COMPUTABLE GENERAL EQUILIBRIUM MODELLING: AN IMPORTANT TOOL FOR TOURISM POLICY ANALYSIS

Original scientific paper

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Abstract
Purpose – Economic impact analysis in tourism has recently undergone a profound change in approach. In contrast to earlier emphasis on input-output (I-O) models, computable general equilibrium (CGE) models, are being used worldwide to estimate the resulting net macroeconomic and industry effects and for tourism policy analysis. The purpose of this paper is to provide an overview of the role that computable general equilibrium modelling is playing and can play in estimating the economic impacts of tourism shocks and in tourism policy formulation and implementation by destination managers.
Design – The study discusses the nature of CGE modelling to project the economic impacts of tourism demand shocks, comparing its advantages over standard I-O analysis. It then identifies several studies where CGE analysis provides insights to tourism researchers that could not be revealed using the standard I-O technique. The importance of CGE analysis for tourism policy analysis is highlighted
Methodology and Approach – The study reviews important contributions to CGE modelling in tourism contexts, including many of the authors publications
Findings – The paper discusses applications of CGE modelling to tourism, identifying several areas where tourism analysis and policy have been suitably informed as a result of such modelling. Particular insights that CGE modelling has brought to tourism planning, forecasting and policy analysis are identified.
Originality of the research – Due to its technical nature, tourism researchers are generally unaware of the advantages of CGE modelling compared to standard economic impact analysis using I-O models. This study identifies and discuss the key reasons why CGE modelling should be accorded greater attention by governments and their agencies, consultants and researchers associated with tourism analysis and policy.
Keywords Economic impact analysis, computable general equilibrium modelling, tourism policy analysis

INTRODUCTION

A reading of the tourism literature relevant to economic impact analysis (EIA) reveals many confusions as to the preferred approach to be employed by destination managers to provide accurate estimates of the effects of shocks to tourism demand on key economic variables such as gross domestic product and employment. Unfortunately, due to its technical nature, tourism researchers generally are unaware of the usefulness of computable general equilibrium (CGE) modelling in tourism contexts (Dwyer, 2015). Since CGE modelling is the preferred approach to EIA, the purpose of this

paper is to provide the reader with insights into the nature of this approach and its potential importance for tourism planning, development and policy analysis.

EIA estimates the changes that take place in an economy due to an existing or proposed project, action, event or policy shock. EIA is typically employed to trace the flows of spending associated with a change (positive or negative) in tourism activity in an economy through business, households and government to identify, both *ex post* and *ex ante*, the resulting changes in economic variables such as sales, output, household income, value added, government tax revenues and employment. Economic impact refers to the changes in the economic contribution resulting from specific events or activities that comprise 'shocks' to the tourism system. Examples of such "shocks" include growth or contraction in tourism flows, changes in policy settings, such as through amendments to taxes or visa requirements, changes in destination marketing activity, the holding of a mega-event, or provision of new tourism related infrastructure. The accuracy of any modelling technique used in EIA depends on its capacity to acknowledge economic realities both in their structural assumptions and in the attributes of the destination that forms the context of the modelling.

1. THE ECONOMIC IMPACT OF A TOURISM EXPENDITURE SHOCK

For any given expenditure shock to a destination, the change in economic variables will vary according to several features of the economy (Dwyer et. 2000). These include:

- he size of the expenditure shock (positive or negative)
- the particular industries that are the recipients of the direct expenditure
- strengths of the business linkages between the different industry sectors in the economy
- the assumed factor constraints (supplies of land, labour, capital)
- the import content of consumer goods and inputs to production
- the production and consumption relationships assumed
- changes in the prices of inputs and outputs
- changes in the exchange rate
- the workings of the labour market,
- the government fiscal policy stance.

In earlier years, tourism researchers and policy makers have employed input-output (I-O) or Social Accounting Matrix (SAM) models to estimate the economic impacts of changes in tourism expenditure. Unfortunately, these models have very restrictive assumptions which affect the accuracy of their estimates (Briassoulis 1991; Dwyer, Forsyth and Spurr 2004, 2005). These include:

- For a positive demand shock standard I-O models assume that all inputs and resources are supplied freely and no resource constraints exist. In real-world economies, however, resource constraints generally are present and must be taken into account when estimating impacts of increased visitor expenditure on economic activity. I-O modelling, which produces positive impacts whatever the context, does not recognize that an expanding tourism industry tends to "crowd out" other sectors of economic activity.

- A constant returns to scale production function is assumed with no substitution among the different inputs. The constant technical coefficients assume away diminishing marginal returns to inputs in production activities and changes in input mix due to price-induced substitution between factors. It is also assumed that there are fixed budget shares in household consumption. If households shift their demand patterns when their income changes, this assumption will be violated.
- Input and output prices are assumed to be fixed. In reality there are likely to be capacity constraints in the economy which cause prices and costs to rise in an expansion of economic activity. Wage and other input price rises will limit the extent of the expansion; and may even lead to contractions in economic activity in some sectors.
- Exchange rate changes are ignored. I-O modelling does not allow for effects through the trade sector, for example, through foreign tourism demand pushing up exchange rates, thereby reducing the competitiveness of traditional exports and import competing firms, with adverse effects on income and employment in those sectors.
- In I-O models, the behaviour of the government budget sector is ignored. In reality tax revenue will increase in an economic expansion, enabling the government to increase spending, reduce other taxes, or some combination. I-O modelling does not allow for the impacts of different constraints on the Public Sector Borrowing Requirement (PSBR) which affects levels of taxation and government spending and, hence, the ultimate economic impacts of a change in tourism expenditure.
- In standard I-O modelling, 'impacts' on economic activity, are measured by changes in GDP, employment or similar measures. However, since 'economic impacts' do not equate to 'net benefits', except under the most restrictive assumptions (Dwyer and Forsyth, 2009), impact estimates represent poor measures of welfare and inappropriate policy objectives.

