provided detailed responses.

OTHER DATA

The survey data provided the basis for estimating the direct effects of the Port of Fremantle and for modifying the input-output tables. The BTE also used publicly available information to prepare estimates of revenue and costs for some port-related activities. Wherever possible, industry sources were approached to provide an assessment of the general validity of these estimates.

Stevedoring

The stevedores' questionnaire requested data on proportions (eg the percentage of total expenditure in each category) rather than absolute figures. The BTE adopted this approach in response to stevedores' concerns about providing data that would indicate their profitability or competitive position. As a result of this factor, the completed questionnaires did not contain figures for total revenue or total costs.

The BTE therefore had to prepare estimates of total stevedoring revenue and costs at the Port of Fremantle. Revenue was calculated on the basis of FPA traffic data and information on average

stevedoring charges provided by ship's agents. The revenue estimates were then used to calculate total costs, assuming a 10 per cent profit margin.

Rail transport

The port industry, as defined in the study, included certain land transport activities. In particular, it covered road and rail movement between the port and the nearest warehouse, terminal, customer premises or processing plant in the Perth region (excluding retail distribution).

The application of this definition to rail transport involved some practical difficulties, as most rail freight for the port is carried on unit trains. These trains operate direct to and from inland locations, and are not broken up or assembled at a point near the port. Thus, there is not a readily identifiable, port-specific component of the rail service.

Following discussions with the FPA and a major bulk shipper, the BTE based its analysis of port-related rail transport on movements between Midland (bulk traffics) or Kewdale (containers) and the relevant port facilities. Information provided by the FPA indicated that these sectors involved average rail distances of 60 kilometres for bulk cargoes and 45 kilometres for containers.

Total revenue for port-related rail transport was calculated using traffic data and average revenue figures. The volume of port-related rail traffic was based on FPA and shippers' data for grain, sulphuric acid, caustic soda and containers. The traffic data and distance figures were then combined to estimate port-related tonne-kilometres in 1998–99. A revenue estimate was prepared using this freight task and the published, system-wide revenue figures (per tonne-kilometre) for Westrail's freight operations. Information from Westrail's annual report was then used to calculate total costs and major cost components.

FPA data

The FPA provided a substantial amount of data for the port impact study. Major inputs included the mailing list for the survey, a fully completed questionnaire, and various published documents.

Officers of the FPA also responded to numerous BTE requests for specific information at various stages of the study. Examples of these requests included the number of containers moved to and from the port by rail, the number of ship calls by individual ship

types, and handling arrangements for specific commodities moved through the port.

ASSESSING THE SURVEY RESULTS

The survey process included comprehensive checking of the data and an assessment of the extent to which the survey covered all Fremantle port-related activities.

Checking of data

BTE staff checked each completed questionnaire to ensure that the data were internally consistent and of the expected magnitude. The checking process included an examination of relationships such as the ratio of total revenue to costs, the average earnings implied by the total wages and employment figures, and the relative size of individual firms. If there appeared to be an inconsistency or an incorrect figure, a BTE officer contacted the organisation that had submitted the completed questionnaire.

The checking process also covered partial responses (eg figures obtained by telephone). The figures provided by each organisation were compared with detailed data obtained from comparable organisations, in order to assess whether the figures were of appropriate magnitude.

Coverage

Many Fremantle port-related activities are undertaken by only one or two operators. Examples include port authority operations, pilotage, towage, line boats, bunkering, and specific government activities. In these cases, the survey data (or the alternative estimates obtained by the BTE) provided comprehensive coverage of the activity at the Port of Fremantle.

Several other port-related activities are undertaken by large numbers of firms. The proportion of firms covered by the survey therefore had a potentially significant effect on the accuracy of the data for these activities. In the case of ship's agents, the survey provided comprehensive coverage as the nature of the activities meant that all of the significant firms could be easily identified. However, it was difficult to identify all of the firms undertaking port-related freight forwarding, customs broking and road transport. This reflected the large numbers of firms involved in these activities, particularly small firms located outside the port area.

In the case of road transport, the general magnitude of Fremantle port-related activities was estimated using traffic data for the port and freight rates supplied by industry sources. The estimate indicated that the survey data provided satisfactory coverage of Fremantle port-related road transport activities.

It was not possible to obtain comparable estimates of the overall size of port-related customs broking or freight forwarding. The survey results may therefore involve some under-reporting of these activities, since some smaller operators were not included in the survey. However, the effect is unlikely to be significant as the survey was designed to cover all of the larger firms.

ESTIMATING THE DIRECT EFFECTS

The detailed estimation of the direct effects of the Port of Fremantle focused on output, value added, household income and employment. Taxes and other payments to governments were considered separately, as the survey did not provide comprehensive information on these payments.

Output and value added

Gross revenue was used to measure the output of organisations (including the FPA) that provided port-related services to external buyers on a commercial basis. Value added was calculated as the sum of wages and salaries (including supplements), depreciation, interest, profit and net commodity/indirect taxes.

Gross revenue does not provide an appropriate measure of output for the port-related activities of government agencies. This reflects the absence of an open market for some of these activities (eg quarantine services) and, in some cases, costing systems that do not clearly identify the revenues and costs for Fremantle port-related activities. The output of government agencies was therefore measured on the basis of their gross expenditure on Fremantle port-related activities. Value added was calculated as the sum of wages and salaries (including supplements), depreciation and net commodity/indirect taxes.

The component of conservancy dues received by the FPA was included in the estimation of the direct effects of the Port of Fremantle. The remaining conservancy dues were not Fremantle port-related as they were used for facilities in other parts of the State.

Gross expenditure was also used to measure the output of port-related activities that were an internal cost centre for several major shippers. This approach was adopted as these services were not provided in an open market. Value added incorporated wages and salaries (including supplements), depreciation, interest and net commodity/indirect taxes.

Payments to governments

The survey provided only limited information on taxes and other payments to governments (ie payroll tax, local council rates and motor vehicle registration fees). The BTE therefore prepared indicative estimates of total payments, by combining readily available statistics (eg ABS taxation revenue and national income data) with Fremantle port industry data obtained from the survey.

In view of the diverse nature of the firms involved in flow-on activities, the BTE concluded that taxes as a proportion of gross product for the wider economy would provide a reasonable basis for estimating payments by these firms. The analysis of flow-on activities was therefore based on the ratio of State and local government revenues to Gross State Product and the ratio of Commonwealth Government revenue to Gross Domestic Product.

Modified ratios were used to analyse port-related activities, as economy-wide relationships would not accurately reflect payments by firms involved in these activities. In addition, port-related firms would not pay certain indirect taxes, due to the nature of their activities, and firms involved in flow-on activities would pay the indirect taxes on inputs for port-related activities. The BTE assumed that various taxes (eg income taxes levied on non-residents) would not be applicable to port-related activities. Modified ratios of revenue to gross product for port-related firms were prepared on the basis of this analysis.

The analysis also included some information provided by the FPA about its payments to the Commonwealth (fringe benefits tax), the State Government (payroll tax, income and sales tax equivalents, motor vehicle registration) and local government (rates). The FPA's dividend and interest payments to the WA Treasury, and the tax equivalents rebate (as equity contributions), were not included in the BTE's analysis as they involved transactions with the provider of equity and loan funds.

The BTE's analysis indicated that taxes and other payments to governments represented around 28 per cent of total value added

attributable to Fremantle port-related activities. This is an approximate figure.

