# Chapter 1.
# Computable general equilibrium (CGE) models and tourism economics

## Introduction

Computable general equilibrium (CGE) models have been extremely popular for these last forty years for the evaluation of trade and fiscal policies and for the measurement of the effects of shocks on the economic and social conditions in a country, especially the structure of its production sectors and its income distribution. Robinson (1989) and Dixon and Parmenter (1996) give excellent and synthetic introductions to these models and their applications to developed and developing countries.

The application of CGE models to tourism economics is much more recent, mainly, as we will see, because of a lack of precise and reliable data. However, the quality and quantity of information on tourism activities have steadily improved in a large number of countries since the beginning of this decade. The number of CGE models including tourism activities, and of applications to problems where tourism plays an important role, have followed this movement.

Dwyer, Forsyth and Spurr (2004) and Blake, Gillham and Sinclair (2005) wrote two excellent surveys on the application of CGE models to the analysis of tourism. This chapter will try to complement rather than duplicate these two papers, for instance by giving more importance to the technical features of CGE models.

The first section presents the foundations of CGE models. These models have a theoretical Walrasian structure. But to be simulated, their mathematical functions have to be parameterised. Then, these parameters have to be given numerical values that are calibrated.
The second section explains how international trade and the government are introduced in a CGE model. Then, it discusses the strength and limits of these models. The third section presents the recent improvement in the systematic collection of data on tourism by many industrialised and developing countries. Then it shows how these data can be used to introduce tourism activities in a CGE model. The last section presents a series of applications of CGE models to tourism economics questions.

## 1. The foundations of computable general equilibrium (CGE) models

The theoretical basis of CGE models is the Walrasian general equilibrium model, in its modern form developed by Arrow and Debreu. This model uses a very general mathematical specification for the preferences of the agents and the production abilities of firms. We have to be much more specific and introduce fully specified parameterized utility and production functions to be able to run simulations. The Walrasian model operates with individual goods and agents. To make this model operational in applied research, we must instead use aggregates. Then, finally, we have to give numerical values to the parameters of the model, then use a simulation algorithm.

A CGE model is a very versatile structure, which can easily be adapted to the special features of any economy, to the questions that are asked, and to the data, which are available. Its assumptions can easily be changed so that the results of a simulation can be interpreted, for instance, as describing a short-term equilibrium, or a medium-run equilibrium.

The basic theoretical Walrasian model for a static economy without uncertainty will be presented in the first paragraph. We will introduce a flexible and easy to use parameterization of the general mathematical functions of this model in the second paragraph. In the third paragraph, we will show how to substitute individual goods and agents by aggregates. Then, we will explain how the model can be calibrated, then simulated. We will comment on the versatility of CGE models in the last paragraph.

### *1.1. Mathematical theory*

We will follow the seminal presentation of the Walrasian model by Debreu (1959). We consider an economy with $l$ commodities indexed by $h$. Commodities differ by their nature, their quality or their location. This economy includes $n$ firms indexed by $j$ and $m$ households indexed by $i$. The production of firm $j$ is $y_j \in Y_j \subset R^l$. $Y_j$ is the production set of firm $j$, which represents its production abilities and $R^l$ is the commodity space. Household $i$ consumes the commodity bundle $x_i \in X_i \subset R^l$ with $X_i$ being the consumption set of this household. Commodities can be exchanged freely on markets at price $p \in R^l$.

The negative components of $y_j$ are the inputs of firm $j$, and its positive components are its outputs. Then, the profit of this firm is $\pi_j = \sum_{h=1}^{l} p_h y_{hj}$. We assume perfect competition on each market. Thus, firm *j* chooses the production, which maximises its profit in its production set.

The positive components of $x_i$ are the inputs of household *i*. Its negative components are its outputs. We assume that this household has a utility function defined on his consumption set $u_i(x)$ and owns a wealth $w_i \in R$. He chooses the consumption, which maximises his utility in his consumption set, under his wealth constraint $\sum_{h=1}^{l} p_h x_{hi} \le w_i$.

Each household *i* owns an endowment of commodities $\omega_i \in R^l$, and gets a share $\theta_{ij}$ of the profit of firm $j$, with $\theta_{ij} \ge 0$ and $\sum_{i=1}^{m} \theta_{ij} = 1$. So, the expression of his wealth is $w_i = \sum_{h=1}^{l} p_h \omega_{hi} + \sum_{j=1}^{n} \theta_{ij} \pi_j$.

An equilibrium of the economy is defined by a price vector such that on each market *h* we have $\sum_{i=1}^{m} x_{hi} = \sum_{j=1}^{n} y_{hj} + \sum_{i=1}^{m} \omega_{hi}$.

