Audit of Economic Models for Aviation, Tourism and the Australian Economy

Prepared for the
Australian Department of Industry, Tourism and Resources

Applied Economics

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Executive Summary

The Australian Department of Industry Tourism and Resources (DITR) commissioned Applied Economics (in association with the STCRC's Centre for Tourism Economics and Policy Research) to prepare a report on economic models for use in the aviation and tourism industries.

Drawing on consultations with government and industry, the first chapter of this report describes the major kinds of outputs that government and industry are looking for. Separate chapters then follow on general economy (multi-sector) models, market-specific models, and other relevant models respectively.

- A general economy (multi-sector) model is a model of all sectors (industries) of the economy, but it may apply to a region as well as to the country as a whole.
- A market-specific model is a model of a market and typically applies to one sector or industry or, quite often, to a sub-sector.
- Other relevant models include various structural estimation and time series models, including aggregate (non-sectoral) macroeconomic models.

The main text provides an overview of these models along with some applications. Appendices provide more detailed descriptions of the models and applications.

The last chapter of the main report summarizes the main strengths and weaknesses of these economic models and draws conclusions. An important conclusion is that the models are often complementary and studies may often draw on more than one kind of model.

Outputs required by government and industry

Table S.1 shows the major forms of outputs that the economic models are expected to produce at national, regional and industry level.

Table S.1 Major outputs required for aviation and tourism analysis

Level of analysis	Output required
National impacts	Gross domestic output and employment Gross value added in aviation and tourism sectors National welfare (net social benefit) effects
Regional impacts	Regional output and employment Regional welfare (net social benefit) effects
Industry impacts	Gross expenditure in aviation and tourism No of tourists and expenditure per tourist Gross expenditure on industry sub-sectors Gross expenditure by region

Importantly the models need to be able to provide both forecasts of economic activity (output and employment) and estimates of welfare effects (the benefits to Australian consumers and producers). Industry is primarily concerned with models that provide forecasts but may also need to show that policy changes are in the public interest. On the other hand, government is primarily interested in the public welfare effects, nationally or regionally, but will usually also be interested in forecasts of economic activity.

In any case, economic activity is generally an important component of welfare. However, output as measured by gross domestic product (GDP) and welfare are not necessarily equivalent. Welfare depends also on terms of trade effects, consumer benefits, benefits accruing to Australians, the opportunity cost of additional employment, and non-market effects that are generally not captured in the GDP metric.

This report examines three main categories of models:

- Multi-sector economy models, notably input-output and computable general equilibrium models,
- Market-specific (partial equilibrium) models, and
- Other models, including multivariate structural models and time series models.

Table S.2 provides a summary of the major strengths, weaknesses and potential applications of these model types. In brief:

- Input-output models may be used to estimate impacts of major events and regional impacts, but only with considerable caution and explicit notes on limitations.

- CGE models are good for modeling industry wide effects, inter-industry effects, and national or regional impacts of major economic changes. They can also provide welfare estimates but these need to be decomposed and explained.

- Market-specific models are the most direct and cost-effective model for analysing effects in a single market. They can provide forecasts and estimated welfare effects. They are often required to produce inputs to CGE models and they can use outputs from CGE models.

- Multivariate structural models trace impacts and outcomes of major events, activities and changes through the industry and for different components of the industry. They can be used for analysis and forecasts. They do not provide welfare measures.

- Time series models are used for forecasting variables where past structure is likely to dominate outcomes. They can also be extended to test causation and its direction with other variables.

However, the models are often not mutually exclusive methods. As discussed below, in many applications more than one type of model may be employed.

Table S.2 Summary of major features of models

Model-Type	Strengths	Weaknesses	Applications
Input-Output	The models track inter-industry relationships and knock-on effects	Models contain no resource constraints and no prices and assume that effects are taken as fixed with no adjustments in behaviour or feedbacks. Not helpful for forecasting since too many variables are kept constant.	May be used, but only with considerable caution and explicit notes on limitations, to estimate impacts of major events and regional impacts.
CGE models	Good CGE models track inter-industry relationships, are based on realistic behavioural assumptions, and allow for resource constraints and prices. They can provide fully simulated economic impacts and welfare estimates.	CGE models are industry based and may require substantial detailed modeled inputs. Model assumptions regarding scale effects, adjustment mechanisms, and labour supply need close scrutiny. The modelling often seems black box to non-expert users. Maybe overkill for small changes.	Good for modeling industry wide effects, inter-industry effects, and national or regional impacts of major economic changes. Good for conditional forecasting, but less so for unconditional forecasts and for time paths. Can provide welfare estimates but these need to be decomposed and explained.
Market-specific models	Market-specific models focus on the key details and primary effects. They use well-understood demand and cost functions and produce transparent results. Welfare effects are readily estimated.	A partial equilibrium model misses any flow-on effects and feed-backs outside the industry, if these are significant. Relies upon external rather than own-estimation of the magnitude of the internal relationships.	Market-specific models are the most direct and cost-effective model for analysing effects in a single market. Can be used for forecasts and for estimates of welfare. They are often required to produce inputs to CGE models and they can use outputs from CGE models.
Multivariate structural estimation models	Within-industry relationships and detail tracked closely. Provides estimates of the magnitude of underlying relationships and diagnostics for the model's accuracy in representing past behaviour.	Misses any flow-on effects and feed-backs outside the industry, if these are significant. Subject to a range of problems in measuring and isolating all relevant variables.	Traces impacts and outcomes of major events, activities and changes through the industry and for different components of the industry. Can be used for analysis and forecasts. They do not provide welfare measures.
Time series models (univariate and multivariate)	Do not depend upon theoretical structures or upon data beyond the variable of interest.	Not directed at comprehensive analysis of behaviour and relationships.	Major use is for forecasting variables where past structure is likely to dominate outcomes. Can be extended to test causation and its direction with other variables.

Clearly the model of choice depends on the task. If the task is a forecast of tourist numbers or expenditure for commercial purposes, a multivariate structural estimation model or a time series model is likely to be the model of choice.

If the task is principally to analyse the economic and welfare effects of a change in one sector, with minimal spillover effects to other sectors, as occurs with minor policy changes in the aviation sector, a market-specific model is appropriate. However, this may still draw on a structural estimation or time series model to provide some inputs.

Matters are more complex when two or more sectors are involved and when both forecasts of economic activity and estimates of welfare changes are required. Here, as shown in Figure S.1, there are three main approaches. For convenience, these approaches are described in this report as the traditional approach, a mixed approach, and the gold-standard approach.

Importantly, in each case the starting point is likely to be estimates derived from a primary market-specific aviation model, drawing on relevant estimation methods.

Traditional approach. After estimating the consumer and producer surpluses or deficits in the primary market, the analyst estimates the net benefits in the secondary tourism market from some other source and adds these effects together with the primary effects. The 'other source' may be either the analyst's own estimates of the net benefits in the tourist market using a partial equilibrium model for that sector or estimates derived from results of existing CGE model work.