INPUT-OUTPUT TABLES

Input-output tables, modified to incorporate specific rows and columns for the Fremantle port industry, were used to calculate the multipliers for the study.

Western Australian tables

The 1992–93 Western Australian input-output tables were the latest tables available when the study was undertaken. They were prepared by the Economic Research Centre at the University of Western Australia, using the national input-output tables and regional data. The transactions table incorporated 111 industry sectors.

The BTE considered various options for obtaining more recent tables, as there may have been significant changes in the structure of the State economy (and in the multipliers) since 1992–93. However, the time and resource constraints of the study meant that it was not possible to generate new tables from the most recent national tables or to update the Western Australian tables. The 1992–93 tables were therefore used.

As the input-output tables covered an earlier year than the survey responses, the data were aligned by inflating the input-output tables to 1998–99 prices. This adjustment did not affect the relationships between the direct effects, flow-on effects and total impact.

Modification of tables

The Western Australian input-output tables included most Fremantle port-related activities, together with various other activities, in the transport and storage sector. It was therefore necessary to develop modified tables that separately identified the Fremantle port industry and the sub-sectors for the detailed impact measures. The components of the 28 industry sectors used in the BTE's analysis are listed in appendix V.

The first step was to estimate the transactions between the Fremantle port industry and other industry sectors, and between components of the Fremantle port industry. This was done using the survey data and port authority information on trade shares by commodity.

The information on transactions was then used to prepare a modified transactions table that incorporated a separate row and column for

the Fremantle port industry. Three other modified transactions tables, that were required for estimation of the disaggregated impact measures (port function, cargo type, port area), were also prepared.

CALCULATION OF MULTIPLIERS

The modified transactions tables were used to calculate the multipliers for the Fremantle port industry. They were first converted to tables of direct requirements coefficients by dividing each column entry by the associated column total. The inverse matrix for each table was then prepared, and tables of multiplier coefficients were derived.

The output, value added, and household income multipliers were calculated directly from the modified tables. As input-output tables are expressed in monetary units, some additional data (on output per employee in Western Australia) were required to prepare the employment multipliers.

Several procedures were used to validate the estimation process and the accuracy of the multipliers. They included the design of the database, data entry and data checking, assessment of the internal consistency of the multipliers, and comparison with multipliers obtained in other port impact studies.

Table 8.2 presents the multipliers in terms of the impact of an initial amount of output in the Fremantle port industry. For example, $1.00 of output in the Fremantle port industry leads to output of $1.14 in other industries, resulting in total output of $2.14. Alternatively, $1.00 of output generates $0.63 of value added in Fremantle port-related activities, $0.66 in other industries and a total impact of $1.29. Similar relationships can be identified for household income.

TABLE 8.2 MULTIPLIERS FOR FREMANTLE PORT INDUSTRY, 1998–99

Measure	Direct effects	Flow-on effects	Total impact
Output[a]	1.00	1.14	2.14
Value added[a]	0.63	0.66	1.29
Household income[a]	0.36	0.29	0.65
Employment[b]	7	10	17

a. Dollar impact of $1.00 of output in port industry.

b. Number of jobs (full-time equivalent) per $ million of output in port industry.

Source BTE analysis.

The employment effects are expressed in terms of the number of full-time jobs per million dollars of output in the Fremantle port industry. Table 8.2 indicates that $1 million of output generates 7 jobs in Fremantle port-related activities, 10 jobs in other industries and a total impact of 17 jobs.

Table 8.3 presents the multipliers for components of the Fremantle port industry. It indicates that there is significant variation in the multipliers. For example, the output multiplier is 1.91 for liquid bulk cargoes and 2.17 for dry bulk cargoes. Similarly, output of $1 million for port authority operations results in 13 jobs (full-time equivalent), but the same output for ship operations involves 19 jobs (full-time equivalent). The variation reflects differences in labour inputs

TABLE 8.3 MULTIPLIERS FOR COMPONENTS OF FREMANTLE PORT INDUSTRY, 1998–99

Port component	Output[a]	Value added[a]	Household income[a]	Employment[b]
Function				
Port authority operations	2.03	1.12	0.51	13
Ship operations	2.22	1.39	0.74	19
Ship loading/unloading	2.14	1.32	0.70	17
Cargo services	2.13	1.32	0.66	19
Land transport & storage	2.08	1.21	0.55	15
Government agencies	2.36	1.42	0.89	24
Total	2.14	1.29	0.65	17
Cargo type				
Containers	2.16	1.36	0.71	18
Other general cargo	2.15	1.33	0.68	18
Liquid bulk	1.91	1.10	0.47	13
Dry bulk	2.17	1.20	0.60	16
Other	2.09	1.26	0.60	16
Total	2.14	1.29	0.65	17
Port area				
Inner Harbour	2.16	1.35	0.70	18
Outer Harbour	2.09	1.18	0.57	15
Total	2.14	1.29	0.65	17

a. Dollar impact of $1.00 of output in same component of port industry.

b. Number of jobs per $ million of output in same component of port industry.

Source BTE analysis.

(affecting consumption-induced flow-on effects) and in the use of other local inputs (affecting production-induced flow-on effects).

The disaggregated multipliers for the Fremantle port industry are presented in appendix VI.

VISITING NAVAL VESSELS

The impact of foreign naval vessels was estimated using US Navy data for crew expenditure ashore. There were 10 visits to the Port of Fremantle by US Navy vessels in 1998–99. Crew sizes on individual ships ranged from 160 to 5300, with a total of 14 700 crew on the ships that visited the port.

The crew expenditure associated with each ship visit was estimated using a formula, developed by the US Navy, that incorporated:

- the number of days the ship was in port;
- the number of crew members ashore (calculated as three-quarters of the ship's crew, as one-quarter of the crew remains aboard the ship at all times); and
- average expenditure of $200 per day (Australian dollars) for each crew member ashore.

Detailed information on the multipliers associated with this expenditure was not available. The BTE therefore prepared multipliers on the basis of available data on tourist expenditure patterns and the Western Australian input-output tables. Data on expenditure patterns by foreign tourists in Australia, obtained from a survey by the Bureau of Tourism Research, were used to allocate crew expenditure to industry sectors. Weighted average multipliers were then estimated by applying the expenditure patterns to the multipliers for each sector (derived from the Western Australian input-output tables).

The resulting multipliers indicate that $1.00 of crew expenditure results in total output of $2.20. Each million dollars of crew expenditure provides 19 jobs (full-time equivalent) in Western Australia.

The US Navy data provide a partial estimate of the impact of visiting foreign naval vessels. They do not include expenditure associated with 12 other foreign naval vessels that visited the Port of Fremantle in 1998–99. A simple pro rata adjustment based on the US Navy data would not provide an accurate estimate of crew expenditure for these vessels, as crew sizes and average expenditure levels would probably differ significantly from the US figures.

Some local expenditure that would be generated by foreign naval vessels was not included in the crew expenditure figures. Examples include payments for ship supplies, pilotage, rubbish removal, and shore landing facilities.

MAIN POINTS—DATA FOR FREMANTLE STUDY

- Data on Fremantle port-related activities were obtained from the industry survey, the FPA, and BTE analysis of publicly available data.
- The industry survey incorporated detailed planning of the questionnaires, the mailing list, the pilot survey, and follow-up activities for the main survey.
- The 141 relevant organisations included in the survey provided 71 detailed responses and 70 partial responses.
- The survey process included comprehensive checking of the data and an assessment of the extent to which the survey covered all Fremantle port-related activities.
- Western Australian input-output tables, modified to incorporate specific rows and columns for the Fremantle port industry, were used to calculate the multipliers for the study.
- The BTE prepared indicative estimates of payments to governments, using adjusted ratios of aggregate government revenue to gross product.
- The impact of visiting foreign naval vessels was calculated using US Navy data on crew expenditure ashore and multipliers for relevant WA industry sectors.