We can easily notice that if *p* is an equilibrium price, $\lambda p$, with $\lambda > 0$ is also an equilibrium price. Moreover the *l* equilibrium equations are linearly dependent because we can easily establish that $\sum_{h=1}^{l} p_h \sum_{i=1}^{m} x_{hi} \equiv \sum_{h=1}^{l} p_h \sum_{j=1}^{n} y_{hj} + \sum_{h=1}^{l} p_h \sum_{i=1}^{m} \omega_{hi}$, the so-called Walras' identity. Thus, we have to solve a system of *l-1* equations with as many unknown variables. Any commodity or bundle of commodities can be taken as *numeraire* and have its price set to 1 (as soon as it is non zero).

Debreu proved that there exists an equilibrium in this economy under a set of assumptions on the production and consumption sets and on the utility functions of households. He also proved that this equilibrium is Pareto optimal. However, his purely mathematical approach cannot lead us much farther. If we want to do static comparative exercises (for instance what would be the effect of a redistribution of the profits shares across households?) or extend the model toward more realism (adding a Government and taxes and investigate the effects of the tax structure) we must use simulation methods.

*1.2. From a mathematical to a computable general equilibrium model: I Parameterization*

van der Mensbrugghe (2005) develops a very complete and flexible computable general equilibrium model, which encompasses most of those currently in use. We will use it as a reference in most of this chapter. First, we have to clarify the abstract concept of commodity by distinguishing goods indexed by $h = 1,..,l_1$, capital and land indexed by $h = l_1 + 1,..,l_2$, and the various kinds of labour indexed by $h = l_2 + 1,..,l$.

CGE models extensively use the technique of nested CET and CES functions. We will explain this technique in the case of three decisions taken by firm *j*. First, we assume that this firm produces the quantity $y_{0j}$ of a *composite* good, which is transformed into a bundle of goods $y_{hj}$, with $h = 1,..,l_1$, by the CET function of transformation elasticity $\omega_j$: $y_{0j}^{1/\omega_j+1} = \sum_{h=1}^{l_1} \gamma_{hj}^{\omega_j} y_{hj}^{1/\omega_j+1}$, in a way which maximises the value of this bundle of goods $\sum_{h=1}^{l_1} p_h y_{hj}$. We deduce from this maximisation program the expression of the price of the composite good in function of the prices of goods $p_{0j}^{1+\omega_j} = \sum_{h_1=1}^{l_1} \gamma_{hj} p_h^{1+\omega_j}$. We also get the production of each good in function of the production of the composite good and of their relative price $y_{hj} = \gamma_{hj} y_{0j} \left(p_h / p_{0j}\right)^{\omega_j}$.

Secondly, the production of composite good by firm *j* is a CES function, with substitution elasticity $\sigma_{1j}$, of an intermediary consumption in a *composite* goods and of the added value of the firm $y_{0j}^{1-1/\sigma_{1j}} = a_{1j}^{1/\sigma_{1j}} ci_j^{1-1/\sigma_{1j}} + \left(1 - a_{1j}\right)^{1/\sigma_{1j}} va_j^{1-1/\sigma_{1j}}$. The firm sets the levels of its intermediary consumption and its added value to minimise its cost $p_{ci_j} ci_j + p_{va_j} va_j$. We deduce from this minimisation program the expression of these two variables

$ci_j = a_{1j} y_{0j} \left( p_{0j} / p_{ci_j} \right)^{\sigma_{1j}}$ and $va_j = \left(1 - a_{1j}\right) a_{1j} y_{0j} \left( p_{0j} / p_{va_j} \right)^{\sigma_{1j}}$. We also get a relation between the price of the composite good and the prices of its two components $p_{0j}^{1-\sigma_{1j}} = a_{1j} p_{ci_j}^{1-\sigma_{1j}} + \left(1 - a_{1j}\right) p_{va_j}^{1-\sigma_{1j}}$.

Finally, the intermediary consumption of composite good *j* is assumed to be a CES function, with substitution elasticity $\sigma_{2j}$, of the intermediary consumptions $ci_{hj}$ of the $l_1$ goods. We deduce from the minimisation of the cost of producing this composite good $ci_{hj} = b_{hj} ci_j \left( p_{ci_j} / p_h \right)^{\sigma_{2j}}$ and $p_{ci_j}^{1-\sigma_{2j}} = \sum_{h_1=1}^{l_1} b_{hj} p_{h_1}^{1-\sigma_{1j}}$, with $\sum_{h_1=1}^{l_1} b_{hj} = 1$.

The technique of nested CES or CET functions has allowed us to model the multi-good production of a firm and to compute its intermediary consumption in a more general and flexible way than by using the technical coefficients of Leontief. We can notice that the prices of the composite goods can be computed from the prices of the goods themselves.

We continue with the description of the rest of the production side of the economy

- The added value of firm *j* is a CES function of an aggregate of capital and labour on one hand, and of land on the other hand, used by this firm.
- The aggregate of capital and labour is a CES function of an aggregate of capital and skilled labour on one hand, and of unskilled labour on the other hand, used by firm *j*.
- The aggregate of capital and skilled labour is a CES function of aggregate capital and of skilled labour used by firm *j*
- The aggregate capital is itself a CES function of the various kinds of capital used by firm *j*.

