Tourism, income, and jobs

Improving the measurement of regional economic impacts of tourism

Jeroen Klijs

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1. Introduction

1.1 Measurement of regional-economic impacts of tourism

This thesis discusses the measurement of regional economic impacts of tourism. Tourism is defined by the UNWTO (2015) as "a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes." These people- are termed visitors, and their activities imply tourism expenditure.
A visitor is classified as a tourist or overnight visitor, if his / her trip includes an overnight stay, or as a same-day visitor or excursionist otherwise.

Tourism can have a broad range of impacts for the economy, for the natural and built environment, for the local population, and for visitors themselves (e.g. Archer et al., 2012; Cooper et al., 2005; Mathieson & Wall, 1982). This thesis discusses the measurement of economic impacts of tourism using economic impact analysis (EIA). The economic impact of tourism are well recognized (Baaijens et al., 1998). Tourism creates income for many regions, including those that have few other options for economic development or in which other industries are performing poorly (e.g. Szivas et al., 2003; Vaugeois & Rollins, 2007; Zampoukos & Ioannides, 2011). Furthermore, tourism includes activities carried out in many industries (trade, transport, accommodations, catering, culture, sports and recreation, etc.) and requires intermediary supplies by many other industries such as agriculture and health care (Fletcher, 1989). Finally, tourism is relatively labour intensive (e.g. Kelliher, 1989; Surugiu et al., 2012) and thereby creates numerous employment opportunities for a tremendous variety of employees.

Many tourism stakeholders can seek to know more about the economic impact of tourism, especially when changes in the quantity or quality of tourism opportunities or policy shifts are being considered or when there are exogenous changes in tourism demand (Dwyer et al., 2004; Stynes, 1997). Some of the stakeholders are:

- Policy makers, government treasuries monitoring spending on tourism projects, or local authorities who want to know the impacts of subsidies given to events, promotions, activities or facilities, or who want to compare impacts of tourism to those of an alternative resource allocation policy (Crompton, 2006; Stynes, 1997)
- Project developers, event organizers, hotels, restaurants, and or other tourism businesses may be interested in the economic impacts of their activities. Although their primary interest lies with the impacts on their own organization, they may also be interested in economic impacts for other organizations and people, for two main reasons. First, it is important for them to have a good relationship with other tourism businesses, suppliers, customers, and residents, as tourism leads to activities that depend on and affect the entire community. Knowledge about economic impacts can help to demonstrate a positive contribution and create community support (Stynes, 1997). Second, activities in tourism often require approval and/or support of public bodies (e.g. local tax, zoning or other policy decisions). Evidence of economic impacts can convince a public authority and/or can even be part of a formal requirement placed upon private actors (Crompton, 2006; Stynes, 1997).

- For the 'tourism industry' as a whole (including many private and semi-public actors), being able to show its economic significance can give the industry greater respect among the business community, public officials, and the public in general, leading to decisions that are favourable to tourism (Stynes, 1997).

This thesis focuses on the measurement of impacts on output, value added, and employment caused by the flow of currency into a destination's economy as a result of visitor expenditure. This includes impacts in the industries supplying goods and services directly to these visitors – for example catering, accommodations, transport, and culture, sports, and recreation - and indirect impacts in these and other industries caused by the supply of intermediary products (e.g. Crompton, 2006; Fletcher, 1989; Frechtling, 1994a). The measurement of the direct impacts usually depends on establishing the number of visitors to a destination and their expenditure, e.g. via visitor surveys. The measurement of indirect impacts usually depends on the usage of models that represent the relationships within an economy (Frechtling, 1994a; Stynes, 1997).

Two types of economic impact measurements are possible. In an economic impact analysis (EIA), information about changes in tourist spending ('shocks to tourism demand') is used to calculate the total economy-wide impacts (direct and indirect). Economic significance analysis involves the calculation of 'the contribution that tourism-related spending makes to key economic variables such as GDP, household income, . . ., employment and so on' (Dwyer et al., 2010). Although many of the insights generated in this thesis are also relevant for economic significance analyses, the focus is on EIAs.

Furthermore, this thesis concentrates on the measurement of regional-economic impacts for three reasons. First, large differences exist between regions regarding their economic dependence on tourism. Income of tourism can be of vital importance for some regions and can be a tool to decrease regional disparities in employment and income per capita (Baaijens et al., 1998; Fletcher, 1989). Second, public and private decisions regarding tourism are increasingly made on a regional and a local level, increasing the importance of regional EIAs. Finally, tools to measure regional-economic impacts are in need of further development. On the spatial scale of regions there is often a need to make the most out of limited data availability and to carry out EIAs within a relatively small budget and a limited amount of time, especially when analyses are carried out in a non-academic setting.

Finally, this research study focuses on the choice between models to calculate indirect economic impacts and the data-requirements, usage, and further development of one specific model, namely the Input-Output (I-O) model, which is commonly used in EIAs in tourism (Dwyer et al., 2004).

1.2 I-O models

The starting point of an I-O model is final demand, i.e., the value of goods and services bought by final users for the direct fulfilment of their needs and wants (in contrast to goods and services used as an intermediary input). When the I-O model is applied to tourism, final demand refers to the value of the goods and services bought by visitors, termed visitor expenditure.

Final demand brings about a chain of production. First, goods and services that are part of final demand need to be produced. This requires production factors (i.e., capital and labour) as well as

intermediate inputs. These intermediate inputs also need to be produced, again requiring production factors and a subsequent 'level' of intermediate inputs. This process continues for several rounds. Combining final demand and all 'levels' of intermediate inputs, an I-O model enables calculation of the output required to satisfy final demand. Moreover, output of an industry can be linked to the final demand of another industry, e.g., the amount of output from the industry 'Agriculture' due to final demand in the industry 'Culture, Sports, and Recreation'.

Besides data on final demand, the I-O model requires an I-O table. I-O tables are part of the national accounts and give a detailed overview of interrelationships between industries, deliveries to final users, and use of production factors. I-O tables can be used to calculate I-O coefficients a_{ij}, that show the use of intermediate input i to produce one unit of output of industry j. Matrix algebra is used to develop an I-O model (e.g. Fletcher, 1989; Horváth & Frechtling, 1999; Miller & Blair, 2009) whereby a technical operation is performed on the matrix containing the I-O coefficient a_{ij} (A) to develop a 'Leontief inverse matrix' (L):

$$L = (I - A)^{-1} \tag{1.1}$$

L is the Leontief inverse, I is the unity matrix and A is the matrix containing I-O coefficients a_{ij}. Equation 1.2 shows that the Leontief inverse enables the calculation, for any level (Y) or change (ΔY) of final demand, of the required output in all industries of the economy (X or ΔX). Y and X are column vectors containing respectively final demand and output, per industry. ΔX and ΔY are column vectors containing the change of final demand and output, per industry.

$$X = L \cdot Y \tag{1.2}$$

$$\Delta X = L \cdot \Delta Y \tag{1.3}$$

Using industry-specific ratios between value added and output, income and output, or employment and output, contained in the diagonal matrix v , the I-O model can also be used to calculate impacts on value added, income, or employment per industry, contained in the column vector V. Value added is the difference between the value of output and purchases of intermediate inputs. Alternatively, it is the money earned by employees, owners, and investors. Income concerns the part of value added that is paid to employees as salaries. Employment is the numbers of jobs or full time equivalents (FTEs). For value added and income, the ratios with output can be derived from the I-O table. Additional employment data is required to calculate ratios between employment and output.

$$V = v \cdot X \tag{1.4}$$

The I-O model was originally developed by Wassily Leontief, earning him a Nobel Prize in economics. Following upon earlier work of economists such as François Quesnay, Léon Walras, Karl

Marx and Jean Charles Léonard de Sismondi, Leontief was the first to use a matrix representation for the relationships between industries in a nation or region. Since the 1960s, the I-O model has been used extensively, by academics as well as practitioners \ within tourism and beyond.

1.3 Advantages and disadvantages of I-O models

The popularity of the I-O model can be explained by its advantages[1]:

1. The I-O model is relatively simple. Computations can be done in standard software such as MS Excel. The calculations and the outcomes can be explained to non-experts, including most clients. Nonetheless, they might struggle to understand consequences of underlying assumptions (e.g. Dwyer et al., 2004; Horváth & Frechtling, 1999; Zhang, 2002).
2. I-O models are well known. The advantages, disadvantages, structure, and usage are extensively discussed in many publications (e.g. Dwyer et al., 2004; Horváth & Frechtling, 1999; Schaffer, 1999). The extensive usage of I-O models implies that new applications can potentially be compared to applications in other regions, at other times, or for other final demand (changes) (Archer, 1995; Fletcher, 1989).
3. Data demands of I-O models are relatively modest. They require an I-O table, data on final demand per industry and, for calculation of employment impacts, ratios between employment and output per industry. When an I-O table is not available at the appropriate spatial scale methods are available to create such a table[2]. For some EIAs data on final demand can be derived from a Tourism Satellite Account[3].
4. The level of detail of outcomes is relatively high. I-O models show impacts on output, value added, income, and employment, per industry. This can lead to valuable insights for clients and the organizations they want to inform or convince (e.g. Horváth & Frechtling, 1999; Loveridge, 2004; West & Gamage, 2001).
5. An I-O model offers flexibility. It can be used for
    - significance analysis, to calculate the indirect economic impacts related to (a part of) final demand (e.g. Liu et al. 2013; Martínez-Roget et al., 2013; Murillo et al., 2013);
    - impact analyses, to calculate the indirect impact of a change of final demand (Barajas et al., 2014; Huang et al., 2014; Warnick et al., 2015);
    - and/or linkage analysis, to calculate the strength of relationships between industries (e.g. Cai et al., 2006; Khanal et al., 2014; Robles Teigeiro & Díaz, 2014; Soulie & Valle, 2014).

1 Advantages and disadvantages of I-O models are discussed in more depth in chapter 2.

2 These methods are often categorized into non-survey methods (deriving RIOCs from the national I-O table, through mathematical procedures), survey methods (based solely on regional data, obtained from expert interviews, survey of industries and final consumers) and hybrid methods (non-survey methods combined with regional data) (Bonfiglio & Chelli, 2008; Jensen, 1990). Chapter 3 explores the usage of one subcategory of non-survey methods, namely location quotients.

3 Tourism Satellite Accounts are discussed e.g. by Ahlert (2007), Frechtling (2010), and Heerschap et al. (2005). Combinations of I-O analyses and Tourism Satellite Accounts can be found e.g. in Munjal (2013), Smeral (2006), and Ünlüönen et al. (2011).

An I-O model however also has some important disadvantages:

1. Determining the (change of) final demand is not part of the model. The researcher must determine how to collect and interpret the required data. This is difficult when dealing with future changes, as it involves estimating spending of future visitors. This estimation can be complex for present-day estimates as well, as one should only include the part of final demand which would not be in the region without the developments for which impacts are calculated (e.g. Crompton, 2006; Fletcher, 1989; Wagner, 1997).
2. For applications on the subnational level, I-O tables may be unavailable on the appropriate spatial scale, and any method to create such tables requires additional data and further assumptions.
3. The model is built on strong assumptions. The most important assumption is 'no scarcity of production factors': It is assumed there is a reservoir of labour and capital from which, without any restriction, extra labour and capital can be extracted (or disposed). This implies that final demand changes do not lead to relative prices changes, input substitution and redistribution of production factors among industries (e.g. Briassoulis, 1991; Copeland, 1991; Dwyer et al., 2004).
4. The assumption 'no scarcity of production factors' implies that an increase of output automatically leads to a linear increase in the usage of labour. Productivity changes are assumed to be absent. In reality, an increase in final demand can also lead to productivity increases, i.e. employees working longer, harder, or more efficiently (Sun, 2007).
5. An I-O model starts with exogenous (changes of) final demand. For analyses of different type of 'shocks' (e.g. changes of taxation or subsidies) I-O models are less or not appropriate (e.g. Archer, 1982; Blake et al., 2001; Fletcher, 1989).
6. The exogenous nature of final demand also implies there is no link between incomes earned and final demand (e.g. Batey & Rose, 1990; Loveridge, 2004; West, 1993).
7. Spatial considerations are only partly included in I-O models as impacts are calculated for an entire region. Although the analysis shows the relationship of the region with the outside world (import and export) it does not show how impacts are distributed within the region (e.g. Batey & Rose, 1990; Loveridge, 2004; Oosterhaven & Polenske, 2009). For EIAs in tourism this can nonetheless be an important consideration, because tourism is often concentrated in certain specific locations (Briassoulis, 1991).
8. Temporal considerations are only limitedly included in I-O models: For some EIAs in tourism the time dimension can nonetheless be very important: After a change of final demand some time may elapse before an economy has adapted and before all industries produce the right quantity of output. I-O models only show the difference in impacts between the old and the new equilibrium situation and do not give any insight into the dynamics and duration of the adjustment process (e.g. Briassoulis, 1991; Dwyer et al., 2004; Loveridge, 2004).
9. I-O models do not give any insight into social, environmental, and economic externalities (Dwyer et al., 2004). Results are limited to economic impacts related to final demand.

Table 1.1 shows, for each disadvantage of I-O models, which solutions exists to solve this problem.

Table 1.1 Disadvantages of I-O models and solutions

	Disadvantages of I-O models	Solutions
1	Relevant data on (change of) final demand is not always readily available	Collect and interpret primary and secondary data, make assumptions
2	I-O table is not always available on the appropriate spatial scale	Create I-O table or use alternative model (not dependent on I-O table) e.g. a Multiplier model
3	Assumption of "no scarcity of production factors" needs to be accepted	Use alternative model: CGE, NLIO
4	Assumption of "no productivity changes" needs to be accepted	Use alternative model: CGE, NLIO
5	Only applicable to calculate impact of (changes of) final demand	Use alternative model: CGE, NLIO
6	No link between income and final demand	Use alternative model: I-O model with endogenous consumption, SAM based model, CGE
7	No spatial dimension	Use alternative model: Bi- or multi-regional I-O model, CGE or NLIO including spatial dimension
8	No temporal dimension	Use alternative model: extended I-O model, CGE, NLIO including time
9	No social and environmental impacts and no economic externalities	Use alternative model: I-O or CGE, NLIO model with environmental impacts,

When data on the (change of) final demand are not readily available, these data need to be collected. New primary data (e.g. visitor inquiries) or secondary data may be required. In many cases assumptions are required in the interpretation of the secondary data because, for example, information is required on the expenditure of a specific group of tourists, while expenditure data is only available for tourists in general.

The absence of an I-O table implies that the I-O model cannot be applied. The researcher is then left with the choice to either create an I-O table (using the methods described later in this thesis) or to apply a model that does not depend on an I-O table, i.e. a multiplier model.

When the disadvantages 2 – 9 are a serious problem for an EIA, the researcher might be forced to use a different model than an I-O model. Possibilities are multiplier models, extended I-O models (I-O model with endogenous consumptions[4], bi- or multiregional I-O models[5], econometrically extended I-O models[6], and I-O models with environmental impacts[7]), Social Accounting Matrix (SAM) based models, Computable General Equilibrium (CGE) models, and Non-Linear I-O (NLIO) models.

4 I-O models with endogenous consumptions: Include relationships between income earned by households and their consumption (e.g. Bracalente et al., 2011; Polo & Valle, 2008)

5 Bi- or multiregional I-O models: Include relationships between the demand by industries in one region for imports from other regions and the output produced by industries in these other regions. Regional spillovers are taken into consideration (e.g. Freeman & Sultan, 1997; Manente, 1999; Soulie & Valle, 2014)

6 Econometrically extended I-O models: Relationships, that are assumed fixed or absent in the I-O model, are econometrically estimated (Bonn & Harrington, 2008; Israilevich & Hewings, 1996; Loveridge, 2004; Oosterhaven & Polenske, 2009; Rey, 2000; West, 1995). Can include a spatial (Batey & Rose, 1990; Loveridge, 2004) or temporal dimension (Loveridge, 2004; West, 1993, 1995).

7 I-O models with environmental impacts: By establishing ratios between output and environmental impacts (e.g. CO2 emissions), for each relevant industry, economic impacts calculated by the I-O model can be translated into environmental impacts (e.g. Collins et al., 2012; Jones, 2008; Sun & Pratt, 2014)

Multiplier models[8] are characterized by using a multiplier that is not based on an I-O table to go from direct to total impacts. Multipliers can be calculated using Export Base (e.g. Chang, 1981; Hora & Bond, 1977), Keynesian, Ad Hoc (e.g. Archer & Owen, 1972; Milne, 1987) or Proportional Multiplier models (e.g. Saayman & Saayman, 2006, 2010) or combinations (e.g. Pacaud et al., 2007). In some studies multipliers are based on an evaluation of multipliers used in earlier studies (e.g. Auld & McArthur, 2003; Song et al., 2012)[9].

