6 Economic modelling and forecasting

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This chapter provides an introduction to economic modelling and forecasting. An economic model is a simplified representation of economic phenomena. Some of the concepts and issues discussed in this chapter are also covered in chapter 12, and it may help to read these two chapters in conjunction with each other. Some of the main forms of economic models are:

- simple statistical models;
- market-specific models;
- macroeconomic models;
- input-output models; and
- computable general equilibrium models.

This chapter draws on a 2006 report entitled *Audit of Economic Models for Aviation, Tourism and the Australian Economy* prepared by Applied Economics P/L in association with the Sustainable Tourism Collaborative Research Centre for Tourism Economics and Policy Research for the then Australian Department of Industry Tourism and Resources. The authors of this consultancy report were Philippa Dee, Larry Dwyer, Peter Forsyth, Roselyne Joyeux and Glenn Withers as well as the present author.

We will see that these models are not mutually exclusive and can often be used in combination to assess the impact of proposed changes or actions. We will illustrate the general concepts involved in economic modelling and forecasting with reference to a ‘live’ policy issue, namely modelling the impact of liberalising aviation policies on the Australian economy, and particularly on the tourism sector.

Modelling requirements

Economists use economic models to explain and predict different types of economic outcomes. These outcomes include quantities and prices of goods, revenues and costs, wages, the rate of interest, exchange rates and trade outcomes, to name but a few. These outcomes may be modelled at the level of the firm, industry or market. They can also be modelled at the level of a region or the economy as a whole. To understand the alternative economic models that can be used to inform decision-making we need to be clear about the outcomes we require the model to produce.

It is important to note that different stakeholders will often be interested in different types of outcomes. Thus the outputs required of a model of the impacts of liberalising aviation by the Australian and state governments and by industry may well differ. The Australian government is likely to be most interested in national outcomes, though not exclusively so. Industries are likely to have a more sectoral and geographic perspective, though again not exclusively so.

National effects

There are two main kinds of output that affect the nation as a whole and which may be the desired outcome of an economic model: national economic activity as measured by changes in gross domestic production (GDP); and the national welfare effect. As will be seen, national economic activity and welfare are related, but they differ in significant ways.

GDP equals the sum of gross value added (GVA) 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 in that sector.

On the other hand, the national welfare effect is the sum of benefits (or surpluses) to Australian producers, consumers, governments and third parties that arise from a particular change. Benefit is defined here, as is usual in measures of economic welfare, as the value of the activity to consumers or producers over the (opportunity) cost to consumers or producers of acquiring that benefit. The opportunity cost of something is its highest value in alternative use. All inputs to production are likely to have an opportunity cost. The larger the sum of the net benefits, the greater is the gain in economic welfare, also described as national net social benefit.

The concept of net social benefit or welfare is broader than production or income as measured by GDP. The following examples from airline deregulation and the tourism industry illustrate how welfare effects are not necessarily reflected in, or measured by, change in GDP.

- The benefits to Australians currently travelling overseas who pay lower prices to foreign airlines and who purchase goods and services while overseas do not show up in GDP figures. This is an example of a 'terms of trade' effect.
- GDP does not measure consumer surpluses associated with increased overseas trips. Suppose that an Australian consumer is faced initially with a $2500 airfare from a foreign airline and chooses to purchase an imported television for $2000. Now the airfare falls to $2000, and the consumer purchases the airfare 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 tourism 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 tourism employment in Port Macquarie on the New South Wales coast. Currently he works in the mine because there is no tourist job available. With a fall in airfares as s result of deregulation and an increase in tourism, he takes a new 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 policy purposes, the welfare effect is more important than the output effect. Economic activity is a major component of welfare but not the whole of welfare. Sometimes an economic activity measure can be used as a proxy for economic welfare, but this should be done cautiously.

Regional effects

Typically state and local governments are most interested in economic effects at the state, regional or local level. The economic effects here are usually regional output and employment. Industry also has an interest in regional impacts because these can strongly influence local planning decisions and other industry facilitation processes.