The prices of the aggregate or composite commodities can be computed from the prices of commodities (goods, capital, land and labour). Capital, land and labour are owned by households, and their available quantities are exogenously set (they are components of vector $\omega$).

Let us turn to the specification of household behaviour. Household *i* owns given amounts of shares of firms that is of their profits. He also owns exogenously given quantities of capital, land and labour, which he rents to firms. His disposable income is the sum of his profits and rents (including wages). He saves a proportion $s_i$ of his income and spends the rest on consumption. The allocation of his consumption spending across the various goods can be determined by a linear expenditure system (LES), which is derived from a Stone-Geary utility function: the spending on each good is the sum of the value of a subsistence minimum in this good and of a share of supernumerary income (subtracting savings and aggregate expenditures on the subsistence minima from disposable income).

Household saving is equal to the value of total investment. Total investment is a CES function of the investment in the different goods.

### *1.3. From a mathematical to a computable general equilibrium model: II Calibration and simulation*

Because of the limits of economic observation, we cannot include in an applied model all the commodities, firms and households existing in an economy. What we will call a commodity in the rest of the chapter will in fact be an aggregate of elementary commodities. For instance *manufacture of machinery and equipment* will include dishwashers used by households and machine tools used by firms. This raises the problem that the composition of this aggregate in elementary commodities, differs when it is relative to production, consumption or investment. A (not entirely convincing) solution is to consider the aggregate commodities defined at the production level, as references. Then, we assume that each aggregate commodity defined at the consumption (investment) level is a CES function of the former aggregates. Similarly, firms are substituted by industries and households by classes of households, for instance middle-income farmers.

A CGE model includes two kinds of parameters: scales and shares parameters such as $\gamma_{hj}$ or $b_{hj}$ and elasticities such as $\omega_j$ or $\sigma_{1j}$. The second parameters are assigned values based on literature search, in general the results of econometric studies. The values of the first parameters are computed so that the model can reproduce the observed economic situation in a base year. This observed situation has been registered in a social accounting matrix (SAM), which includes much detailed and consistent information.

As we saw in paragraph 1.1, we can sum up the model by a system of *l* market equilibrium equations with *l* unknown prices. However, the equations are not independent because of the Walras' identity, and a commodity or bundle of commodities must be taken as *numeraire* and have its price set to one. This result has the important implication that the difficulty in simulating the model is related to the number of its commodities but not to the number of its agents. Thus, if we substitute a class of households (for instance the medium-income farmers) by a wide sample of households belonging to this class and whose choices were registered by a household survey, we do not make the simulation of the model more complex and we add realism to it. This is the basic principle of micro-simulations. Very efficient simulation methods have been developed and incorporated in computer software such as GAMS.

*1.4. Versatility of CGE models*

A CGE model is a very versatile structure, which can easily be adapted to many problems. We can add plenty of disaggregations to the specification of the previous paragraphs, for instance of land or labour, by the introduction of other CES functions. The production functions can include firm-specific resources, which allows for decreasing returns to scale. Or they can include fixed costs, which allows for increasing returns to scale. We can assume monopolistic competition between the firms in the same industry. Households can deduce their supply of labour from the maximisation of their utility function. Firms can retain a share of their profits. Their financing can proceed through financial markets or banks. The labour market can be segmented between industries, urban and rural areas or regions. Then, migration costs prevent perfect and instantaneous arbitrage between the wages of workers with the same skill but working in different industries. Wages can be bounded from under by a legal minimum wage. If it is above the equilibrium wages for some skills, the workers with these skills will partly be unemployed. Etc.

We have assumed that the allocation of labour, capital and land between firms (or industries) can change without cost. We can consider that under this assumption the model determines a *medium-run* equilibrium. A *short-term equilibrium* can be defined by the assumption that capital and land cannot move between firms (industries).

We have assumed until now that the available amount of capital is predetermined. In the basic version of the model, investment is equal to households' saving. This specification can be improved by taking into account firms, Government and foreign saving. Then, the model can be dynamically simulated under the assumption that the capital available in the next period is equal to the capital of the current period, plus investment and less depreciation. The *long-run equilibrium* of the model can be defined as the balanced growth path of this dynamics.

## 2. Extensions and questions

The Walrasian model, in its Arrow-Debreu version, has neither international trade nor Government. Applied models must include these two features. We will show how they are introduced in CGE models in the two first paragraphs. In the last paragraph we will discuss the strengths and limits of these models.

### *2.1. International trade*

The specification of international trade rests on the assumption that foreign and domestic goods with the same denomination are imperfect substitute. This property can be formalised, one more time, with nested CES and CET functions, for instance

- The households' consumption of good *h* is a CES function of nationally produced and of imports of good *h.* These imports are themselves a CES function of imports from each trading partner of the modelled country. A similar specification is used for the investment and the intermediary consumption by firms in good *h*.
- The domestic production of good h is a CET function of domestic demand and of exports of this good. The exports of this good are themselves a CET function of its exports to each of the trading partners of the economy.
- In both cases the foreign prices of exports and imports in dollars are exogenously given. However, we could instead specify the demand functions for good *h* by each foreign country (for instance by constant price-elasticity functions) and deduce its prices on each foreign market from the equilibrium between the supply and demand of the exports of this good on this market.
- Finally, the value of exports balances the value of imports or the trade balance is in equilibrium. We notice that if the exchange rate and the prices of all commodities are multiplied by parameter $\lambda > 0$, nothing else changes in the economy. So, we can

freely choose a *numeraire* as in the previous section. The most natural choice is to set the value of the nominal exchange rate to one.