SAM based models are similar in structure to I-O models, except that they are based on a SAM instead of an I-O table. Besides the information contained in an I-O table, a SAM reveals details about the transfer of money between industries and institutions and includes market and non-market financial flows. Thus, SAM-based multipliers account for income distributional consequences.

CGE models[10] can be regarded as I-O models extended with explicit demand groups (e.g. households), markets for goods, services and production factors (each with its own set of economic rules), and links between markets. These models take into account that production factors are potentially scarce and that final demand changes can lead to relative price changes, input substitution, and redistribution of production factors between industries (Adams & Parmenter, 1995; Copeland, 1991; Narayan, 2004). Furthermore, final demand is endogenous, being dependent on earning and (re)distribution of income, and impacts can be calculated of different types of 'shocks', not just final demand changes (e.g. Blake, Gillham, & Sinclair, 2006; Dwyer, Forsyth, & Spurr, 2007; Loveridge, 2004; Narayan, 2004; Sugiyarto et al., 2002). Finally, CGE models can be extended to include productivity changes (Blake, Sinclair, & Soria, 2006), a spatial dimension (e.g. Dwyer et al., 2003), and a temporal dimension (e.g. Blake, 2009), As shown in Table 1.1 CGE models offer a solution for many of the disadvantages of I-O models. However, CGE models also have disadvantages themselves. Besides an I-O table they require data on who earns income, income transfers, and how income is spent, i.e. a SAM. Furthermore, assumptions need to be made regarding behaviour of producers and consumers (Adams & Parmenter, 1995; Dwyer et al., 2004), the model is more complex (requiring specialized software and more economic and mathematical knowledge), and results may be less transparent and more difficult to explain to non-experts (Jansen, 2008; Sugiyarto et al., 2002; West & Gamage, 2001; Zhou et al., 1997).

NLIO models[11] can be seen as a model 'in between' I-O and CGE. As in a CGE model production factors are potentially scarce, leading to relative price changes, input substitution, and redistribution of production factors between industries. Impact can be calculated of types of shocks beyond final demand changes. Integration of productivity changes, and including spatial and temporal dimensions, is possible. The main differences with a CGE model is that a NLIO does not require a SAM and that final demand is exogenous (West & Jackson, 2005).

Table 1.2 (presented at the end of this chapter) and Figure 1.1 show the usage of all of these models in scientific articles about economic impacts of tourism. The I-O model is dominant overall, 57% of all applications have been based upon I-O or extended I-O models and I-O models have been

8 Advantages and disadvantages of three of the multipliers models (Export Base, Keynesian and Ad Hoc) are discussed in more detail in chapter 2

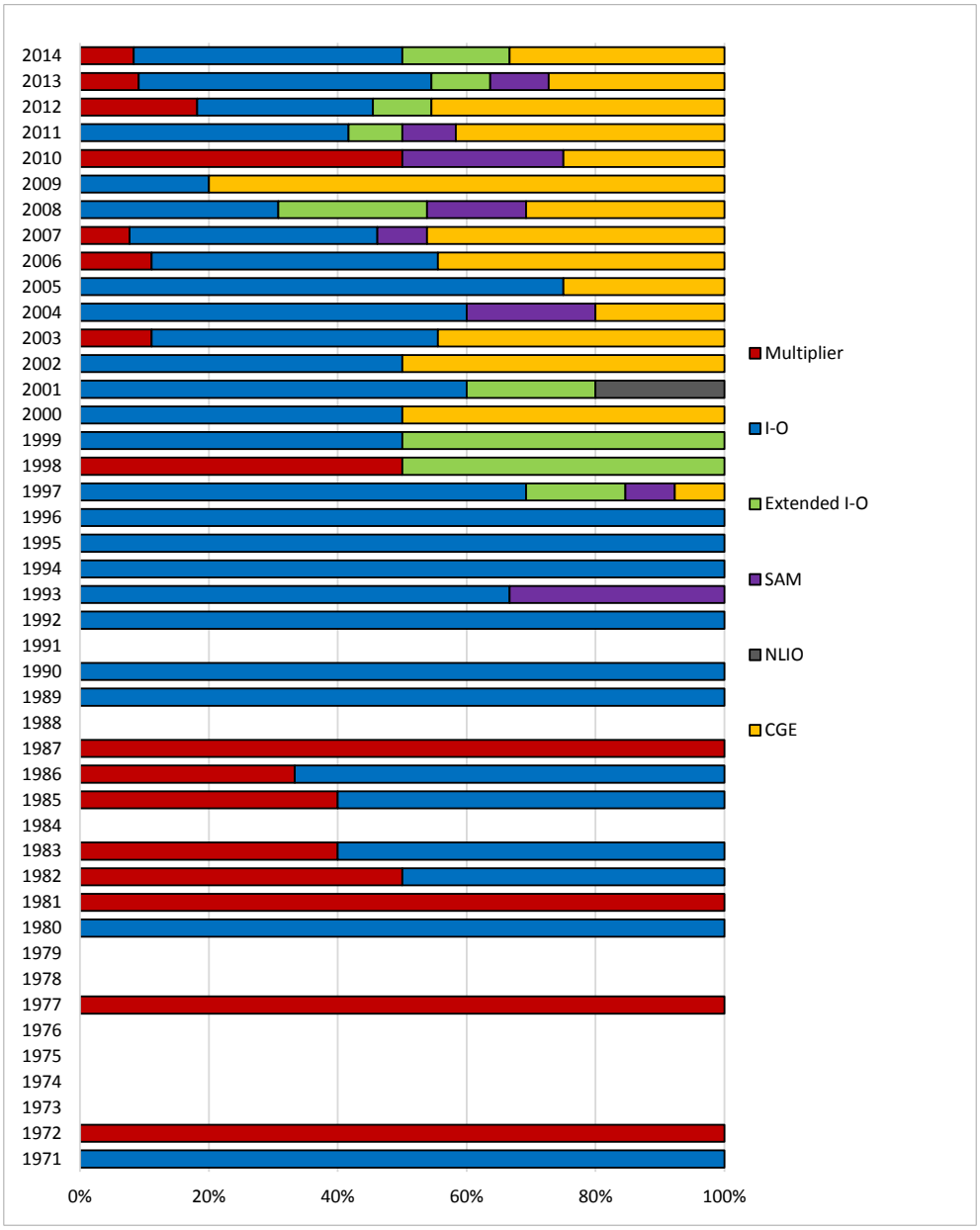
9 Var and Liu combine Ad Hoc and I-O Models (e.g. Liu et al., 1984; Liu & Var 1982; Var & Quayson1985).

10 CGE models and their advantages and disadvantages are discussed in more detail in chapter 2.

11 As discussed in chapter 5 different types of NLIO models are possible. Here we refer to NLIO modes in which the Leontief production function has been replaced by alternative production functions, resulting in price induced input substitution. The NLIO is discussed in much greater detail in chapter 6 and 7.

used exclusively in eleven years. From 2000 onwards Multiplier, I-O, extended I-O, SAM based and CGE models are used simultaneously. The NLIO model is used only once.

Figure 1.1 Usage of economic impacts models in scientific articles



1.4 Research objectives

The most important insights from the discussion so far are that:

1. Researchers need to make a well informed choice which economic impact model to use in an EIA, given the advantages and disadvantages of these models, the questions underlying the EIA, and data availability.
2. The I-O model can be an appropriate choice for EIAs under certain conditions:
    a. Relevant data exist on (the change of) final demand, i.e. visitors expenditure per industry.
    b. There is an I-O table on the appropriate spatial scale.
    c. The assumption of "no scarcity of production factors" is acceptable (which implies there are no relative prices changes, input substitution, or redistribution of production factors among industries).
    d. The assumption of "no productivity changes" is acceptable.
    e. Impacts are analysed of (a change in) final demand.
    f. There is interest in indirect impacts on output, value added, income and/or employment per industry, while there is little interest in induced impacts[12], spatial considerations, temporal consideration, social impacts, environmental impacts, and economic externalities.

However, not all EIAs in tourism are carried out within such a context. One can imagine situations where data on final demand is not readily available, there is no I-O table on the appropriate spatial scale, analysis is required of final demand changes that are likely to lead to redistribution of labour between industries or to increases of productivity, or there is an interest in induced impacts, spatial considerations, social impacts, environmental impacts, or economic externalities. This thesis aims to contribute to the measurement of regional economic impacts by establishing criteria based on which an appropriate model can be selected for an EIA and providing solutions for context in which one or more of the conditions b) to e) are not fulfilled. The ambition is to provide these solutions without introducing prohibitive complexity and data demands because, as was mentioned in section 1.1, EIAs on the regional level often need to make the most out of limited data and need to carried out within a relatively small budget and a limited amount of time[13]. This leads to the overall objective of this thesis:

To improve the measurement of regional economic impacts of tourism by

1. establishing criteria based on which an appropriate economic impact model can be selected for an EIA in tourism and;

12 Induced impacts: Changes in economic activity resulting from spending of incomes earned directly or indirectly as a result of visitor expenditure (Stynes, 1997)

13 Furthermore, the commissioners of this research have stated this as an explicit requirement.

2. providing solutions for those situations where
    - an Input Output table on the appropriate spatial scale is not available;
    - and/or analysis is required of different 'shocks' than final demand changes;
    - and/or the assumption 'no scarcity of production factors' cannot be accepted (which implies that there can be relative prices changes, input substitution and/or redistribution of production factors among industries);
    - and/or the assumption 'no productivity changes' cannot be accepted

   without introducing prohibitive complexity and data demands to an I-O model.

This overall objective is subdivided into the following specific objectives:

1. Provide an overview and evaluation of the criteria for the selection of economic impact models.
2. Provide an explanation for the sign of the difference between regional I-O coefficients calculated between two alternative LQ methods, for all combinations of demanding and supplying industries.
3. To analyze medical tourism's state-level economic impacts in Malaysia.
4. Address the limitations of I-O models and 'upgrade' the I-O model, without introducing the complexity and data collection costs associated with a full CGE model.
5. To include labour productivity changes, caused by a change in final demand in the tourism industries, into a non-linear I-O model.

Below each specific objective is discussed, including the methodology, data, and study area (where relevant). Each specific objective is the subject of a separate chapter (chapters 2 to 6).

Note that our chosen delimitation implies that this thesis does not provide solutions for situations where there is interest in induced impacts, spatial considerations, temporal consideration, social impacts, environmental impacts, and economic externalities (condition f). Furthermore, the focus in this thesis is not on how to deal with a situation where data are lacking and data on final demand is not readily available (condition a). Although this thesis mentions this problem by discussing the problems related to missing data for the case studies (chapters 4 and 5), it does not contain a structured and integral discussion of all questions, problems and solutions related to the search for relevant data and more specifically data on final demand. Finally, this thesis aims to provide contributions and is certainly not the final answer to the research questions raised.

Criteria for the selection of economic impact models of tourism

A researcher who wishes to carry out an EIA in tourism has to choose which economic impact model to use. This first specific objective determines the criteria based on which this choice can be made. First, a literature review is used to uncover potential criteria. Second, interviews are held with experts in tourism and/or EIA, including both practitioners and academics, in which all of the potential criteria are evaluated. Third, based on an analysis of the interview results two levels of 'essential criteria' are determined (1) criteria considered 'important' or 'essential' by at least 75% of experts (2) criteria for which there is a statistically significant difference in opinion between academics and practitioners. Finally, the resulting essential criteria are used to evaluate and compare the five economic impact models that are most used in EIAs in tourism: Export base, Keynesian, ad hoc,

I-O and CGE models. A literature review is used to 'measure', based on arguments given by other scholars, how well these models 'perform' on each essential criterion.

Difference between regional I-O coefficients calculated by alternative location quotient methods

When an I-O table does not exist on the appropriate spatial scale such a table needs to be created. One method to do this is based upon location quotients (LQs). LQs use information about relative size of industries on the level for which an I-O table is available compared to the level for which it is required (e.g. Bonfiglio & Chelli, 2008). The four most used LQ methods are Simple Location Quotient (SLQ), Cross industry Location Quotient (CILQ), Round's Location Quotient (RLQ), and Flegg's Location Quotient (FLQ) (Flegg & Tohmo, 2013). To choose between the LQ methods it is important to understand the differences. This second specific objective is formulated to enable researchers to make a more informed choice between these LQ methods, when there is a need to create a regional I-O table.

Formulas are derived for the differences between the LQs generated by these four methods. These formulas are used to determine a ranking in size of the LQs, trade coefficients, and regional I-O coefficients (RIOCs) for any combination of demanding and supplying industries. Based on the ranking it can be determined under what conditions LQs, trade coefficients, and RIOCs increase or decrease when changing between LQ methods. Conditions are established under which the ranking of LQ methods, based on RIOCs, is equal to the ranking based on total output multipliers. The conditions are illustrated for a hypothetical and empirical case study. The empirical case study is the region of Antwerp in Belgium.

Medical tourism's state-level economic impacts in Malaysia

The third specific objective is formulated to demonstrate the application of the (traditional) I-O model. This is important as the I-O model is commonly used in EIAs in tourism (Dwyer et al., 2004) and is the starting point of the development of the Non-Linear I-O model (in chapters 5 and 6). Furthermore, the chapter illustrates which problems can exist in relation to the collection of data on final demand and possible solutions. Data sources are combined and assumptions are made that provide a solution in the specific context of this case study.

This case study is an analysis of economic impacts of medical tourism in Malaysia, at the state level. Medical tourism is "a growing industry that involves patients intentionally travelling abroad for non-emergency medical services" (Snyder et al., 2011, p. 530) and Malaysia is ranked among the most recognized international medical tourism destinations (Ormond, 2013b). A state level analysis is relevant because each of Malaysia's states has a different tourism and economic profile and there are differences between states in the numbers, origins and types of medical tourists they receive (Association of Private Hospitals of Malaysia, 2008).

Nine regional I-O models are developed for nine Malaysian states. The required RIOCs are derived from the national I-O table, using FLQ. Several data sources need to be combined and several assumptions have to be made to estimate final demand by the relevant visitor group, i.e. medical tourists. The regional I-O models are used to calculate the state-level significance of medical tourism on output, value added, and employment.

'Upgrading' the I-O model to a Non-linear I-O model

This specific objective focuses on the situation where the assumption 'no scarcity of production factors' cannot be accepted. A literature review is used to determine the best way to integrate relative price changes, input substitution and redistribution into I-O analysis, from a theoretical and empirical point of view. The decision was made to replace the Leontief production function of the I-O model by a Constant Elasticity of Substitution (CES) production function, creating a NLIO model. This model is applied to analyze regional economic impacts of tourism in the province of Zeeland in the Netherlands, based on three scenarios and three alternative versions of the NLIO (different assumptions regarding capacity constraints and factor mobility). By comparing the results of the three versions of the model in the three scenarios, conclusions are drawn regarding the added value of the NLIO model compared to the I-O model. A sensitivity analysis is used to determine to what degree the conclusion regarding the added value depends on the chosen parameters of the NLIO model.

Including labour productivity changes into a non-linear I-O model

This final specific objective focuses on the situation where the 'no productivity changes' assumption cannot be accepted. A literature review is used to identify which labour productivity changes can be expected as a consequence of a final demand change, whereby labour productivity is defined as output divided by the number of labour inputs (e.g. Blake et al., 2006; Botti & Briec, 2010; Hadad et al., 2012). A division is made between quasi-productivity changes (substitution of labour by other inputs which automatically leads to higher labour productivity) and real productivity changes (changes that enable the production of more output per unit of labour). Furthermore, a differentiation is made between productivity increases for core and peripheral labour. Core labour is the central and foundational group of full-time and/or permanent employees providing skills essential to the survival and growth of an organization. Peripheral labour includes part-time and/or temporary employees, undertaking important but non-vital day-to-day activities, that are dispensed of in less affluent times or when demand is lower (e.g. Johnson, 1985; Krakover, 2000; Zampoukos & Ioannides, 2011).

Real productivity changes are integrated into the NLIO model by introducing Factor Augmenting Technical Change (FATC), for which an endogenous specification is used. Quasi-productivity changes are already integrated into the NLIO because of the CES production function. The differentiation between core and peripheral labour is translated into the NLIO model in the form of smaller ranges of FATC for peripheral labour, which implies that there is less room for productivity increases. The consequences of accounting for productivity changes are analysed by using the NLIO model with and without FATC to calculate regional economic impacts of a specific final demand change (10% change in expenditure in tourism in the province of Zeeland in the Netherlands). By comparing the results of the two models conclusions are drawn regarding the added value of including productivity changes.

Finally, this thesis provides a critical reflection on the research and the main conclusions.