In general, I-O or SAM multiplier analysis to estimate economic impacts is more reasonable in economies with high unemployment and small capital constraints than in economies at full employment or where technological limitations on production exist. For many real world tourism economies, however, these restrictive assumptions imply that an I-O model or SAM exaggerates the economic impacts of tourism shocks to destinations. Real world features of demand and supply that affect the economic impacts of shocks to tourism expenditure can only properly be taken into account using CGE models.

2. CGE MODELLING

CGE models consist of equations describing model variables and a database (usually very detailed) consistent with the model equations. The equations describe the economic transactions of households, firms, government, the rest of the world, and capital accounts in the markets for factors of production, commodities, exports and imports, and investment funds (Hanson et al, 2002; Burfisher, 2011; Cardenete, Guerra & Sancho,2012).).The central core of a CGE model is a set of input-output accounts (tables) or a social accounting matrix (SAM), based on a System of National Accounts.

A SAM elaborates the interrelationship between economic and social statistics by linking together the (mainly) macro-statistics of national accounts with the (mainly) micro- statistics of the labor market (eg occupations, gender, earnings, education, hours worked) and of households (eg. expenditure data, age, education, income distribution, transfers). The most credible data source for data on tourism demand and the supply of tourism industries is a national or regional Tourism Satellite Account (TSA). CGE models developed for tourism industry analysis now increasingly include tourism data from TSA, providing a consistent means of modelling tourism's economic impacts. Modellers have incorporated the tourism sector into the CGE framework more explicitly in recent years (Dwyer Forsyth, Spurr and Ho, 2003; Blake et al., 2006; Pham and Dwyer, 2013). A TSA is now acknowledged to be a necessary tool to adapt I-O tables and national accounts (and thus SAM derived from them) to tourism specificities.

In a CGE model, the initial stimulus can originate anywhere in the economy, and can be literally anything that can occur in an economic framework (Wing, 2004). Based on neoclassical economic theory, CGE models capture a wider set of economic impacts derived from a shock or the implementation of a specific policy reform. They allow for the inclusion of the constraints absent from I-O calculations and allow flexible prices and wages. CGE models include more general specifications of the behaviour of consumers, producers, governments and investors than other types of models. Substitution possibilities are incorporated so that the behaviour of agents in the model economy is sensitive to changes in relative prices as well as to quantity variables. CGE models treat an economy as a whole, allowing for feedback effects of one sector on another. By setting up the economic conditions whereby each market, sector and household reacts to changes in the economy, a CGE approach can model a variety of possible scenarios to fit different real world circumstances.

CGE models can be divided into two broad categories, *comparative static* and *dynamic*. A *comparative static* model compares the economy at two distinct points in time, without modelling any explicit time periods or time path. In contrast, *Dynamic CGE* models explicitly trace each variable through time, often at annual intervals, so that the adjustment path of the economy can be examined (Blake, 2009).

Although CGE models can simulate future effects of policy changes, they are not a forecasting tool. Policies are evaluated by comparing the economy between two states of the world. The pre-policy baseline is generated from the base year data and the impact of a policy is estimated by measuring deviations from the baseline following the policy change (Pratt, Blake, & Swann, 2013).

Importantly, CGE models can incorporate welfare measures - measures of the value of the gain in economic activity less the cost needed to enable this extra activity- giving the simulations policy significance. Unfortunately, tourism researchers continue to confuse the 'impacts' and the 'benefits' of tourism growth, ignoring the fact that tourism growth has an economic cost, since it requires the use of scarce resources. Recognising that changes in GDP, income and other economic variables are 'gross measures' of impacts, not benefits, researchers have introduced explicit measures of economic welfare into CGE modelling of tourism impacts. Welfare measures indicate

how much better or worse off an economy is as a result of a tourism demand shock. (Dixon and Rimmer, 2002; Blake, 2010; Dwyer, Jago and Forsyth, 2016).

3. APPLICATIONS OF CGE MODELLING TO TOURISM

CGE models are now increasingly used in tourism economic analysis and policy formulation. Some examples of broad topics addressed include: economic impacts of changes in inbound tourism; tourism effects on income distribution and poverty reduction; economic impacts of crises affecting tourism expenditure; economic impacts of climate change; economic impacts of special events; evaluation of the effects of different policy instruments on tourism industries.