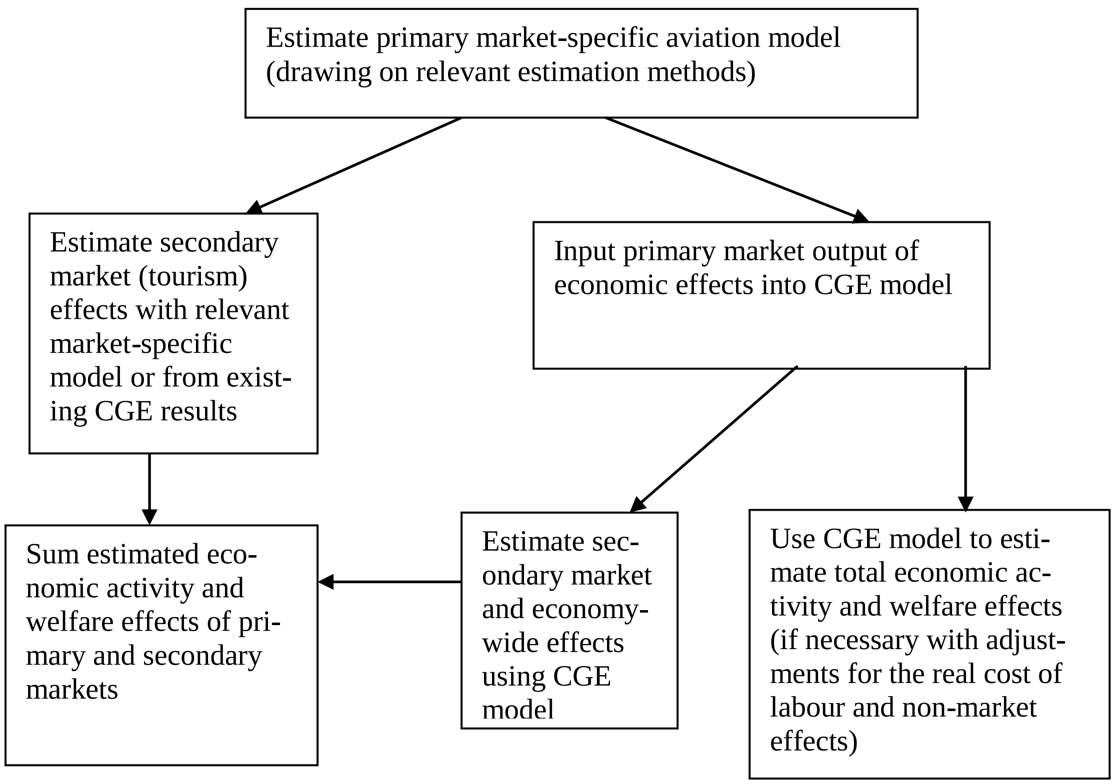

Figure S.1 Alternative approaches to estimating multi-sector effects

This approach is practical and for many applications it provides robust and quite accurate answers for both economic activity and welfare. However a partial equilibrium analysis of the tourism sector does not pick up all the economy-wide spillovers and reliance on existing CGE outputs may not pick up on the circumstances of the particular case under study.

Mixed approach. Under this approach, the analyst inputs the estimated primary market effects into a CGE model and then takes the outputs of the CGE model for the tourism sector back into account in summing the primary and secondary effects.

This approach is useful when modeling the full secondary effects is important and an existing CGE model can be readily used. It provides most of the outputs of the 'gold standard' model below but with a slightly lower level of robustness.

Gold-standard approach. Under this approach, the estimated primary market effects are input into a CGE model and the CGE model is used to estimate the total economic activity and welfare effects. This approach links a detailed industry-specific aviation model directly into an advanced CGE model. Combining the results of these linked models will provide detailed economic and welfare outputs.

This approach may be regarded as the gold standard especially for major economic events or policies. However, it requires sophisticated analysis of large numbers of assumptions which need to be made transparent. Also the welfare effects have to be carefully specified. It may be viewed as an excessively weighted analysis for many aviation issues.

Conclusions for multi-sector models

An industry specific aviation model is generally needed to capture the specifics of proposed changes, such as the changes in inbound and outbound travel and the change in profitability of the airline industry.

Ideally the results of the aviation model would be input into a CGE model with a tourism sector to capture the full primary and spillover changes nationally or regionally. The ideal (gold standard) model is capable of implementation, and for large changes it can be used or at least approximated.

Input-output models are not sufficient for this purpose in most cases, although they may be relevant in some regional analysis.

The mixed modeling approach, using an aviation model along with a CGE model to estimate the spillover effects, can often provide reasonable estimates of economy-wide effects and is less complex.

When spillovers are small, the traditional approach using partial equilibrium estimates or existing CGE results to estimate secondary effects, can provide practical and robust results for both economic activity and welfare.

1 Introduction

1.1 Report Objectives

The terms of reference for this report require the consultant to:

- Identify existing models commonly used to quantify tourism benefits in relation to aviation issues.
- Identify other economic models including CGE models that could be applied to tourism and aviation issues.
- Describe the theoretical framework, assumptions, scope and relevance to policy development and industry planning of each identified model.
- Assess the strengths and weaknesses of each model and advise how the models might best be suited to various policy development and industry planning purposes.
- Generally discuss the role of modeling in tourism and aviation business and policy decisions.

Two themes of the above dot points are that the report is expected to be useful (i) for policy development or decisions and (ii) for aviation and tourism industry planning.

In a start-up meeting with officers of DITR, officers stated that a focus of the report is to identify the kind of economic modeling that the government should do, or commission, to assess the impacts of aviation policy or events, especially those related to international aviation, on tourism and the Australian economy. For example, the modeling should be able to assess the impacts of policies or events like liberalisation of specific international routes, code sharing or mergers on specific routes, major changes in cost inputs such as fuel prices or airport charges, and provision of new international services from existing or new Australian airports. Although the Commonwealth perspective is a national one, it was also recognized that state and local jurisdictions usually have regional or local perspectives. The analysis of models should also bring out key decision-making features, such as cost, timeliness and transparency, and consider when such modeling should be done.

In addition, the study is expected to describe and assess models that could be useful to the aviation and tourism industries. There are many potentially useful models for industry, including many forecasting models and a variety of sub-models. The report is necessarily selective in analysis of these models.

Importantly, industry itself has two interests. One is to influence public policy and the other is to plan its own commercial activities. In the former regard, the models that industry is likely to be most interested in using are essentially the same models that policy makers regard as important. Thus industry commissions works on models that describe, forecast and evaluate general economic activity as well as industry own-purpose models.

1.2 Outputs Required from Economic Models

In this section we summarise the major outputs required by the Australian and State governments and by industry. These may be categorized primarily as national, regional and industry impacts respectively. However, this is not intended to imply that the Australian government is interested only in national impacts or that industry is interested only in industry effects. The Australian government is often interested in regional and industry effects; state governments in national and industry effects; and industry in national and regional effects.

National economic impacts and welfare effects

At the national level, there are two main kinds of output of interest: **national economic activity (production or income) effects** as measured by changes in gross domestic production (GDP) or gross value added (GVA) and the **national welfare effect.** As will be seen, the national economic activity and welfare effects are related, but they are different in some significant ways.

The difference between GDP and GVA is that GDP is measured at market prices, which include commodity taxes and subsidies, whereas GVA excludes commodity taxes and subsidies. Thus GDP is usually higher than GVA. Because GDP is a measure of total income, it is the more commonly used measure of output.

GDP is a measure of the total value of economic production in Australia in a given period. Subject to minor statistical discrepancies, the value of production generated should equal the value of income generated. This includes income generated to foreign owners of local resources.

GDP equals the sum of value added in each of 17 major industry sectors (plus the value of ownership of dwellings) plus indirect taxes. The value added in any sector equals the gross expenditure (or gross output) in the sector less the value of goods and services purchased for, or used up in, the process of production.

Transport and storage is one of the 17 sectors. Within the transport and storage sector, there are various sub-sectors, which are represented by a two-digit ANZSIC codes. One of these is the air and space industry, which includes airports and air navigation services as well as airlines.

Tourism is not one of the basic 17 industry sectors. Tourism is a consumption activity and the value of tourism is typically measured by the amount of expenditure by persons deemed to be tourists. Tourism outputs include the outputs of various industry sub-sectors, such as airports, airlines, domestic transportation, accommodation, food and drink, recreational services, other retail and so on.

The Australian Bureau of Statistics (Cat. No. 5249.0), estimated that gross value added due to tourism summed to $26.0 billion in 2003/04, which was equivalent to 3.5 per cent of total industry gross value added. In terms of GVA, tourism ranks thirteenth out of the 17 industries. This figure is estimated separately in the *Tourism Satellite Accounts.* It is not estimated or recorded routinely within GDP. Accordingly a separate accounting framework (separate from standard GDP accounting) is usually required to estimate the impacts on tourism.

The **national welfare effect** is the sum of benefits (or surpluses) to Australian producers, consumers, government, and third parties. Benefit is defined here, as is usual in measures of economic welfare, as the value of the activity *over* its cost to consumers or producers.

The benefit to any of these parties is thus the benefit *less* any cost incurred, including opportunity cost. Opportunity cost is the highest value of a factor of production in alternative use. All factors of production, especially but not only labour, are likely to have an opportunity cost. If the cost exceeds the benefit, as it does for households experiencing aircraft noise, the net benefit is negative.

The larger is the sum of these benefits, the greater is the gain in economic welfare. The national welfare effect is also described as national net social benefit.

It is important to recognize that the concept of national welfare (or net social benefit) is broader than the impact on production or income as measured by GDP. The following are some examples of how welfare effects are not necessarily reflected in, or measured by, changes in GDP.