9

ECONOMIC IMPACT OF THE PORT OF FREMANTLE

The total impact of the Port of Fremantle comprises the direct effects and the flow-on effects to the rest of the Western Australian economy. Impact is mainly measured in terms of output (gross revenue/expenditure), value added (payments to primary inputs of production), household income and employment. Detailed measures indicate the impact attributable to individual port functions, cargo types and port areas.

OVERALL IMPACT

Table 9.1 presents the estimates of the overall impact of the Port of Fremantle. The results are not directly comparable with the results of the 1992 study, as different methods were used in parts of the analysis.

TABLE 9.1 ECONOMIC IMPACT OF THE PORT OF FREMANTLE, 1998–99

Impact measure	Direct effects	Flow-on effects	Total impact
Output ($m)	341	387	728
Value added ($m)	215	225	440
Household income ($m)	124	99	223
Employment (no.)[a]	2 294	3 499	5 792

a. Number of full-time equivalent jobs.
Note Components may not sum to totals due to rounding.
Source BTE analysis.

Direct effects

Fremantle port-related activities (ie the direct effects) involved output of $341 million and value added of $215 million in 1998–99. These activities generated household income of $124 million and 2294 jobs (full-time equivalent).

Employment in Fremantle port-related activities accounted for around 0.3 per cent of total employment in Western Australia in 1998–99. Average household income for these activities was $54 000 per annum, which was well above the State average (all industries) of $31 000 per annum.

Flow-on effects

The BTE estimated the flow-on effects to other sectors of the Western Australian economy using the multipliers described in chapter 8. These effects result from purchases of goods and services by firms involved in Fremantle port-related activities and from expenditure by households that receive income from employment in these sectors.

The flow-on effects of the port involved output of $387 million, value added of $225 million, household income of $99 million and 3499 jobs (full-time equivalent) in 1998–99.

Table 9.2 provides information on the flow-on effects to individual industry sectors. It indicates that the two sectors most affected by the operation of the port were wholesale and retail trade etc, and other business services. These sectors each accounted for 26 per cent of the flow-on effects in terms of value added. For employment, the proportions were 44 per cent and 12 per cent respectively.

Total impact

The Port of Fremantle had a total impact (direct and flow-on effects) of $728 million in terms of output.

Value added attributable to the operation of the port was $440 million. This was equivalent to 0.9 per cent of Gross State Product, a measure of the overall level of economic activity in the State, in 1998–99. The input-output tables indicate that other industry sectors in Western Australia with the most comparable levels of value added included fertilisers and chemicals ($489 million, 1.0 per cent) and non-metallic mineral products ($316 million, 0.6 per cent). Value added in the road transport sector was $1074 million (2.1 per cent).

TABLE 9.2 FLOW-ON EFFECTS OF THE PORT OF FREMANTLE BY INDUSTRY SECTOR, 1998–99

Sector[a]	Output ($m)	Value added ($m)	Household income ($m)	Employment (no.)
Wholesale & retail trade, etc	96.6	59.3	32.5	1 530
Other business services	87.6	58.8	13.5	405
Community services	21.4	17.0	14.4	380
Utilities	23.0	13.1	3.8	60
Services to transport, storage (excl. port)	18.8	10.3	3.2	113
Communication services	13.4	9.4	4.0	122
Finance	13.4	8.5	3.7	89
Road transport	12.5	8.2	2.3	106
Personal services	14.4	7.8	5.1	198
Food manufacturing	18.5	5.1	2.7	79
Primary	9.1	4.3	1.0	83
Rail, pipeline & other transport	5.7	4.0	2.9	31
Wood & paper	7.9	3.3	1.9	57
Building & construction	5.2	2.6	1.4	44
Fertilisers & chemicals	12.8	2.5	1.0	34
Other	27.0	10.6	5.2	169
Total	387.2	224.9	98.6	3 499

a. Individual sectors are ranked by value added.

Note Components may not sum to totals due to rounding.

Source BTE analysis.

Household income attributable to the operation of the port totalled $223 million. Employment involved 5792 jobs (full-time equivalent), which was equivalent to 0.8 per cent of total employment in Western Australia. The input-output tables indicate that other industry sectors in Western Australia with the most comparable employment levels included fertilisers and chemicals (6522 jobs, 0.9 per cent) and non-metallic mineral products (5042 jobs, 0.7 per cent). Employment in the road transport sector involved 13 772 jobs (2.0 per cent).

As noted in chapter 6, there were 1771 calls at the Port of Fremantle by commercial trading vessels in 1998–99. The results of the study therefore indicate that, on average, each ship call at the Port of Fremantle involved the following impact (direct and flow-on effects) on Western Australia:

- $411 000 of output;

- $248 000 of value added;
- $126 000 of household income;
- 3.3 jobs (full time equivalent).

Taxes and other payments to governments attributable to the operation of the port are estimated at $125 million in 1998–99. This is an approximate figure, which covers direct and flow-on activities. It comprises payments to Commonwealth, State and local governments (excluding duties and taxes on imports handled at the Port of Fremantle).

COMPONENTS OF PORT IMPACT

Detailed measures of port impact identify the relative contribution of individual port functions, cargo types and port areas. The proportion for a particular component may vary according to the impact measure being used, due to factors such as differences in average incomes and labour intensity.

Port function

Table 9.3 provides information on the impact of individual port functions.

Ship loading and unloading, which mainly comprises stevedoring and loading and unloading of bulk cargoes, had the largest impact. It generally accounted for around 30 per cent of total impact. However, there was significant variation in the direct effects, with figures of 27 per cent for employment and 34 per cent for household income.

Ship operations (eg ship's agency, pilotage, towage and bunkering) generated around 23 per cent of total impact. However, there was significant variation in the figures for the direct effects, which varied between 21 per cent (output) and 26 per cent (employment) for individual impact measures.

Land transport and storage accounted for 15-20 per cent of the direct effects, with the exact figure depending on the impact measure, and around 18 per cent of total impact. Cargo services (eg freight forwarding, customs broking) generated around 14 per cent of port impact, the exception being an employment-based figure of 19 per cent for the direct effects. Port authority operations contributed 7-13 per cent of the direct effects, and 10-12 per cent of total impact. Government agencies generally accounted for 3 or 4 per cent of port impact.

TABLE 9.3 ECONOMIC IMPACT OF THE PORT OF FREMANTLE BY FUNCTION, 1998–99

Function	Output ($m)	Value added ($m)	Household income ($m)	Employment (no.)
Direct effects				
Port authority operations	43	22	11	165
Ship operations	73	49	31	597
Ship loading/unloading	102	67	42	619
Cargo services	47	31	17	428
Land transport & storage	68	40	19	380
Government agencies	9	6	5	105
Total	341	215	124	2 294
Total impact				
Port authority operations	87	48	22	555
Ship operations	162	101	54	1 401
Ship loading/unloading	218	135	72	1 694
Cargo services	99	61	31	897
Land transport & storage	141	82	37	1 033
Government agencies	21	13	8	213
Total	728	440	223	5 792

Note Components may not sum to totals due to rounding.