- We can extend the specification of the model by introducing trade margins and transportation costs in foreign trade, remittance by migrants, foreign capital income, foreign aid, capital inflows, etc.

*2.2. Government*

The government collects taxes and duties, allocates transfers, consumes and invests. Its introduction in a CGE model is mainly an accounting problem. Taxes create wedges between production and consumption prices, the cost of labour to firms and the net wages perceived by workers, the cost of capital to firms and the returns to investment to households, foreign and import prices, etc. These wedges distort the working of markets and lead to efficiency losses.

The allocation of Government consumption and investment between the various goods domestically produced or imported from different countries, can be modelled by nested-CES functions. The balance of the budget of the government is obtained by an adjustment of all or some taxation rates. Of course, the model can also assume an exogenous deficit of the Government, or consider all taxations rates exogenous and the deficit as endogenous.

*2.3 Strengths and limits of CGE models*

A CGE model describes a Walrasian equilibrium of an economy with many details. The social accounting matrix (SAM) it is based on, includes a wide range of industries and classes of households, and the fiscal policy of the Government is very detailed. Thus, the simulations of a CGE model give precise and detailed information on the changes in the allocation of resources and in the distribution of income resulting from changes in the environment or the structure of a country, or in the policy of its Government.

The first limit of a CGE model is that it is essentially static. Technically, we saw that it can be simulated along a dynamic path. However, the model includes almost none of the dynamic behaviour and nominal and real rigidities based on intertemporal optimisation and the assumption of rational expectations. In that it differs from the recent dynamic general equilibrium (DGE) models such as the IMF models GEM and GFM (see Bayoumi and *alii*, 2004 and Botman and *alii,* 2006), and their stochastic versions such as those by Smets and Wouters (2003) or Christiano, Eichembaum and Evans (2005). On the other hand, a CGE model is fit on a base year, but is not econometrically estimated. Thus, it cannot reproduce the observed path of the economy over the last 15 or 20 years. In that, it differs from traditional macroeconometric models such as the model of the Bank of England (2005). However, DGE and macroeconometric models are much less detailed than CGE models: they include a very small number, often only one, of goods, sectors and classes of households. Thus, they cannot comply with the main mission of CGE models.

The second limit of CGE models comes from their Walrasian features. The effects of a big reform can have many major implications besides a change in the allocation of scarce resources between industries. For instance, a policy developing tourism will encourage domestic residents to learn foreign languages and to invest in education, will develop international business networks, will encourage the diffusion of international knowledge and technology, will increase efficiency in the service industry, etc. We saw that CGE models are versatile enough to be able to include non Walrasian mechanisms. However, if we go too far in this direction we will include in the model more and more *ad hoc* and hardly measurable mechanisms, and will spoil the clarity and credibility of the model.

Let us be more specific. If we use a CGE model to compute the effects of a radical reform of the tax or trade protection system, we get the disappointing result that the GDP or the total households' consumption increase by a small amount, often less than 1 per cent of GDP. The reason is that the inefficiencies resulting from the bad allocation of scarce resources are limited, at least in a neoclassical setting. However, the interest of a CGE model is not so much in computing the aggregated effects of these reforms than in measuring the allocation of their effects across industries (those, which expand and those, which contract) and the changes in income distribution and poverty. The economic meaning of changes in aggregated values in a disaggregated model is ambiguous because, ultimately, we can compute the changes in welfare of each class of households, but we have no way of aggregating them.

The third limit of CGE models comes from their calibration, especially from the discretionary choice by the model-builders of the values of the elasticity parameters. The authors of a CGE model usually make a sensitivity analysis of their model: how the results of simulations change with the values of elasticity parameters. The results of this analysis are often encouraging and give the impression that the model is robust. However, the results of simulations can be much more sensitive to the specification of the model itself, especially the structure and hierarchy of the nested CET and CES functions. They constrain a lot the elasticity of substitution between goods and factors, and that in a way, which has more technical than economic justifications.

## 3. How to introduce tourism in a general equilibrium model

Tourism is not an industry *per se* but a collection of interrelated industries, which sell products to tourists as well as to a range of other customers: hotels, tour operators and travel agents, airlines, etc. Thus, introducing tourism in a SAM matrix asks for precise information on tourism demand and the way it is served by these industries. This information is not part of national accounts and this deficiency explains why CGE models have been applied to the investigation of the effects of changes in tourism demand or to the evaluation of tourism policies, only recently and in a limited number of countries (such as Australia, Indonesia, Spain, the United Kingdom and the United States).