- The benefits to Australians currently traveling overseas who pay foreign airlines lower prices and who purchase more goods and services while overseas do not show up in GDP figures. This is an example of a 'terms of trade' effect.

- Consumer surpluses associated with increased overseas trips. Suppose, for example, suppose that an Australian consumer is faced initially with a $2500 air fare from an foreign airline and chooses to purchase an imported television for $2000. Now the airfare falls to $2000, and the consumer purchases the air fare instead of the television. The consumer is better off because she is making a preferred purchase, but there is no change in Australian GDP.

- If the tourist sector expands by employing previously unemployed labour and leisure has a value (work has an opportunity cost), GDP increases by more than net welfare.

- Suppose that a worker is indifferent between working for $60,000 in a coal mine in the Hunter region or for $40,000 in tourist employment in Port Macquarie on the NSW coast. Currently he works in the mine because there is no tourist job available. With the fall in air fares and the increase in tourism, he takes a job for $45,000 in Port Macquarie. There is a welfare gain of $5000 (in welfare terms the worker is $5000 better off), but GDP has fallen by $15,000.

- GDP does not include non-market effects, notably environmental effects such as aircraft noise or emissions of greenhouse gases.

- Some income from GDP may accrue to foreigners.

For most public policy purposes, the national (or regional) welfare effect is the most important criterion.[1] Economic activity is a major component of welfare but not the whole of welfare. Sometimes, in lieu of an overall measure of economic welfare, an economic activity measure can be used as a proxy, but this should be done cautiously.

Regional economic impacts

Typically state and local governments are most interested in economic effects at the state, regional or local level (referred to in this report generically as 'regional effects'). The economic effects here are usually regional output (measured using GDP techniques) and employment.

In our consultations, industry also emphasized its interest in regional impacts because these can strongly influence local planning decisions and other industry facilitation processes.

It should be noted here that, as shown in Forsyth (2005a), the regional economic impact from increased tourism can exceed the national impact. This occurs when tourism expenditure is concentrated in one region and draws resources from other regions. In these cases, the increase in regional output in one area is partly offset by a reduction in output in another area.

Secondly, as noted by Forsyth (2005a), changes in regional output effects may exceed the regional net welfare benefits when (i) previously unemployed local resources are brought into production and these resources have a leisure opportunity cost and (ii) labour or other factors of production move into the region in response to increased demand.

Also, studies that focus exclusively on the production side of economic activity may overlook effects for consumers and third parties.

Finally, it should be noted that gross expenditure is sometimes assumed to be synonymous with gross output and regarded accordingly as an important output of an economic model. However, changes in total output can be estimated *only after* allowing for the costs of production (possible losses in other sectors or locations). Forecasts of gross expenditure are an important input to estimates of changes in regional output, but expenditure itself is often a misleading indicator of regional output effects.

Industry impacts

Members of the aviation and tourism industries (and their industry associations) need information to position and promote the industries publicly (at national and regional levels) and for their own direct commercial planning purposes. For example, Melbourne and Coffs Harbour airports have used economic models to argue for extension or maintenance of curfew free times.

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[1] For example, National Competition Policy requires that the national welfare benefit is the guiding policy principle. Clause 5(1) of the Competition Principles Agreement provides that: 'The Guiding Principle is that legislation (including Acts, enactments, ordinances or regulations) should not restrict competition unless it can be demonstrated that: (a) the benefits of the restriction to the community as a whole outweigh the costs…"

Turning to commercial planning, given the number and variety of interests in the two industries, there is a demand for a great deal of market data. Often this is highly commodity or service specific and very often it is also area specific. The two industries contain many significant sub-sectors, especially the tourism industry which, as has been noted, is a function of expenditure patterns rather than the supply of a particular commodity.

Based on our consultations, the core data needs of the two industries are:

- Gross national expenditure on aviation and tourism, including (i) numbers of tourists by type and origin and (ii) expenditure per tourist by type and origin;

- Numbers employed nationally in the aviation and tourism industries;

- Gross expenditure and/or employment in major industry sub-sectors (airports/airlines or domestic transportation/accommodation/food and drink/recreational services/other retail etc;

- Models of impacts of expenditure of specific kinds of tourism expenditure, such as expenditure on major events, arts culture and entertainment, tourism retailing, and educational tourism.

- Gross expenditures and/or employment by industry by region; and

- Gross value added in aviation and tourism industries.

Officers of the Tourism and Transport Forum emphasized in particular the need for models that showed value added in regional centres rather than high level macroeconomic models. Further they stressed the need for measurable and clear indicators.

Summary

Table 1.1 provides a summary of the major economic outputs required by the various main stakeholders in aviation and tourism and the national economy.

Table 1.1 Major outputs required for aviation and tourism analysis

Level of analysis	Output required
National impacts	Gross domestic output and employment
	Gross value added in aviation and tourism sectors
	National welfare (net social benefit) effects
Regional impacts	Regional output and employment
	Regional welfare (net social benefit) effects
Industry impacts	Gross expenditure in aviation and tourism
	No of tourists and expenditure per tourist
	Gross expenditure on industry sub-sectors
	Gross expenditure by region

1.3 Major Types of Economic Models

Table 1.2 shows the main economic models available to provide the major required outputs previously identified.

To estimate national or regional levels of economic activity (output and employment) there are three main forms of model: input-output, computable general equilibrium (CGE) and macro-economy models (usually based on structurally estimated multiple regression equations).

However, to estimate the effect of changes within an industry, it may be preferable to employ a market-specific model that focuses on changes in expenditure and output of firms within the industry. Such models are often described as **partial equilibrium models** because they focus on the output and prices within a particular sector rather than with inter-industry effects.

A range of structural estimation and time series models are available for estimating and quantifying behavioural relationships and for forecasting expenditure in the aviation and tourism sectors and sub-sectors, nationally and by region.

Importantly, it should be noted that economy-wide, market-specific and other (mainly forecasting) models are not mutually exclusive. Outputs from forecasting models are often inputs to market and general economy models and outputs from market models are often used as inputs to general economy models. Applications by government or industry may draw on more than one of these kinds of models.

Turning to measures of economic welfare, as will be seen, input-output models do not produce measures of economic welfare. Nor can forecast expenditure be equated with welfare gains.

Table 1.2 Main models for major outputs

Output required	Main models
Gross domestic output	Input-output, CGE, macro-economy models[a]
Gross value added in aviation and tourism sectors	Input-output, CGE, industry models
National welfare (net social benefit) effects	CGE + a measure of economic welfare
	Market (partial equilibrium) models + CBA[b]
Regional output and employment	Input-output, CGE models
Regional welfare (net social benefit) effects	CGE + measure of economic welfare
	Market specific models + regional CBA
Gross expenditure in aviation and tourism	Structural estimation or time series models
No of tourists and expenditure per tourist	Structural estimation or time series models
Gross expenditure on industry sub-sectors	Structural estimation or time series models
Gross expenditure by region	Structural estimation or time series models

(a) This macro-economy model would usually be a structural estimation model.
(b) CBA stands for cost-benefit analysis. A CBA is a study of all costs and benefits to relevant parties.

However, it is possible to incorporate measures of economic welfare in CGE models. Such measures are based on the benefits and costs of various options to all relevant parties and, if well-specified, they are a comprehensive form of cost-benefit analysis. Measures of economic welfare can be readily combined with market-specific models. Typically these models are used to provide inputs to cost-benefit analyses.

2 Multi-Sector Economy Models and Economic Welfare

2.1 Input-Output Models

Traditionally, input-output (I-O) models were the most common form of model used to estimate the economic activity effects of aviation and tourism (separately or combined), both nationally and more especially at regional levels. Dwyer et al (2000) cite numerous of I-O studies of the economic effects of tourism especially in the 1980s and 1990s. In recent years, the aviation industry in the United States has continued to use I-O studies to estimate the economic impacts of aviation. See for example Economic Research Associates (2003), Air Transport Action Group (undated), and Gillis (2005).

An I-O model shows the demand and supply of goods (in dollar terms) across industries and includes the household sector and imports and exports. Table 2.1 shows a simple transactions model with three industries and household and trade sectors. The sales (outputs) are shown along the rows and the purchases (inputs) down the columns. For each industry, the sales to other industries, households and exports must equal the purchases from other industries, labour and imports. Likewise labour sales (wages) must equal household purchases and in equilibrium exports equal imports. Such tables are typically developed initially from industry survey data for a particular historic period.