Source BTE analysis.

Cargo type

Table 9.4 contains information on the impact attributable to individual cargo types at the Port of Fremantle. The BTE collected data on several major bulk commodities, but the results are reported in aggregate form in order to maintain the confidentiality of data provided by individual firms.

Containerised cargo accounted for 52-59 per cent of the direct effects and 52-56 per cent of total impact, with the exact figure depending on the impact measure. This cargo comprised only 13 per cent of the total tonnage moved through the Port of Fremantle in 1998–99. The relatively high impact reflects factors such as high average earnings for labour at the container terminals and extensive land transport operations.

Dry bulk cargo accounted for 20-24 per cent of the direct effects and 22-25 per cent of total impact. It comprised around 42 per cent of the total tonnage moved through the port in 1998–99. The input

TABLE 9.4 ECONOMIC IMPACT OF THE PORT OF FREMANTLE BY CARGO TYPE, 1998–99

Cargo type	Output ($m)	Value added ($m)	Household income ($m)	Employment (no.)
Direct effects				
Containers	177	121	73	1 331
Other general cargo	45	30	18	340
Liquid bulk	35	20	8	158
Dry bulk	83	44	25	459
Other	1	1	0	7
Total	341	215	124	2 294
Total impact				
Containers	382	240	125	3 195
Other general cargo	96	59	31	800
Liquid bulk	67	38	17	441
Dry bulk	181	100	50	1 339
Other	2	1	1	19
Total	728	440	223	5 792

Note Components may not sum to totals due to rounding.

Source BTE analysis.

requirements per tonne for this cargo are relatively low as a result of highly mechanised handling techniques and large tonnages which provide economies of scale.

Other general cargo (break bulk cargo, livestock and motor vehicles) accounted for 13-15 per cent of the direct effects and 13-14 per cent of total impact. Although this cargo represented only 3 per cent of the tonnage handled at the port, the port-related activities are relatively resource-intensive due to the characteristics of the cargoes.

Liquid bulk cargo accounted for 6-10 per cent of the direct effects and 8-9 per cent of total impact. This cargo represented 41 per cent of the total tonnage moved through the Port of Fremantle in 1998–99. The input requirements for port-related activities are relatively low as large ships are used and most of the cargo is pumped between the wharf and nearby facilities.

Other traffics handled at the Port of Fremantle in 1998–99 mainly involved cruise ships. Table 9.4 indicates that the impact of these traffics was minimal. However, the BTE study focused on port-related activities and did not include the impact of expenditure ashore by cruise ship passengers. A total of nine international cruise ships visited the port in 1998–99.

Port area

Table 9.5 provides information on economic impact by port area.

The Inner Harbour accounted for 64-70 per cent of the direct effects and 65-68 per cent of total impact, with the exact figure depending on the impact measure. However, it handled only 18 per cent of the total tonnage at the port. The traffic handled at the Inner Harbour comprised containerised and general cargoes, which have a relatively high impact per tonne.

The Outer Harbour contributed 30-36 per cent of the direct effects and 32-35 per cent of total impact. The bulk cargoes handled at this area accounted for 82 per cent of port traffic.

INTERPRETING THE RESULTS

The estimates of economic impact indicate the general magnitude of the effects associated with the Port of Fremantle. They do not

TABLE 9.5 ECONOMIC IMPACT OF THE PORT OF FREMANTLE BY PORT AREA, 1998–99

Port area	Output ($m)	Value added ($m)	Household income ($m)	Employment (no.)
Direct effects				
Inner Harbour	217	147	88	1 613
Outer Harbour	124	68	37	681
Total	341	215	124	2 294
Total impact				
Inner Harbour	470	293	152	3 896
Outer Harbour	258	146	71	1 896
Total	728	440	223	5 792

Note Components may not sum to totals due to rounding.

Source BTE analysis.

provide precise estimates, as only approximate data were available for some parts of the analysis.

The results of the study provide estimates of the output (including value added), income and employment attributable to activities required for the movement of ships, cargoes and passengers through the port. They do not indicate net economic benefits, technical efficiency, competitiveness, trade facilitation effects or the contribution of port infrastructure to regional development. In addition, the impact estimates do not include the economic benefits of exports and imports handled at the port, or the impact of industrial activities in the port area that are not involved in the transport of cargo. It should also be noted that the results of the study do not indicate the net effects on the national economy.

Data from the study may potentially be used to forecast the likely impact of increased trade through the port. However, such an assessment should not be based on a mechanistic application of relationships from the impact study. Any estimate of the impact of increased port activity should take account of factors such as the cargo types involved, economies or diseconomies of scale, and existing capacity utilisation.

VISITING NAVAL VESSELS

Expenditure by crews from visiting US Navy vessels totalled around $10 million in 1998–99. Total impact (direct plus flow-on effects) is estimated at $22 million in terms of output.

This expenditure generated the equivalent of around 193 full-time jobs in Western Australia. However, due to the occasional nature of visits by these vessels, a significant part of the employment effect probably involved short-term jobs or increased earnings for existing employees working longer hours.

These figures probably provide a conservative estimate of the impact of foreign naval vessels. They exclude some types of local expenditure (eg purchases of ship supplies, port authority charges). In addition, data on crew expenditure are not available for 12 other foreign naval vessels that visited the port during 1998–99.

MAIN POINTS—ECONOMIC IMPACT OF PORT OF FREMANTLE

- Fremantle port-related activities generated direct output of $341 million, value added of $215 million, household income of $124 million and 2294 jobs (full-time equivalent) in 1998–99.
- These activities also had significant flow-on effects to other industry sectors in Western Australia.
- Total impact of the port (including the flow-on effects) involved output of $728 million, value added of $440 million, household income of $223 million and 5792 jobs (full-time equivalent).
- Total impact was equivalent to 0.9 per cent of Gross State Product and 0.8 per cent of total employment in Western Australia.
- Taxes and other payments to governments attributable to the operation of the port are estimated at around $125 million in 1998–99.
- The contribution of port functions to total impact was analysed in terms of ship loading and unloading (30 per cent), ship operations (23 per cent), land transport and storage (18 per cent), cargo services (14 per cent), port authority operations (11 per cent) and government agencies (4 per cent).
- The contribution of individual cargo types to total impact was considered in terms of containerised cargo (55 per cent), dry bulk cargoes (23 per cent), other general cargo (13 per cent) and liquid bulk cargoes (9 per cent).
- The Inner Harbour accounted for around 67 per cent of total impact and the Outer Harbour contributed around 33 per cent.
- Expenditure by crews from visiting US naval vessels resulted in total output of $22 million and 193 jobs (full-time equivalent) in Western Australia.
- The estimates of economic impact do not indicate the net effects on the broader (eg national) economy, as there may be offsetting reductions in activity in other regions from which resources are drawn.

PART C – APPENDIXES

APPENDIX I

TERMS OF REFERENCE

The Association of Australian Ports and Marine Authorities Inc (AAPMA) requests the Bureau of Transport Economics (BTE) to undertake a study of the regional impact of individual ports in Australia. Fremantle Port Authority has agreed to be the subject of the study and will provide the relevant economic data that is available to them. Additional data necessary for the study will be provided or collected by BTE.

1. The goals of the study are:
    a) develop a generic framework able to be used to calculate the economic impact of activity which is directly related to the activities of an individual port community and the magnitude of the flow-on effects (both indirect and induced) which these activities have on the rest of the economy (economic impact); and
    b) provide a basis to estimate changes to the economic impact that occur as a result of increased trade flows through, and/or capital expenditure made by, the individual port.