Economic impacts of changes in inbound tourism

While an expansion in inbound tourism can generate an increased overall growth in real GDP, real exchange rate, real wages the Consumer Price Index (CPI) and net benefits or welfare, the modelling provides empirical evidence to support Copeland's (1991) theoretical argument that some sectors benefit and some lose as the result of tourism expansion. CGE model simulations undertaken in both developed and developing countries have several outcomes in common:

- Adams and Parmenter (1995) showed that sectors which gain from increased inbound tourism to Australia included service industries catering directly to international tourists (eg. air transport, restaurants and hotels) and industries indirectly supplying tourism-related activities (eg. aircraft maintenance and construction), while sectors which contract include non-tourism exporters (eg. agriculture, mining, food and metals processing), and import-competing industries (eg. transport equipment, chemicals, textiles, clothing and footwear).
- Narayan (2004) showed that, following increased tourism to Fiji from major source markets, the gains to tourism related sectors (in hotels, transport, personal services) are offset to some extent by losses in traditional export and import competing industries (sugar, kava, manufactured products) due importantly to a tourism induced appreciation of the Fijian dollar.
- CGE modeling shows that inbound tourism contributes significantly to the Singaporean economy, competing with non-tourism sectors for resources (Meng, 2014). Inbound tourism causes a significant appreciation of the Singapore dollar and thus has considerable negative effects on its other exports. The results show that Singapore's yield-driven marketing approach, targeted to maximise total visitor expenditure, may not necessarily maximise tourism's contribution to GDP, employment and household income.

Unless there is significant excess capacity in tourism-related industries, the primary effect of an economy-wide expansion in inbound tourism is to alter the industrial structure of the economy rather than to generate a large increase in aggregate economic activity, including income and employment generation. Its effect will thus show up as a change in the composition of the economy rather than as a net addition to activity. The findings associated with particular countries are generalizable, suggesting that

economic planners, especially those in developing countries, should be cautious in nominating the tourism industry as a key sector in the development process.

Economic impacts of tourism crises

CGE modelling reveals many interesting and varied policy implications of external events affecting tourism demand or supply.

- A CGE model was used to estimate the impacts on tourism in the USA of actual and proposed policy responses of the US government following the terrorist attacks of September 11, 2001 (Blake and Sinclair, 2003). Major findings were that an airline production subsidy and subsidies to accommodation establishments are reasonably effective at boosting GDP and saving jobs in both sectors. In contrast, subsidies to catering and entertainment can worsen GDP and labor and capital adjustment, as they encourage workers to move out of the airline and accommodation sectors, thereby increasing the job losses in these sectors.
- A study of the economy wide effects of Foot and Mouth Disease (FMD) in the UK (Blake, Sinclair and Sugiyarto, 2003) found that the policy of maintaining FMD-free status supported meat exports at a substantial cost to the UK tourism industry. A policy geared towards supporting tourism would have been far less costly than the government's policy of supporting agricultural exports by means of slaughtering animals and prohibiting access to many rural areas. The implication is that policy makers, including DMOs need to adopt a 'whole of industry approach' to decisions relating to FMD and in formulating agricultural policies. CGE modelling provides just such an approach.
- A multi-regional CGE model for Indonesia was employed to estimate the short-run effect of a decline in tourism following the 2002 Bali bombings on the Indonesian economy (Pambudi et al, 2009). Within Bali, the tourism-related and non-tradable sectors contain the worst affected industries while export-oriented industries, such as textiles, clothing and footwear, and import-competing industries, such as machinery and electronics expand. To have most effect, policy-makers and lending agencies should take into account not only the regional macroeconomic implications of a crisis affecting tourism demand, but also the sectoral results in allocating compensation packages.
- Although the SARS crisis in 2003 resulted in less inbound tourism to Australia, it also reduced outbound tourism flows. Using a CGE model of the Australian economy, simulations of the impacts of SARS showed that the net effects on the Australian tourism industry were not as severe as were perceived by tourism stakeholders (Dwyer, Forsyth, Spurr and Ho, 2006).The net economic impacts on a destination depend upon the extent to which cancelled or postponed outbound travel are allocated to savings, to domestic tourism, or to the purchases of other goods and services. The results indicate that substitution effects must be taken into account in estimating the impact of some adverse situation on the economic contribution of tourism to a destination.

Studies using CGE models reveal that crises affecting tourism affect other industries as well as the total impact must be considered in formulating policy responses. CGE modelling provides valuable input into policy formulation with its identification of gainers and losers from tourism changes as well as different crisis responses.

Economic impacts of special events

- A dynamic CGE model of the UK and London economies was used to forecast the economic impacts of the London 2012 Olympics (Blake, 2005).While the overall impacts on GDP and employment in the UK were projected to be positive, the simulations reveal that there would be a loss of GDP and employment in the areas outside London primarily due to resource flows into the capital. The study also showed that the impact of the Games varies significantly across different sectors of the UK economy. Sectors that *expand* include construction, passenger land transport, business services, hotels and restaurants. Sectors that *contract* include manufacturing, agriculture, fishing and other services. The modelling indicates that in a developed country, a mega event, even of the size of the summer Olympics, is unlikely to provide any substantial boost to either the national or host-region economy.
- That the type of model used to estimate the economic impacts of special events has a substantial effect on the assessment results became evident in a study by Dwyer et al. (2005) which compared the results of using CGE and I–O modelling to estimate the economic impacts of the Qantas Formula 1 Grand Prix. The same expenditure data was fed into both an I–O and a CGE model. The modelling reveals that positive economic impacts on the host state were almost offset by losses in states comprising the rest of Australia. I–O modelling projects a much greater impact on real output for both the host region and the nation (A$112.0 million and A$120.1 million), as compared to CGE modelling (A$56.70 million and A$24.46 million). The projected increase in employment using an I–O model is 521 (full-time equivalent) jobs in the host region and 592 jobs throughout Australia. Using a CGE model the projected employment effects are 318 jobs and 129 jobs, respectively. I–O modelling projects a positive change in output and employment in all industries in the host region except oil, natural gas and brown coal, where no change is projected. In contrast, the CGE model projects reduced output and employment in several industries including some mining sectors and transport services.
- CGE modelling of the 2010 Football World Cup showed that the event positively impacts on the economy of South Africa in terms of GDP growth and employment especially in the service sectors, with negative effects that include higher inflation and net export losses overall (Saayman & Rossouw, 2008). A study by Bohlmann and van Heerden (2008) using different assumption sets concluded that, overall, the effects on GDP and employment are positive but small. These gains were found to be driven mainly by unskilled unemployed resources that were drawn into economic activity by the demand injection.