In an I-O model, an increase in sales to an industry requires an increase in inputs purchased by that industry. An I-O model traces and estimates the input requirements. Thus additional demand for output from industry A, due say to more tourists, will require extra inputs from industries B and C and extra inputs from labour as well as extra imports. The extra sales by industries B and C and the extra labour income will require in turn more inputs from each industry and more labour and thus generate another round of expenditure.

Table 2.1 A simple input-output transactions table

			Sales			
Inputs	Industry A	Industry B	Industry C	Households	Exports	Total
Industry A	0	300	100	600	0	1000
Industry B	100	0	100	400	1400	2000
Industry C	100	300	0	600	0	1000
Labour	600	1200	400	0	0	2200
Imports	200	200	400	600	0	1400
Total	1000	2000	1000	2200	1400	

This process continues as long as industries can meet additional demands and labour and other resources are available. Total generated output may be twice as high as the initial increase in expenditure, which would indicate a multiplier of 2.0, or even higher.

However, an I-O model does not explain where the extra labour and capital services come from. It simply computes the requirements. In so far as the results are interpreted as forecasts of output, it is assumed that the resources are available with no loss of existing output.

Information provided on economic activity levels

Input-output models provide information about a range of variables of interest to policy makers and industry. In particular, they provide information about the values of industry outputs, and how these might change in the face of a *pre-specified* increase in demand in one particular industry, *assuming* that the required labour and capital is available to support this expansion.

Where I-O models are built for a region rather than at the national level, they can provide all this information for that region, rather than for the economy as a whole.

I-O models cannot provide other types of information that might be of interest. They cannot provide projections for numbers of tourists, expenditure per tourist or gross expenditure on tourism activities. On the contrary, they require assumptions to be made about these variables, in order to provide the pre-specified increase in demand for tourism services.

Information provided on economic welfare

Input-output models cannot provide measures of economic well-being at the national or regional level.

I-O models track how an increase in tourism spending could potentially add to the income produced in Australia *if* the labour and capital resources were available at no extra cost. This is a strong and generally unrealistic assumption.

I-O models do not distinguish between income *produced in* Australia (GDP) and income earned *earned by* Australians (gross national product, GNP). The two can differ because of net profit repatriation to foreigners.

Nor do I-O models allow for increased demand to put upward pressure on prices and hence to reduce the real purchasing power of that income.

2.2 Computable General Equilibrium Models

CGE models are much more complex. At their core, they have an input-output framework. However, they also have equations to explain household and business demand for goods and allow for changes in relative prices, substitution in consumption and production between industries, and supply-side constraints.

CGE models can explain:

- where the extra demand for an industry's services comes from;
- where additional labour and capital services might come from to meet that demand (including the industry they may come from) ; and
- how input ratios may change if the prices of those inputs change.

These features mean that the projected final impact of a tourism expansion might be quite different from that projected by an input-output model.

CGE models of a single country typically allow that an increase in demand from foreign tourists is an external event which is input to the model. However, spending by domestic tourists can be explained within a CGE model by relating domestic tourism expenditure to incomes, which depend on wages and profits, prices of tourism activities, and prices of all other things that compete for the household budget.

A CGE model will also specify the supply of labour and capital available. If there is significant unemployment, a small tourism expansion may not lead to skills shortages. But if labour markets are tight, skills shortages may occur and hotels and other suppliers may need to offer higher wages to bid workers away from other parts of the economy.

Finally, most CGE models can allow for hotels and other industries to switch their relative use of labour and capital in response to changes in wages and required rates of return.

CGE models specify how demands and supplies for goods and services, capital and labour are kept in balance via price adjustment. For example, an increase in tourism demand can lead to an increase in supply of tourism services by allowing providers of these services to raise their prices and to attract more workers into their businesses.

Within CGE models, there is considerable variation in assumptions. Critical assumptions are the nature of unit costs (whether industries have constant, falling or rising unit costs); whether additional capital comes from domestic saving or foreigners; and the availability and real opportunity cost of local labour. Each of these is critical for the results. The output from increased tourism increases with falling unit costs and greater local supply of capital and labour. As shown in Appendix E, the estimated impacts of changes in trans-Tasman aviation on the tourist sector and economy in New Zealand were very sensitive to assumptions about the supply of labour.

Information provided on economic activity levels

CGE models can provide all the information that an input-output model can. They can also provide estimates of value added, wages and profits in an industry.

Most CGE models are capable of producing regional as well as national outputs. However, estimates of regional output can vary greatly as a result of different assumptions about inter-regional labour and capital mobility.

Single country CGE models can provide projections for gross expenditure by Australian tourists on domestic and overseas trips, as well as for the real value of goods and services that those tourists buy.

But they cannot provide projections for numbers of foreign tourists or for expenditure per tourist. Thus, single country CGE models typically assume that export demands, including by foreign tourists, are explained outside the model. Projected changes can be fed in by assumption, but the model itself cannot predict what those changes might be.

Usually single-country CGE models (e.g. the standard Monash model) are based on conventional input-output tables; they do not have a separate tourism industry. Tourism is treated as a consumption activity, not a production activity. Some of the output of each industry such as hotels, air passenger transport, photographic equipment, and so on, will be sold to Australian consumers when they are on holiday. So the tourism consumption of Australians will be a component of total household consumption, but it will not be shown separately. Similarly, some output of each industry will be sold to foreigners when on holiday in Australia. Such foreign tourism consumption is a component of total export sales, but again not separated out.

However, as described in Appendix A, some CGE models incorporate data from the Tourism Satellite Accounts. These accounts show how much Australian household consumption expenditure is bought by Australian tourists, and how much of Australia's export sales are to foreign tourists. Models that incorporate those accounts can keep track of tourism expenditures explicitly.

CGE models can provide two kinds of projections of tourism expenditures. The first kind is a projection of the consequences of a *single* policy change or event (such as an advertising campaign). A single factor that is not already explained within the model can be fed into the model and the consequences traced through for all the other variables that are explained within the model, such as domestic incomes and prices, and domestic tourism expenditures.

CGE models can also generate forecasts. These trace through the consequences of *all* factors that are not already explained within the model. The Monash model is often used in this way. The quality of the forecasts depends on the quality of the business-as-usual scenarios for the variables not explained within the model as well as on the quality of the equations determining the variables that are explained within the model.

Information provided on economic welfare

Traditionally CGE models focused on measures of economic activity, but in recent years several models have incorporated measures of economic welfare. Importantly for their credibility, it is now often possible to decompose changes in economic well-being as the sum of

- consumer surpluses;
- producer surpluses;
- terms of trade effects;
- technical change effects;
- endowment effects; and
- net payments to foreigners.

These effects are similar to those from partial equilibrium analysis of the sort discussed in Chapter 3 as well as in Appendices A and B.

It is important to recognize that such a CGE measure of economic well-being differs from real GDP because of terms of trade effects and net payments to foreigners. Depreciation and net payments to foreigners need to be deducted from GDP to obtain net national income and income is then deflated by consumption prices rather than production prices.

However, it should also be noted that neither this CGE measure of welfare nor GDP may account for the real opportunity cost of labour (when workers have leisure or occupational preferences) or for non-market (environmental) effects. Allowances for these effects may have to be added on.

Applications of CGE models

CGE models have been developed more recently than I-O models. Despite considerable *general* international use of CGE models (see Appendix A), our literature review in Appendix D found only a small number of applications to the tourism sector in other countries. Examples include the study of economic effects of a fall in tourism in Hawaii by Zhou et al. (1997), papers produced by researchers at the Christel DeHaan Tourism and Travel Research Institute at Nottingham University on a range of CGE modeling applications to tourism in the UK, Spain, USA, Indonesia, and to Small Island States, including Blake 2000, Sugiyarto, Blake and Sinclair 2002, and Blake et al (2000); and applications to Fiji in Narayan (2004).

However, there has been active development and use of CGE models for estimating aviation and tourism effects in Australia. The Industry Commission (1996) estimated output results of the Monash CGE model for moving the Grand Prix from Adelaide to Melbourne. This did not include a formal welfare evaluation. Econtech (2001) used its in-house model to estimate the GDP effects of the decline in flying due to the 11/09/01 New York attack and the collapse of Ansett. But, again, there is no welfare analysis. Woollett et al (2002) developed a one-off CGE model specifically to estimate the effects of tourism in Queensland. The consulting firm NECG (2002) also made extensive use of CGE modeling to present the case for the Qantas/Air New Zealand alliance across the Tasman (see Appendix E).