In so doing,

    c) measure and document the effect of economic activity which is directly related to the activities of the Fremantle port and the magnitude of the flow-on effects (both indirect and induced) which these activities have on the rest of the economy as a means of identifying the issues and concerns relevant to (a) and (b) above.

2. In conducting the study, BTE should have regard to:
    a) the major activities of the port community (the activities of the individual port authority and towage, stevedoring, shipping agents activities etc);

b) the types of cargo that pass through the individual port (containers, bulk liquids, break bulk, dry bulk, general cargo and passengers);

c) the major commodities relevant to the individual port; and

d) any other factors that significantly affect (positively or negatively) the economic impact of the individual port.

3. The economic impact should be calculated:

   a) with respect to the regional (local) and State economies; and

   b) in terms of revenue, salaries and wages, employment level, payments to government and the value of production attributable to the activities of the port community.

4. The economic impact calculated in 3(a) and 3(b) should also be expressed in terms of the wider Australian economy.

5. It is accepted that some simplification of the framework used by BTE to calculate the economic impact of the Fremantle port may be necessary in the development of the generic framework. The framework, method used and the relevant documentation should be easy to understand and be able to be applied by the staff at individual ports.

6. The study should be completed and provided to AAPMA by November 1999.

John Hirst
Executive Director

APPENDIX II

CGE MODELS AND INTEGRATED MODELS

The major alternatives to input-output analysis include CGE models and integrated models. These models are more sophisticated than input-output analysis but their suitability for port impact studies is limited by several factors including data requirements and costs.

COMPUTABLE GENERAL EQUILIBRIUM MODELS

CGE modelling allows the analyst to model a broader range of economic variables (eg balance of payments, exchange rate, factor supplies) than input-output analysis. It also takes into account some resource and balance of payments constraints, and can incorporate factor substitution and changes in relative prices.

However, the CGE approach has several features which limit its suitability as a general approach for assessing the regional impact of individual ports. The available models generally focus on national or State impacts, and it is difficult to build regional CGE models due to a lack of adequate regional accounts. CGE models also include some restrictive assumptions, such as perfect competition and full market clearing, that do not apply to regional economies.

CGE models are data-intensive and require substantial resources. Significant expertise is needed to evaluate the results.

West and Roy (1998, pp. 163-164) note that, due to the relative openness of regional economies, it is less likely that the conditions of (local) general equilibrium will hold for these economies. The outcome may be a partial equilibrium situation (in which the input-output model has been shown to converge to the more complex CGE model). At the other extreme, the economy may move from one disequilibrium to another in response to external factors.

As a result of these limitations, CGE models have not been used to a significant extent in economic impact studies of ports.

INTEGRATED MODELS

Integrated models, which combine input-output and econometric techniques, have been used to analyse activities such as tourism and the environment (West & Roy 1998).

These models retain the detailed sectoral disaggregation of the input-output system, and are closed using a system of endogenous non-linear econometric relationships. This closure captures the response through time as the economy is subjected to shocks, enabling the cumulative effects that occur over several years to be analysed.

Integrated models are not restricted by the assumptions of constant returns to scale and fixed input proportions that are incorporated in the basic input-output model. They can capture marginal changes over time resulting from price changes, technological change and changing returns to scale. Price changes are considered without the CGE model's limiting assumptions of perfect competition, perfect knowledge and full market clearing.

An integrated model, incorporating five regions and 15 industry sectors, has been constructed for Queensland. However, similar models are not available for other regions of Australia. In addition, West and Roy (1998, p. 168) note that the current regional boundaries in the Queensland model may be considered too broad for some applications.

The construction of an integrated model requires substantial data, resources and expertise. The requirements significantly exceed those of input-output modelling.

The level of expertise required to use an integrated model is relatively high. Skills in constructing and operating these models in Australia are currently limited to a small group of academics.[17]

17 See West (1995) for a more detailed comparison of input-output, integrated and CGE models.

APPENDIX III

QUESTIONNAIRE FOR PORT-RELATED FIRMS

This appendix contains one of the four versions of the questionnaire that was used in the Fremantle port impact study. The version on the following pages was developed for firms whose activities were wholly or primarily Fremantle port-related.

APPENDIX IV

COVERING LETTER FOR QUESTIONNAIRE

This appendix contains an example of the covering letter that accompanied the questionnaire. The standard letter was used for all organisations on the mailing list for the main survey.

Dear

ECONOMIC IMPACT STUDY OF FREMANTLE PORT

The Bureau of Transport Economics (BTE) is preparing a general framework for assessing the economic impact of ports in Australia. The project was proposed by the Association of Australian Ports and Marine Authorities (AAPMA) and is being conducted with their cooperation. A key component of the project is a Port of Fremantle case study, which is being actively supported by the Fremantle Port Authority.

The BTE is part of the Commonwealth Department of Transport and Regional Services. It provides advice to the Government and information to the community by undertaking applied economic research on transport, regional and related issues. The BTE's maritime publications include the quarterly newsletter *Waterline*.

The case study will provide information on the direct economic impact of the Port of Fremantle and the flow-on effects to other parts of the State economy. The indicators will include revenue, value added, employment and wages/salaries. Public availability of this information will contribute to land use planning, transport planning and other activities that support the port as a centre for trade facilitation.

You may recall that an earlier report on the economic impact of the Port of Fremantle was published in 1993. This report assisted the Fremantle Port Authority to effectively promote the interests of the port community in a wide range of areas. However, the information in the 1993 report is now seven years old. A new study will therefore provide recent information that will be useful to the Fremantle port community as we approach the year 2000.

As part of the study, the BTE is conducting a survey of firms involved in port-related activities. The survey will provide information that is not available from published sources. It will enable the BTE to estimate the direct impacts of the port, to calculate multipliers for the estimation of flow-on effects, and to prepare specific impact measures (eg by major cargo type).

I would be grateful if you would support the port impact study by completing the attached questionnaire and returning it to the BTE by **30 September 1999**. To maintain the confidentiality of data from individual organisations, the final report will present results in aggregated forms only. All completed questionnaires will be held by the BTE, treated in confidence and subsequently destroyed. The AAPMA and the Fremantle Port Authority will not have access, nor will they seek to obtain access, to the completed questionnaires.

If you have any queries with regard to the project or the questionnaire, please contact one of the BTE officers working on the project:

- Mr Kym Starr on (02) 6274 6857, e-mail at Kym.Starr@dotrs.gov.au, or
- Ms Jin Liu on (02) 6274 6788, e-mail at Jin.Liu@dotrs.gov.au.

We would like to offer you a free copy of the results of the study. Please tick the box on page 1 of the questionnaire if you would like to receive a copy.

Thank you for assisting us with the study of the economic impact of the Port of Fremantle.