The building of SAM matrices including tourism activities and the application of CGE models to tourism economics, have recently become easier with the development of Tourism Satellite Accounts (TSAs). These accounts have been set up in 2000 by an Intersecretariat Working Group convened by the United Nations Statistics Division (UNSD), with the participation of Statistical Office of the European Community (EUROSTAT), the Organisation for Economic Co-operative Development (OECD) and the World Tourism Organisation (UNWTO) (see for instance UNSD, EUROSTAT, OECD and UNWTO, 2008). In 2007, more than 70 countries from all parts of the world and different degrees of development were involved in setting up a TSA.

The purpose of a tourism satellite account is to analyse in detail all the aspects of demand for goods and services associated with the activity of visitors, to observe the operational interface with the supply of such goods and services within the economy; and to describe how this supply interacts with other economic activities. Tourism as a demand side phenomenon refers to the activities of visitors, and their role in the acquisition of goods and services. It can also be viewed from the supply side and tourism will then be understood as the set of productive activities that cater mainly to visitors. A visitor is a traveler taking a trip to a main destination outside his/her usual environment for less than a year and for any main purpose (business, leisure or other personal purpose) other than to be employed by a resident entity in the country or place visited. Tourism is divided into domestic tourism by residents and foreign tourism made by non residents. The consumption of foreign tourists represents tourism exports, tourism imports being consumption of overseas produced goods and services by residents on overseas trips.

The complete TSA provides:

- Macroeconomic aggregates that describe the size and the economic contribution of tourism, such as tourism direct gross value added and tourism direct gross domestic product, consistent with similar aggregates for the total economy, and for other productive economic activities and functional areas of interest;
- Detailed data on tourism consumption and a description on how this demand is met by domestic supply and imports, that can be compiled both at current and constant prices;
- Detailed production accounts of the tourism industries, including data on employment, linkages with other productive economic activities and gross fixed capital formation;
- A link between economic data and non-monetary information on tourism, such as number of trips (or visits), duration of stay, purpose of trip, modes of transport etc. which are required to specify the characteristics of the economic variables.

The Australian Bureau of Statistics (2008) and Van Ho and *alii* (2008) present a good example of a TSA for Australia in 2006-2007. They give for each state of Australia, various measures of the activities of the sectors producing tourism goods and services (output, gross value added, gross domestic product and employment), tourism consumption and tourism interstate trade. The TSA is disaggregated by industries or products such as long distance passengers' transportation or accommodation services. It also includes the income components of tourism (compensations of employees, gross operating surplus) by industries. We can notice that in Australia domestic tourism consumption is about three times larger than foreign tourists' consumption. These direct measures of the output of tourism activities are supplemented by indirect measures computed with an input-output table.

A CGE model including tourism must separate domestic and foreign tourism. Foreign tourists visit a country (state, province) for a limited duration of time and consume in this country. This inbound tourism is very similar to the exports of goods and services. In a similar way outbound tourism, residents who visit foreign countries and consume in these places, is very similar to imports. The model will include one or several class of non resident tourists, with their total spending and their utility functions, besides resident households.

Domestic tourism is a consumption activity of resident households. This activity can be specified as a new stage in a system of nested utility functions or expenditure systems of these households. In summary the SAM matrix of the model will include two more activities than usual, private expenditures of domestic tourists and of foreign tourists, besides private consumption, investment, exports, etc. These activities will include the expenditures of foreign and domestic tourists on each good and services.

A last problem is the forecast of the number of tourists by kinds (business, symposium, leisure) or origins (foreign or domestic) and of their spending by great categories (transport to the country, accommodation, etc.) under various assumptions on environment changes. Sinclair, Blake and Sugiyarto (2003) explain in their survey that the best econometric estimations on the demand of tourism use Almost Ideal Demand Systems (AIDS) or Linear Expenditure Systems (LES) to explain the share of destination *i* in the world (or regional) total spending on tourism in function of this spending and of the prices of each destination. The interest of these systems is to specify in a consistent way the competition between destinations on the world (or on a regional) market of tourism. The estimated values of the price elasticities are extremely useful for the setting of tourism pricing and tax policies trying to extract rent from foreign tourists. The allocation of total tourists' spending in a destination between the various goods and services can be specified by a second LES.

**4. Applications of CGE models to tourism economics**

This section will present a selection of applications of CGE models to economic problems connected to tourism. An interest of these applications is that their general equilibrium approach leads to results that cannot be reached by partial economic models or that even contradict the results of these models. The most interesting general equilibrium mechanism in this context is the Coppeland effect (1991, for a discussion see Hazari and Sgro, 2004). Foreign tourists allocate a high proportion of their total spending to the consumption of non-traded goods and services. Their action increases the prices and outputs of these goods, which leads to a contraction of the traded goods sectors. Thus, an expansion of foreign tourism in a country generates a kind of Dutch disease, with effects similar to those resulting from an increase in the price of an exportable commodity. However, as noted by Blake (2008b), the similarity ends there. The natural resource curse, the fact that natural resource extraction seems to lead to low growth levels, does not extend to tourism: none of the very poor performing economies in the world have relied on tourism.