In recent years, the STCRC Centre for Tourism Economics and Policy Research has been developing a CGE model for use in Australia (see Dwyer et al., 2003, 2005, 2006). These publications describe the M2RNSW model developed by the Centre to estimate the contribution of tourism to the NSW and Australian economies. This model adapts the Monash multi-regional forecasting (MMRF) model of Australia. It contains an industry classification of 42 non-tourism industries and 14 tourism industries distinguished by source of the traveler (intrastate, interstate, overseas, and outbound) and purpose of travel (holidays, visiting friends and relatives, business and conferences, and other). Each tourism industry purchases a range of products from the 42 standard industries identified in the model and onsells them to travelers at cost price. This model also has a regional breakdown and is being developed to simulate the impacts on the eight Australian states and territories (MR8CGE).

3 Market-Specific Models and Economic Welfare

3.1 Market-Specific Models

CGE models are basically industry-level models. They can model an industry level impact and show the interactions *between* industries (or sectors). However usually they do not show what happens *within* an industry or market. In such circumstances, a market-specific model is required.

Market-specific (partial equilibrium) models are concerned with changes in the specific market where the policies or events are occurring and not directly with flow-on effects to other sectors (although the latter can also be analysed with a separate partial equilibrium or CGE model).

The key parameters in a market-specific model are the estimates of demand and supply (for example demand elasticities). These may be estimated as part of the development of the model or generated from other studies and applied to the market-specific model.

There are many studies of air transport liberalisation based on a market-specific approach to estimating outcomes and assessing the gains. In a major review paper, Winston (1993) summarised estimates of benefits and costs to consumers and producers from several studies of deregulation of various industries in the United States, including the transport industry.

The reports by the Productivity Commission (1998) and by Gregan and Johnson (1999) are other examples of a market-specific approach. The latter constructed a model of airline activity along a particular international route structure. Its treatment of demand and supply along those routes was considerably more complex than it would be in a typical CGE model (see Appendix B). However, these studies did not evaluate welfare effects.

On the other hand, Forsyth (2005b) provides a market-specific analysis of the aviation sector supplemented by estimates of tourism benefits derived from CGE modeling, which we cite below.

Information provided on activity and welfare

A market-specific model can examine the effect on the airline industry of route-specific events such as the entry of a new competitor on particular routes, the merger of two airlines, or the liberalization of particular air services agreements. Such models, with appropriate demand and supply functions, can provide projections for passenger numbers, air ticket prices, and expenditure on airline travel on a route-by-route basis arising from such changes. They can also provide projections for airline revenues, costs and profits.

Market-specific models can provide good estimates of the direct welfare effects (consumer and producer surpluses) in that market. This assumes that any changes in the air travel industry associated with this policy event do not spill over to other industries or affect household incomes in a major way. In effect, it assumes that prices in other sectors are close to marginal cost so that in so far as consumers spend their savings (or producers their profits) in other sectors, the generated surplus in other sectors is small or negligible. This is a common assumption in economic evaluations where changes are small and employment high.

However, as seen below, a specific market analysis can be extended to include secondary effects in related sectors.

3.2 Cost-Benefit Analysis

Cost-benefit analysis (CBA) provides an evaluation framework for estimating welfare effects. But CBA is not itself an explanatory or forecasting model. In the first instance, other models (especially those described in Chapter 4) must be used to develop explanations and forecasts of price and quantity effects in the specific market or industry under examination.

Appendix B describes the basic concepts in CBA. The initial focus of the analysis is on individual firms and households within specific markets.

The basic valuation principle for any scenario is that the net benefit to consumers and producers is the sum of their surpluses (benefits less costs). However, CBA also allows (where appropriate) for non-market impacts and for impacts in secondary markets (‘indirect’ impacts).

Turning to possible increases in tourism expenditure in Australia, what net benefits can be expected from this expenditure? Note that the aim is to estimate the *net benefit* (NB) of extra tourist expenditure (ΔTE). This is given in the first round by:

$$NB = \Delta TE - CI \qquad (3.1)$$

where CI is the opportunity cost of all inputs. Only the *surplus* of expenditure over the cost of inputs is a net benefit.

The level of benefit is generally related positively to the level of unemployment of resources. When resources are fully employed, there are usually only small gains from reallocating them from one sector to another. On the other hand, when there are unemployed resources, employment creates a surplus over opportunity costs.

Two other points should be noted. First, there may be further multiplier effects. In so far as an increase in local incomes is re-spent locally and in so far as there remain some local unemployed resources, there will be a second round and even a third round increase in incomes. Secondly, there may be some beneficial terms of trade effects. This may arise from an appreciation of the exchange rate and a reduction in the price of imports across all sectors.

Analytically, the key point is that the net economic benefit of increased expenditure on the tourism sector is a function of the excess of expenditure over the costs of servicing this expenditure. This net benefit may be estimated directly from analysis of the returns to expenditure in the tourism industry or obtained from a CGE model. However, the former approach will not include any multiplier effects.

3.3 An Example of Cost-Benefit Analysis

Appendix B also provides an illustrative cost-benefit analysis of allowing greater airline competition across the Pacific. The aim is to illustrate the approach by showing the outcome for one scenario rather than to review the realism of the assumptions or the estimated results.

There are two main sets of benefits: benefits to Australian travelers and gains to the tourism industry from extra overseas visitors. There are also two main sets of losses: losses to Qantas and losses to tourism from more Australians traveling overseas.

The results for one year are summarized in Table 3.1.

Table 3.1 Illustrative results for one year for trans-Pacific scenario

Benefit or cost	Net benefit ($million per annum)
Benefits	
Benefits to Australian travelers	112.75
Tourism gains from overseas visitors	19.50
Total	132.25
Costs	
Losses to Australian interests in Qantas	112.00
Tourism losses from Australian travelers	5.50
Total	117.50
Net Benefit	14.75

Some key points that emerge are:

- The benefits and costs are based on the direct benefits and costs estimated for the aviation market.
- These benefits and costs are estimated directly from demand and cost functions.
- The benefits and costs are the sum of benefits and costs to individual consumers and firms that are involved directly in the relevant market.
- The analysis is a bottom-up micro-based analysis.
- The assumptions and results are transparent and can be tested.
- Benefits from secondary industries, in this case the tourism industry, are included. These benefits depend crucially on the excess of prices in that industry over production costs.
- The benefits in the secondary industry may be estimated from direct analysis of returns in the industry (which would again be a partial equilibrium analysis) or from a CGE model.

4 Other Potentially Relevant Economic Models

4.1 Introduction

Two further major generic types of economic models require mention. These are basic models for generating estimates of behavioural relationships and/or forecasts. In many cases, these models are required to generate inputs into multi-sector or market-specific models. Importantly, however, the models discussed below are not themselves evaluation or welfare models.

The first generic model type is univariate time series where the variable of interest is estimated without reference to other variables.

The second generic model type is a multivariate model. Multivariate models specify relationships between several data series. These relationships may be structural or non-structural. A structural relationship is based on economic theory. A non-structural relationship is based on robust statistical correlations rather than on economic principles.

Structural models have been used in tourism and aviation analysis from time to time, such as Gregan and Johnson (1999) for the Productivity Commission and the Tourism Forecasting Committee for its regular forecasts for international visitor arrivals, domestic visitor activity, outbound departures and export earnings.

Another study by Oxford Economic Forecasting (1999) is a hybrid work. The report straps an I-O based set of estimates for the aviation industry on to a typical macro-economic model with standard consumption and investment regression equations and time series regressions relating air travel to GDP.

But the potential for use of univariate time series analysis and other non-structural models has apparently yet to be picked up in this area.

Each type of model is discussed briefly below. More detail is provided in Appendix C.

4.2 Univariate Time Series Models

Univariate time series model depend upon sets of time series data that allow the inherent composition of the variable of interest and how that operates over time to be discerned.

Essentially the deconstruction of the variable as recorded over many observations through time takes place by representing the trend, cycle and seasonality elements that can be derived from the data history. This can be done is by using a regression equation fitted to the historical data that reflects these elements along with relevant diagnostic tests.

A univariate time series model can provide forecasts without requiring knowledge of, and forecasts for, any other contemporaneous explanatory variables. Such a model is a sophisticated form of extrapolation that takes the systematic components of past behaviour and projects them into the future.