Yours sincerely,

Kym Starr,
Project Leader

8 September 1999

APPENDIX V

INPUT-OUTPUT SECTOR DEFINITIONS

WA industry sectors	Corresponding WA input-output table sectors (111)
1. Primary	01011 Sheep meat 01012 Sheep wool 01021 Grain cereals 01022 Grain pulses & oilseeds 0103 Beef cattle 0104 Dairy cattle 0105 Pigs 0106 Poultry 01071 Horticulture 01072 New industries and other agriculture 0200 Services to agriculture; hunting and trapping 0300 Forestry and logging 0400 Commercial fishing
2. Mining	1101 Coal 1102 Oil and gas 1301 Iron ores 1302 Non-ferrous metal ores 1400 Other mining 1500 Services to mining
3. Food manufacturing	2101 Meat and meat products 2102 Dairy products 2103 Fruit and vegetable products 2104 Oils and fats 2105 Flour mill products and cereal foods 2106 Bakery products 2107 Confectionery 2108 Other food products 2109 Soft drinks, cordials and syrups 2110 Beer and malt 2111 Wine and spirits

WA industry sectors	Corresponding WA input-output table sectors (111)
4. Textiles and clothing	2201 Wool scouring 2202 Textile fibres, yarns and woven fabrics 2203 Textile products 2204 Knitting mill products 2205 Clothing 2206 Footwear 2207 Leather and leather products
5. Wood and paper	2301 Sawmill products 2302 Plywood, veneer and fabricated wood 2303 Other wood products 2304 Pulp, paper and paperboard 2305+ 2306 Paperboard containers; paper bags and sacks and other paper products 2401 Printing and services to printing 2402 Publishing; recorded media and publishing
6. Fertilisers and chemicals	2501 Petroleum and coal products 2502 Fertilisers 2503 Other basic chemicals 2504 Paints 2506 Soap and other detergents 2505+ 2508 Medicinal & pharmaceutical products; pesticides & other chemical products 2509 Rubber products 2510 Plastic products
7. Non-metallic mineral products	2601 Glass and glass products 2602 Ceramic products 2603 Cement and lime 2604 Concrete slurry 2605 Plaster and other concrete products 2606 Other non-metallic mineral products
8. Metal, metal products	2701 Iron and steel 2702 Basic non-ferrous metal and products 2703 Structural metal products 2704 Sheet metal products 2705 Fabricated metal products
9. Motor vehicles and parts; other transport equipment	2801 Motor vehicles and parts; other transport equipment

WA industry sectors	Corresponding WA input-output table sectors (111)
10. Ships and boats	2802 Ships and boats
11. Aircraft and railway equipment	2803 Railway equipment 2804 Aircraft
12. Machinery, equipment and household appliances	2805 Photographic and scientific equipment 2806 Electronic equipment 2807 Household appliances 2808 Other electrical equipment 2809 Agricultural machinery 2810 Mining & construction machinery equipment 2811 Other machinery and equipment
13. Other manufacturing	2901 Prefabricated buildings 2902 Furniture 2903 Other manufacturing
14. Utilities	3601 Electricity supply 3602 Gas supply 3701 Water supply; sewerage and drainage services
15. Building and construction	4101 Residential building construction 4102 Other construction
16. Wholesale & retail trade, etc	4501 Wholesale trade 5101 Retail trade 5401 Repairs 5701 Accommodation, cafes and restaurants
17. Road transport	6101 Road transport
18. Rail, pipeline and other transport	6201 Rail, pipeline and other transport
19. Water transport	6301 Water transport
20. Air and space transport	6401 Air and space transport
21. Services to transport and storage	6601 Services to transport and storage
22. Port	This sector is a composite of parts of a number of other sectors including 6601, 6101 and 6201.
23. Communication services	7101 Communication services

WA industry sectors	Corresponding WA input-output table sectors (111)
24. Finance	7301 Banking 7302 Non-bank finance 7303 Financial asset investors
25. Other business services	7401 Insurance 7501 Services to finance, investment and insurance 7701 Ownership of dwellings 7702 Other property services 7801 Scientific research, technical and computer services 7802 Legal, accounting ... management services 7803 Other business services
26. Public administration and defence	8101 Government administration 8201 Defence
27. Community services	8401 Education 8601 Health services 8701 Community services
28. Personal services	9101 Motion picture, radio and television services 9201 Libraries, museums and the arts 9301 Sport, gambling and recreational services 9501 Personal services 9601 Other services

APPENDIX VI

DISSAGGREGATED MULTIPLIERS

TABLE VI.1 DISAGGREGATED OUTPUT MULTIPLIERS

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Primary	0.00	0.00	0.00	0.00	0.11	0.03	0.03	1.24
Mining	0.00	0.00	0.01	0.01	0.43	0.01	0.02	0.71
Food manufacturing	0.00	0.00	0.00	0.00	0.13	0.05	0.05	2.54
Textiles & clothing	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.35
Wood & paper	0.00	0.00	0.00	0.01	0.52	0.02	0.02	1.08
Fertilisers & chemicals	0.00	0.01	0.01	0.01	1.07	0.02	0.04	1.76
Non-metallic mineral products	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.18
Metals, metal products	0.00	0.00	0.00	0.00	0.26	0.01	0.01	0.47
Motor vehicles & parts; etc.	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.24
Ships & boats	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.03
Aircraft & railway equipment	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.04
Machinery, equipment, etc.	0.00	0.01	0.00	0.01	0.63	0.00	0.01	0.55
Other manufacturing	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.29
Utilities	0.00	0.02	0.01	0.03	2.37	0.04	0.07	3.15
Building & construction	0.00	0.01	0.00	0.01	0.94	0.00	0.02	0.71
Wholesale & retail trade, etc.	0.00	0.08	0.01	0.09	6.96	0.19	0.28	13.26
Road transport	0.00	0.02	0.00	0.02	1.34	0.02	0.04	1.72
Rail, pipeline, other transport	0.00	0.01	0.00	0.01	0.79	0.01	0.02	0.78
Water transport	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.19
Air & space transport	0.00	0.00	0.00	0.00	0.09	0.01	0.01	0.37
Services to transport; storage	0.00	0.05	0.00	0.05	3.71	0.00	0.06	2.58

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TABLE VI.1 DISAGGREGATED OUTPUT MULTIPLIERS (continued)

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Port	1.00	0.00	0.00	1.00	73.69	0.00	1.00	46.83
Communication services	0.00	0.01	0.01	0.02	1.37	0.02	0.04	1.85
Finance	0.00	0.01	0.01	0.01	0.87	0.03	0.04	1.85
Other business services	0.00	0.03	0.03	0.06	4.10	0.20	0.26	12.03
Public admin. & defence	0.00	0.00	0.00	0.00	0.10	0.00	0.01	0.28
Community services	0.00	0.00	0.00	0.00	0.03	0.06	0.06	2.94
Personal services	0.00	0.00	0.00	0.00	0.15	0.04	0.04	1.97
Total	1.00	0.25	0.11	1.36	100.00	0.78	2.14	100.00

a. Sector definitions are given in Appendix V.

b. First round + industrial support effects = production induced effects

Type I Multiplier 1.36

Type II Multiplier 2.14

Source BTE analysis.