Use of CGE models to estimate the economic impacts of special events has revealed many outcomes that would not have emerged using I-O models, which until recently have been the standard technique used by tourism researchers. CGE modelling provides, in principle, much more accurate estimates of the 'return on investment' from public support for special events as well as identifying winners and losers in different regions and industry sectors.

Evaluation of economic policy

Employment Creation

- Tourism strategies often identify employment creation as an important aim of industry development. Labour markets can be modelled in various forms, with the possibility of allowing for unemployment and skills shortages in different economic sectors CGE modelling shows that the impacts of tourism growth on employment varies according to the causes of any existing unemployment, the efficiency of the labor market in terms of real wage flexibility, changes in the real exchange rate and the labor intensiveness of different sectors in the economy affected by tourism spending and government fiscal policy. There is little effect on unemployment when existing unemployment is structural or regional in nature since real exchange rate changes will alter the composition of existing industry in a way that offsets the gross employment gains to the tourist industry (IAC, 1989; Dwyer and Forsyth, 1998).

Taxation Policy

- In a study of taxation in Spain using CGE modelling (Blake, 2000), marginal increases in taxes on foreign tourism were found to result in higher domestic welfare, since the effect of the increases is to reduce the pre-existing distortions in the Spanish economy that result from low levels of domestic taxation. A Mauritian study (Gooroochurn and Milner, 2005) concluded that the structure of indirect taxation in Mauritius is not optimal and that tourism-related sectors appear to be under-taxed.
- CGE modelling of the impacts of Australia's Passenger Movement Charge, a tax on all persons departing Australia, show that while the tourism industry loses, there is a net positive impact on the economy as a whole (Forsyth et al, 2015). This comes about because of the tax effect- Australia gains from foreign tourists paying Australian taxes rather than Australian residents. This result contrasts with studies done in other countries of air passenger duties using I-O approaches that are unable to estimate net taxation effects with any accuracy.

Poverty Alleviation

- A study of increased inbound tourism.to Brazil using CGE modelling (Blake, Arbache, Sinclair and Teles, 2008) concluded that the structure of earnings in non-tourism export sectors plays a significant role in determining the net poverty effects (via changes in prices, earnings and government revenues). A study for

Thailand revealed that inbound tourism expansion raises incomes across the board, but the main share of the gains accrues to the non-poor, given the distribution of factor ownership across household groups (Wattanakuljarus and Coxhead, 2008). The finding highlights that additional policy instruments are required to correct for the inequalities in income distribution in Thailand resulting from tourism growth. These studies indicate that simplistic views of tourism's ability to relieve poverty need heavy qualification depending on destination context. CGE modelling is required to identify the barriers and facilitators of economic growth.

Environmental Policy

Recently CGE models have begun to make important contributions to modeling the impacts of international climate change policies in a CGE context (Conrad, 2002; Nijkamp, Wang, S. & Kremers, 2005). To date, only a few studies have specifically address tourism issues.

- Berrittella, Bigano, Rosona, and Tol (2006) studied the economic implications of climate-change-induced variations in tourism demand, using a world CGE model. The impact of climate change on tourism is represented by means of two sets of shocks, occurring simultaneously. The first shocks translate predicted variations in tourist flows into changes of consumption preferences for domestically produced goods. The second shocks reallocate income across world regions, simulating the effect of higher or lower tourists' expenditure. The analysis highlights that variations in tourist flows will affect regional economies in a way that is directly related to the sign and magnitude of flow variations. At a global scale, climate change will ultimately lead to a welfare loss, unevenly spread across regions.
- CGE models can link with environmental impact models, to evaluate the environmental impacts of tourism, such as on greenhouse gas emissions, energy use and ecological footprint (Lundie, Dwyer and Forsyth, 2007). CGE modelling can provide essential input into determining the environmental impacts of tourism shocks including estimates of the effects on tourism's carbon footprint. MMRF-GREEN (Adams et al 2008) has been developed to estimate the greenhouse gas emissions associated with economic activity. Little research has been done to explore the role of 'green' CGE models in tourism policy analysis despite their potential to inform policy analysis in this area.
- Based on the MMRF-GREEN model, researchers investigated the potential economic impacts of introduction by the Australian government of its now abandoned Carbon Pollution Reduction Scheme, a cap and trade mechanism for reducing greenhouse gas emissions in Australia (Dwyer et al., 2012, 2013). Dynamic CGE modelling projects that the tax will lead to changes in key macroeconomic variables, reducing growth in real GDP, real consumption, and employment. Most tourism industries in Australia will experience a small but significant contraction in output relative to projected baseline values over the period to 2020 in line with a reduction in growth for the economy as a whole. A slightly larger reduction in tourism employment, relative to that of other Australian industries, is projected for the same period. The largest falls occur in the Accommodation; Air and water transport; and the Cafes, restaurants and food outlets industries. Since direction of impacts on the tourism industry can be

expected to be similar for any pricing scheme to reduce carbon emissions, the analysis has implications for tourism policy globally.