Univariate time series modelling is often useful where knowledge of the determinants of the primary variable is limited or data is difficult to obtain, but good historical data on the primary variable is obtainable. However, such time series models are not designed to forecast at long horizons.

In the tourism and aviation industries, the method could give precise short-term forecasts on key variables such as fuel prices or consumer expenditure in aggregate or, especially, for market segments, particularly where there are no major known changes in train in relation to structure of the market or impacts on the market. Superior accuracy in ‘business as usual’ forecasts, where only the forecast itself is needed e.g. for inventory management, casual work-force hiring etc., can be provided usefully and economically by univariate methods.

Where longer-term forecasts are needed or where interest also lies in multi-variate understanding of causation and behavioural relationships, for either industry or government purposes, univariate time-series analysis can be still be used as a check on the effectiveness of the alternative more elaborate methodologies which are based on data for additional variables.

4.3 Multivariate Models

Structural Estimation Models

Structural estimation models take their lead from economic theory, which specifies in general terms how a variable of interest (the dependent variable) is influenced by other explanatory variables (independent variables). For example consumer theory tells us that the number of airline passenger flights undertaken is a function of the own-price of such flights, the price of complements and substitutes (e.g. rail or car travel), income levels, and a range of possible additional variables relating to the qualitative characteristics of the flights and the surrounding environment.

The relationships indicated from the process of theorizing can be expressed in a single multivariate equation form or sometimes in a system of such equations. Thus, for a region, tourism expenditure may be a function of, among other things, the level of unemployment. But the unemployment level in a highly tourism oriented local economy may itself be a function of tourism expenditure.

Empirical estimates are commonly achieved by using regression methods to estimate the magnitudes of the relationships — how much variation in one variable affects another variable of interest. It is not enough to know that more airlines operating on a particular route might reduce prices through competition. We may wish to estimate the likely size of such an impact from past experience and, further, estimate what the effect is in turn upon total passenger movements on that route. The estimates so obtained can be imported as parameters into the CGE and intra-industry models outlined in the previous section.

A range of regression-based estimation models have been used in tourism and aviation analysis. A common model is the discrete choice model used to analyse customer responses to different product characteristics eg the importance of flight frequency, in-flight service characteristics, plane size and configuration etc. (Louviere, Hensher and Swait, 2000). This is especially appropriate for business planning by service providers in public and private business spheres. Rail corporations, government airlines, private transport operators etc, all need to know what aspects of the bundles of service they offer are valued in what ways by consumers. Focus groups and other qualitative market research techniques can assist along with intuition and experience of executives, but for major reconfigurations by major organizations it can be helpful to move to more precise formal methods.

The tourism and aviation literature has also occasionally called upon estimated regressions prepared for other purposes to impute impacts from the sector. Adaptation of general purpose macro-econometric models for the whole economy to incorporate a detailed tourism and aviation component is featured in the work of Oxford Economic Forecasting (1999), which uses results from direct estimation studies elsewhere to establish that aviation has had a positive effect on the productivity of other sectors. It adjusts the results of its own macro-econometric models to take this effect into account, but by way of ad hoc adjustment.

Finally, in terms of multivariate models, the important work of the Tourism Forecasting Committee needs to be mentioned. Tourism Australia releases detailed forecasts of a range of variables or activities of relevance both to industry and governments (Tourism Forecasting Committee 2005). The forecasts are described as ‘consensus’ forecasts of activity across international, domestic and outbound tourism sectors, based upon a first stage of econometric modelling looking at income, seasonality, as well as significant events impacting on source markets. This involves direct structural estimation, and subsequent ‘qualitative’ adjustments made after expert evaluation of the model forecasts, particularly in relation to matters not easily represented in the formal modeling process.

Multivariate time series models

Unlike multivariate structural estimation, multivariate time series modeling does not rely on economic theory. Rather, each variable is explained by its own past and the past of the other variables in the system.

Multivariate time series modeling can also be used to test which variable adds to the explanation of the past history of another variable. This can help verify a causation relationship and its strength, and can be important where data for full structural estimation are not available and analysis can still proceed on variables of interest without problems of omitted variable bias intruding. In areas of transport and aviation where lags in response are common, this approach allows superior examination of these properties, but largely devoid of other interpretative behavioural structure.

Macroeconomic models

Macroeconomic models are used in all major economies and are usually designed to forecast domestic and international economic developments. Forecasts of GDP, inflation, interest rates, exchange rates, commodity prices, and so on, are essential to business and government planning. Australian examples of macro-economic models include the original Murphy model (MM), the Federal Treasury's model (TRYM), and the McKibbin and Sachs MSG multi-country model.

Modern macroeconomic models consist of a large system of simultaneous nonlinear equations relating macroeconomic variables. The number of equations varies according to the level of disaggregation required. For example, the G-cubed model contains 7000 equations. The TRYM model consists of 26 behavioural equations, 3 behavioural identities, and 102 accounting identities. These equations are specified according to some economic theory.

However, these macroeconomic models generally do not have a sector or industry breakdown. For tourism and aviation, macro-economic models are mostly used in conjunction with sectoral models with the macro-economic elements providing aggregate economy controls. Alternatively they are integrated with CGE models so that the consequences of macroeconomic changes for the aviation and tourism sectors can be traced. The latter are discussed above in relation to CGE models. The former are less evident as current approaches, but could be present within industry on a commercial-in-confidence basis.

5 Review of Models: Strengths, Weaknesses and Applications

5.1 Introduction

In this chapter we summarise the main strengths and weaknesses of the models discussed in the previous changers as well as possible applications.

However, it is important to recognize that the models are to some extent complementary. Explanatory and forecasting statistical models of the kind described in Chapter 4 are used to provide inputs to CGE models and market-specific models. Market-specific models can provide inputs to I-O and CGE models. CGE models can be used with market–specific models to generate welfare effects in secondary and primary markets respectively and so a total measure of welfare.

5.2 Input-Output Models

Input–output models have often been used to estimate the effects of changes in expenditure on different economic sectors and/or regions. Input-output models can estimate inter-industry relationships and employment effects.

Input-output models are seen as practical. At the national level, I-O tables are compiled on an occasional basis by the Australian Bureau of Statistics (ABS), and the only software required to run an I-O model is a package such as Excel that can perform matrix inversion, which is the mathematical technique used to count inputs back ad infinitum.

However, practicality is becoming less important. Where the data exist to build a national or regional input-output model, the software also exists to build a corresponding national, regional, or multiregional CGE model (if one has not been built already).

At the regional level, I-O tables need to be compiled by the model developer because the ABS does not compile them as a matter of course. This is not a trivial exercise. Often I-O tables are based on data that is many years old, sometimes more then 10 years old. And some of the data required for regional I-O tables needs to be imputed, since the ABS does not compile data on key requirements, particularly interstate or interregional trade flows, at all. Nevertheless, over the years several such databases have been built, for example the NSW input-output model developed by the Centre for Agricultural and Regional Economics at the University of New England.

However, I-O modeling is based on assumptions that are often unrealistic. I-O models are not resource constrained and do not allow for price changes. Consequently, unless there is high unemployment or high mobility of resources in a regional context, the projected output and employment effects are usually substantial over-estimates. While superficially attractive in yielding ‘a large number’ for the spillover benefits of a new tourism activity, these questionable assumptions cast serious doubt on the credibility of the results.

Further, I-O models cannot report net social benefits or the impact on national economic well-being. Increasingly these concepts, rather than just activity levels, are required for national economic policy making.

5.3 Computable General Equilibrium Models

CGE models are highly sophisticated and comprehensive models. They have an input-output structure at their core, but allow for resource constraints and use price adjustment to reconcile demands and supplies for goods, services and resources. This means that they produce much more realistic estimates of output and employment than do input-output tables (unless there are no effective resource constraints).

In addition, CGE models that consistently assume that households make the best choices they can, given their incomes and prices, have a well-defined measure of net economic well-being. However, it may be questioned whether they accurately value the real opportunity cost of labour and they omit non-market effects. CGE models commonly assume that expansion of employment has a zero opportunity cost. If this is considered inappropriate, the welfare results from CGE models can be adjusted with back-of-envelope estimates to subtract the opportunity cost of additional employment. Dwyer, Forsyth and Spurr (2005) did this, for example. Likewise non-market effects can be added in.