Table 1.2 Overview of scientific articles in which an economic impact model is used to calculate indirect impacts of tourism[14]

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
1971	Standley	TR		X					Upper Main Stem Basis of Colorado Ski Corridor, USA	Skiers
1972	Archer and Owen	TR	X						Anglesey, UK	Tourism
1977	Della Bitta et al.	TR	?	?[a]					Rhode island, USA	Tall Ships '76 Celebration
	Hora and Bond	TR	X						Arizona, USA	Tourism
1980	Baster	TM		X					Scotland	Tourism
1981	Chang	TR	X						Alabama, USA	Mobile Municipal Auditorium
1982	Liu and Var	TM	X	X					Victoria, USA	Tourism accommodations
1983	Gartner and Holecek	TR	?	?[1]					Metropolitan Detroit, USA	Greater Michigan Boat and Fishing Show
	Cournoyer and Kindahl	TR		X					Massachusetts, USA	Travel and tourism
	Liu and Var	TR	X	X					Victoria, USA	Tourism
1984	Liu et al.	TM	X	X					Turkey	Tourism
1985	Kreck	TR	X						Spokane, USA	Canadian tourists
	Var and Quayson	TM	X	X					Okanagan Region, Canada	Tourism
	Mescon and Vozikis	AN		X					Dade County, USA	Port of Miami cruise industry and cruise passengers
	Ruiz	TM		X					Puerto Rico	Tourism

14 Articles were selected by using a meta search engine, with access to e.g. to Business Source Premier, Emerald, Sage Online Journals, Scopus, Springer Journals, Science Direct, Web of Science, and Wiley Online Library. The following query was used: "economic impact" or "economic impacts" or "economic benefit" or "economic benefits" or "economic effect" or "economic effects" or "melultiplier" or "input-output" or "I-O" or "IO" or "CGE" or "general equilibrium". These words were searched for in the title, abstract, and keywords and the results were limited to scientific articles published in the journals 'Annals of Tourism Research', 'Tourism Management', 'Journal of Travel Research', and 'Tourism Economics'. This led to 582 results. All these results were reviewed and relevant articles (articles in which a models is used to calculate indirect impacts of tourism) were included in the table.

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
1986	Liu	TR	X	X					Hawaii	Tourism
	Fletcher	AN		X					Jamaica	Tourism
1987	Milne	AN	X						Cook Islands	Tourism
1989	Fesenmaier et al.	TR		X					Texas Gulf Coast, USA	Outdoor recreation
	Mak	TR		X					50 states and districts of Colombia, USA	Tourism
1990	Heng and Low	AN		X					Singapore	Tourism
	Khan et al.	AN		X					Singapore	Tourism
1992	Braun	TR		X					Orlando, USA	Conventions
	Burgan and Mules	AN		X					Australia	Major sporting events
1993	Johnson and Moore	AN		X					Klamath and Jackson county region, USA	White-water recreation
	Taylor et al.	TR		X					North-central Wyoming	Visitors to historical sites and other recreational visitors
	West	AN				X			Queensland, Australia	Tourism
1994	Hurley et al.	TM		X					Ireland	EC Community grants for tourism
	King and Gamage	TR		X					Sri Lanka	Expatriate Sri Lankans resident in Australia visiting Sri Lanka
1995	Archer	AN		X					Bermuda	Tourism
	Finn and Erdem	TM		X					Edmonton, USA	Mega-Multi Mall
	Lee and Kwon	TR		X					South Korea	Tourism
	Parlett et al.	TM		X					Edinburgh, Scotland	Tourism
1996	Ali Bicak and Altinary	AN		X					North Cyprus	Israeli tourists
	Archer and Fletcher	AN		X					Seychelles	Tourism

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Borden et al.	TR		X					Washoe County, USA	Tourism
	Hansen and Jensen	TE		X					Denmark	Tourism
1997	Andrew	AN		X[b]					Cornwall	Accommodation-centred tourism
	Grado et al.	TR		X					South-western Pennsylvania, USA	Travel and tourism (antiquing as a separate activity)
	Lee and Kwon	TR		X					South Korea	Casino Industry
	Henry and Deane	TM		X					Ireland	Tourism
	Raguraman	AN		X					Thailand	Additional weekly services by a foreign air carrier
	Van Limburg	TM		X					Amsterdam, Netherlands	Overnight tourism
	Zhou et al.	AN		X				X	Hawaii	Decrease in tourism
	West	TE		X[c]					Victoria, Australia	Tourism
	Freeman and Sultan	TE			Multi-regional				Regions of Israel	Tourism
	Fleischer and Freeman	AN			Multi-regional				Rural regions of Israel	Tourism
	Wagner	AN				X			Guaraquesaba, Brazil	Tourism
1998	Huse et al.	AN	x						Towns of Norway	Tourism
	Felsenstein and Freeman	TR			Multi-regional				Regions of Israel	Casino
1999	Frechtling and Horvath	TR		X					Washington, USA	Tourism
	Manente	TE			Multi-regional				Regions of Italy	Tourism
2000	Schwer et al.	AN		X					South Nevada	Grand Canyon air-tours
	Alavalapati and Adamowicz	AN						X	Resource extraction regions	Change of environmental taxation on tourism and on the resource industry

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
2001	Crompton et al.	TR		X					Ocean City, USA	Springfest
	Tyrrell and Johnston	TR		X					Rhode Island, USA	Newport Folk Festival
	Upneja et al.	TR		X					Pennsylvania, USA	Sport fishing and angler wildlife watching
	Felsenstein and Freeman	TM			Multi-regional				Regions of Israel and Egypt	Casino Gambling
	West and Gamage	TR					X		Victoria, Australia	Tourism
2002	Braun et al.	TE		X					Port Canaveral, USA	Cruise Tourism
	Brown et al.	TE		X					Brazos County, USA	Messina Hof wine and jazz festival
	Cooper and Wilson	TE						X	UK	Travel and tourism
	Zhang	TE						X	Municipalities of Denmark	Tourism (output, income, employment, tax, and margins with and without tourism)
2003	Auld and McArthur	TE	X						Manawatu-Wanganui, New Zealand	Event-driven tourism
	Deegan and Dineen	TE		X					Ireland	Tourism
	Chhabra et al.	TR		X					North Carolina, USA	Scottish Highland Games
	Gelan	AN		X					Carnoustie, Angus, and Dundee City, Scotland	1999 British Open
	Kim et al.	TM		X					South Korea	Conventions
	Blake and Sinclair	AN						X	US	Decrease in tourism demand after 9-11
	Blake et al.	TE						X	UK	Decrease in tourism caused by foot and mouth disease
	Dwyer et al.	TE						X	New South Wales, Australia	Increase in tourism

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Sugiyarto et al.	AN						X	Indonesia	Globalization via tariff reductions and tourism growth
2004	Daniels	TR		X[d]					Mecklenburg County, USA	Girls fast pitch world series
	Witt et al.	TE		X					Denmark	Forecasts of changes in tourism
	Daniels et al.	AN		X[d]		X			Charleston, Dorchester, and Berkeley, USA	Cooper River Bridge Run
	Narayan	TE						X	Fiji	Increase of tourism
2005	Lee and Taylor	TM		X					Southern Korea	2002 World Cup
	Mules	TE		X					Kosciuszko National Park (KNP), Australia	Visitors to KNP
	Tohmo	TE		X					Keski-Pohjanmaa, Finland	Kaustinen Folk Music Festival
	Gooroochurn and Sinclair	AN						X	Mauritius	Changes of tourism taxation
2006	Saayman and Saayman	TE	X						Addo Elephant National Park, South Africa	Park visitors
	Cai	TR		X					Hawaii	Tourism industry
	Hodur et al.	TE		X					Fargo-Moorhead, USA	Multi-purpose event facility
	Loomis and Caughlan	TE		X					Teton County, Wyoming and Idaho, USA	Grand Teton National Park
	Smeral	TR		X					Austria	Tourism
	Blake, Sinclair, and Soria	AN						X	UK	Productivity changes in tourism
	Berrittella et al.	TM						X	Regions of the World	Climate change
	Dwyer, Forsyth, Spurr, and VanHo	TE						X	Australia	Decrease of tourism caused by world tourism crisis
2007	Pacaud et al.	TE	X						Aisne department, France	Implantation of Center Parcs resort
	Bowker et al.	TE		X					Washington and Grayson counties, USA	South-Western Creeper Rail Trail visitors

Year	Authors	Journal	Model					Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Chhabra	TR		X					Counties of Iowa, USA	Casino Gambling
	Daniels	AN		X					Mecklenburg and York, USA	"B" Girls fast pitch World Series
	Loomis	TE		X					Wyoming, USA	Rafting on Snake River
	Sun	TM		X[e]					Taiwan	Hotels
	Croes and Severt	TE				X			Kissimmee/St Cloud, USA	Tourism
	Dwyer, Forsyth, and Spurr	TE						X	Australia	Increase in tourism
	Dwyer, Forsyth, Fredline, Deery, Jago, Lundie	TE						X	Australia	Increase in tourism
	Nowak and Sahli	TE						X	Small Island	Increase in coastal tourism ('Dutch disease')
	Sahli and Nowak	TR						X	Developing countries	Increase of tourism
	Yeoman et al.	TM						X	Scotland	Oil depletion
	Zhang and Lee	TE						X	Florida	Growth and volatility in wildlife watching, fishing and hunting
2008	Diakomihalis and Lagos	TE		X					Greece	Yachting
	Keske and Loomis	TE		X					Colorado, US	Climbing 'Fourteeners'
	Viu et al.	TE		X					Granada, Spain	Alhambra and Generalife complex (UNESCO World heritage site)
	Polo et al.	TE		X		X			Balearics, Spain	Change in distribution of tourism expenditure
	Jones	TE			Environmental impacts				Wales	UK Round of 2004 World Rally Championship
	Polo and Valle	TE			Endogenous consumption	X			Balearics, Spain	(Decrease in) tourism
	Bonn and Harington	TE			Econometrically extended			X	Florida	Four events (output, income, and employment with and without these events)

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Ahlert	TR						X	Germany	Increase in tourism
	Blake et al.	AN						X	Brazil	Increase in tourism
	Schubert and Brida	TE						X	Small open economy	Implementation of production subsidy to Tourism
2009	Orens and Seidl	TE		X					Rocky Mountain West, USA	Winter tourism
	Blake	TE						X	UK	Anticipated and unanticipated tourism booms
	Gago et al.	TM						X	Spain	Specific and general taxation of tourism
	Pambudi et al.	TM						X	Indonesia	Decrease in tourism caused by Bali bombing
	Schubert and Brida	TE						X	Small country	Increase in tourism (caused by exogenous increase of foreigners' income and tourism marketing activities)
2010	Hojman and Hiscock	TM	X						East Devon, UK	Sidmouth International Festival
	Saayman and Saayman	TE	X						Two national parks, South Africa	National park visitors
2012	Akkemik	TM				X			Turkey	Tourism
2010	Lee et al.	TE						X	South Korea	Changes in tourism caused by 2002 World Cup and 9/11 terrorist attacks
2011	Kashian and Pfeifer-Luckett	TE		X					Wisconsin, USA	Camps and clinics of the University of Wisconsin-White-water
	Lacher and Oh	TR		X					Three regions of North Carolina, USA	Tourism
	Romero and Tejada	TM		X					Andalucía, Spain	Tourism industry
	Pratt	AN		X				X	Hawaii, USA	Tourism (industry) and changes in tourism as it moves through the Tourism Area Life Cycle

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Rossouw and Saayman	TE		X				X	South Africa	Increase of tourism
	Bracalente et al.	TE			Bi-regional + endogenous consumption				Umbria, Italy	Umbria Jazz music festival
	Saayman and Rossouw	TE				X			Eastern Cape Province, South Africa	Grahamstown National Arts Festival
	Li et al.	TE						X	China	Beijing 2008 Olympics
	Schubert et al.	TM						X	Antigua and Barbuda	Increase in tourism
	Sheng	TM						X	Tourist Cities	Increase in tourism (specialization vs. diversification)
2012	Sobol et al.	TE	X						Bavaria, Germany	Climate change
	Song et al.	TM	X						China	Decrease of tourism caused by Visa restrictions
2011	Ünlüönen et al.	TE		X					Turkey	Tourism
2012	Hanly	TM		X					Ireland	Conferences
	Kenneally and Jakee	TE		X					Ireland	Tourism
	Collins et al.	TR			Environmental impacts				UK	Stages of 2007 Tour de France
	Becken and Lennox	TM						X	New Zeeland	Increase in oil prices
	Dwyer et al.	TR						X	Australia	Implementation of carbon tax via tourism
	Ihalanayake	TE						X	Australia	Tourism tax changes
	Lennox	TE						X	New Zeeland	Increase in oil prices
	Pratt	TE						X	Hawaii, USA	Additional visitor from different geographical segments
	Schubert et al.	TE						X	Portugal	Changes in casino taxation

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
2013	Murillo et al.	TE	X	X					Barcelona, Spain	City tourists and day-trippers
	Della Lucia	TM		X					Trento	Festival of Economics
	Liu et al.	TM		X					Taiwan	Chinese tourists
	Martinez-Roget, Pawlowska, and Rodriguez	TE		X					Galicia, Spain	Academic tourism
	Munjal	TE		X					India	Tourism industry
	Haddad et al.	TE			Inter-regional				Brazil	Alternative hypotheses for the sources of financing of tourist expenditures
	Spencer and Nsiah	TM				X			Spearfish, USA	local citizens' support for a historic fish hatchery
	Li and Song	AN						X	Beijing and China	Changes in tourism caused by visa restrictions and 2008 Beijing Olympics
	Meng et al.	TM						X	Singapore	Tourism policies
2014	Robles Teigeiro and Diaz	TM	X	X					OECD countries	Tourism industry
	Barajas et al.	TE		X					Galicia, Spain	2010 Pope visit to Santiago de Compostela 2010
	Huang et al.	TE		X					Shanghai	Three major sport events
	Khanal et al.	TE		X					Loa PDR	Tourism (industry)
	Sun and Wong	TE		X[f]					Taiwan	Hotels
	Soulie and Valle	TE			Inter-regional				Balearic Islands, Spain	Top (tourism) industries
	Sun and Pratt	TR			Environmental impacts			X	Taiwan	Chinese tourists
	Forsyth, Dwyer, and Spurr	AN						X	Australia	Mining boom

Year	Authors	Journal	Model						Region	Impact of
			Multiplier	I-O	Extended I-O	SAM	NLIO	CGE		
	Forsyth, Dwyer, Spurr, Pham	TM						X	Australia	Increase of tourism taxation
	Pratt	TE						X	Fiji	Currency devaluation
2015	Warnick et al.	TR	?	?[a]					Pioneer Valley and county area, USA	Westfield International Air Show
	Carrascal Incera and Fernández	TM				X			Galicia, Spain	Tourism
	Pham et al.	TE						X	Australia	Mining boom

a The method used to calculate the multiplier is not specified.
b Andrew (1997) combines the I-O model with linear programming, which is a method to achieve the best outcome (e.g. lowest costs or highest profit) in a mathematical model whose requirements are represented by linear relationships. The objective function is optimized under a set of constraints. In the study of Andrew (1997) output is maximized using values from a RIOT as constraints.
c West and Gamage (1997) use an I-O model based on marginal labour demand coefficients
d Daniels (2004) and Daniels et al. (2004) combine the results of I-O analysis with data regarding the occupational make-up of industries and average earnings per industry to illustrate how occupations categories (e.g. managerial and administrative, technical operations, sales and related) within industries are affected by tourism events.
e Sun (2007) discusses the stability of I-O coefficients.
f Sun and Wong (2014) discuss the stability of I-O coefficients.

2. Criteria for the selection of economic impact models of tourism[15]

2.1 Introduction

Visitors to a tourism destination spend money on buying goods and services, creating economic impacts. The resulting flow of currency into a destination's economy impacts value added, profit, income, tax income, employment and other output indicators – both directly and through secondary impacts (for example, Archer, 1982; Hórvath & Frechtling, 1999; Tyrell & Johnston, 2006). Several models are used to analyse these economic impacts of tourism. There are substantial differences between these models in the nature and precision of results, data demands, complexity and underlying assumptions. Models are, however, often selected without consideration of these differences (for example, Crompton, 2006; Dwyer et al., 2004; Sinclair & Sutcliffe, 1988). Clients (for example, policy makers or policy advisers), hiring experts to carry out analysis, may not be aware of these differences. Experts themselves (such as academics or consultants) often prefer working with a particular type of model, not taking full account of its appropriateness. The goal of this chapter is to provide an overview and evaluation of criteria that can be used to evaluate, compare and ultimately select a model (hereinafter 'criteria').