It should be noted that the regional economic impact could exceed the national impact. For example, tourism expansion in one region might draw on resources from other regions (Forsyth 2005a). An increase in output in one area is then partly offset by lower output in another area, so that the total national effect can be significantly different from the regional outcome.

Changes in regional output effects may also exceed the regional net welfare benefits when:

- previously unemployed local resources are brought into production and these resources have a leisure opportunity cost; and
- labour or other factors of production move into the region in response to increased demand.

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

A change in gross expenditure is sometimes assumed to be synonymous with a change in gross output and regarded accordingly as an important output of an economic model. However, changes in total output depend on the availability of resources and can be estimated only after allowing for the opportunity cost of production (losses in other sectors). 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 effects

The purpose of economic modelling can be to assess the impact of possible changes on a specific industry or industries alone. There is a great variety of market data that can be relevant to such an assessment. Such data are often commodity or service specific and area specific. For example, the core data needs of the aviation and tourism industries include:

- 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 (such as airports, airlines, domestic transportation, accommodation, food and drink and recreational services, and other retail);
- models of impacts 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.

Table 6.1 provides a summary of the major economic outputs that may be required by the main stakeholders in aviation and tourism and the national economy. The output(s) and level(s) of analysis desired by decision-makers then frames the choice of economic models, and the various choices discussed in the following sections.

Table 6.1 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 Number of tourists and expenditure per tourist Gross expenditure on industry sub-sectors Gross expenditure by region

Basic statistical models

Basic statistical models draw on generic statistical methods (discussed in chapter 12) to describe economic phenomena. There are three types of basic statistical models:

- univariate time series;
- multivariate time series; and
- multivariate structural estimation models.

Univariate time series models

A univariate time series model can provide forecasts without requiring knowledge of, and forecasts for, any other 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 models depend upon sets of time series data. The pattern of movement of this series of data is broken down into various components. The variable, as recorded over many observations through time, is decomposed into the trend, cycle and seasonality elements.

An example is airline passenger numbers over a given route. We can make a forecast of passenger numbers for this route for the next year by looking at monthly data collected for the past ten years. This data series is broken down into the long-term trend of passenger numbers, cyclical ups and down around this trend over shorter periods such as 3-5 year intervals, and seasonal variation such as summer highs and winter lows.

Univariate time series modelling is useful where knowledge of the determinants of the primary variable is limited, or data for other explanatory variables are difficult to obtain, but good historical data on the primary variable are available. However, such time series models are not designed to forecast over long horizons. In our example, a forecast of passenger numbers in ten years time, based on the behaviour of passenger numbers over the previous ten years, is a risky business; predicting what these numbers will be over the next year is less so.

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 used as a check on the effectiveness of more elaborate methodologies, which are based on data for additional variables.

Multivariate time series models

Multivariate time series models are more complex than univariate models in that the forecast values of the variable of interest (such as passenger numbers) are explained not just by the past values of the variable of interest, but also by the past values of other variables in the model. In this way, multivariate time series modelling can be used to test which variables help to explain the past history of another variable. The model is thereby 'built up' from the statistical analysis (rather than from theory, as is the case with multivariate structural estimation models are discussed below). This statistical testing of which variables are related to the primary variable of interest can verify the existence of a causal relationship and its strength, and can be important where data for full structural estimation are not available. Analysis of dependent variables can still proceed without problems of bias due to omitted independent variables affecting the results.

Multivariate structural estimation models

Structural estimation models, unlike time series 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 price of such flights, the price of complements and substitutes (for example, rail or car travel), income levels, and a range of possible other variables relating to the characteristics of the flights and the surrounding environment. Data are thereby obtained (if possible) for the variables that the theory puts forward as important.

The relationships indicated from the process of theorising can be expressed in a single equation, where a set of independent variables determines the value of a dependent variable such as passenger numbers. Alternatively, the relationship may be more complex and be expressed in a system of interlocked equations. Thus, for a region, tourism spending may be a function of, among other things, the level of unemployment. But the unemployment level in a tourism-oriented local economy may itself be a function of tourism spending.