A traditional concern with CGE models was the cost of building and running them. However, these costs have fallen dramatically with the availability of generic model construction and solution software (such as GEMPACK, see Harrison and Pearson 1996), and even generic theoretical specifications (such as the GTAP theory). This has facilitated development of a range of available single and multi-country models with desirable features such as a regional dimension and an explicit treatment of tourism expenditure. Often, no adaptation will be necessary. If it is, the additional data requirements will often be the most expensive part of the adaptation.

An important issue is the size and complexity of CGE models even for simple applications. This has several implications. First most CGE models are based on an industry structure. As we have seen, they usually do not have intra-industry structures. Often the primary effects of a policy or event change have to be estimated first using a market-specific or intra-industry model (along with relevant estimation models). The outputs from these models (the projected increases in total tourism expenditure along with estimates of the changes in average costs in the aviation sector) can then be input into a CGE model to estimate secondary and total effects. The CGE model could then provide a consistent evaluation of the effects of these changes, along with further flow-on effects, on economic well-being. However, for many applications a CGE model is not a standalone model.

Second, CGE models use numerous assumptions about economic behaviour, such as how consumers and producers substitute between different goods and services. Users need to be aware whether the values of the parameters in the model are supported by evidence or highly uncertain. For example, in considering trade liberalisation, there is considerable debate about the values of the parameters that determine the degree to which consumers and producers switch between domestic and imported goods. Sensitivity tests can illustrate the likely range of outputs, but do not cancel the uncertainty.

For tourism and aviation applications, CGE results are typically sensitive to assumptions about model structure. Two key assumptions are whether capital and labour are in fixed supply to the economy as a whole and whether capital and labour are mobile between regions. In the trans-Tasman debate, the estimated tourism benefits were very sensitive to assumptions about the labour market (see Appendix E). Model users need to check whether the appropriate assumptions are being made for their own application.

Related to the complexity, CGE models are often viewed as black boxes, with results that are hard to understand and verify. Complexity depends on the application. Most aviation and tourism applications of CGE models are much simpler than scenarios involving multilateral liberalisation of goods trade, for example.

Also, until recently, the basis for welfare estimates from CGE models was unclear. However, it is now possible with some models to decompose economic welfare into components familiar from simpler modelling frameworks. In these cases, users of CGE models should be able to request that the model's measure of well-being is broken down this way.

Nevertheless, if simpler models can produce answers that appear to be as accurate, or more accurate, than CGE models and perhaps more transparent, complexity is a disadvantage. This was the conclusion of the New Zealand Commerce Commission which, in reaching its determination in the trans-Tasman case, put more emphasis on partial equilibrium market models than on CGE models (see Appendix E).

5.4 Market-Specific Models

Market-specific models often incorporate much richer detail of activity within a particular sector than is possible within a CGE model. Most CGE models are not well-suited to looking at detailed policy changes in aviation.

Market-specific models generally need to be developed for a particular application. In most cases, this requires estimates of demand and cost functions for a small set of services which draw on standard estimation methods. Their construction may also require industry cooperation to provide the necessary data on route traffic and route cost structures. The Productivity Commission (1998) built a detailed network from scratch for its air services inquiry.

Market-specific models can be developed quite easily. They directly address the main problem under examination. Interpretation of the results is generally transparent.

Also they provide the basis for estimating welfare effects in the primary market under examination. These generally constitute the major effects.

However, spillover effects notably to tourism activity may have to be estimated separately. Note that these benefits depend crucially on the excess of prices in that industry over production costs.

There are two main ways to take such spillover effects into account and to add them to the impacts in the primary market. One is to undertake additional partial equilibrium analysis of the tourism expansion and add the effects to the primary market effects. The other is to feed the effects of the primary market into a CGE model to estimate the tourism effects, and to add the results of the two exercises together. Forsyth and Ho (2003) used the latter approach.

Alternatively, as noted above, the outputs of the market-specific model can be input into a CGE model and the latter model can produce total economic and welfare effects.

5.5 Other Economic Models

Numerous other models are available to estimate key market quantities such as number of tourists and total tourist expenditure. Structural estimation models provide both forecasts and information on the role played by a wide range of explanatory variables in influencing the activity measured as the dependent variable in such analysis.

These advantages explain the adoption of such regression approaches in the tourism literature. The parameters estimated in this way can complement and be imported into the market-specific models and CGE work.

But equal weight must be given to a standard set of estimation problems. These include the demanding data requirements for sufficient degrees of freedom for all relevant variables and the statistical analysis issues that need to be reviewed in such areas as omitted variables, collinear variables, simultaneity and identification of the separate relationships in simultaneous systems.

Time series models have strong data requirements on the activity variable adopted, but do not require data on associated variables. They are strong on lag structures for the activity variable and can be a useful complement because of this for structural estimation in some circumstances. However the absence of explanatory variables in the approach means that however good the forecasting capacity of such models they provide no guidance on the magnitude of links to the other variables.

Nevertheless the forecasting capability of this method has been shown in many applications to be superior to using structural equations for forecasting. Of course, adjustment of both time series and structural forecasts can be made exploiting the intuitions and experience-based knowledge of industry practitioners, but this should not simply be ad hoc are there are well-attested mechanisms for incorporating such information in a disciplined, transparent and systematic way (e.g. Bayesian methods).

The availability of alternative models also means that they can be used to cross-check results and understandings.

However, these statistical methods do not themselves provide measures of economic welfare.

5.6 Summary: Strengths, Weaknesses and Applications

Table 5.1 provides a summary of the major strengths and weaknesses of the major types of models. Most of these points have been described previously. The table brings the main points together. In summary:

- Input-output models may be used to estimate impacts of major events and regional impacts, but only with considerable caution and explicit notes on limitations.

- CGE models are good for modeling industry wide effects, inter-industry effects, and national or regional impacts of major economic changes. They can also provide welfare estimates but these need to be decomposed and explained.

- Market-specific models are the most direct and cost-effective model for analysing effects in a single market. They can provide forecasts and estimated welfare effects. They are often required to produce inputs to CGE models and they can use outputs from CGE models.

- Multivariate structural models trace impacts and outcomes of major events, activities and changes through the industry and for different components of the industry. They can be used for analysis and forecasts. They do not provide welfare measures.

- Time series models are used for forecasting variables where past structure is likely to dominate outcomes. They can also be extended to test causation and its direction with other variables.

However, as has been stressed, the models are often not mutually exclusive methods. As discussed in the final section, in many applications more than one type of model may be employed.

Table 5.1 Summary of major features of models

Model-Type	Strengths	Weaknesses	Applications
Input-Output	The models track inter-industry relationships and knock-on effects	Models contain no resource constraints and no prices and assume that effects are taken as fixed with no adjustments in behaviour or feedbacks. Not helpful for forecasting since too many variables are kept constant.	May be used to estimate impacts of major events and regional impacts, but only with considerable caution and explicit notes on limitations.
CGE models	Good CGE models track inter-industry relationships, are based on realistic behavioural assumptions, and allow for resource constraints and prices. Can provide fully simulated economic impacts and welfare estimates.	CGE models are industry based and may require substantial detailed modeled inputs. Model assumptions regarding scale effects, adjustment mechanisms, and labour supply need close scrutiny. The modelling often seems black box to non-expert users. Maybe overkill for small changes.	Good for modeling industry wide effects, inter-industry effects, and national or regional impacts of major economic changes. Good for conditional forecasting, but less so for unconditional forecasts and for time paths. Can provide welfare estimates but these need to be decomposed and explained.
Market-specific models	Market-specific models focus on the key details and primary effects. They use well-understood demand and cost functions and produce transparent results. Welfare effects are readily estimated.	A partial equilibrium model misses any flow-on effects and feed-backs outside the industry, if these are significant. Relies upon external rather than own-estimation of the magnitude of the internal relationships.	Market-specific models are the most direct and cost-effective model for analysing effects in a single market. Can be used for analysis and forecasts. Also they are often required to produce inputs to CGE models and they can use outputs from CGE models.
Multivariate structural estimation models	Within-industry relationships and detail tracked closely. Provides estimates of the magnitude of underlying relationships and diagnostics for the model's accuracy in representing past behaviour.	Misses any flow-on effects and feed-backs outside the industry, if these are significant. Subject to a range of problems in measuring and isolating all relevant variables.	Traces impacts and outcomes of major events, activities and changes through the industry and for different components of the industry. Can be used for analysis and forecasts. They do not provide welfare measures.
Time series models (univariate and multivariate)	Do not depend upon theoretical structures or upon data beyond the variable of interest.	Not directed at comprehensive analysis of behaviour and relationships.	Major use is for forecasting variables where past structure is likely to dominate outcomes. Can be extended to test causation and its direction with other variables.