Specifically, we discuss criteria to select models for use in tourism economic impact analyses (EIAs). In an EIA, information about changes in tourist spending ('shocks to tourism demand') is used to calculate the total economy-wide impacts (direct and secondary). Dwyer et al. (2010) explain that a different type of analysis also exists: analysis of economic significance – 'the contribution that tourism-related spending makes to key economic variables such as GDP, household income, . . ., employment and so on'. Although both EIAs and significance analyses can contain a calculation of tourism's total economy-wide impacts, the focus of EIAs on impacts caused by changes in tourist spending makes it important to define criteria specifically for EIAs.

We begin by reviewing the relevant literature to generate a list of potentially relevant criteria. As described in the methodology section, the resulting list was presented to 34 experts, who were asked to judge the importance of each criterion. This enabled a prioritization and a list of 'essential criteria' to be established. These essential criteria are considered vital when choosing between models for EIAs. To illustrate the usage of the essential criteria they are applied to five models. The results of the expert interviews and the evaluation of the models are presented in the analysis and discussion. In the conclusions the main findings are summarized and recommendations are formulated.

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2.2 Literature review

In the literature very few explicit references to criteria can be found. An exception is Frechtling (1994a) who gives five broadly defined criteria: relevance, coverage, efficiency, accuracy and transferability. Another exception, Jansen (2008), mentions the criteria complexity, familiarity, relevance, reliability, level of details and completeness, costs, descriptive/predictive, and efficiency. The author specifies, with somewhat more detail, how these criteria can be implemented and used to select a model. Stynes (1997) does not explicitly mention criteria, but he does give a number of questions that can be asked to assess the quality of an EIA. Some of these questions can be interpreted as criteria when they relate to the selection of an appropriate model. Most of the questions, however, do not relate to the selection of a model but to the quality of its application (for example, making use of reliable and relevant data).

Textbooks about tourism economics such as The Economics of Tourism Destinations (Vanhove, 2011), Tourism Economics and Policy (Dwyer et al., 2010) and more general textbooks, such as Tourism Principles and Practice (Cooper et al., 2005), discuss reasons why economic impact models are (more or less) appropriate for specific applications. These reasons can be interpreted as criteria. There are also a limited number of articles in which two or more models for EIAs in tourism are described and compared. Bonn and Harrington (2008), Gasparino et al. (2008), Dwyer et al. (2004), Jansen (2008), Stynes (1997) and Zhou et al. (1997) are examples. As in the above mentioned books, these articles do not explicitly specify criteria, but the characteristics on which the models are compared can be considered as such. Lastly, there are many articles that give one or more reasons why models should be (further) developed (for example, Milne, 1987; Daniels, 2004; Daniels et al., 2004; Sinclair & Sutcliffe, 1982, 1988). These reasons, often formulated as criticisms of existing models, can also be interpreted as criteria. The conclusion is that there are many sources that contain – often implicitly – one or more criteria. In almost all cases, however, the emphasis is on the application of criteria. Sources of criteria are generally not specified or based on anecdotal evidence. This article extends the literature by focusing on establishing criteria and the assessment of their relative importance.

As a starting point, articles about EIAs, published in the past 10 years in the journals Annals of Tourism Research, Journal of Travel Research, Tourism Management and Tourism Economics, were checked for criteria. Next, references in these articles were used to find other relevant articles about EIAs (not limited to tourism). These articles were also checked. Lastly, other types of sources, such as textbooks, working papers and consultancy reports, were reviewed. This method does not guarantee a 100% complete list of criteria. Nonetheless, all efforts were made to arrive at a representative list.

Table 2.1 shows the criteria that were found, with a brief description of each criterion and references to the literature. Ten groups of criteria can be identified:

1. Efficiency: How much time and money is required to apply a model and can efficient use be made of existing data?
2. Data used as input into models: Are data consistent, reliable and up-to- date?
3. Comparability: Standardization (3A) of models (for example, assumptions, formulas) and definitions regarding input and results (for example, types of spending to include and definitions of output indicators such as income and employment) is a condition for comparability. The last two criteria in this group demand, to counterbalance standardization, an appropriate model (3F)

and appropriate definitions (3E) regarding input and output for the question and context of an EIA.
4. Transparency and simplicity.
5. Trust in models and their application. Validation (5C) and familiarity (5D) can be seen as ways to increase trust.
6. Sensitivity analyses.
7. Underlying assumptions.
8. Types of visitor spending of which models should enable a calculation of impacts.
9. Output-indicators and level of detail of results.
10. Externalities.

Many of the criteria are mentioned in more than one source: 36 are mentioned in at least four. Although this is a subjective delineation, the 16 remaining criteria, mentioned in three or fewer sources and marked with an 'X' in the final column of Table 2.1, can be considered less well-established in the literature. Standardization (3A), compare tourism destinations (3B), compare geographical levels (3C), and temporal comparison (3D) are mentioned in only two sources – Interprovinciaal Overleg (2009) and Tourism South East (2008). The explanation is that these two documents do not explicitly distinguish between criteria relevant for EIAs and criteria relevant for significance analyses. It can be expected that comparability is more relevant for significance analysis, where a temporal or geographical comparison is often required to arrive at meaningful conclusions. There are three sources – Jansen (2008), Stynes (1997), and Tyrell and Johnston (2006) – that mention the criteria transparent question and context (4A), transparent model and application (4D), transparent results (4E) and model understood by clients (4F). In contrast to many other sources, these publications focus on the application of EIAs in practical situations and the interpretation and usage of the results by clients. The criterion Model applied by non-experts (4G) is mentioned in only one source, Jansen (2008). The literature is, however, almost unanimous in saying this is not a desirable criterion; models should be applied by people who understand the (technical) details. Trust in model (5A) is mentioned in three sources – Jansen (2008), Tyrell and Johnston (2006) and Tourism South East (2008). The authors explain trust is a prerequisite for clients' acceptance of results of any (economic) analysis. Validation (5C), mentioned only in Tourism South East (2008), and Familiarity (5D), mentioned only in Jansen (2008), can be seen as ways to increase trust. Many other sources (for example, Crompton, 2006), however, criticize the selection of models only because they are familiar or have been validated. Crompton et al. (2001), Stynes (1997) and Tourism South East (2008) advocate taking spending on durable goods (8C) and spending by friends and relatives (8D) into consideration when these are relevant for a specific EIA (for example, when data or previous research have demonstrated their importance). Lastly, Loveridge (2004), Schaffer (1999) and Zhang (2002) mention the ability of models to show the spatial distribution of impacts (9N) as a relevant model characteristic, at least in certain applications of EIAs.

A final note regarding Table 2.1: Not all criteria can be used directly to select a model; some are related to the manner in which models are applied – for instance, based on reliable data (2B) or how reporting is being done – for instance, with transparent definitions (4B). These criteria (in italics) were kept in the list because their importance is strongly emphasized in the literature. The quality of an EIA not only depends on the selection of a model, but also on the quality of its application.

Table 2.1 Criteria identified from the literature

Nr.	Criteria	Description	Sources	≤3
1A	Cost-efficiency	The model should enable a cost-efficient EIA to be carried out	(e.g.) Blake, Gillham, & Sinclair, 2006; Dwyer et al., 2004; Egan and Nield, 2003	
1B	Time-efficiency	The model should enable a time-efficient EIA to be carried out	(e.g.) Baaijens et al., 1998; Fletcher, 1989; Jansen, 2008	
1C	Data-efficiency	The model should enable a data-efficient EIA to be carried out (optimal use of existing data)	(e.g.) Archer and Owen, 1972; Briassoulis, 1991; Zhou et al., 1997	
2A	Consistent data	The data (used as input into the model) should be consistent with the definitions and delineations used in the EIA, and the structure of the model	(e.g.) Interprovinciaal Overleg, 2009; Loveridge, 2004; Tyrell and Johnston, 2006	
2B	Reliable of data	The data (used as input into the model) should be reliable	(e.g.) Interprovinciaal Overleg, 2009; Mathieson and Wall, 1982; Tyrell and Johnston, 2006	
2C	Up-to-date data	The data (used as input into the model) should be of a recent date	(e.g.) Frechtling, 1994a; Jansen, 2008; Tyrell and Johnston, 2006	
3A	Standardisation	The structure of the model and the definitions and delineations used in the EIA should be standardised	Interprovinciaal Overleg, 2009; Tourism South East, 2008	X
3B	Compare tourism destinations	The model should enable a comparison of the results of an EIA with the results of EIAs carried out for other tourism destinations	Interprovinciaal Overleg, 2009; Tourism South East, 2008	X
3C	Compare geographical levels	The model should enable a comparison of the results of an EIA with the results of EIAs carried out on other geographical levels (local, regional, national)	Interprovinciaal Overleg, 2009; Tourism South East, 2008	X
3D	Temporal Comparison	The model should enable a comparison of the results of an EIA with the results of EIAs carried out for other time periods	Interprovinciaal Overleg, 2009; Tourism South East, 2008	X
3E	Appropriate definitions	The definitions and delineations used in the EIA should be appropriate for the question and context underlying the EIA	(e.g.) Blake, Gillham, & Sinclair, 2006; IP, 2009; Sinclair and Sutcliffe, 1982	
3F	Appropriate model	The structure of the model should be appropriate for the question and context underlying the EIA	(e.g.) Blake et al., 2001; Fletcher, 1989; Tyrell and Johnston, 2006	
4A	Transparent question / context	The question and context underlying the EIA should be explained	Jansen, 2008; Stynes, 1997; Tyrell and Johnston, 2006	X
4B	Transparent definitions	The definitions and delineations used in the EIA, should be explained	(e.g.) Crompton, 2006; Stynes, 1997; Tyrell and Johnston, 2006	
4C	Transparent choice of model	The choice of the model should be explained	(e.g.) Daniels et al., 2004; Sinclair and Sutcliffe, 1988; Tyrell and Johnston, 2006	
4D	Transparent model and application	The technical details of the model and its application should be made publicly available	Jansen, 2008; Stynes, 1997; Tyrell and Johnston, 2006	X
4E	Transparent results	The model should produce results that can be explained to and understood by clients	Jansen, 2008; Stynes, 1997; Tyrell and Johnston, 2006	X
4F	Understood by clients	The structure of the model should be simple enough to be explained to and understood by clients (non-experts)	Jansen, 2008; Stynes, 1997; Tyrell and Johnston, 2006	X

Nr.	Criteria	Description	Sources	≤3
4G	Applied by non-experts	The model should be simple enough to be applied by organisations/ persons not familiar with the technical details (non-experts)	Jansen, 2008	X
5A	Trust in model	Client should trust the model	Jansen, 2008; Tourism South East, 2008; Tyrell and Johnston, 2006	X
5G	Trust in application	Clients should trust the way the model is applied by the organisation / persons carrying out the EIA	(e.g.) Interprovinciaal Overleg; Loveridge, 2004; Tyrell and Johnston, 2006	
5C	Validation	The model should be scientifically / independently validated	Tourism South East, 2008	X
5D	Familiarity	Clients should be familiar with the model, because it has been applied (many times) before	Jansen, 2008	X
6A	Sensitivity analysis of definitions	The model should enable a sensitivity analysis to be carried out, to show the consequences of varying the definitions and delineations used in the EIA	Stynes, 1997	X
6B	Sensitivity analysis of model	The model should enable a sensitivity analysis to be carried out, to show the consequences of varying the structure of the model	(e.g.) Blake et al., 2003; Dwyer et al., 2004; Zhou et al., 1997	
7A	Production factors	In the calculations in the model it should be taken into account there can restrictions to the availability of production factors and there are (opportunity) costs related to their usage	(e.g.) Burgan and Mules, 2001; Crompton et al., 2001; Frechtling, 1994c	
7B	Prices	In the calculations in the model it should be taken into account prices can respond to shocks (flexible prices)	(e.g.) Copeland, 1991; Sugiyarto et al., 2003; Zhang, 2002	
7C	Dynamics	In the calculations in the model it should be taken into account not all impacts manifest themselves immediately. Calculation of impacts over time should be possible	(e.g.) Blake, 2006; Loveridge, 2004; Narayan, 2004	
7D	Disequilibrium / Market imperfections	In the calculations in the models it should be taken into account There can be disequilibrium on markets and market imperfections can have an influence on impacts	(e.g.) Blake, Gillham, & Sinclair, 2006; Briassoulis, 1991; Copeland, 1991	
7E	Scale economics	In the calculations in the models it should be taken into account (dis)economies of scale can have an influence on impacts	(e.g.) Briassoulis, 1991; Copeland, 1991; Sugiyarto et al., 2003	
8A	Spending in traditional tourism Ind.	The model should enable a calculation of the impacts of visitor spending in 'traditional tourism industries' (e.g. restaurants and hotels)	(e.g.) Archer and Owen, 1972; Cai et al., 2006; Crompton et al., 2001	
8B	Spending in all industries	The model should enable a calculation of the impacts of visitor spending in all industries selling to visitors (also outside of 'traditional tourism industries')	(e.g.) Cai et al., 2006; Crompton et al., 2001; Pao, 2005	
8C	Spending on durable goods	The model should enable a calculation of the impacts of visitor spending on durable goods (e.g. a holiday caravan or second home)	Crompton et al., 2001; Stynes, 1997; Tourism South East, 2008	X

Nr.	Criteria	Description	Sources	≤3
8D	Spending by friends and relatives	The model should enable a calculation of the impacts of spending by friends and relatives, done to cater for needs of visitors staying with them	Crompton et al., 2001; Stynes, 1997; Tourism South East, 2008	X
8E	Import substitution	The model should enable a calculation of the impacts of inhabitants' spending that, without the presence of tourism facilities, would have taken place outside the tourism destination	(e.g.) Crompton, 2001; Dwyer, Forsyth, & Spurr, 2006; West and Gamage, 2001	
8F	Crowding out	The model should enable a calculation of the impacts of inhabitants' spending 'crowded out' of the tourism destination as a consequence of tourism	(e.g.) Crompton et al., 2001; Dwyer, Forsyth, & Spurr, 2006; West and Gamage, 2001	
9A	Impact on production	The model should enable a calculation of the impact of visitor spending on production (output)	(e.g.) Bonn and Harrington, 2008; Copeland, 1991; Sugiyarto et al., 2003	
9B	Impact on value added	The model should enable a calculation of the impacts of visitor spending on value added	(e.g.) Dwyer, Forsyth, and Spurr, 2005; Heng and Low, 1990; West and Gamage, 2001	
9C	Impact on income	The model should enable a calculation of the impacts of visitor spending on inhabitants' personal income	(e.g.) Bonn and Harrington, 2008; Crompton, 2006; Stynes, 1997	
9D	Impact on profit	The model should enable a calculation of the impacts of visitor spending on proprietors' income and profit	(e.g.) Copeland, 1991; Frechtling, 1994a, Jansen, 2008	
9E	Impact on tax income	The model should enable a calculation of the impacts of visitor spending on government's tax income	(e.g.) Blake et al., 2001; Loveridge, 2004; Milne, 1987	
9F	Impact on employed persons	The model should enable a calculation of the impacts of visitor spending on the number of employed persons	(e.g.) Archer, 1984; Heng and Low, 1990; Sugiyarto et al., 2003	
9G	Impact on employed FTEs	The model should enable a calculation of the impacts of visitor spending on the number of employed FTEs and self-employed persons	(e.g.) Crompton et al., 2001; Daniels et al., 2004; Milne, 1987	
9H	Impact on job types	The (results of the) model should give insight into types of jobs created (e.g. different skill and wage levels)	(e.g.) Daniels et al., 2004; Loveridge, 2004; Zhang, 2002	
9I	Direct impacts	The model should enable a calculation of impacts resulting directly from visitor spending (direct impacts)	(e.g.) Archer, 1982; Baaijens et al., 1998; Egan and Nield, 2003	
9J	Indirect impacts	The model should enable a calculation of indirect impacts: Industries selling to tourists buy intermediary goods and production factors, which generates indirect impacts	(e.g.) Archer, 1982; Dwyer et al., 2007; Egan and Nield, 2003	
9K	Induced impacts	The model should enable a calculation of induced impacts: Visitor spending leads to increased income of households. This increases their spending, which generates induced impacts	(e.g.) Baaijens et al., 1998; Heng and Low, 1990; Milne, 1987	
9L	Impact per visitor category	The model should enable a calculation of the impact of visitor spending per category of visitors (e.g. different nationalities)	(e.g.) Archer, 1972; Bonn and Harrington, 2008; West and Gamage, 2001	
9M	Impact per industry	The model should enable a calculation of the impact of visitor spending per industry (e.g. agriculture, industry)	(e.g.) Bonn and Harrington, 2008; Daniels et al., 2004; Loveridge, 2004	

Nr.	Criteria	Description	Sources	≤3
9N	Spatial distribution of impacts	The (results of the) model should give insight into the spatial distribution of impacts throughout the tourism destination	Loveridge, 2004; Schaffer, 1999; Zhou et al., 1997	X
10A	Positive externalities	The (results of the) model should give insight into positive externalities: Tourism can e.g. lead to a wider array of goods and services to become available in a destination	(e.g.) Archer and Fletcher, 1996; Burgan and Mules, 2001; Dwyer et al., 2006	
10B	Negative externalities	The (results of the) model should give insight into negative externalities: Tourism can e.g. create congestion and pollution	(e.g.) Burgan and Mules, 2001; Copeland, 1991; Mathieson and Wall, 1982	

2.3 Methodology

Ideally, before selecting a model to be applied in an EIA, criteria are explicitly considered according to context. As a step towards this ideal, this chapter offers insights into the relative importance of the criteria. The list in Table 2.1 was presented to experts. They were asked to judge the importance of each criterion on a five-point Likert scale, with the options: −2: Irrelevant; −1: Not important; 0: Neutral (nice to have, but not vitally important); +1: Important; +2: Essential. As the interviews were carried out face-to-face or by telephone, experts had the opportunity to explain their choices. This enabled them to give, for example, more than one reason to judge the same criterion as 'essential', to describe relationships and trade-offs, to indicate in which situations criteria are more or less important, and to explain why they might think differently about the importance of criteria compared to the clients they are working for. At the start of the interview the open-ended question was asked about which criteria experts consider important and, at the end of the interview, which criteria should be added to the list. The objective of these questions was to check for any missing criteria. The choice was made to include experts from different backgrounds and different contexts of EIA application. This enables an analysis of differences in perspectives on criteria between different types of experts, based on the explanations they gave for their judgements.