A consequence of this mechanism is that, as soon as foreign tourists' consumption of non-traded goods has finite price elasticity, the government has a monopoly power on the markets of these goods. This power can be used to extract a rent from international tourists by taxing their consumption or more widely the goods they consume (so a part of the tax is paid by the residents who also consume these goods). Evaluations of this policy will be examined in the first paragraph.

Is an expansion of tourism in a developing country good or bad for its resident? In paragraph 2 we will present some results on this old question, bearing on the effects of tourism on poverty. We will see that all depends if the poor work in tourism sectors, which expand, or in export sectors, which contract.

The effects of tourism on a large country can be unevenly distributed across its regions. We will see in paragraph 3 that tourism in Australia has a negative effect on the tourist state of Queensland, and benefits to the state of Victoria. This result still comes from the Dutch disease effect induced by tourism. The last paragraph presents evaluations of government policies decided in times of a natural catastrophe (such as the food and mouth disease in the UK) or after a terrorist attack (September 11).

*4.1. Taxing foreign tourists*

Blake (2000) develops a model of the Spanish economy. He shows that foreign tourism activities in Spain are, relatively to other sectors, highly taxed but that domestic tourism is effectively subsidised. This difference in taxation is largely because domestic tourists are more intensive users of land transport. This sector is subsidised, particularly for rail transport where for every 100 pesetas paid by passengers an additional 102.8 pesetas are paid in (net) subsidy.

Raising the levels of taxation on foreign tourism will, however, increase domestic welfare since these tourists bear most of the welfare loss associated with higher revenues. A "perfect" tourism tax, should tax the consumption of all the goods bought by foreign tourism and only those goods. Of course this type of tax is unworkable. Blake finds that any of the taxes on tourism sectors (which are in part paid by domestic residents who buy the goods produced by these sectors) improves the welfare of domestic residents to a far smaller extent than a perfect tourism tax. He also finds that the welfare benefits from taxing tourism are more sensitive to assumptions relating to tax handles than they are to the elasticity of demand for tourism.

Gooroochurn and Sinclair (2005) make a similar study in the context of the tourism-dependent economy of Mauritius. As Blake they find that directly taxing foreign tourists increases domestic welfare. The authors also examine production and sales tax reforms and compare the welfare cost of raising additional revenue from a tax on a specific commodity while other taxes remain constant. They find that tourism-related sectors (restaurants/hotels and transport/communication) are undertaxed, that the cost of increasing the taxation of these sectors would be mainly born by foreign tourists and that increasing taxes in these sectors has smaller effects on poorer than on richer households and reduces income inequality The main driver of the last result is the higher proportion of domestic consumption from the richer household groups for tourism-related sectors. A narrow policy, taxing the highly tourism-intensive sectors extracts significantly more revenues from tourists than a broader policy where all tourism-related sectors are taxed. The narrow policy has a higher beneficial term of trade effect than the broader policy. Higher term of trade implies that the local economy can obtain more imports (hence consumption) for a given amount of exports.

*4.2. Tourism and poverty*

Blake, Arbache, Sinclair and Teles (2007) examine the issue of how tourism affects poverty in Brazil. They show that the effects on all income groups are positive. The lowest income households benefit, but by less than some higher income groups.

Tourism consumption usually leads to increased output, prices and wages in the industries that sell products directly to tourists. Therefore, poor households are likely to be negatively affected via the price channel; rising price will reduce the real income effect. The largest increases in prices that result are, in general, for the types of goods and services that tourists consume. These are products that domestic residents only usually consume if they take a trip (accommodation, passenger transport, tour agency and operation services, recreational services, and souvenir goods), if they go to restaurants or if they buy food products. Most products are those purchased more by higher income households; the direct effect of the channel will lead to small increases in prices paid by poor households, through food products. Even in this case, tourists tend to buy a different set of food from those consumed by poor households.

Poor households can benefit from the higher wages and increases in production in tourism-related industries. This effect might be moderate, however, if the poor households lack the skill required for employment in these businesses. An offsetting earnings effect comes from the fall in production and wages in traditional export sectors. An adverse aspect of tourism expansion is that if the poor rely heavily on earnings from commodity export sectors, an increase in tourism demand may lead to an increase in poverty.

Tourism consumption (for example domestic tourism) is mainly concentrated upon the wealthiest sections of society. On the other hand, the remuneration of households through the industry is increasingly concentrated, in relative terms, towards the lowest- and low- income households. These data suggest a distribution of income from the richest, through consumption, to the poorest, through remuneration. It is notable that the largest inter-household flows are from high-to low-income households, but not to the lowest income ones.