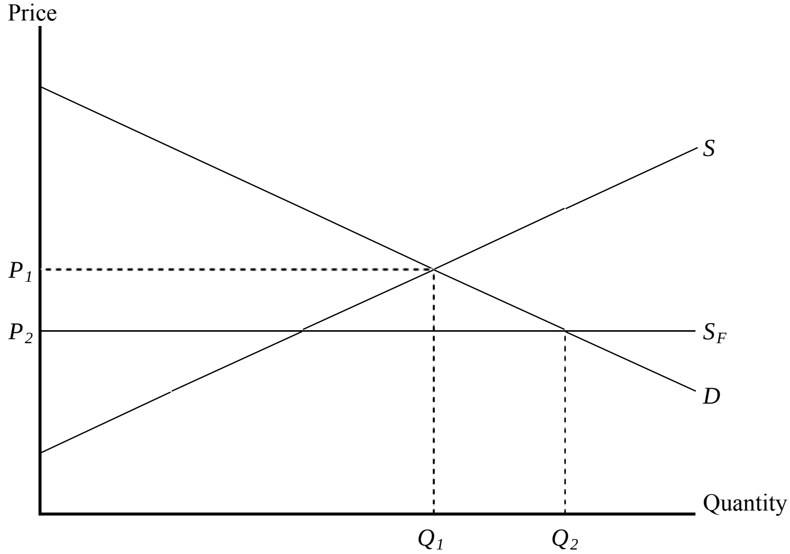
Empirical estimates are commonly achieved by using regression methods (discussed in chapter 12) to estimate the magnitudes of the relationships – that is the degree to which variation in one variable affects another variable of interest. The results of this quantitative analysis can be used to inform other types of economic modelling. These other forms of modelling, into which the results of basic statistical models can feed, are the subjects of the following sections.

Market-specific models

Market-specific models are concerned with outcomes in specific markets. They are sometimes described as partial equilibrium models because they tend to focus on particular markets and to ignore flow-on effects of changes in these markets on other parts of the economy. However, this is an over-simplification because, as described below, studies of markets can examine and model the effects in related markets for substitute or complementary goods.

Consider first a single market for a good as illustrated in Figure 6.1. In this figure, demand is depicted with a downward sloping curve, D; demand increases as price falls. The upward sloping curve, S, shows domestic supply as a function of price. With no imported goods, Q_1 goods will be consumed at price P_1 (where demand and supply are equal). The horizontal line, S_F represents the price at which foreign goods can be imported. With foreign trade, the price falls to P_2 and domestic consumption rises to Q_2.

Figure 6.1 A single market with imported goods



The key parameters in a market-specific model are the estimates of demand and supply/cost and, in particular, estimates of demand and supply elasticities. The price elasticity of demand (supply) is the percentage change in quantity demanded (supplied) as a function of the percentage change in price. These elasticities may be estimated as part of the development of the model, or generated from other studies and applied to the market-specific model.

A market-specific model can examine the effect on the airline industry of route-specific events such as the entry of a new airline on particular routes, the merger of two airlines, or the liberalisation 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 models can also consider interactions between markets, as illustrated in Figure 6.2. The government wants to upgrade a major road, but also wants to know the impact this might have on rail use along an adjacent railway line. Panel (a) shows the demand for road use with two sets of costs to the road users: C_1 before a road upgrade, and C_2 after it. The upgrade of the road increases road use from Q_1 to Q_2. Panel (b) shows the effect in the rail market. After the road upgrade, the demand schedule for rail trips falls from D_1 to D_2 and rail trips fall from Q_1 to Q_2 as road travel becomes relatively more attractive after the upgrade. If the fare (F) exceeds the marginal cost (MC) of a rail trip as in the diagram, the rail operator (which may also be the government) loses profits equal to area $(Q_1 - Q_2) \times (F - MC)$.