Destination Marketing

- The overall impact on an economy of different tourists from different origins, with different travel motivations and spending patterns determines the yield per visitor from different markets (Pratt, 2012). A more recent study (Dwyer et al, 2014) confirms the results of CGE modelling in estimating the economy wide impacts of different tourism market segments compared to the simple expenditure yield measures that drive destination marketing in many countries. Economy-wide visitor yield measures derived from CGE modelling represent not only the 'bottom line" of the economic impacts of different visitor markets to any destination, but also form the basis for estimating the return on investment from additional visitor targeted marketing expenditure. In this respect, CGE modelling estimates of 'yield' per visitor provides a much more detailed basis for estimating the 'return on investment' from allocating funds to destination marketing than narrower approaches to determining per visitor yield

Industry Policy

The effects of changes in a wide range of forms of government industry assistance to tourism can be analysed using CGE models.

- Depending on the industry mix within an area, tourism growth may increase or decrease Gross Regional Product (GRP) and employment in that area. The simulations for tourism growth at regional level in Australia indicate that a State government that simply maintains its share of a growing national market may experience a fall in its GRP and overall employment, depending on the composition of its industry. Due to appreciation of the exchange rate, three heavily (non- tourism) export oriented states in Australia were found to be net *losers* from general tourism stimulation nationally (Adams and Parmenter, 1999) – an unexpected result. This finding would not have been revealed in the absence of a regionally disaggregate CGE model
- Mining as an export industry competes with other sectors of an economy for labor, capital and goods and services, thereby pushing up prices and the exchange rate. CGE modelling was used to assess the impacts of the mining boom on the Australian economy and tourism in particular, through two broad mechanisms: an income effect and a price effect (Forsyth et al, 2014; Pham et al, 2015). The boost to household consumption provided by the boom, through increased mining revenues, supports increased demand for leisure tourism generally. These gains are offset, however, by reduced inbound tourism and increased outbound tourism resulting from the higher value of the Australian dollar. 'Crowding out' effects are most apparent for those parts of the tourism industry with greater dependence on leisure travel in the mining states, where competition from mining-related business travel is most intense, and in segments of the domestic industry which compete most directly with outbound travel.

The examples offered above comprise only some of the growing volume of publications in tourism that apply CGE models for economic impact analysis. Nevertheless, they indicate the types of issues that are being addressed by researchers. CGE models are now increasingly used in tourism economics analysis and policy formulation. The results of the modelling are sometimes surprising and indicate the value of using this sophisticated approach to impact analysis rather than standard I-O modelling. The relevance of the above findings extend beyond their immediate interest to tourism economists. CGE studies that have been undertaken demand the attention of tourism planners and tourism marketers as well as public policy makers. A number of lessons can be learned regarding the advantages of CGE for tourism analysis and policy formulation. While many of the results are generalizable to other countries worldwide, the extent to which this is the case can only be determined by future studies that take account of the circumstances of different destinations.

4. INSIGHTS THROUGH CGE MODELLING

Tourism researchers have gained important insights from CGE model simulations which contribute to our knowledge of tourism behavior in response to demand shocks and can make an important contribution to policy analysis.

Flexibility

CGE models possess a significant advantage in flexibility over other forms of modelling in specifying how economic agents react to changes in the economy. CGE models can be applied to any combination of demand and supply-side shocks, under a range of alternative macroeconomic environments and policy scenarios. CGE models are helpful to tourism policy makers who seek to use them to provide guidance about a wide variety of 'What if?' questions, arising from a wide range of potential domestic or international expenditure shocks. A strength of CGE analysis is that many of its assumptions can be varied and the sensitivity to them tested (Dixon & Parmenter,1996). The discussion of tourism applications of CGE modelling demonstrate the wide range of contexts in which this technique can be employed.

Broader Perspective

Public policy makers and treasury officials at the national and state or provincial levels, who are concerned with wider policy and development planning issues, or with funding and resource allocation decisions affecting tourism, will have a particular interest in how the economy as a whole will be affected by changes in tourism numbers and expenditure, not just the tourism industry itself. CGE estimated destination-wide measures of tourism's economic impact, provide information unavailable on the other approaches (Dwyer et al, 2000, 2014) especially concerning industry interactive effects and the economic impacts in different government jurisdictions.