Finally, in Brazil while the poor do not benefit greatly from tourism, they are not heavily involved in other exporting sectors, so do not lose out. In Kenya, Tanzania and Uganda, they receive more income from non-service exports (such as coffee and tea) than they do from tourism (or, the hotel and restaurant sector, Blake, 2008a). The conclusion has to be that tourism can make the poor worse off, which is a result that Wattanakuljarus and Cixhead (2008) obtain for Thailand.

*4.3 Interregional effects*

Adams and Parmenter (1993, 1995) investigate the effects of a general stimulation of international tourism in Australia, with the ORANI model. With stimulation of international tourism, there is a strengthening of the exchange rate. This movement leads to import substitution and the contraction of traditional export sectors of mining and agriculture which, with the high import content of the tourism sector, causes the balance of trade to worsen. Some sectors experience direct stimulation (air transport, restaurants and hotels), others experience indirect stimulation due to the rising prices of intermediary inputs supplied to the tourism sector (food, clothing) and other contract as the result of adverse exchange rate effects.

The authors establish that Queensland (Australia's sunshine state and the main destination of many foreign tourists) would be a small loser. Certainly, international tourists spend money in Queensland, although not as much as one might believe before looking at the relevant statistics. Although many tourists travel in Queensland, the bulk of their money is spent in New South Wales, especially on airline tickets for flights in and out of Sydney. Thus, the Queensland economy experiences moderate only gains from the expenditures of international tourists.

The downside for Queensland comes from the trade accounts. The appreciation of the exchange rate adversely impacts on export-oriented activities including mining and agriculture. With these activities representing a comparatively large share of its gross state product, Queensland is left as a net loser from general tourism stimulation. Victoria, with little reliance on traditional exports and where one of the country's principal airports is located, experiences the largest expansion.

*4.4. Stabilising policies in times of natural catastrophe and terrorism*

Blake, Sinclair and Sugiyarto (2003) evaluate the UK government's policy toward food and mouth disease (FMD) in the UK. The UK government decided the slaughtering of animals that were deemed to have or be at high risk of having the disease to stop the virus spreading, with compensation packages for farmers whose livestock was slaughtered. It also included banning access to large areas in the countryside that include historic sites and tourist attractions and cancelling or postponing sports and public events. The authors establish that the FMD had much larger adverse effects on tourism, domestic and foreign, than on agriculture, the main reason being that tourism is a considerably larger sector to start with. Most of the reduction in GDP due to the FMD crisis from 2001 to 2004 came from tourism expenditure reductions. The largest reductions in tourism expenditures occurred in Scotland and London.

The UK government could have followed alternative policies. One option would have been to vaccinate susceptible animals against FMD. Vaccination would not eradicate the disease and may result in a permanent reduction of meat and milk productivity and exports. However, this loss would have affected farmers, a small share of the UK population, but supported by powerful lobbies. An alternative would have been to allow infected animals to recover from the disease as 95% of the affected animals recover within two weeks (with little or no treatment) and there is virtually no risk to human health.

Blake and Sinclair (2003) evaluate the US's government response to the events of September 11. Airlines industries were especially hit with a decrease in the number of passengers of 34% for domestic and 23% for international travel in October 2001. By June 2002 some recovery had taken place, with emplanements down by 11% and 7% respectively over the preceding 12 months. The other activities, which provide services to tourists, but to other agents as well, could defuse part of the shock.

The policy of providing government loans and compensation to airlines, as well as other financial and safety measures, has been much more effective than alternative policies asked by the tourism's industry of tax credit for travel and for the workforce employed in the industry, business loans programs, the extension of allowance for net operating losses and government and private sector funding for advertising to stimulate travel to and in the United States. The intuition behind this result is that a stabilising policy of a sharp but localised and relatively short-lived crisis is more efficient if it targets to the few sectors, which have been seriously hit, rather than if it allocates its means between a large numbers of recipients, which can swallow the shock without too much difficulty.

## 5. Conclusion

CGE models are an invaluable method to evaluate the effects of shocks and of policies at a much disaggregated level. They have no serious rival, which can determine which sectors will expand and which will contract, and which classes of households will see an improvement in their welfare and which will suffer deterioration of it.

We saw that the structure of these models, based on a sequence of nested CES or CET functions, can much constrain the substitution elasticities between goods without much economic justification. This kind of simplification is the price to pay if we want to run general equilibrium simulations. However, this limit also suggests that there is still room left for partial equilibrium analysis, which can adopt a more flexible specification.

We also saw that that the dynamics and the macroeconomics of CGE models are poor. But again, these weaknesses should be dealt by using in parallel, aggregated dynamic general equilibrium models.

The application of CGE models to tourism economics has been much restrained until recently by the lack of data. We saw that the development of TSA has progressively dampened this difficulty, and we have seen more and more of these applications in the recent years. This trend will certainly continue.

**References**

Adams P.D. and B.R. Parmenter (1993) – "The Medium-term Significance of International Tourism for the State Economies", *Report commissioned and published by the Bureau of Tourism Research*, Australian Government Publishing Service, Canberra, pp.55 + viii.