Figure 6.2(a) A model of related road and rail markets: road market

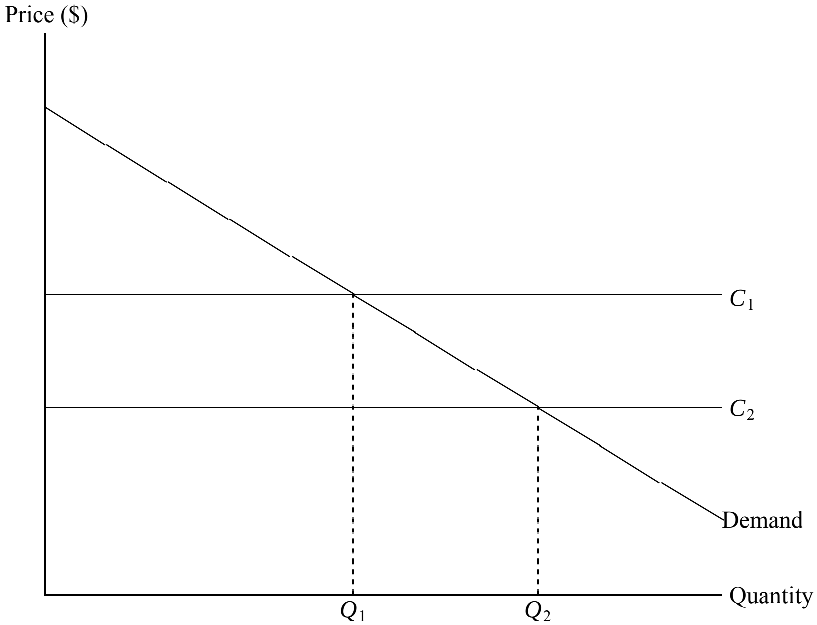
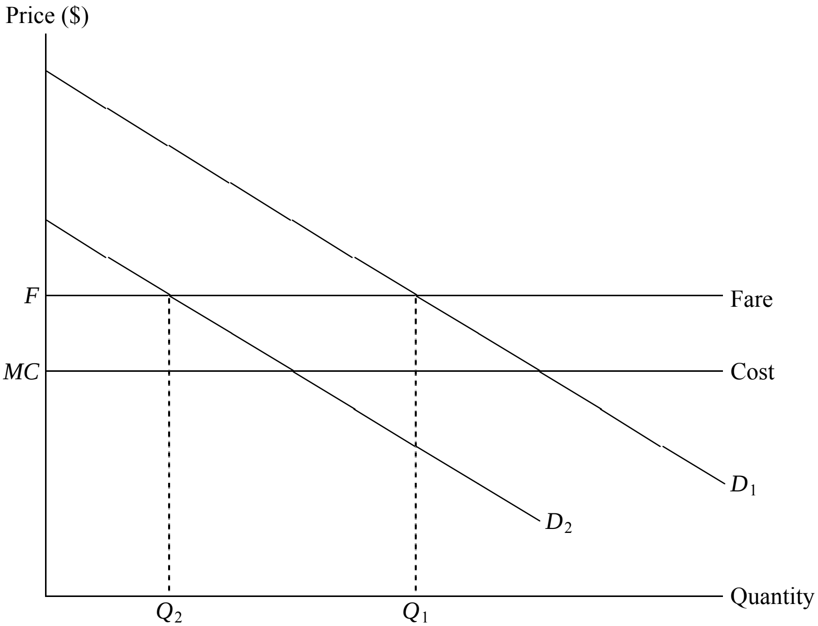


Figure 6.2(b) A model of related road and rail markets: rail market



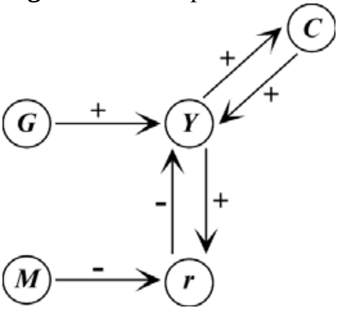
Such market or sector-specific models can provide good estimates of the welfare effects (consumer and producer surpluses) in both the principal market affected by a change and in related markets. In most cases these estimates are a reasonably comprehensive measure of the welfare effects. The key assumption is that this policy event does 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 where changes are small and employment high. However, if there are major spillover effects across numerous sectors, a multi-sector model may be required.