The first round selection of experts was based on suggestions made by partners of the European SusTRIP programme. In SusTRIP (Sustainable Tourism Research Intelligence Partnership), partners from four countries worked together to strengthen the tourism industry through research. These partners were Visit Kent (UK), Comité Régional de Tourisme Nord-Pas de Calais (France), Westtoer (Belgium), NHTV University of Applied Sciences (Netherlands) and HZ University of Applied Sciences (Netherlands). Each partner was asked to name experts in the domain of tourism EIAs, who were contacted and interviewed. Next, each expert was asked to recommend other experts, who were interviewed in the second round.

In total 34 experts were interviewed. In the first round 35 experts were contacted, 26 of whom (74%) agreed to an interview. In the second round 19 experts were contacted, 8 of whom (42%) took part. Their nationalities were: Dutch, 17 (50%), British, 6 (18%), Belgian, 6 (18%), French, 3 (8%), Irish, 1 (3%) and Australian, 1 (3%). The experts were working for consultancy firms (11 experts, 32%), tourist marketing organizations (7 experts; 24%), universities (7 experts; 21%), scientific research

institutes (4 experts; 12%), national statistical institutes (3 experts; 8%), development corporations (1 expert; 3%) and regional governments (1 expert; 3%). 14 (41%) experts were categorized as academics; they were working for a university, scientific research institute, or national statistical institute. The other 20 experts (59%) were categorized as practitioners; they were working for a consultancy firm, tourist marketing organization, development corporation, or regional government[16]. 7 experts (21%) used EIAs to make policy decisions, 12 (35%) commission EIAs to be carried out, 13 (38%) study the phenomenon of EIAs, 25 (74%) produce EIAs themselves and 26 (77%) used EIAs to give advice (many experts fall into more than one category).

It is important to establish that the 'experts' were indeed qualified as such. 11 experts (including all experts working for universities) have published one or more scientific (internationally peer-reviewed) articles about impact analysis (not necessarily related to tourism) and/or economic aspects of tourism (not necessarily EIAs). Experts that did not fulfil this 'criterion' showed their expertise in other ways. Experts working for scientific research institutes had participated in at least three EIAs in tourism; experts working for a national statistical institute had participated in the creation of tourism specific statistics (such as a Tourism Satellite Account); experts working for a tourist marketing organization, development corporation or regional government had all participated in and/or commissioned at least three tourism EIAs.

Based on an analysis of the interview results, two levels of 'essential criteria' were determined. The first level contains criteria considered 'important' or 'essential' by at least 75% of experts. A majority of 75% provides sufficient evidence that a criterion is important in many (types of) EIAs. The second level contains criteria for which there is a statistically significant difference in opinion between academics and practitioners. Differences in opinion between experts can be regarded as equally important as agreement. Conflicting arguments given by (different types of) experts to consider criteria more or less important can be very useful when selecting criteria for a specific EIA. Therefore a choice was made not to aim for consensus among experts (for example, by applying a Delphi technique). In this chapter the analysis of differences in opinion is limited to the comparison of academics and practitioners, but the data would also enable comparisons to be made between other groups of experts.

The essential criteria were used to compare five models. Because this is meant as an illustration of the usage of criteria, five models were chosen that are often discussed in the literature: Export Base, Keynesian, Ad Hoc, Input–Output (I-O) and Computable General Equilibrium (CGE) models. Tourism satellite accounts and cost-benefit analyses were not included because they are distinctly different in both form and application (Dwyer et al., 2007). A tourism satellite accounts is a model used in tourism significance analysis. A cost-benefit analysis is broader than an EIA. In a cost-benefit analysis all impacts of a certain development are analysed, including social and environmental impacts. A second literature review was used to 'measure', based on arguments of other scholars, how well the five models 'perform' on the essential criteria. This should not be seen as a complete and final analysis of the models. It is, for example, based on only a subset of criteria. Also, models are evaluated in their most basic form and arguments of other scholars might depend on the specific type of EIA

16 Tourism marketing organizations conduct research, give advice and/or implement tourism marketing strategies. Scientific research institutes are closely related to a university, and often carry out commercially funded research. Development corporations support entrepreneurs of a region by influencing policy making, lobbying for funds, knowledge development and knowledge dissemination.

they consider (for example, an EIA on a specific spatial scale). The analysis still supports some useful conclusions about the overall usability of these models in EIAs of tourism.

2.4 Analysis and discussion

2.4.1 Results of the expert interviews

Table 2.2 shows experts' judgments of the criteria, only including criteria considered 'essential' or 'important' by at least 75% of the experts The criteria are ordered based on the fifth column; the sum of the percentage scores 'essential' and 'important'. Below, the motivation the experts provided for their judgements are briefly discussed, separately for each of the 10 groups of criteria:

1. Data efficiency (1C) scores highest of the three types of efficiency. Collecting primary EIA data consumes time and money. Models should therefore make optimal use of existing data.
2. All criteria from group 2, even though not directly useable to select a model, are included in Table 2.2. Using consistent (2A), reliable (2B) and up- to-date (2C) data is considered a basic condition for quality of EIAs.
3. The experts confirmed that comparability is vital for significance analysis, but usually somewhat less important for EIAs. Exceptions are, for example, EIAs used to compare alternative investment proposals. Some experts advocated standardization (3A), as a requirement for both comparability and efficiency. However, if standardized definitions and models are not appropriate for the specific context and question, it is necessary to make adjustments and work towards appropriate definitions (3E) and an appropriate model (3F).
4. Experts argued that the model should produce transparent results (4E) but also the model itself should not be unnecessarily complex. It should be accepted that a model is always a simplification and complex models easily lead to mistakes. Some experts emphasized that limiting complexity is not more important than arriving at appropriate results. No matter how simple or complex the analysis, being – to a certain degree – transparent about the models and its application (4D) is important. When clients understand the model, it can lead to better decisions.
5. Trust in the model (5A) and its application (5B) are important preconditions for clients' acceptance and usage of results, whereby long-term trust in organizations/people applying models can persist only if they are known to carry out objective analyses.
6. Although sensitivity analysis can be important when developing new models, experts were generally not in favour of carrying these out for individual EIAs. There can be exceptions, such as EIAs that are based on two almost equally valid assumptions, but clients usually prefer to get one single outcome, not a range of possibilities.
7. Criteria from group 7, related to assumptions, are not included in the important criteria in Table 2.2. Experts explained that whether assumptions can or cannot be justified depends on the context underlying a specific EIA. A general comment from the experts is that increasing realism introduces more complexities and data demands.
8. Of the experts, 97% considered it important or essential that models enable calculation of impacts of spending in traditional tourism industries (8A). The possibility of calculating impacts of spending in all industries (8B) did not score much lower – 89%.

9. Employment – both measured in employed persons (9F) and FTEs (9G) – was an output-indicator that is 'top-of-mind' for policy makers. Also impact on value added (9B) was considered important, even though the concept can be confusing for non-experts. The ability of models to show impact on tax- income (9E) can be a strong argument towards the public sector. Ninety-four per cent of experts considered it essential that models enable calculation of direct impacts (9I), followed (at some length) by indirect impacts (9J) and induced impacts (9K). The concepts induced, and to a lesser degree, indirect impacts can be difficult to understand for non-experts and calculations can quickly become complex. Furthermore, mistakes made in the calculation of the direct impacts are multiplied in the calculation of indirect and induced impacts, making it vital that the first calculation is correct. The subdivision of impacts per visitor category (9L) is relevant information for many policy decisions.
10. Lastly, in many EIAs it is important to mention externalities but it is, according to many experts, sufficient when this is done in a qualitative way ('outside the model'). Some experts, however, were of the opinion that increasing interest in externalities makes it more important to quantify them, to avoid over- or underestimation.

A Mann–Whitney U test[17] was used to determine for which criteria significantly ($\alpha < 0.05$) different judgments were given by academics and practitioners (Table 2.3). Criteria with high U-values are valued differently by academics and practitioners. Experts provided explanations for the differences:

Efficiency (group 1) is very relevant in a practical setting. In an academic setting more time and money might be available to do research, enabling more sophisticated analysis.

For practitioners, comparability and standardization (group 3) are often strong requirements. Standardization was seen as a way to achieve comparability, efficiency and to increase trust of clients. Many academics were critical of possibilities to compare results, when, for example, under- lying tourism statistics are inconsistent. They often were more concerned with conducting EIAs in the most appropriate way at a particular location and at a particular moment, independent of how other EIAs had been carried out.

Differences in opinion about transparency (group 4) were not easily explained based on the explanations of the experts.

The differences in valuation of disequilibrium and market imperfections (7D) and negative externalities (10B) can be explained, however. These considerations are academically challenging and increase realism. Practitioners were less in favour, given the additional complexities and data demands.

Clients of EIAs often prefer a single outcome. This explains why practitioners were less interested in sensitivity analysis (group 6). For academics, sensitivity analyses were an important tool to determine robustness of models.

Impact on employed FTEs (9G) and impact per visitor category (9L) score highly among all experts (see Table 2.2); practitioners valued these even higher than academics because it is information often explicitly requested by policy makers.

17 A non-parametric test was used because the dependent variable (importance of criteria as judged by experts) is ordinal and the dataset is not big enough to assume a normal distribution. Because the data contains many 'ties' (experts that assign the same value to criteria) a correction was made to the standard formulas of the Mann–Whitney U test.

Table 2.2 Criteria judged 'Essential' or 'Important' by at least 75% of experts

Rank	Criteria	Essential	Important	Sum
1	Direct impacts (9I)	94%	6%	100%
2	Transparent results (4E)	88%	12%	100%
3	Spending in traditional tourism industries (8A)	91%	6%	97%
4	Reliable data (2B)	85%	12%	97%
5	Impact on value added (9B)	79%	18%	97%
6	Impact on employed persons (9F)	85%	9%	94%
7	Transparent definitions (4B)	76%	18%	94%
8	Impact per visitor category (9L)	79%	12%	91%
9	Transparent question / context (4A)	76%	15%	91%
10	Consistent data (2A)	65%	26%	91%
11	Spending in all industries (8B)	74%	15%	89%
12	Impact on employed FTEs (9G)	79%	9%	88%
13	Trust in application (5B)	45%	42%	87%
14	Data-efficiency (1C)	62%	24%	86%
15	Trust in model (5A)	39%	45%	84%
16	Transparency choice of model (4C)	62%	21%	83%
17	Appropriate definitions (3E)	50%	32%	82%
18	Up-to-date data (2C)	44%	38%	82%
19	Impact on tax income (9E)	41%	41%	82%
20	Transparent model and application (4D)	48%	33%	81%
21	Compare tourism destinations (3B)	56%	24%	80%
22	Impact on production (9A)	50%	29%	79%
23	Cost-efficiency (1A)	47%	32%	79%
24	Appropriate model (3F)	32%	47%	79%
25	Temporal comparison (3D)	65%	13%	78%
26	Time-efficiency (1B)	45%	33%	78%
27	Indirect impacts (9J)	53%	24%	77%
28	Standardisation (3A)	50%	26%	76%

Source: Own calculations

The expert interviews were used to check the completeness of Table 2.1. The experts were asked, at the start of the interview, what criteria they could mention themselves and, at the end of the interview, to suggest additional criteria. When comparing their answers to the second column of Table 2.1, all but five criteria in this Table were mentioned by at least one expert. The exceptions were

applied by non-experts (4G), disequilibrium/market imperfections (7D), scale economics (7E), import substitution (8E) and impact on job types (9H). Apparently, these criteria are not 'top-of-mind' for experts. Some experts suggested criteria not yet included in the list. First, in group 5 (trust) some experts said that, although objectivity remains a condition for long-term trust, clients sometimes use as an (implicit or explicit) criterion that model results should not harm their interests. EIAs are often used to convince other people (for example, the government) of the value of tourism. Thus, clients have an interest in presenting significant economic impacts. Second, in group 7, some experts added that models should take into account both the demand and supply side of tourism (for example by taking appropriate account of the possibility of increasing occupancy rates to accommodate an increase in tourism demand). Third, in group 10, experts mentioned some additional output indicators: impact on sales (not the same as production), balance of payments, wellbeing and entrepreneurship. Lastly, some experts mentioned the need for models to enable insight into the spatial distribution of impacts inside and outside the region: Which positive and negative impacts remain in the relevant region and which impacts 'leak out'? The overall conclusion is that (as expected) additional criteria can be added to Table 2.1. This creates opportunities for additional research. Still, almost all of the criteria in Table 2.1 were mentioned by the experts in the open-ended question at the start of the interview and the limited number of additional criteria proposed suggests Table 2.1 contains the most essential criteria.

Table 2.3 Differences in opinion between practitioners and academics

Criteria	Valued highest by	U	Z	α
Impact on employed FTEs (9G)	Practitioners	88,500	-2.555	0.011
Compare tourism destinations (3B)	Practitioners	88,000	-2.022	0.043
Impact per visitor category (9L)	Practitioners	85,500	-2.703	0.007
Compare geographical levels (3C)	Practitioners	84,500	-2.187	0.029
Sensitivity analysis of definitions (6A)	Academics	83,500	-2.054	0.040
Disequilibrium / market imperfections (7D)	Academics	84,000	-2.049	0.040
Transparent question / context (4A)	Academics	84,000	-2.644	0.008
Standardisation (3A)	Practitioners	83,000	-2.159	0.031
Transparent model and application (4D)	Practitioners	80,500	-1.980	0.048
Negative externalities (10B)	Academics	80,000	-2.180	0.029
Sensitivity analysis of model (6B)	Academics	76,500	-2.283	0.022
Cost-efficiency (1A)	Practitioners	71,500	-2.589	0.010
Time-efficiency (1B)	Practitioners	71,000	-2.339	0.019
Temporal comparison (3D)	Practitioners	57,000	-2.814	0.005

Source: Own calculations

2.4.2 Essential criteria

Table 2.4 includes criteria considered 'essential' or 'important' by at least 75% of experts (Table 2.2) and criteria over which there are significant differences in opinion between academics and practitioners (Table 2.3). Criteria that belong to both groups are included only once. Some of the criteria, included in italics in Table 2.1, cannot directly be used to compare models. These are excluded from Table 2.4. The remaining 24 criteria are called 'essential criteria' from now on. They are considered most vital.

Table 2.4 Essential criteria

Rank	Criteria	Rank	
1	Direct impacts (9I)	13	Impact on production (9A)
2	Transparent results (4E)	14	Cost-efficiency (1A)
3	Spending in traditional tourism industries (8A)	15	Appropriate model (3F)
4	Impact on value added (9B)	16	Temporal comparison (3D)
5	Impact on employed persons (9F)	17	Time-efficiency (1B)
6	Impact per visitor category (9L)	18	Indirect impacts (9J)
7	Spending in all industries (8B)	19	Standardisation (3A)
8	Impact on employed FTEs (9G)	20	Compare geographical levels (3C)
9	Data-efficiency (1C)	21	Negative externalities (10B)
10	Trust in model (5A)	22	Sensitivity analysis of model (6B)
11	Impact on tax income (9E)	23	Sensitivity analysis of definitions (6A)
12	Compare tourism destinations (3B)	24	Disequilibrium / market imperfections (7D)

Source: Own calculations

When Table 2.4 is compared to Table 2.1, it can be noted that of the 16 criteria that were considered less well established in the literature (marked with an X in the final column of Table 2.1) there were seven that were nonetheless included in the essential criteria: standardization (3A), compare tourism destinations (3B), temporal comparison (3D), transparent question/ context (4A), transparent model and application (4D), transparent results (4E) and trust in model (5A). This confirms the earlier conclusion that, although standardization and comparability are regarded as more important for significance analysis, practitioners in particular still value these criteria. Even though transparency of models and their application is not emphasized in the literature, it is regarded as very important by experts (both practitioners and academics). As can be seen in Table 2.2, transparent results (4E) is indeed the second highest ranked criteria overall (only topped by direct impacts). Transparency is vital when the results are used to make or influence policy decisions. The importance of trust in model (5A) can be seen in the same light.