Adams Philip D. and Brian R. Parmenter (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.

Bayoumi Tamin, Douglas Laxton, Hamid Faruqee, Benjamin Hunt, Philippe D Karam, Jaewoo Lee, Alessandro Rebucci and Ivan Tchakarov (2004) – *GEM: A New International Model*, Occasional Paper 239, International Monetary Fund, Washington DC.

Blake Adam (2000) – "The Economic Effects of Tourism in Spain", *TTRI Discussion Paper* n° 2000/2.

Blake Adam (2008a) – "Tourism and Income Distribution in East Africa", *International Journal of Tourism Research* 10(6), pp. 511-524.

Blake Adams (2008b) – "Tourism and Economics: Not Just a Number Game, not Just Impactsé, Inaugural Lecture, Bournemouth University; 26th November.

Blake Adam, M. Thea Sinclair (2003) – "Tourism Crisis Management. US Response to September 11", *Annals of Tourism Research* (4), pp. 813-832.

Blake Adam, M. Thea Sinclair and Guntur Sugiyarto (2003) – "Quantifying the Impact of Foot and Mouth Disease on Tourism and the UK Economy", *Tourism Economics* 9(4), pp. 449-465.

Blake Adam, J. Gillham and M. Thea Sinclair (2005) – "CGE Tourism Analysis and Policy Making", *International Handbook of the Economy of Tourism*, Edward Elgar.

Blake Adam, Jorge Saba Arbache, M. Thea Sinclair and Vladimir Teles (2008) – "Tourism and Poverty Relief", *Annals of Tourism Research* 35(1), pp. 107-126.

Botman Dennis P. J. and Manmohan S. Kumar (2006) – *Fundamental Determinants of the Effects of Fiscal Policy*, Working Paper WPIEA2006072, International Monetary Fund, Washington DC.

Christiano L., Eichenbaum M. and Evans C. (2005) – "Nominal Rigidities and the Dynamic Effect of a Shock to Monetary Policy", *Journal of Political Economy*, 113, pp. 1-45.

Copeland B.R. (1991) – "Tourism, welfare and de-industrialization in a small open economy", *Economica*, 58, pp. 515-529.

Debreu Gérard (1959) - *Theory of Value. An Axiomatic Analysis of Economic Equilibrium*, Cowles Foundation Monograph 17, John Wiley and Sons, New York.

Dixon Peter B. and B.R. Parmenter (1996) – “Computable um Modelling for Policy Analysis and Forecasting”, in *Handbook of Computational Economics*, Volume I, Edited by H.M. Amman, D.A. Kendrick and J. Rust, Elsevier, Science B.V., pp. 3-85.

Dwyer Larry, Peter Forsyth and Ray Spurr (2004) – “Evaluating Tourism’s Economic Effects: New and Old Approaches”, *Tourism Management* 25, pp. 307-317.

Gooroochurn Nishaal and M. Thea Sinclair (2005) – “Economics of Tourism Taxation. Evidence from Mauritius”, *Annals of Tourism Research* 32(2), pp. 478-498.

Harrison Richard, Kalin Nikolov, Meghan Quinn, Gareth Ramsay, Alasdair Scott and Ryland Thomas (2005) – *The Bank of England Quarterly Model*, Bank of England, London.

Hazari Bharat R. and Pasquale M. Sgro (2004) – *Tourism, Trade and National Welfare*, Contributions to Economic Analysis, 265, Elsevier: Amsterdam.

Robinson Sherman (1989) – “Multisectoral Models”, in *Handbook of Development Economics*, Volume II, Edited by H. Chenery and T.N. Srinivasan, Elsevier Science Publisher, B.V, pp. 885-947.

Sinclair M. Thea, Adam Blake and Guntur Sugiyarto (2003) – “The Economics of Tourism”, in *Aspect of Tourism. Classic Reviews in Tourism*, Edited by Chris Cooper, Channelview Publications, pp.22-54.

Smets F. and Wouters R. (2003) – “An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area”, *Journal of European Economic Association*, 1, pp. 1123-1175.

UNSD, EUROSTAT, OECD and UNWTO (2008) – “2008 Tourism Satellite AccountRecommended Methodological Framework (TSA: RMF 2008)”, Statistical Commission, Thirty-ninth session 26-29 February.

van der Mensbrugghe Dominique (2005) – “Prototype Model for a Single Country Real Computable General Equilibrium Model”, mimeographed Development Prospect Group, The World Bank, September 26.

Van Ho Thiep, Ray Spurr, Daniel Pambudi, Peter Forsyth, Larry Dwyer and Serajul Hoque (2008) – “Tourism Satellite Accounts 2006-2007: Summary Spreadsheets”, Sustainable Tourism Cooperative Research Centre, Centre for Economics and Policy, Gold Coast, Queensland, Australia.

Wattanakuljarus A. and I. Coxhead (2008) – “Is Tourism-Based Development Good for the Poor? A General equilibrium Analysis for Thailand”, *Journal of Policy Modeling*, 30, pp.929-955.