5.7 Applications Further Considered

Clearly the model of choice depends on the task. If the task is a forecast of tourist numbers of expenditure for commercial purposes, a multivariate structural estimation model or a time series model is likely to be the model of choice.

If the task is principally to analyse the economic and welfare effects of a change in one sector, with minimal spillover effects to other sectors, as is the case for minor policy changes in the aviation sector (such as a change in night curfew hours), a market-specific model is appropriate. However, this may still draw on a structural estimation or time series model to provide some inputs.

Matters are more complex when two or more sectors are involved (as may occur when a new airline is added to a route or a new route is introduced to an airport) and when both forecasts of economic activity and estimates of welfare changes are required. Here, as shown in Figure 5.1, there are three main approaches. These approaches do not have formal names. For convenience here we will label them below as the traditional approach, the mixed approach, and the gold-standard approach.

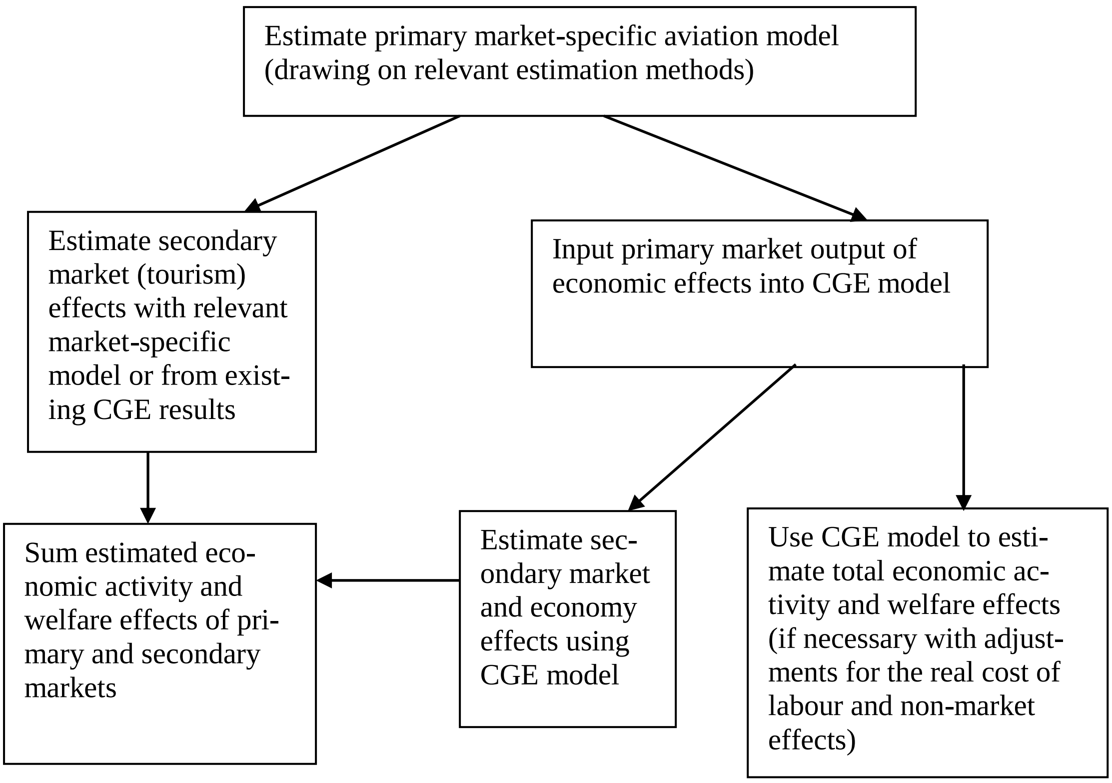

Figure 5.1 Alternative approaches to estimating economic activity and welfare effects

Importantly, in each case the starting point is likely to be estimates derived from a primary market-specific aviation model, drawing on relevant estimation methods.

Traditional approach. In this approach, after estimating the consumer and producer surpluses in the primary market, the analyst estimates the net benefits in the secondary tourism market from some other source and adds these effects together with the primary effects. The 'other source' may be either the analyst's own estimates of the net benefits in the tourist market using a partial equilibrium model for that sector or estimates derived from results from existing CGE model work. This kind of approach is commonly used in multi-modal transport studies where estimates of effects in the primary mode (say aviation or rail) are estimated first and then the estimated spillover effects on other modes are added in.

This approach is practical and for many applications it would provide robust and quite accurate and comprehensive answers. However it is limited in that a partial equilibrium analysis of the tourism sector does not pick up all the economy-wide spillovers and reliance on existing CGE outputs may not pick up on the circumstances of the particular case under study.

Mixed approach. Under this approach, the analyst inputs the estimated primary market effects into a CGE model and then takes the outputs of the CGE model for the tourism sector back into account in summing the primary and secondary effects.

A simple model of the relevant primary markets can be estimated, using information about airline costs, elasticities of demand for air travel and tourism, and tourism expenditure levels and patterns. This model provides estimates of changes in consumer and producer surpluses. It can also be provide estimates of changes in tourism demand etc. as inputs to a CGE model.

The changes in tourism expenditure can be fed directly into a CGE model with a tourism sector. If the CGE model does not possess this sector, the impacts on individual industries must be specified as inputs. The CGE model will produce estimates of changes in key variables such as GDP, GNP and GSP. Further adjustments will need to be made to produce estimates of changes in net benefits if factors used change.

The estimates provided by the aviation and CGE model can then be combined to obtain estimates of overall changes in welfare, consumer surplus, employment and other variables of interest. This approach can produce the same range of outputs as the gold-standard approach below, though some estimates are less rigorous and more approximate.

This approach is useful when modeling of the full secondary effects is important and an existing CGE model can be readily used.

Gold-standard approach. Under this approach, the estimated primary market effects are input into a CGE model and the CGE model is then used to estimate the total economic activity and welfare effects.

This approach involves a detailed industry-specific aviation model linked in with an advanced CGE model. The aviation model would incorporate demand and cost functions, along with the capability to explore behavioural issues (such as how airlines compete). The CGE model would incorporate an explicit welfare measurement module as well as shadow prices of any inputs, like labour, which might vary. It would also incorporate a detailed tourism sector.

Such a model could incorporate a detailed aviation industry, but detail at the level necessary for useful analysis may make the model expensive and cumbersome. It would be better to tailor aviation models to the problem at hand. Thus the aviation model used would differ if the issue were one of extra flights from China rather than of a Trans-Tasman strategic alliance.

However, the aviation and the CGE models would be closely linked. The aviation model would provide, inter alia, estimates of the changes in inbound and outbound tourism numbers and expenditures, including if necessary estimates of direct arrivals and departures through a gateway and the impacts on indirect flows (through other gateways). It would also provide estimates of the change in the demand for home-provided aviation industry services.

Combining the results of these linked models will give a range of outputs of interest:

- Estimates of the welfare gains to Australia or a state as a result of the change;
- Gains to consumers of air transport (home and foreign) as a result of the change;
- Impacts on the airline industry in terms of demand and profits;
- Impacts on national and state GDP/GSP and employment;
- Impacts on tourism industry output, profits and employment; and
- Changes in federal and state taxes.

This approach may be regarded as the gold standard especially for major economic events or policies. However, it requires sophisticated analysis of large numbers of assumptions. Also the welfare affects need to be analysed carefully. It may be viewed as an excessively weighted analysis for many aviation issues.

Conclusions on multi-sector models

An industry specific aviation model is generally needed to capture the specifics of proposed changes, such as the changes in inbound and outbound travel and the change in profitability of the airline industry.

Ideally the results of the aviation model would be input into a CGE model to capture the full primary and spillover changes nationally or regionally. The ideal (gold standard) model is capable of implementation, and for large changes it can be used or at least approximated.

Input-output models are not sufficient for this purpose in most cases, although they may be relevant in some regional analysis.

The mixed modeling approach, using a CGE model to estimate the spillover effects, can often provide reasonable estimates of economy-wide effects and is less complex.

When spillovers are small, the traditional approach using more partial equilibrium estimates or existing CGE results to estimate secondary effects, can provide practical and robust results.