Macroeconomic models

Macroeconomic models, unlike market-specific models, are designed to explain and forecast economy wide aggregates such as GDP, inflation, employment, interest rates, exchange rates and imports and exports. Macroeconomic models vary from simple models with a handful of equations up to models with several thousand equations. The simple models focus on key macroeconomic variables. More detailed models address relations between output, employment investment and other variables.

Figure 6.3 (<www.geoffwyatt.com>) provides a simple illustration of a macroeconomic model designed to explain GDP in terms of output or its equivalent, income (*Y*). GDP is a measure of the total value of economic production in a country 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. As shown here, GDP (or income) increases with household consumption expenditure (*C*) and government expenditure (*G*) but is a negative function of the rate of interest (*r*). On the other hand, both household consumption and the rate of interest rise with income (the latter because of the higher demand for money holding money supply constant). Further, the money supply (*M*) is negatively related to the rate of interest. In this simple model, *G* and *M* are determined outside the model (exogenously) by government and central bank decisions respectively. *Y*, *C* and *r* are determined within the model (and are described as endogenous variables).

Figure 6.3 A simple macroeconomic model



Modern macroeconomic models consist of a large system of simultaneous equations relating macroeconomic variables. Australian examples include the Treasury's model (TRYM), the Monash and Econtech (Murphy) models, and the McKibbin and Sachs MSG multi-country model. The number of equations varies according to the level of disaggregation required. For example, the TRYM model consists of 26 behavioural equations, three behavioural identities, and 102 accounting identities. (The exact numbers vary as the model is modified.) These equations are generally specified according to some economic theory.

However, these macroeconomic models generally do not have a sector or industry breakdown. To relate macroeconomic changes to specific industries, such as tourism, macro models can be used in conjunction with sectoral models, with the macro-economic elements providing aggregate economy controls. Alternatively, as noted later in this chapter, they can be integrated with computable general equilibrium models so that the consequences of macroeconomic changes for the aviation and tourism sectors can be traced.

Multi-sector input–output models

An input-output (I–O) model shows the demand and supply of goods in dollar terms across industries, and includes the household sector and imports and exports. In an I–O model, an increase in output by an industry requires an increase in inputs purchased by that industry. This then requires an increase in output by those industries supplying the inputs for the first industry, and these industries then require increases in their inputs to production. An I–O model traces and estimates these input requirements among industries.

Table 6.2 shows a simple transactions model with three industries and household and trade sectors. Such tables are typically developed from industry survey data for a particular historic period. 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.

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 6.2 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 while industries can meet additional demands, and labour and other resources are available to increase production to meet this additional demand. Total generated output may be twice as high as the initial increase in expenditure on the output of the first industry. This ratio of the total output across industries to the initial increase is called a multiplier, which in this instance has a value of 2.0, or even higher.

Input–output models can be constructed for an economy as a whole or for regions or local areas. They can provide information about a range of variables of interest to decision-makers. In particular, they provide information about how values of industry outputs 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. 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.

I–O models cannot provide other types of information that might be of interest. For example, 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. Nor do input–output models provide measures of economic wellbeing at the national or regional level.

Computable general equilibrium models

Computable general equilibrium (CGE) models combine a national accounting framework, as described by a macroeconomic model, with an industry-level input–output model. The macroeconomic equations provide a balancing framework to ensure that the model satisfies resource constraints. Under the macroeconomic equations, there are numerous equations linking the industries to each other and specifying how production is determined (the production function) in each industry. The production function specifies how output varies with inputs, notably capital and labour. CGE models 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.

A CGE model is typically estimated from a base year set of data with a large number of relationships between the variables in the economy. The model is generally assumed to represent an equilibrium economy. Changes to key variables are made and the effects chased through all sectors until another macroeconomic equilibrium is reached.

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.

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.