To illustrate the usage of the 24 essential criteria they will be applied to five well-known models, which are introduced in the section below.

2.5 Models

In the literature on EIAs in tourism, five models are often discussed: export base models, Keynesian models, ad hoc models, I-O and CGE models. As is also discussed below, many different variants of these models have been developed and applied. The goal here, however, is to illustrate how the essential criteria may be applied. Therefore we apply the criteria to the models in their most basic form. The essential criteria could of course also be used to evaluate further developed models.

2.5.1 Export base models

When applying an export base model, industries in the economy are divided into basic and non-basic. Basic industries produce for markets outside the region and bring in new money. Non-basic activities produce for local markets and redistribute money throughout the region. New income from basic activities generates a multiplying process through basic activities. The tourism industry is thereby considered to be basic (for example, Archer, 1982; Egan & Nield, 2003; Loveridge, 2004). An important assumption underlying export base models is that there are no resource limitations; 'no scarcity of production factors'. This means that increases in visitors' spending always lead to positive economic impacts. There are no negative feedback effects caused by redistribution of production factors and price changes (Copeland, 1991; Egan & Nield, 2003; Dwyer et al., 2004). In addition to 'no scarcity of production factors', export base models also assume that: (1) Basic sales have the same multiplier effect regardless of industry source (Cooper et al., 2005; Heijman et al., 2002; Loveridge, 2004); (2) Economic growth is attributable solely to export (Schaffer, 1999). Applying export base models to calculate impacts of tourism involves the following steps (Schaffer, 1999; Loveridge, 2004):

- Determine how output (or for example, income, employment) is divided between basic and non-basic.
- Develop a ratio of total to basic output to estimate an export base multiplier.
- Calculate tourism's output.
- Apply the multiplier to tourism's output to obtain total impacts.

In some applications of export base models, the proportion of each industry that can be considered basic is determined based on location quotients. In other applications, econometric estimates of relationships between basic and non-basic industries are made (Schaffer, 1999; Loveridge, 2004).

2.5.2 Keynesian models

A Keynesian model can be used to analyse impacts of inflows of money into a tourism destination. The reasoning is that inflows lead to income for inhabitants and companies. These inhabitants and companies then increase consumption and savings (Schaffer, 1999). Consumption leads to a second round increase in income, which translates again into saving and consumption. This process continues in successive rounds. In each round, leakages (money that is saved, paid as taxes or spent on imports) decrease effects. The sum of partial effects is (Archer, 1982; Schaffer, 1999; Pao, 2005)

$$\Delta X = \frac{(1 - L) \cdot \Delta Y}{1 - C \cdot (1 - T) + M}, with\ multiplier\ k \qquad (2.1)$$

$$= \frac{1}{1 - C \cdot (1 - T) + M}$$

where ΔY is the shock to output, C is the marginal propensity to consume, T is the tax rate, M is the share of income spent on foreign goods, and (1 - L) is the capture rate. Applying basic Keynesian models to calculate impacts of tourism involves the following steps (Schaffer, 1999):

- Determine the values for L, C, M, and T and calculate the multiplier.
- Calculate tourism's output.
- Apply the multiplier to tourism's output to obtain total impact on output.

Keynesian models can be brought closer to reality, for example, by modelling first round leakages tailored to the nature of the initial shock and including propensity values that are different for the short and long term (Gasparino et al., 2008; Sinclair & Sutcliffe, 1982, 1988).

2.5.3 I-O models

In I-O models, which are in essence Keynesian systems incorporating production of intermediary goods (Zhang, 2002), I-O tables are used to describe inter-industry relationships among industries. By tracing flows of spending associated with final sales back through these industries, the I-O model allows the direct and secondary impacts to be estimated.

Besides the assumption 'no scarcity of production factors', there are additional assumptions underlying I-O models (for example, Bonn & Harrington, 2008; Briassoulis, 1991; Fletcher, 1989). On the consumption side, households must maintain the same division between types of goods they buy and, on the production side, linearity and homogeneity are assumed. Linearity means firms can only change production levels by buying inputs from the same suppliers in the same proportion. Homogeneity means that firms cannot increase output of one product unless they proportionally increase output of all other products. I-O models also assume firms in each industry employ the same technology to produce identical products. In most applications the functioning of labour markets is also simplified (for example, Crompton et al., 2001; Daniels, 2004; Dwyer et al., 2004). All jobs created are new jobs and there are no productivity changes, wages are fixed, no commuters from outside the region are hired, there is no seasonality, and there are no differences between skilled/unskilled work and no people holding multiple jobs. Applying an I-O model to calculate impacts of tourism involves the following steps (for example, Fletcher, 1989; Hórvath & Frechtling, 1999; Miller & Blair, 2009):

- Use an I-O table to calculate the output multipliers[18] contained in a Leontief inverse matrix.

18 Based on an input–output (IO) table, different types of multipliers can be calculated: Keynesian multipliers (to be multiplied by visitor spending), ratio multipliers (to be multiplied by direct impacts), transactions, output, income, employment and tax income multipliers and multipliers including or excluding induced impacts (for example, Miller & Blair, 2009).

- Calculate tourism's output: An (n x 1) vector of 'final tourist demand (direct output)', with n equal to the number of industries in which visitors spend their money.
- Multiply the Leontief inverse matrix with the matrix of 'final tourist demand' to obtain total impacts on output.

It is possible, through adjustment and extensions, to relax some of the assumptions. Wanhill (1988) and Fletcher (1989) show, for example, that capacity constraints can be included in the analysis; Daniels (2004) and Daniels et al. (2004) extend I-O models with occupation based modelling, West and Gamage (2001) develop a non-linear I-O model and Cai et al. (2006) extend I-O model with linkage analysis. In the literature (for example, Wagner, 1997; Dwyer et al., 2010) models are also discussed that, although similar in structure to I-O models, are based on Social Accounting Matrices (SAMs) instead of I-O tables. Besides the information contained in an I-O table, a SAM also reveals details about the transfer of money between industries and institutions and includes market and non-market financial flows. Thus, multipliers based on a SAM account for the distributional consequences of 'shocks to final demand' and allow for a more detailed calculation of secondary impacts. Although these adjustments and extensions do not give I-O models the same level of sophistication as CGE-models (Dwyer, Forsyth, & Spurr, 2006), they bring them closer to reality.

2.5.4 Archer's ad hoc model

As a solution to high data demand of I-O models, Archer and Owen (1972) developed a model, based on a combination of Keynesian theory and a limited I-O model, focusing on industries considered most relevant to tourism. The basic ad hoc model has since been reworked, improved, tested and applied on many occasions, and is well documented in the literature (for example, Milne, 1987).

2.5.5 CGE models

In general eqilibrium (GE) models the assumption 'no scarcity of production factors' underlying the four previous models is removed. As a result, some output gains – potentially induced by multiplier effects – are dampened by price increases. Furthermore, production factors may reallocate across industries. Economies are considered integrated wholes, in which many feedback mechanisms operate (for example, Adams & Parmenter, 1995; Copeland, 1991; Dwyer et al., 2004):

- Price changes make goods, services and production factors more or less expensive to buy.
- Making production factors available for an activity means that alternative activities have fewer resources.
- When consumers spend on new activities they divert spending away from other goods.
- Governments can spend money, but to do so they must raise taxes (or debt) meaning that other actors in the economy can spend less.
- Markets may not perform well; market imperfections can, for example, lead to unemployment.

Underlying GE models is reasoning that, because of feedback effects, a change in final demand results in a change in the pattern of economic activity that may or may not be accompanied by an increase in overall economic activity (Dwyer et al., 2004).

GE-models come in many forms, differing in model structure, complexity, and assumptions. In general, however, they can be seen as extended I-O models, with explicit demand groups (such as households), markets for goods, services and production factors (each with its own set of economic rules) and links between markets (for example, Blake et al., 2001; Pao, 2005; Zhang, 2002). Increasingly, computable general equilibrium (CGE) models are also available. These models can be used to simulate and calculate economy-wide impacts of shocks such as tax changes or exogenous demand changes (for example, Dwyer et al., 2007; Narayan, 2004).

2.6 Scores of models on the essential criteria

In Table 2.5 arguments given by other scholars are used to compare the models regarding each of the 24 essential criteria. Some closely related essential criteria (such as direct and indirect impacts) are discussed under one header. In Table 2.6 arguments from Table 2.5 are used to determine, for each criterion separately, which model is the first or second choice preference.

An important consideration is that some advantages and disadvantages, as presented in general terms in Table 2.5, in reality depend on the context. Low data-efficiency (1C) of CGE-models, for example, can be exaggerated at a regional or local level, because more of the data needed is not available in these contexts; the scores of models on comparability and appropriateness depend on which models are applied in EIAs to which the results will be compared, and the structure of the local economy respectively.

Table 2.5 Scores of models on essential criteria

Efficiency: data, time, cost (Group 1)	
All models	Time- and cost-efficiency depend, to a large degree, on the amount of data-collection needed (data-efficiency).
Ex. base	Less data is required than for the other models and the data needed to calculate the export base multiplier is usually available in existing statistics. The change in visitor spending needs to be known (Loveridge, 2004; Schaffer, 1999).
Keynes	A substantial amount of data is needed, but still less than for I-O / CGE models. The change in visitor spending needs to be known (Gasparino et al., 2008; Sinclair & Sutcliffe, 1982).
Ad hoc	A substantial amount of data is needed, but still less than for I-O / CGE models. The change in visitor spending needs to be known (e.g. Archer & Owen, 1972; Baaijens et al., 1998; Milne, 1987).
I-O	Creating an I-O table is cost- and time-consuming. The change in visitor spending needs to be known, subdivided per industry (e.g. Fletcher, 1989; Hórvath & Frechtling, 1999; Wagner, 1997).
CGE	Creating a SAM, the basis of a CGE-model, is cost- and time-consuming. When a CGE and I-O model are both available time, money and data demands of applying them are much the same. The change in visitor spending needs to be known, subdivided per industry (e.g. Dwyer et al., 2004; Sugiyarto et al., 2003; Zhou et al., 1997).
Standardisation and comparability (Group 3)	
Ex. Base / Keynes / Ad hoc / I-O	The basic structures of these models are well established and can be seen as standardised. Different variants of the basic models have been developed, which reduces comparability (e.g. Briassoulis, 1991; Milne, 1987; Sinclair & Sutcliffe, 1982).
Ex. Base / Ad hoc	Subjective choices need to be made about which industries to include as basic, reducing standardisation and comparability (Loveridge, 2004).
I-O / Ad hoc	I-O models and Ad hoc models are the predominant models used in EIAs in tourism. The chance that results of EIAs can be compared to those of other EIAs increases if one of these models is applied (e.g. Archer, 1995; Dwyer et al., 2004; Fletcher, 1989).
CGE	CGE-models are extensively used to estimate impacts, in applications across many industries. In tourism CGE models are also used, but until now to a lesser degree. CGE-models are not standardised; they come in many shapes, differing substantially in e.g. model structure, complexity, and assumptions (e.g. Blake et al., 2003; Copeland, 1991; Dwyer et al., 2004).
Appropriateness of model (Group 3)	
Ex. Base / Keynes / Ad hoc / I-O	These models are appropriate to trace the impacts of specific 'economic shocks', in a one-way deterministic system. They show short-run impacts in certain industries, and they are based on strong assumptions. Through adjustments and extensions some assumptions can be relaxed (e.g. Archer, 1982; Blake et al., 2001; Fletcher, 1989).
CGE	CGE-models can be used for 'what if' simulations: Initial 'economic shocks' can originate anywhere in the economy and can be anything that occurs in an economy (e.g. population growth, demand and policy changes). CGE-models are appropriate in many situations; the structure and assumptions can be adjusted to the question and context underlying the EIA (e.g. Blake et al., 2006; Loveridge, 2004; Sugiyarto et al., 2003).
Transparent results (Group 4)	
Export base / Keynes / Ad hoc / I-O	Predictable results: Increases in visitor spending lead to positive impacts. The technical details and limitations of these models are not always completely understood, which can lead to wrong interpretations (e.g. Archer, 1982; Dwyer et al., 2004; Hórvath & Frechtling, 1999).
CGE	Unpredictable results: Increases in visitor spending do not necessarily lead to positive impacts. Results are not always what clients expect or are hoping for. The results can be less transparent and difficult to explain (e.g. Dwyer et al., 2004; Jansen, 2008; Sugiyarto et al., 2003).
Trust in model (Group 5)	
Ex. Base / Keynes / Ad hoc / I-O	Development and applications of these models are well documented in the literature (Schaffer, 1999; Sinclair & Sutcliffe, 1982).

Ad hoc / I-O	Ad hoc and I-O models have been applied many times (in general and specifically in tourism) and score high on familiarity, which contributes to trust (e.g. Archer, 1995; Horváth & Frechtling, 1999; Zhang, 2002).
CGE	CGE-models are still a relatively new development in tourism (Sugiyarto et al., 2003).
Sensitivity analysis of model and definitions (Group 6)	
All models	All models offer possibilities for sensitivity analysis. The consequences of changing the definitions and delineations used in the EIA can be shown, e.g. the consequences of including (or not) certain types of visitor spending. I-O and especially CGE-models are more flexible; they offer most possibilities for sensitivity analysis.
Ex. Base / Keynes / Ad hoc / I-O	The (implicit) assumptions of these models are highly stylized. The possibilities for sensitivity analyses regarding the structure of the model are limited (Dwyer et al., 2004; Dwyer et al., 2005; Dwyer, Forsyth, & Spurr, 2006).
CGE	Compared to the other models CGE-models are most comprehensive, hence more assumptions must be (explicitly) made: Behavioural assumptions (e.g. elasticities) and production assumptions (e.g. scale economies). These assumptions can however be made transparent and sensitivity can be tested (e.g. Adams & Parmenter, 1995; Blake et al., 2003; Dwyer et al., 2004).
Disequilibrium / market imperfections (Group 7)	
Ex. Base / Keynes / Ad hoc / I-O	These models typically assume equilibrium between demand and supply of goods and services and perfect competition (e.g. Archer, 1982; Jansen, 2008; Schaffer, 1999).
CGE	CGE-models enable disequilibrium and market imperfections to be taken into consideration. Most CGE-models however assume equilibrium of supply and demand on all markets (e.g. Copeland, 1991; Sugiyarto et al., 2003; Zhou et al., 1997).
Spending in traditional tourism industries / in all industries (Group 8)	
Keynes	In (basic) Keynesian models industries are not explicitly recognised (Schaffer, 1999).
Ex Base / Ad hoc	Export base and ad hoc models are based on an average multiplier for a selection of industries. If visitor spending takes place in industries outside the traditional tourism industries, it might therefore be impossible to calculate the impacts (Baaijens et al., 1998; Milne, 1987).
I-O	If the distribution of visitor spending over industries is known, no matter if these industries belong to traditional tourism industries or not, an I-O model can be used to calculate the impacts. The impacts can be shown per industry (Fletcher, 1989; West and Gamage, 2001).
CGE	CGE-models can be used to calculate the impacts of 'shocks' originating anywhere in the economy, inside or outside traditional tourism industries. Impacts can be shown per industry (Blake et al., 2001; Dwyer et al., 2007; Narayan, 2004).
Direct and indirect impacts (Group 9)	
All models	The purpose of all five models is to calculate the total of direct and secondary impacts. If interest is only in direct impacts it is not necessary to apply them (Frechtling, 1994a)
Ex. Base / Keynes / Ad hoc	These models enable a calculation of indirect impacts. The realism of the results is however doubtful, because inter-industry linkages are not explicitly modelled (e.g. Archer & Owen, 1972; Heijman et al., 2002; Milne, 1987).
I-O	I-O models are based on explicit inter-industry linkages, leading to more realistic results and a deeper understanding. Indirect impacts can be shown per industry (e.g. Archer & Fletcher, 1996; Hórvath & Frechtling, 1999; Loveridge, 2004).
CGE	CGE-models produce detailed and realistic results. Indirect impacts are however not calculated separately. They are included among the total impacts. A CGE-model is capable of showing that industries directly or indirectly affected by tourism gain from increased visitor spending while other industries reduce output (e.g. Adams & Parmenter, 1995; Copeland, 1991; Narayan, 2004).
Impact on employment (Group 9)	
All models	For all five models an accurate / realistic assessment of employment impacts can be difficult because of issues such as seasonality, part-time jobs, and people holding multiple jobs (Briassoulis, 1991; Dwyer et al., 2005; Dwyer, Forsyth, & Spurr, 2006).