TABLE VI.2 DISAGGREGATED VALUE ADDED MULTIPLIERS

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Primary	0.00	0.00	0.00	0.00	0.09	0.01	0.01	0.98
Mining	0.00	0.00	0.00	0.00	0.39	0.01	0.01	0.66
Food manufacturing	0.00	0.00	0.00	0.00	0.06	0.01	0.02	1.17
Textiles & clothing	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.15
Wood & paper	0.00	0.00	0.00	0.00	0.35	0.01	0.01	0.74
Fertilisers & chemicals	0.00	0.00	0.00	0.00	0.34	0.00	0.01	0.58
Non-metallic mineral products	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.11
Metals, metal products	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.23
Motor vehicles & parts; etc.	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.09
Ships & boats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Aircraft & railway equipment	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02
Machinery, equipment, etc.	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.36
Other manufacturing	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.15
Utilities	0.00	0.01	0.01	0.02	2.20	0.02	0.04	2.98
Building & construction	0.00	0.01	0.00	0.01	0.78	0.00	0.01	0.60
Wholesale & retail trade, etc.	0.00	0.05	0.01	0.06	6.94	0.12	0.17	13.48
Road transport	0.00	0.01	0.00	0.01	1.43	0.01	0.02	1.87
Rail, pipeline, other transport	0.00	0.01	0.00	0.01	0.91	0.00	0.01	0.91
Water transport	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.10
Air & space transport	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.32
Services to transport; storage	0.00	0.03	0.00	0.03	3.29	0.00	0.03	2.34

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TABLE VI.2 DISAGGREGATED VALUE ADDED MULTIPLIERS (continued)

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Port	0.63	0.00	0.00	0.63	75.30	0.00	0.63	48.85
Communication services	0.00	0.01	0.00	0.01	1.56	0.01	0.03	2.14
Finance	0.00	0.00	0.00	0.01	0.90	0.02	0.03	1.94
Other business services	0.00	0.02	0.02	0.04	4.47	0.14	0.17	13.38
Public admin. & defence	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.20
Community services	0.00	0.00	0.00	0.00	0.04	0.05	0.05	3.86
Personal services	0.00	0.00	0.00	0.00	0.13	0.02	0.02	1.77
Total	0.63	0.15	0.06	0.84	100.00	0.45	1.29	100.00

a. Sector definitions are given in Appendix V.

b. First round + industrial support effects = production induced effects

Type I Multiplier 1.33

Type II Multiplier 2.05

Source BTE analysis.

TABLE VI.3 DISAGGREGATED INCOME MULTIPLIERS

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Primary	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.45
Mining	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.28
Food manufacturing	0.00	0.00	0.00	0.00	0.06	0.01	0.01	1.20
Textiles & clothing	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.20
Wood & paper	0.00	0.00	0.00	0.00	0.37	0.00	0.01	0.83
Fertilisers & chemicals	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.47
Non-metallic mineral products	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.11
Metals, metal products	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.22
Motor vehicles & parts; etc.	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.13
Ships & boats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Aircraft & railway equipment	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.04
Machinery, equipment, etc.	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.46
Other manufacturing	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.22
Utilities	0.00	0.00	0.00	0.01	1.18	0.01	0.01	1.70
Building & construction	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.62
Wholesale & retail trade, etc.	0.00	0.03	0.00	0.03	7.08	0.06	0.10	14.60
Road transport	0.00	0.00	0.00	0.00	0.74	0.00	0.01	1.03
Rail, pipeline, other transport	0.00	0.01	0.00	0.01	1.24	0.00	0.01	1.32
Water transport	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.05
Air & space transport	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.23
Services to transport; storage	0.00	0.01	0.00	0.01	1.89	0.00	0.01	1.42

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TABLE VI.3 DISAGGREGATED INCOME MULTIPLIERS (continued)

Sector[a]	Initial	First[b]	Indust.[b]	Total	(%)	Consumption	Total	(%)
Port	0.36	0.00	0.00	0.36	81.19	0.00	0.36	55.82
Communication services	0.00	0.00	0.00	0.01	1.23	0.01	0.01	1.79
Finance	0.00	0.00	0.00	0.00	0.73	0.01	0.01	1.66
Other business services	0.00	0.00	0.00	0.01	1.91	0.03	0.04	6.07
Public admin. & defence	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.35
Community services	0.00	0.00	0.00	0.00	0.06	0.04	0.04	6.44
Personal services	0.00	0.00	0.00	0.00	0.16	0.01	0.01	2.27
Total	0.36	0.06	0.02	0.45	100.00	0.20	0.65	100.00

a. Sector definitions are given in Appendix V.

b. First round + industrial support effects = production induced effects

Type I Multiplier 1.23

Type II Multiplier 1.79

Source BTE analysis.

TABLE VI.4 DISAGGREGATED EMPLOYMENT MULTIPLIERS[a]

Sector[b]	Initial	First[c]	Indust.[c]	Total	(%)	Consumption	Total	(%)
Primary	0.00	0.00	0.01	0.01	0.14	0.23	0.24	1.44
Mining	0.00	0.00	0.01	0.01	0.13	0.02	0.03	0.19
Food manufacturing	0.00	0.00	0.01	0.01	0.08	0.22	0.23	1.36
Textiles & clothing	0.00	0.00	0.00	0.00	0.02	0.04	0.04	0.26
Wood & paper	0.00	0.02	0.03	0.05	0.52	0.11	0.17	0.98
Fertilisers & chemicals	0.00	0.02	0.02	0.04	0.39	0.06	0.10	0.58
Non-metallic mineral products	0.00	0.00	0.01	0.01	0.10	0.01	0.02	0.14
Metals, metal products	0.00	0.00	0.01	0.01	0.14	0.02	0.04	0.22
Motor vehicles & parts; etc.	0.00	0.00	0.01	0.01	0.06	0.02	0.03	0.16
Ships & boats	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03
Aircraft & railway equipment	0.00	0.00	0.01	0.01	0.05	0.01	0.01	0.06
Machinery, equipment, etc.	0.00	0.07	0.02	0.09	0.92	0.03	0.12	0.72
Other manufacturing	0.00	0.00	0.01	0.01	0.08	0.08	0.09	0.54
Utilities	0.00	0.05	0.03	0.08	0.86	0.09	0.18	1.03
Building & construction	0.00	0.10	0.01	0.11	1.11	0.02	0.13	0.76
Wholesale & retail trade, etc.	0.00	1.28	0.22	1.50	15.36	2.99	4.49	26.41
Road transport	0.00	0.13	0.03	0.15	1.57	0.16	0.31	1.82
Rail, pipeline, other transport	0.00	0.06	0.00	0.06	0.61	0.03	0.09	0.54
Water transport	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.04
Air & space transport	0.00	0.00	0.00	0.00	0.05	0.03	0.03	0.19
Services to transport; storage	0.00	0.29	0.01	0.30	3.11	0.03	0.33	1.96

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TABLE VI.4 DISAGGREGATED EMPLOYMENT MULTIPLIERS[a] (continued)

Sector[b]	Initial	First[c]	Indust.[c]	Total	(%)	Consumption	Total	(%)
Port	6.73	0.00	0.00	6.73	69.01	0.00	6.73	39.60
Communication services	0.00	0.12	0.05	0.17	1.74	0.19	0.36	2.11
Finance	0.00	0.04	0.04	0.08	0.81	0.18	0.26	1.54
Other business services	0.00	0.12	0.14	0.26	2.64	0.93	1.19	6.99
Public admin. & defence	0.00	0.00	0.01	0.01	0.14	0.05	0.06	0.36
Community services	0.00	0.00	0.01	0.01	0.07	1.11	1.11	6.56
Personal services	0.00	0.00	0.03	0.03	0.29	0.55	0.58	3.41
Total	6.73	2.28	0.74	9.75	100.00	7.24	16.98	100.00

a. Jobs per million dollars.

b. Sector definitions are given in Appendix V.

c. First round + industrial support effects = production induced effects.

Type I Multiplier 1.45

Type II Multiplier 2.52

Source BTE analysis.