Resources used in one sector have to come from another sector or, if there is unemployment, from an unemployed pool. A CGE model specifies 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. Assumptions about the availability of resources are critical to CGE forecasts.

Within CGE models, assumptions vary greatly. Critical assumptions are the nature of unit costs (whether industries have constant, falling or rising unit costs as the volume of production increases); whether additional capital comes from domestic saving or foreigners; and the availability and real opportunity cost of local labour.

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. 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.

Most CGE models can produce 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.

Generally CGE models focus on measures of economic activity rather than on explicit measures of economic welfare. However, it is usually possible with care to decompose changes in the model into the value 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 market-specific models). However, CGE models generally do not account for the real opportunity cost of labour (when workers have leisure or occupational preferences) or for non-market (environmental) effects.

Strengths, weaknesses and applications of the models

Table 6.3 provides a summary of the major strengths and weaknesses of the major types of models. Important summary points contained in this table are as follows:

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

Table 6.3 Summary of major features of models

Model type	Strengths	Weaknesses	Applications
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.
Multivariate structural estimation models	Provide estimates of magnitude of underlying relationships within an industry and diagnostics for model's accuracy in representing past behavior.	Miss any flow-on effects and feedbacks outside the industry; subject to a range of problems in measuring and isolating all relevant variables.	Trace impacts of major events and changes through an industry. Can be used for analysis and forecasts. Do not provide welfare measures.
Market-specific models	Market-specific models focus on 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 may miss flow-on effects and feedbacks outside the industry. Relies upon external rather than own estimation of the magnitude of the internal relationships.	These models are the most direct and cost-effective way to analyse and forecast effects in a single market. They can produce inputs to CGE models and use outputs from CGE models.
Input–output models	The models track inter-industry relationships and knock-on effects.	Models contain no prices or resource constraints and assume effects are fixed with no behaviour adjustments. Poor for forecasting as 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.	CGE models require substantial detailed modelled inputs. Model assumptions regarding scale effects, adjustment mechanisms, and labour supply need scrutiny. Modelling often seems black box to non-expert users. May be overkill for small changes	Can model industry-wide effects, regional or national impacts of major changes. Good for conditional forecasting, but less so for unconditional forecasts and for time paths. Can provide welfare estimates but only with much care.

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

analysing effects in a single market and some related markets. They can provide forecasts and estimate welfare effects. They can also produce inputs to CGE models and use outputs from CGE models.

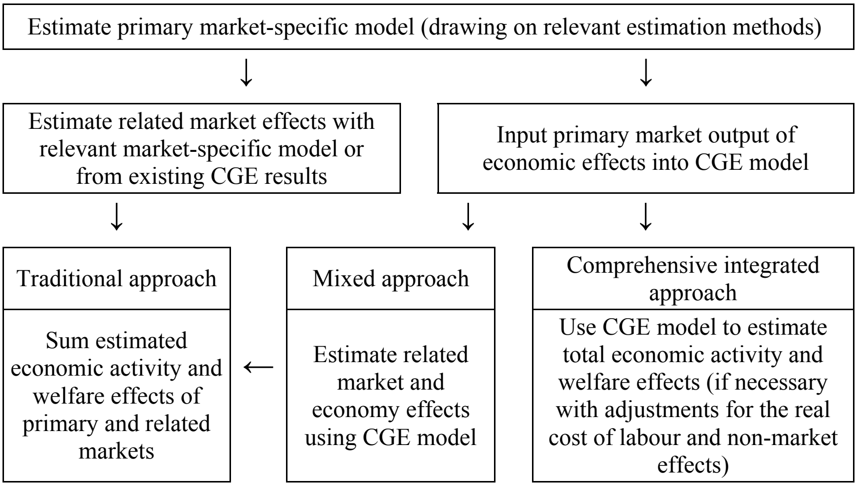
- Input–output models may be used to estimate impacts of major events and regional impacts, but only with considerable caution and explicit notes on limitations.
- CGE models can model industry-wide effects, inter-industry effects, and national or regional impacts of major economic changes. They can also provide welfare estimates, but these need to be decomposed and explained. However, the results are often very sensitive to externally imposed economic assumptions.