Ex. Base / Keynes / Ad hoc	These models enable a calculation of direct and secondary impacts on employment (persons / FTE). Additional structures, with additional assumptions, complexities, and data demands, might be needed (Frechtling, 1994b; Horváth & Frechtling, 1999; Schaffer, 1999).
I-O	I-O models enable a calculation of direct and secondary impacts on employment (persons / FTE). These impacts can be shown per industry. In (basic) I-O models the labour market is presented in a simplified manner (e.g. Archer & Fletcher, 1996; Daniels, 2004; Heng & Low, 1990)
CGE	CGE-models enable a calculation of direct and secondary impacts on employment (persons / FTE). These impacts can be shown per industry. In CGE-models more realistic assumptions can be used regarding the functioning of the labour market (e.g. Tourism South East, 2008; Zhang, 2002; Zhou et al., 1997).
Impact on value added, tax income and production (Group 9)	
Ex. Base / Keynes / Ad hoc	These models enable a calculation of direct and secondary impacts on value added, tax income, and production. Additional structures might be needed (Frechtling, 1994b; Schaffer, 1999).
I-O	I-O models enable a calculation of direct and secondary impacts on value added, tax income, and production. The results can be shown per industry (e.g. Archer & Fletcher, 1996; Heng & Low, 1990; Hórvath & Frechtling, 1999).
CGE	CGE-models enable a calculation of direct and secondary impacts on value added, tax income, and production. The results can be shown per industry. More realistic assumptions can be used (e.g. Blake et al., 2003; Schaffer, 1999; Zhou et al., 1997).
Impact per visitor category (Group 9)	
All models	All five models enable a calculation of impacts per visitor category; under the condition information is available on spending per visitor category.
I-O / CGE	I-O- and CGE-models enable the distribution of visitor spending over industries, which might be different per category of visitors, to be fed directly into the models. This enables a more detailed analysis of the impacts per visitor category (Briassoulis, 1991; Frechtling, 1994b; Heng & Low, 1990).
Negative externalities (Group 10)	
All models	In their basic form none of the models give insight into negative externalities. In the literature some further developed (I-O / CGE) models are described which are suited for this (Gasparino et al., 2008; Sugiyarto et al., 2003).

Table 2.6 Scores of models on essential criteria

Rank	Criteria	Export base	Keynes	Ad hoc	I-O	CGE
1	Direct impacts (9I)					
2	Transparent results (4E)	1st	1st	1st	2nd	
3	Spending in traditional tourism industries (8A)				2nd	1st
4	Impact on value added (9B)				2nd	1st
5	Impact on employed persons (9F)				2nd	1st
6	Impact per visitor category (9L)				2nd	1st
7	Spending in all industries (8B)				2nd	1st
8	Impact on employed FTEs (9G)				2nd	1st
9	Data-efficiency (1C)	1st	2nd	2nd		
10	Trust in model (5A)	2nd	2nd	1st	1st	
11	Impact on tax income (9E)				2nd	1st
12	Compare tourism destinations (3B)			2nd	1st	
13	Impact on production (9A)				2nd	1st
14	Cost-efficiency (1A)	1st	2nd	2nd		
15	Appropriate model (3F)				2nd	1st
16	Temporal comparison (3D)			2nd	1st	
17	Time-efficiency (1B)	1st	2nd	2nd		
18	Indirect impacts (9J)	2nd	2nd	2nd	1st	
19	Standardisation (3A)	2nd	1st	2nd	1st	
20	Compare geographical levels (3C)			2nd	1st	
21	Negative externalities (10B)					
22	Sensitivity analysis of model (6B)				2nd	1st
23	Sensitivity analysis of definitions (6A)				2nd	1st
24	Disequilibrium / market imperfections (7D)					1st

1st: The model is the 1st choice preference on this criterion
2nd: The model is the 2nd choice preference on this criterion
Blank cell: A model is not the 1st of 2nd choice preference on this criterion

In Table 2.6 it can be seen that, if interest is only in a calculation of direct impacts (9I) – the number one criterion – none of these five models is preferred. Although the information contained in an I-O or SAM table can be useful, calculation of direct impact only does not require the application of any of the five models. Correctly estimating the change in visitor spending, and then making the translation to direct impacts in terms of changes in value added, profit, (tax) income, and employment, is nonetheless a very important first step in impact analysis. There is no preferred choice of a model on the criterion of negative externalities (10B). Although it is not impossible, with

additional structures, to use the models (for example, I-O or CGE) to calculate negative externalities, this does not apply to the models in their basic form.

Table 2.6 also shows that, because of their more realistic assumptions, CGE- models are the preferred choice according to many criteria. However, they do not 'score' high on transparency, efficiency and comparability. Keynesian, export base and ad hoc models offer advantages for these criteria, but the realism of their results is limited. For many of the criteria, I-O models are an 'in-between' option. From this the conclusion can be drawn that, with awareness of their obvious shortcomings, I-O models seem to offer good potential for application in a tourism context. Extensions to I-O models, to relax some of their strong assumptions and bring them closer to reality, could make them even more 'ideal' for application to EIAs in tourism. Developing I-O models in the direction of CGE-models by, for example, introducing price effects, substitution effects or limited budgets thus shows promise. The challenge is, however, to maintain a balance between the added value in terms of more realism and detail of results and additional complexities and inefficiencies (data, time, money) that are introduced. An 'ideal model' for many applications of EIAs in tourism could be found somewhere in between I-O- and CGE-models.

2.7 Conclusions

This chapter provides an overview and evaluation of criteria that can be used to evaluate, compare and select an appropriate model for EIAs in tourism. Of the list of 52 potentially relevant criteria that were found in the review of the literature, 24 are seen as essential criteria. This selection includes criteria that are considered 'essential' or 'important' by at least 75% of experts and criteria on which there are significant differences in opinion between academics and practitioners. The essential criteria were used to compare five models. CGE- models offer realistic results, but are not preferred on criteria related to transparency, efficiency and comparability. Export base, Keynesian and ad hoc models score high on these criteria, but their results do not represent the true functioning of the economy. For many essential criteria I-O models are the compromise. This leads to the conclusion that I-O models offer potential to be applied in a tourism context, especially if extensions can bring them closer to reality without making them too complex and (cost, time and data) inefficient.

Important advice to clients when hiring experts to carry out EIAs and to experts themselves is that the choice of a model needs to be based on a context- specific set of criteria. The essential criteria can be the starting point, adding or taking out criteria dependent on the specific question and context. Conscious choices also need to be made about the weighing of criteria. Is improving realism important enough to justify investing additional time and money? This selection process could lead to the application of one of the five models discussed above, but the questions and context underlying an EIA could also require application of a different model.

Some limitations are introduced by the methodology. First, there is no guarantee the list of 52 criteria is complete. As the expert interviews demonstrated, it is possible to come up with additional criteria. Besides the suggestions of the experts, other examples of additional criteria are 'Ability of models to calculate impacts of (changes in) outbound/domestic tourism', 'Ability of models to calculate impacts on the balance of payment', and 'Ability of models to show impacts on the long-term growth trajectory of the economy'. Second, a pragmatic choice had to be made when to stop contacting new experts. The second round of expert interviews could have led to a third round,

and a fourth, and so on. The inclusion of more experts could have led to different scores of criteria, different motivations or additional criteria. Lastly, there are limitations related to the comparison of these models. Other models that could have been analysed are for example, variants of the five 'basic' models. Furthermore, instead of using literature to compare models, a useful direction for future research would be to apply different models to the same case study. By evaluating and comparing the results, conclusions could be drawn about the appropriateness and realism of the models.

3. Location quotient methods[19]

3.1 Introduction

Input-Output (I-O) analysis is a method to calculate the output required per industry to satisfy (a change of) final demand. In spite of the gradual increase of the usage of Computable General Equilibrium (CGE) models (Dwyer et al., 2004) I-O analysis is still commonly applied in impact studies in tourism, for reasons of data availability, comparability, and simplicity (Sun & Wong, 2014). Applications can be found in many scientific studies (e.g. Çela, et al., 2009; Hanly, 2012; Kashian & Pfeifer-Luckett, 2011) and also among consultancy firms it is a popular tool. I-O analysis requires the existence of I-O coefficients[20], that show the intermediate delivery of supplying industry ***i*** to demanding industry ***j*** for the production of one unit of output by demanding industry ***j***. These I-O coefficients can be derived from an I-O table. To carry out I-O analysis on a regional level, which is often the case for impact studies in tourism, the I-O table should be specific for this spatial scale (Richardson, 1985). When a regional I-O table (RIOT) does not exist several methods exist to create such a table.

These methods are often categorized into non-survey methods (deriving regional I-O coefficients (RIOCs) from the national I-O table, through mathematical procedures), survey methods (based solely on regional data, obtained from expert interviews, survey of industries and final consumers) and hybrid methods (non-survey methods combined with regional data) (Bonfiglio & Chelli, 2008; Jensen, 1990)[21]. Although non-survey methods are sometimes criticised as being highly pragmatic in style, and lacking theoretical and empirical support and logical consistency, there are many (empirical) studies for which time, money, data or knowledge limitations rule out survey and hybrid methods (e.g. Flegg & Tohmo, 2011). Within the non-survey methods there are three subcategories: Commodity Balance methods, Location Quotient (LQ) methods, and Iterative Balance methods (Kowalewski, 2012; Kronenberg, 2009; Round, 1983). In a Commodity Balance Method (Isard, 1953) estimated regional commodity demand (based on the national I-O table) is matched with regional commodity supplies to determine RIOCs (Flegg & Tohmo, n.d.; Kronenberg, 2009). LQ methods use information about relative industry sizes (on national and regional level) to determine export and import orientation of industries and RIOCs. In Iterative Balance Methods technical procedures, such as RAS or entropy-maximising techniques, are used to adjust first-round estimates of RIOCs to satisfy certain known constraints (e.g. total intermediate sales in a region).

This chapter deals with the subcategory of LQ methods. When the choice is made to apply a LQ method, the researcher has to decide which LQ method to use, since several alternatives are available. The four LQ methods most often discussed in the literature and used in empirical

19 Accepted for publication as a chapter in the book 'Advances in Tourism Economics' (Springer Series, Edited by Nijkamp, Matias, and Romão)

20 Also for CGE Models, that can be seen as extension of I-O models, an I-O table is required as part of the Social Accounting Matrix (Zhou et al., 1997).

21 Boundaries between categories are, to some degree, arbitrary (Richardson, 1985): Mathematical procedures applied in non-survey methods require some regional-level data (Morrison & Smith, 1974; Round, 1983) and survey method are based to some degree on mathematical procedures and professional judgment, because some data will inevitably be unavailable (Jensen, 1990).

applications (Flegg & Tohmo, 2013) are Simple Location Quotient (SLQ), Cross Industry Location Quotient (CILQ), Round's Location Quotient (RLQ), and Flegg's Location Quotient (FLQ). Several earlier studies have compared two or more of these LQ methods, attempting to measure which one comes closest to replicating 'true values' of RIOCs and to give insight into the 'bias' of the results. Overviews are given in Bonfiglio & Chelli (2008) and Round (1983). Most of these studies apply the same methodology. RIOC are derived from a national I-O table by applying different LQ methods. These RIOCs are then compared to 'true' (survey based) RIOCs (e.g. Harrigan et al., 1980; Harris & Liu, 1998; Morrison & Smith, 1974; Schaffer & Chu, 1969; Stevens et al., 1989). Bonfiglio and Chelli (2008) have the same objective but apply a different methodology. They use Monte Carlo simulations to generate random RIOTs ('true RIOTs'), aggregate these to national I-O tables, apply different LQ methods to generate RIOTs, derive output multipliers and, finally, compare output multipliers based on the 'true RIOTs' to the ones based on the LQ methods, to determine which LQ methods comes closest to replicating 'true' output multipliers.

In this chapter we have a different objective and methodology. Our objective is to provide an explanation for the sign of the difference between RIOCs calculated between two alternative LQ methods, for all combinations of demanding and supplying industries. Although the existing literature discusses differences between LQ methods and provides some explanations for 'bias' (e.g. explanations why FLQ is likely to lead to smaller RIOCs than the other three LQ methods for most combinations between demanding and supplying industries and why SLQ is likely to lead to overestimated RIOCs) a structured and complete analysis of the differences was missing. To achieve this objective we use the formulas of the LQ methods to determine a ranking in size of the RIOCs, generated by the LQ methods, for all possible combinations of demanding and supplying industries. Furthermore, we derive and discuss the differences in ranking of the size of total output multipliers. The chapter can help a researcher to choose the most appropriate LQ method to generate a RIOT for regional I-O analysis.

The remainder of this chapter is organised as follows. In section 2 we describe the four LQ methods. In section 3 we determine the ranking in size of RIOCs. Section 4 discussed the implications for the ranking in size of total output multipliers. In section 5 RIOCs and total output multipliers are calculated for the region of Antwerp (Belgium). Section 6 draws conclusions.

3.2 Location quotient methods

3.2.1 Simple Location Quotient

The SLQ is given by equation 3.1:

$$SLQ_i = \frac{\frac{x_i^R}{x_i^N}}{\frac{x^R}{x^N}} = \frac{I}{S} \tag{3.1}$$

SLQ_i is the SLQ of the intermediate supply of supplying industry i to demanding industry j, x is output, R and N refer to the region and the nation, I is the output of supplying industry i on the regional level

relative to the output of industry i on the national level (x_i^R / x_i^N) and S is the regional output relative to the national output (x^R / x^N). After calculating SLQ RIOCs can be calculated from national I-O coefficients:

$$a_{ij}^N = \frac{s_{ij}^N}{x_j^N} \tag{3.2}$$

$$t_{ij} = \begin{cases} if\ SLQ_i \geq 1, t_{ij} = 1 \\ if\ SLQ_i < 1, t_{ij} = SLQ_i \end{cases} \tag{3.3}$$

$$a_{ij} = t_{ij} \cdot a_{ij}^N \tag{3.4}$$

a_{ij}^N are national I-O coefficients (intermediate input i per unit output of demanding industry j, excluding imports), s_{ij}^N is the value of intermediate input i supplied to demanding industry j (excluding imports), t_{ij} are trade coefficients (Round, 1983) equalling the share of within region supply in total supply of intermediate input i, and a_{ij} are RIOCs.

When $SLQ_i > 1$ it is assumed that supplying industry i is sufficiently present in a region to fulfil the needs of all demanding industries, which implies that the trade coefficients equal one and the RIOC and national I-O coefficients are equal (Flegg & Tohmo, 2011; Flegg & Webber, 1997; Round, 1983). When $SLQ_i < 1$ it is assumed that supplying industry i is not sufficiently present at the regional level to fulfil the needs of demanding industries and import from other regions is required. The trade coefficient is then equal to SLQ_i and the RIOC is smaller than the national I-O coefficient.

This procedure implies that SLQ is based on maximal intraregional trade and minimal interregional trade (Buyst & Bilsen, 2000; Flegg & Tohmo, n.d., 2011, 2013; Kronenberg, 2009). When $SLQ_i > 1$ supplying industry i sells to industries in the region and exports any surplus. When $SLQ_i < 1$ supplying industry i sells to demanding industries in the region and the remainder is imported from other regions. In both cases there is no cross-hauling (simultaneous exporting and importing of commodities produced by the same supplying industry). In reality cross-hauling can exist because of the heterogeneity of a product. Supplying industries can produce different varieties of a product and demanding industries are not necessarily indifferent for the differences in varieties (Kronenberg, 2009). Not taking into account cross-hauling, which can lead to overestimated RIOCs, might be particularly problematic in smaller regions, where cross-hauling is likely to be a particularly important feature (Harris & Liu, 1998).

An important assumption underlying SLQ is that the production structures of demanding industries are equal on the national and the regional level. SLQ only corrects for the fact that some commodities are supplied from outside the region. This assumption is not specific for SLQ; it is used by all four LQ methods (Bonfiglio & Chelli, 2008; Flegg & Webber, 1997; Round, 1983; Stoeckl, 2010).