GLOSSARY

Direct effects	Initial round of output, employment and income generated by port-related activities.
Economic base analysis	An approach for estimating multipliers where the level of regional economic activity is determined by the level of activity in the region's export industries.
Economic impact	Output, income and employment attributable to activities required for the movement of ships, cargo and passengers through the port.
Employment	Number of working proprietors, managers, directors and other employees (in terms of the number of full-time equivalent jobs).
Flow-on effects	Sum of the indirect effects and the induced effects.
Household income	Wages, salaries and other payments to labour (including overtime payments and income tax, but excluding payroll tax).
Indirect effects	Additional output, employment and income resulting from re-spending by firms that receive income from the sale of goods and services to firms undertaking port-related activities.
Induced effects	Additional output, employment and income resulting from re-spending by households that receive income from employment in direct and indirect activities.

Input-output analysis	Analysis based on a set of tables that quantify the linkages and transactions between different sectors of the economy.
Inverse matrix	The inverse of the identity matrix minus the direct requirements coefficients matrix, commonly denoted $[I-A]^{-1}$.
Keynesian multiplier	A multiplier derived from a macroeconomic model that expresses regional income as a function of consumption, investment, government expenditure, exports and imports.
Multiplier	An index (ratio) indicating the overall change in the level of activity that results from an initial change in economic activity.
Output	Gross revenue of goods and services produced by commercial organisations plus gross expenditure of government agencies.
Port industry	All activities that are required for the movement of ships and their cargoes and passengers through a port. Excludes naval ships, fishing vessels, recreational boating activities, and other users of the port.
Port-related activities	Activities that comprise the port industry.
Region	The geographic area for which the flow-on effects and total impact of a port are estimated.
Total impact	The sum of the direct effects and the flow-on effects.
Type I multiplier	(direct effect + indirect effect)/direct effect.
Type II multiplier	(direct effect + indirect effect + induced effect)/ direct effect.

Value added	Payments to the primary inputs of production (labour, capital, land). Equal to gross revenue less the cost of intermediate inputs into production and imported goods and services.
Wool dumping	A process of compressing bales of wool (ie reducing their volume) to enable more bales to be loaded into each container.

REFERENCES

ACIL Consulting 1998, Canberra International Airport and the Australian Capital Region Economy, Economic Study for the Australian Capital Regional Development Council, Canberra.

—1999, Port of Brisbane—Its Economic Value and Impact, Report prepared for the Port of Brisbane Corporation, Brisbane.

BTE 1999, Waterline, issue no. 20, September, Bureau of Transport Economics, Canberra.

Burns, J.P.A. & Mules, T.J. 1985, 'A note on the policy implications arising from the misuse of input-output analysis', Economic Papers, vol. 4, no. 4, December, pp. 73-78.

Butler, G.J. & Mandeville, T.D. 1981, Regional Economics: An Australian Introduction, University of Queensland Press, St Lucia.

Chang, S. 1978, 'In defense of port economic impact studies', Transportation Journal, Spring, pp. 79-85.

Davis, H.C. 1983, 'Regional port impact studies: a critique and suggested methodology', Transportation Journal, Winter, pp. 61–71.

DeSalvo, J.S. 1994, 'Measuring the direct impacts of a port', Transportation Journal, Summer, pp. 33-42.

Dickey, A. 1999, Dutch Maritime Cluster: A Network of Excellence, Lloyd's List, London.

Economic Research Associates 1997, The Economic Significance of Perth International Airport, Report Prepared for the Federal Airports Corporation.

Ernst & Young 1997, Economic Impact of Brisbane Airport, Brisbane Airport Corporation, Brisbane.

FPA 1998, Fremantle Port Trade Review 1997/98, Fremantle Port Authority, Fremantle.

—1999a, Statement of Corporate Intent 1999/2000, Fremantle Port Authority, Fremantle.

—1999b, Annual Report 1999, Fremantle Port Authority, Fremantle.

—1999c, Fremantle Inner Harbour Port Development Plan, Fremantle Port Authority, Fremantle.

Institute of Transport Studies 1996, Report on the Economic Significance of Sydney International Airport, The University of Sydney, Sydney.

Maritime Administration 1985, Port Economic Impact Kit, US Department of Transportation, Washington.

—1999, Maritime Administration to Update its Port Economic Impact Kit (MARAD Port Kit), US Department of Transportation, http:/www.marad.dot.gov/reading%5Froom/announcements/sep28.htm.

Martin O'Connell Associates 1994, The Local and Regional Economic Impacts of the Port of Seattle: Executive Summary, Report Prepared for the Port of Seattle.

McLeod, P. & McGinley, C. 1992, Economic Impact Study, Port of Fremantle, Economic Research Associates Pty Ltd, Perth.

Mills, G. & Morison, J. 1993, Economic Impact of the Sydney Ports, Centre for Microeconomic Policy Analysis, Sydney.

Montalvo, J.G. 1998, 'A methodological proposal to analyze the economic impact of airports', International Journal of Transport Economics, vol. xxv, no. 2, June, pp. 181-198.

Morison, J. & Jensen, R. 1987, The Economic Impact of the Port of Brisbane, University of Queensland, Brisbane.

Mules, T. 1996, 'Kate Fischer or Liz Hurley: which model shall I use?' in Bureau of Tourism Research, Tourism and Hospitality Research: Australian and International Perspectives, Bureau of Tourism Research, Canberra.

Price Waterhouse 1997, Economic Impact Study of the Bunbury Port 1995/96, Bunbury Port Authority, Bunbury.

The Rowland Company 1995, Economic Benefits of the Port of Esperance, Esperance Port Authority, Esperance.

Vancouver Port Corporation 1988, Opening Doors to Economic Benefits: The Economic Impact of the Port of Vancouver, Vancouver Port Corporation, Vancouver.

Verbeke, A. & Debisschop, K. 1996, 'A note on the use of port economic impact studies for the evaluation of large scale port projects', International Journal of Transport Economics, vol. XXIII, no. 3, October, pp. 247-266.

Villaverde-Castro, J. & Coto-Millan, P. 1998, 'Port economic impact: methodologies and application to the Port of Santander', International Journal of Transport Economics, June, pp. 159-179.

Waters, R.C. 1977, 'Port economic impact studies: practice and assessment', Transportation Journal, Spring, pp. 14-18.

West, G.R. 1993, Input-Output Analysis for Practitioners, Version 7.1: User's Guide, G.R. West, The University of Queensland, Brisbane.

—1995, 'Comparison of input-output, input-output+econometric and computable general equilibrium impact models at the regional level,' Economic Systems Research, vol. 7, no. 2, pp. 209-227.

—1999, Notes on Some Common Misconceptions in Input-Output Impact Methodology, Discussion Paper no. 262, Department of Economics, The University of Queensland, Brisbane.

West, G.R. & Roy, J.R. 1998, 'Towards an interregional framework for joint assessment of tourism and the environment', Australasian Journal of Regional Studies, vol. 4, no. 1, pp. 161-176.

Yochum, G.R. & Agarwal, V.B. 1987, 'Economic impact of a port on a regional economy: note', Growth and Change, Summer, pp. 74-87.

ABBREVIATIONS

AAPMA	Association of Australian Ports and Marine Authorities
ABS	Australian Bureau of Statistics
AMSA	Australian Maritime Safety Authority
AQIS	Australian Quarantine and Inspection Service
BTE	Bureau of Transport Economics
CGE	Computable general equilibrium
FPA	Fremantle Port Authority
GRIMP	GRit IMPact program.
GRIT	Generation of Regional Input-Output Tables
teu	Twenty-foot equivalent unit
US	United States of America
WA	Western Australia