Using a combination of models

We emphasised early in this chapter that the model of choice depends on the task at hand. For example, if the task is to forecast 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 or two sectors 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 multiple 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 effects are required. Here, as shown in Figure 6.4, there are three main approaches. These approaches do not have formal names. For convenience they are labelled below as the traditional approach, the mixed approach, and the comprehensive integrated 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.

Figure 6.4 Approaches to estimating economic activity and welfare effects



Traditional approach

In this approach, the analyst estimates the consumer and producer surpluses in the principal market and, separately, the net benefits in the related tourism markets from other sources, and adds these effects together. Other sources may be the analyst’s own estimates of the net benefits in the tourism market using a market-specific model for that sector or estimates derived from results from existing CGE model work. This 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 the estimated spillover effects on other modes are added in.

For many applications this approach provides robust, reasonably accurate and comprehensive answers. However, a market-specific analysis of the tourism sector does not pick up the 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 takes the outputs of the CGE model for the tourism sector back into account in summing the primary and related 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 can also 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 Gross Domestic Product, Gross National Product (GNP) and Gross Social Product (GSP). Further adjustments will need to be made to produce estimates of changes in net benefits with changes in factors used.

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 more comprehensive approach below, though some estimates are less rigorous and more approximate. The mixed approach is useful when modelling the full secondary effects is important and an existing CGE model can be readily used.

Comprehensive integrated approach

Under this approach, the estimated primary market effects are used as inputs into a CGE model; the CGE model is then used to estimate the full economic activity and welfare effects. This approach involves a detailed industry-specific model, such as an 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 could give a range of outputs of interest, including:

- 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, and the welfare affects must be analysed carefully.

Thus, the different types of economic models are not mutually exclusive. Outputs from forecasting models are often inputs to market-specifc and general economy models, and outputs from market-specifc 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.

Modelling of the aviation and transport industries illustrates the way that models are used in combination to generate desired outputs. Many studies of air transport liberalisation are based on a market-specific approach to estimating outcomes and assessing the gains. The reports by the Productivity Commission (1998) and by Gregan and Johnson (1999) are 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. 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 modelling.

Traditionally, input–output 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 input–output studies of the economic effects of tourism, especially in the 1980s and 1990s.

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 input–output set of estimates for the aviation industry on to a macroeconomic 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. 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 (for example, for inventory management or casual workforce hiring) can be provided usefully and economically by univariate methods.

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, for example, flight frequency, in-flight service characteristics, plane size and configuration (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 and private transport operators, for example, 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 the intuition and experience of executives, but for major reconfigurations by major organisations 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. Oxford Economic Forecasting (1999) adapts a general purpose macroeconomic model for the whole economy to incorporate a detailed tourism and aviation component, which uses results from direct estimation studies elsewhere to establish that aviation has had a positive effect on the productivity of other sectors.

In terms of multivariate models, the work of the Tourism Forecasting Committee should be mentioned. Tourism Australia releases detailed forecasts of a range of variables or activities of relevance 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 economic 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 modelling process.

In Australia there has been active development of CGE models for estimating aviation and tourism effects. 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 September 2001 New York attack and the collapse of Ansett. But, again, there is no welfare analysis. Woollett, Townsend & Watts (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 modelling to present the case for the Qantas/Air New Zealand alliance across the Tasman, although not without criticism.

Conclusion

For many policy evaluations, including for modelling aviation and tourism, market-specific models are the most direct and useful models. When spillovers are small, market-specific estimates can provide practical and robust results. These results may be combined with existing CGE results to estimate secondary effects.

In any case, an industry specific model is generally needed to capture the specifics of proposed changes, such as the changes in inbound and outbound air travel and the change in profitability of the airline industry, as inputs to a multi-sector CGE model. Where there are significant sectoral spillovers, a CGE model is needed to capture the full changes nationally or regionally. Input–output models are not sufficient for this purpose in most cases, although they may be relevant in some regional analyses.

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