Microeconomic Information

Researchers are incorporating more microeconomic information into CGE models of tourism, providing improved policy analysis. In particular, econometric modelling is providing ever more accurate estimates of the parameter values that are included in CGE models, relating to more disaggregated levels of analysis. With the substantial increases in computing power and the availability of solution algorithms for large nonlinear equation systems, CGE models with great sector detail became solvable and can accommodate national accounting data in detail (Burfisher, 2011, Cardenete et al., 2012) Microsimulation models linked to CGE models can make a significant contribution to the evaluation and implementation of public policies that reduce income inequalities within and between destinations. They are now being applied at regional levels (Partridge & Rickman,2010). Improved data at the regional and local levels would assist more effective policy formulation, along with better coordination between policy making at the local, regional, national and international levels (Jones, Munday and Roche, 2014).

Industry Mix

CGE studies reveal the essential interdependence between industry sectors in the development process. While the policy emphasis, in many developing countries in particular, has focussed on reducing leakages of tourist expenditure and the forging of stronger links between tourism and other sectors, the findings of CGE studies show the importance of the overall industry mix in tourism destinations, and its implications for tourism's economic contribution to development (Pratt, 2015). For example, an expanding tourism industry may impact adversely on other (non-tourism) export oriented and import competing industries.

Market Distortions

The economy-wide framework associated with CGE modelling identifies various distortions that operate in the economy to influence the provision of tourism services and other goods and services. Some, such as restrictions on shopping hours, air service agreements, visa fees, discourage consumption of tourism services directly. Others, such as domestic taxes, restrictive labour practices, tariffs on imports and wage-cost loadings, operate to raise prices of tourist services indirectly and hence discourage their consumption. Use of CGE modelling can help determine the relative importance of such factors in influencing the economic impacts of shocks to tourism (Dwyer et al., 2000).

Extended Role for TSA

CGE models allow the full potential of the detailed data contained within TSAs to be realised in projecting tourism's overall economic impact and in tourism policy analysis. Where a TSA is already in place, it will provide the statistical basis for much of the tourism specific data required in the development of any CGE model which contains an explicit tourism sector. (Jones & Munday, 2008). The absence of TSAs in many

countries helps to explain why, until recently, few existing CGE models identify a tourism "industry" or incorporate any detailed breakdown of tourism data .Although TSAs and CGE models play different roles in providing policy makers with insights into the economics of tourism, both are important and complement each other in the policy making (Dwyer, 2015).

Welfare Measures

As noted earlier, CGE models can provide a net benefit or welfare measure. Dixon and Rimmer (2002) adjusted GDP simulations to include the cost of capital, a procedure followed in a study of Australian tourism by Dwyer et al 2003). Blake (2009), consistent with economic theory, measures a change in welfare by equivalent variation (EV), which indicates how much the change in welfare is worth to the economy at the pre-simulation set of prices. This welfare concept has been employed in various tourism studies including projected effects of the London Olympics 2012 (Blake 2005) and the poverty reduction potential of tourism to Brazil (Blake et al. 2007).There is scope for greater use of welfare measures in CGE modelling of tourism impacts for greater policy relevance. Researchers are currently attempting to combine CGE modelling and cost benefit analysis to enhance the policy relevance of the technique (Dwyer et al, 2016).

Trade Policy

Foreign trade can be treated in several different ways, to enable the modelling of small and large countries and has a decisive influence on the outcomes of policy simulations. Little research has explored the impacts of international trade policies on tourism, Tourism studies could focus more on different model structures for small and large countries with attention to the demand and supply for exports and imports.

Aviation/Tourism Nexus

Aviation policies can impact on tourism flows and expenditure, and thus they will have impacts on the economy. CGE models can be used for analysing a broad range of aviation issues. When considering proposed strategic alliance between airlines owned by different countries one of the key issues which policy makers will face will be that of whether this stimulates tourism, and if so, what are the benefits. These benefits will need to be set against any costs to the economies associated with the alliance. CGE modelling provides a means of assessing the impacts of aviation alliances or blue skies policies on output and employment, and the net benefits which result. CGE modelling of aviation impacts on tourism in destinations holds promise to provide valuable input into aviation policy (Broecker and Mercenier, 2011).

CONCLUSIONS

Despite their widespread use in policy formulation worldwide, CGE modelling remains relatively under-used in tourism policy analysis. This report has sought to identify and discuss the key reasons why CGE modelling should be accorded greater attention by governments and their agencies, consultants and researchers associated with tourism analysis and policy. CGE modelling has great potential to inform policies that will affect the tourism industry within a country or region and can be applied to a much broader set of policy issues than at present.

The general equilibrium effects of changes affecting tourism demand and supply have long been recognised. Previously, it was not possible to incorporate them in empirical models. Given the availability now of CGE models, researchers have access to workable and flexible models that represent the whole economy and in which resource constraints and feedback effects are explicitly recognised. In a context of ongoing theoretical and practical development, CGE tourism modelling provides a versatile and effective means of examining the wide range of scenarios that can occur in the tourism industries of both developed and developing destinations.

REFERENCES

Adams, P.D. and Parmenter, B.R. (1995), "An Applied General Equilibrium Analysis of the Economic Effects of Tourism in a Quite Small, Quite Open Economy", *Applied Economics*, 27(10), pp. 985-994.

Adams, P.D. and B.R. Parmenter (1999), "General equilibrium models", *Valuing Tourism. Methods and Techniques*, Canberra: Bureau of Tourism Research.

Adams, P (2008), *MMRF: Monash Multi-Regional Forecasting Model - A Dynamic Multi-Regional Applied General Equilibrium Model of the Australian Economy*, Centre of Policy Studies, Monash University.

Berrittella, M., Bigano, A., Rosona, R. & Tol, R.S.J. (2006), "A General Equilibrium Analysis of Climate Change Impacts on Tourism', *Tourism Management*, 27, pp. 913-924.

Blake, A. (2005), *The Economic Impact of the London 2012 Olympics, Research Report 2005/5*, Christel DeHaan Tourism and Travel Research Institute, Nottingham University Business School, http://www.nottingham.ac.uk/ttri.

Blake, A., J.S. Arbache, M.T. Sinclair and Teles, V. (2008), "Tourism and Poverty Relief", *Annals of Tourism Research*, Vol. 35, No. 1, pp. 107-126.

Blake, A.T. (2000), "The economic effects of tourism in Spain", *Christel DeHaan Tourism and Travel Ressearch Institute Discussion Paper*, http://www.nottingham.ac.uk/ttri/series.html, 2000/2.

Blake, A.T. and Sinclair, M.T. (2003), "Tourism crisis management: US response to September 11", *Annals of Tourism Research*, 30(4), pp. 813-32.

Blake, A.T., Sinclair, M.T. and Sugiyarto G. (2003), "Quantifying the impact of foot and mouth disease on tourism and the UK economy", *Tourism Economics*, 9(4), pp. 449-465.

Blake, A., Durbarry, R., Eugenio-Martin, J.L., Gooroochurn, N., Hay, B., Lennon, J. & Yeoman, I. (2006), "Integrating forecasting and CGE models: The case of tourism in Scotland", *Tourism Management*, 27(2), pp. 292-305.

Blake, A. (2009), "The dynamics of tourism's economic impact", *Tourism Economics*, 15(3), pp. 615-628.

Bohlmann, H.R. and van Heerden, J.H. (2008), "Predicting the economic impact of the 2010 FIFA World Cup on South Africa", *Int. J. Sport Management and Marketing,* Vol. 3, No. 4, pp. 383-396.

Briassoulis, H. (1991), "Methodological Issues: Tourism Input-Output Analysis", *Annals of Tourism Research*, 18, pp. 435-449.

Broecker, J and Mercenier, J. (2011), "General equilibrium models for transportation economics", in A de Palma, R Lindsey, E Quinet and R Vickerman (eds) *Handbook in Transport Economics*, Cheltenham, Edward Elgar.

Burfisher, M. (2011), *Introduction to Computable General Equilibrium Models*, Cambridge University Press, Cambridge.

Cardenete, M.A., Guerra, A.I., & Sancho, F. (2012), *Applied General Equilibrium: An Introduction*, Springer Science & Business Media.

Conrad, K. (2002), "Computable general equilibrium models in environmental and resource economics", *The international yearbook of environmental and resource economics*, pp. 66-114.

Copeland, B.R. (1991), "Tourism, Welfare and De-industrialization in a Small Open Economy", *Economica*, 58, pp. 515-29.

Dixon, P. and Parmenter, B. (1996), "Computable General Equilibrium Modelling for Policy Analysis and Forecasting", in H. Aman, D. Kendrick and J. Rust (eds), *Handbook of Computational Economics*, Vol. 1, pp. 4–85, Elsevier Science B.V., Melbourne.

Dixon, P.B., M.T. Rimmer (2002), "Dynamic General Equilibrium Modelling for Forecasting and Policy: a Practical Guide and Documentation of MONASH", *Contributions to Economic Analysis* 256, North-Holland Publishing Company, pp. xiv+338.

Dwyer L, Forsyth, P. (1998), "Estimating the Employment Impacts of Tourism to a Nation", *Tourism Recreation Research*, Vol. 23, No. 2, pp. 3-12.

Dwyer, L., Forsyth, P., Madden, J. and Spurr, R. (2000), "Economic impacts of inbound tourism under different assumptions regarding the macroeconomy", *Current Issues in Tourism,* 3(4), pp. 325-363.

Dwyer, L., Forsyth, P., Spurr, R. and Van Ho, T. (2003), "The Contribution of Tourism to a State and National Economy: A multi-regional general equilibrium analysis", *Tourism Economics*, Vol. 9 (4), pp. 431-448.

Dwyer, L., Forsyth, P., Spurr, R. (2004), "Evaluating Tourism's Economic Effects: New and Old Approaches", *Tourism Management*, Vol. 25, pp. 307- 317.

Dwyer, L., Forsyth, P. and Spurr, R. (2005), "Estimating the Impacts of Special Events on the Economy", *Journal of Travel Research*, Vol. 43, May, pp. 351-359.

Dwyer, L., Forsyth, P., Spurr, R. and Van Ho, T. (2006), "Economic Effects of the World Tourism Crisis on Australia", *Tourism Economics*, Vol. 12, No. 2, pp. 171-186.

Dwyer, L., Forsyth, P., Spurr, R., Hoque, S. (2013), "Economic Impacts of a carbon tax on the Australian Tourism Industry", *Journal of Travel Research*, March, Vol. 52, No. 2, pp. 143-155.

Dwyer, L., Forsyth, P., Spurr, R. (2012), "Wither Australian Tourism?: Implications of the Carbon Tax", *Journal of Hospitality and Tourism Management*, Vol. 19, July, pp. 1-16.

Dwyer, L., Duc Pham, T., Forsyth, P., Spurr, R. (2014), "Destination Marketing of Australia: return on investment", *Journal of Travel Research*, Vol. 53, Issue 3, May, pp. 281-295.

Dwyer, L., Jago, L. and Forsyth, P. (2016), "Economic evaluation of special events: integrating economic impact and cost benefit analysis' forthcoming", *Scandinavian Journal of Hospitality and Tourism.*

Dwyer, L. (2015), *Computable General Equilibrium Modelling for Tourism Policy – Inputs and Outputs*, Statistics and TSA Issues Paper Series, UNWTO, Madrid.

Forsyth, P., Dwyer, L., Spurr, R. (2014), "Is Australian Tourism Suffering Dutch Disease?", *Annals of Tourism Research*, Vol. 46, May, pp. 1-15.

Forsyth, P., Dwyer, L., Pham, T. Spurr, R. (2014), "The impacts of Australia's departure tax: Tourism versus the economy?", *Tourism Management*, 40, pp. 126-136.

Gooroochurn, N. & Milner, C. (2005), "Assessing indirect tax reform in a tourism-dependent developing country", *World Development*, *33*(7), pp. 1183-1200.

Hanson, K., Golan, E.H., Vogel, S.J. & Olmsted, J. (2002), *Tracing the impacts of food assistance programs on agriculture and consumers: A computable general equilibrium model* (No. 33831). United States Department of Agriculture, Economic Research Service.

Industries Assistance Commission (1989), *Some economic implications of tourism expansion. Inquiry into Travel and Tourism*, Discussion Paper, No. 2, March., AGPS, Canberra.

Jones, C. and Munday, M. (2008), "Tourism satellite accounts and impact assessments: some considerations", *Tourism Analysis*, 13, pp. 53-69.

Jones, C., Munday, M. & Roche, N. (2014), "Managing regional tourism: the role of economic modelling", *Journal of Tourism Economics, Policy and Hospitality Management*, *2*(1), 4, pp. 1-17.

Lundie, S., Dwyer, L. and Forsyth, P. (2007), "Environmental-Economic Measures of Tourism Yield", *Journal of Sustainable Tourism*, Vol. 15, No. 5, pp. 1-18.

Meng, S. (2014), "The Role of Inbound Tourism in the Singaporean Economy: A Computable General Equilibrium (CGE) Assessment", *Journal of Travel & Tourism Marketing*, 31:8, pp. 1071-1089.

Nijkamp, P., Wang, S. & Kremers, H. (2005), „Modeling the impacts of international climate change policies in a CGE context: The use of the GTAP-E model", *Economic Modelling*, 22(6), pp. 955-974.

Nordhaus, W.D. & Yang, Z. (1996), "A regional dynamic general-equilibrium model of alternative climate-change strategies", *The American Economic Review*, pp. 741-765.
Narayan, P.K. (2004), "Economic Impact of Tourism on Fiji's Economy: Empirical Evidence from the Computable General Equilibrium Model", *Tourism Economics*, 10(4).
Pambudi, D., McCaughey, N. & Smyth, R. (2009), "Computable general equilibrium estimates of the impact of the Bali bombing on the Indonesian economy", *Tourism Management*, 30(2), pp. 232-239.
Partridge M.D. & Rickman, D.S. (2010), "Computable General Equilibrium (CGE) Modelling for Regional Economic Development Analysis", *Regional Studies,* Vol. 44, Issue 10, Special Issue: Innovations in Regional Computable General Equilibrium (CGE) Modelling, pp. 1311-1328.
Pham, T.D. and Dwyer, L. (2013), "Tourism Satellite Account and Its applications in CGE Modelling", In Tisdell (Eds), *The Handbook of Tourism Economics – Analysis, New Applications and Case Studies*, Chapter 22, World Scientific Publishing.
Pham, TD., Jago, L., Spurr, R. and Marshall, J. (2015), "The Dutch Disease Effects on Tourism – The Case of Australia", *Tourism Management*, Vol. 46, pp. 610-622.
Pratt, S. (2012), "Tourism yield of different market segments: a case study of Hawaii", *Tourism Economics,* 18(2), pp. 373-392.
Pratt, S., Blake, A. & Swann, P. (2013), "Dynamic general equilibrium model with uncertainty: Uncertainty regarding the future path of the economy", *Economic Modelling*, 32, pp. 429-439.
Pratt, S. (2015), "The economic impact of tourism in SIDS", *Annals of Tourism Research*, 52, pp. 148-160.
Saayman, M. & Rossouw, R. (2008), "The economic value of the 2010 Soccer World Cup", *Acta Commercii*, 8(1), pp. 1-14.
Wattanakuljarus, A. & Coxhead, I. (2008), "Is tourism-based development good for the poor? A general equilibrium analysis for Thailand", *Journal of Policy Modeling,* 30 (6), pp. 929-955.
Wing, I.S. (2004), "Computable General Equilibrium Models and Their Use in Economy-Wide Policy Analysis: Everything You Ever Wanted to Know (But Were Afraid to Ask)", *The MIT Joint Program on the Science and Policy of Global Change, Technical Note*, No. 6.

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