3.2.2 Cross Industry Location Quotient

The CILQ, attributed by Schaffer and Chu (1969) to Charles Leven, is given by

$$CILQ_{ij} = \frac{SLQ_i}{SLQ_j} = \frac{\frac{x_i^R / x_i^N}{x^R / x^N}}{\frac{x_j^R / x_j^N}{x^R / x^N}} = \frac{\frac{I}{S}}{\frac{J}{S}} = \frac{I}{J} \tag{3.5}$$

$$t_{ij} = \begin{cases} if\ CILQ_{ij} \geq 1, t_{ij} = 1 \\ if\ CILQ_{ij} < 1, t_{ij} = CILQ_{ij} \end{cases} \tag{3.6}$$

where $CILQ_{ij}$ is the CILQ of the intermediate supply from supplying industry i to demanding industry j and J is the output of demanding industry j on the regional level relative to the output of demanding industry j on the national level (x_j^R / x_j^N)[22]. The amount of intra- and interregional trade is determined by the ratio of I and J. When applying SLQ to a supplying industry i for which $SLQ_i < 1$ it assumed that this supplying industry is unable to fulfil the demand of any demanding industry, leading to imports. When applying CILQ to the same supplying industry less or even no imports are assumed to be required, when this supplying industries is confronted with a demanding industry for which $SLQ_j > 1$. In these cases the application of SLQ might lead to an underestimation of the RIOCs, which is avoided by CILQ. CILQ also leaves open the possibility of cross-hauling. Even when a supplying industry is well represented in the region ($SLQ_i < 1$) commodities supplied by this industry are still imported when $SLQ_j > SLQ_i$ (Flegg & Webber, 1997). Finally, note that CILQ does not take into account regional size (the factors S in the nominator and denominator cancel out).

3.2.3 Round's Location Quotient

According to Round (1978) LQ methods should take into account both the size of supplying and demanding industries and regional size. This criterion is fulfilled by neither SLQ nor CILQ. Round (1978) has therefore developed an alternative, called RLQ:

$$RLQ_{ij} = \frac{SLQ_i}{LOG_2(1 + SLQ_j)} = \frac{\frac{x_i^R / x_i^N}{x^R / x^N}}{LOG_2(1 + \frac{x_j^R / x_j^N}{x^R / x^N})} \tag{3.7}$$

$$= \frac{I/S}{LOG_2(1 + J/S)}$$

$$t_{ij} = \begin{matrix} if\ RLQ_{ij} \geq 1, t_{ij} = 1 \\ if\ RLQ_i < 1, t_{ij} = RLQ_{ij} \end{matrix} \tag{3.8}$$

22 Morrison and Smith (1974) have suggested a modification to CILQ. They proposed that CILQ should be replaced with SLQ along the primary axis (when $i = j$). The original formula namely implies that supplying industry i can always meet the demand for its commodities from its own industries (internal deliveries from and to indystry i), independently of industry size. In this chapter we use the original CILQ.

RLQ_{ij} is RLQ of the intermediate supply from supplying industry i to demanding industry j. Regional size is taken into account because of the logistic transformation, which implies that the factors S in the nominator and denominator do not cancel out. RLQ was developed in such a way to produce a LQ that is 'in between' SLQ and CILQ.

3.2.4 Flegg's Location Quotient

The final LQ method, FLQ, is based on the idea that, even though CILQ allows for cross-hauling, the phenomenon is underestimated and no account is taken of the role of regional size. Flegg et al (1995) base their own LQ method on the hypothesis that there is an inverse relationship between regional size on the one hand and heterogeneity and cross-hauling on the other hand. In a larger region supplying industries are likely to produce more heterogeneous commodities, making it easier for supplying industries to accommodate demand, and cross-hauling is less likely to occur[23].

$$FLQ_{ij} = CILQ_{ij} \cdot \lambda^{\beta} = \frac{I \cdot \lambda^{\beta}}{J} \tag{3.9}$$

$$\lambda^{\beta} = \frac{x^R / x^N}{LOG_2\left(1 + \frac{x^R}{x^N}\right)} = \frac{S}{log_2(1+S)} \tag{3.10}$$

$$t_{ij} = \begin{cases} if\ FLQ_{ij} \geq 1, t_{ij} = 1 \\ if\ FLQ_{ij} < 1, t_{ij} = FLQ_{ij} \end{cases} \tag{3.11}$$

FLQ_{ij} is FLQ of the intermediate supply from supplying industry i to demanding industry j. $CILQ_{ij}$ is decreased by the regional scalar λ^{β}, which is inversely related to regional size.

Responding the criticism by Brand (1997) Flegg and Webber (1997) have later developed a modified function for the regional scalar λ^{*}, which replaces λ^{β} in (3.10).

$$\lambda^{*} = [LOG_2\left(1 + \frac{x^R}{x^N}\right)]^{\delta} = [LOG_2(1+S)]^{\delta}, (\ 0 \leq \delta < 1) \tag{3.12}$$

δ is a weighting parameter for the size of the region. The new regional scalar is more sensitive for changes in S. Our analysis is based on this modified formula.

Flegg and Webber (1997) present the FLQ as an improvement on all three earlier LQ methods. In SLQ cross-hauling is not possible and regional size is included in a manner Flegg and Webber (1997) deem to be counter-intuitive, as for a given I and J the smaller the region (S) the smaller the allowance for imports. CILQ does allow for cross-hauling, but not enough corrections are made and regional size does not enter the equation. RLQ allows for cross-hauling and takes into accounts regional size, but Flegg and Webber (1997) are critical on the 'implicit and obscure' way this enters the equation (via the logistic transformation). More importantly, RLQ suffers from the same weakness

23 Questions can be raised regarding the manner in which Flegg et al (1995) have included this relationship in the FLQ formula: Do heterogeneity of supply and cross-hauling only depend on regional size (as assumed by FLQ)? Or does this (partly) depend on the size of supplying industries? (Kowalewski, 2012) Or are there other intervening factors?

as SLQ in that bigger regional imports are allowed in a larger region than in a smaller one that is equivalent in all other aspects.

3.3 Ranking in size of regional I-O coefficients

In this section we determined the ranking in size of the RIOCs generated by the four LQ methods, for any combination between demanding and supplying industries. This requires, however, that we first establish the ranking in size of LQs and trade coefficients.

3.3.1 Location quotients

Equation 3.13 calculates the difference between two LQs:

$$DLQ_{ij}^{AB} = LQ_{ij}^{A} - LQ_{ij}^{B} \tag{3.13}$$

DLQ_{ij}^{AB} is the difference between the LQs for supplying industry i and demanding industry j, generated by LQ methods A and B. The third column of Table 3.1 shows the results for DLQ_{ij}^{AB}. Note that DLQ_{ij}^{AB} is equal to -DLQ_{ij}^{AB}. Starting from the conditions under which DLQ_{ij}^{AB} = 0 (fourth column) we can determine the conditions under which DLQ_{ij}^{AB} is positive and $LQ_{ij}^{A} > LQ_{ij}^{B}$ (final column).

Table 3.1 Difference between location quotients and conditions for a positive difference between location quotients

LQ_{ij}^{A}	LQ_{ij}^{B}	DLQ_{ij}^{AB}	$DLQ_{ij}^{AB} = 0$	$DLQ_{ij}^{AB} > 0$
CILQ	SLQ	$\frac{I}{J} - \frac{I}{S}$	$J = S$	$J < S$
RLQ	SLQ	$\frac{I/S}{LOG_2(1+J/S)} - \frac{I}{S}$	$\frac{I}{S} \cdot \left(\frac{1}{LOG_2(1+J/S)} - 1\right) = 0 \Rightarrow J = S$	$J < S$
RLQ	CILQ	$\frac{I/S}{LOG_2(1+J/S)} - \frac{I}{J}$	$\frac{1}{LOG_2(1+J/S)} = \frac{S}{J} \Rightarrow J = S$	$J > S$
FLQ	SLQ	$\frac{I \cdot \lambda^*}{J} - \frac{I}{S}$	$I \cdot \left(\frac{\lambda^*}{J} - \frac{I}{S}\right) = 0 \Rightarrow J = S \cdot \lambda^*$	$J < S \cdot \lambda^*$
FLQ	CILQ	$\frac{I \cdot \lambda^*}{J} - \frac{I}{J}$	$\frac{I}{J} \cdot (\lambda^* - 1) = 0 \Rightarrow N.A.$	N.A.
FLQ	RLQ	$\frac{I \cdot \lambda^*}{J} - \frac{I/S}{LOG_2(1+J/S)}$	$J = S \cdot \lambda^* \cdot LOG_2\left(1 + \frac{J}{S}\right) \Rightarrow J = Z^{*}$[3: a]	$J < Z^*$

Sources: Own calculations

a Both λ^* and Z^* depend on S and δ. In Equation 3.12 we established that $\lambda^*=[LOG_2\ (1+S)\ ]^{\delta}$. Determining the formula for Z^* is a less straightforward mathematical exercise. Table 3A.1, however, shows values of Z^* for different values of S and δ, for values of δ near the recommended value of δ=*0.25* (Flegg & Tohmo, 2011).

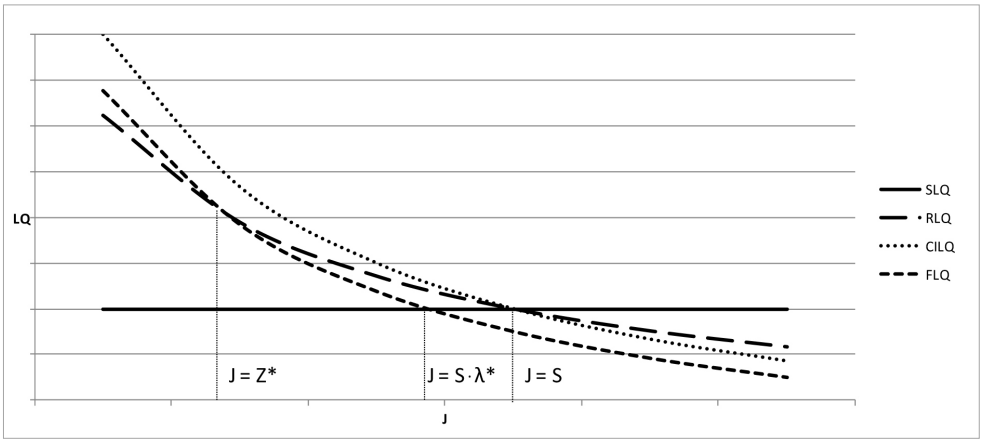
Based on these conditions we conclude that the sign of the difference between the LQ for any combination between demanding and supplying industry depends on J (output of demanding industry j on the regional level relative to the output of demanding industry j on the national level), relative to S, $S \cdot \lambda^*$ and Z^*. Table 3.2 show this ranking in size, for all values of J, and figure 3.1 provides a graphical illustration. When $J = S$ then SLQ = CILQ = RLQ. When $J < S$ then CILQ is larger than SLQ and when $J > S$ then CILQ is smaller than SLQ. The explanation is that CILQ decreases when J increases, while SLQ is independent of J. As mentioned in the previous section, RLQ produces LQs that are 'in between' SLQ and CILQ. When $J < S$ the ranking in size is CILQ > RLQ > SLQ and when $J > S$ the ranking in size is reversed. To generate FLQs values of CILQs are lowered by a factor λ^*, to account for cross-hauling and avoid overestimation of RIOCs. FLQ produces the smallest LQs when $J > S \cdot \lambda^*$. When $J < S \cdot \lambda^*$ then SLQ is smaller and when $J < Z^*$ both SLQ and RLQ are smaller.

Table 3.2 Ranking in size of location quotients

$J < Z^*$	$J = Z^*$	$Z^* < J < S \cdot \lambda^*$	$J = S \cdot \lambda^*$	$S \cdot \lambda^* < J < S$	$J = S$	$J > S$
CILQ	CILQ	CILQ	CILQ	CILQ	CILQ = RLQ = SLQ	SLQ
FLQ	FLQ = RLQ	RLQ	RLQ	RLQ		RLQ
RLQ		FLQ	FLQ = SLQ	SLQ		CILQ
SLQ	SLQ	SLQ		FLQ	FLQ	FLQ

Sources: Own calculations

Figure 3.1 Size of LQs



3.3.2 Trade coefficients

Equation 3.14 calculates the difference between two trade coefficients:

$$DT_{ij}^{AB} = t_{ij}^{A} - t_{ij}^{B} \tag{3.14}$$

DT_{ij}^{AB} is the difference between trade coefficients for supplying industry i and demanding industry j, generated by LQ methods A and B, t_{ij}^{A} is the trade coefficient for supplying industry i and demanding industry j, generated by LQ method A, and LC_{ij}^{B} is the trade coefficient for supplying industry i and demanding industry j, generated by LQ method B.

Table 3.3 Conditions for a positive and negative sign of the difference between trade coefficients

t_{ij}^{A}	t_{ij}^{B}	$LQ_{ij}^{A} < 1, LQ_{ij}^{B} < 1$	$LQ_{ij}^{A} > 1, LQ_{ij}^{B} < 1$	$LQ_{ij}^{A} < 1, LQ_{ij}^{B} > 1$	$LQ_{ij}^{A} > 1, LQ_{ij}^{B} > 1$
CILQ	SLQ	Positive when $J < S$	Positive	Negative	Zero
		Negative when $J > S$			
RLQ	SLQ	Positive when $J < S$	Positive	Negative	Zero
		Negative when $J > S$			
RLQ	CILQ	Positive when $J > S$	Positive	Negative	Zero
		Negative when $J < S$			
FLQ	SLQ	Positive when $J < S \cdot \lambda^{*}$	Positive	Negative	Zero
		Negative when $J > S \cdot \lambda^{*}$			
FLQ	CILQ	Negative	N.A.	Negative	Zero
FLQ	RLQ	Positive when $J < Z^{*}$	Positive	Negative	Zero
		Negative when $J > Z^{*}$			

Sources: Own calculations

Table 3.3 shows the conditions for a positive and negative DT_{ij}^{AB}. We conclude that the sign of the difference between trade coefficients depends on whether or not LQs are larger than one and, when both LQs are smaller than one, on the value of J relative to S, $S \cdot \lambda^{*}$, and Z^{*}. When both LQs are smaller than one trade coefficients are equal to LQs and the conditions for a positive difference between trade coefficients are the same as the conditions for a positive difference between LQs (final column of Table 3.1). When LQ A is larger than one and LQ B is smaller than one the difference between trade coefficients must be positive. When LQ A is smaller than one and LQ B is larger than one the difference between trade coefficients must be negative. When both LQs are larger than one both trade coefficients equal one and the difference is zero. Table 3.4 presents the conditions under which LQs are larger than one.

Table 3.4 Conditions under which location quotients are larger than one

LQ_{ij}	**Condition for** $LQ_{ij} > 1$
SLQ	$\frac{I}{S} > 1 \Rightarrow I > S$
CILQ	$\frac{I}{J} > 1 \Longrightarrow I > J$
RLQ	$\frac{I/S}{LOG_2(1+J/S)} > 1 \Longrightarrow I > S \cdot LOG_2\left(1+\frac{I}{S}\right)$
FLQ	$\frac{I \cdot \lambda^*}{J} > 1 \Longrightarrow I > \frac{J}{\lambda^*}$

Sources: Own calculations

For CILQ > 1 and SLQ < 1, and the difference between trade coefficients to be positive (first row and third column of Table 3.3) the conditions in Table 3.4 imply that $J < S$. This implies that the overall condition for a positive difference between the trade coefficients of CILQ and SLQ is $J < S$, independent of whether or not CILQ is larger than one. Via the same line of reasoning we can establish that the only condition for a negative difference is $J > S$. Equivalent conclusions can be reached for all six comparisons between trade coefficients. The implication is that the ranking in size of LQs, as established in Table 3.2, also applies to trade coefficients. The only exception is that, independent of the value of J, there is equality between trade coefficients when both LQs are larger than one (see conditions in Table 3.4). In that case both trade coefficients are one, and the difference is zero.

3.3.3 Regional I-O coefficients

Equation 3.15 calculates the difference between two RIOCs:

$$DA_{ij}^{AB} = a_{ij}^{A} - a_{ij}^{B} \tag{3.15}$$

DA_{ij}^{AB} is the difference between the RIOC for supplying industry i and demanding industry j, generated by LQ methods A and B, a_{ij}^{A} is the RIOC for supplying industry i and demanding industry j, generated by LQ method A, and a_{ij}^{B} is the RIOC for supplying industry i and demanding industry j, generated by LQ method B. Equation 3.16 shows that the sign of DA_{ij}^{AB} must be equal to the sign of DT_{ij}^{AB}. The only exception is the situation where $a_{ij}^{N} = 0$. In that case, both RIOCs equal zero and DA_{ij}^{AB} will be zero as well.

Table 3.5 Location quotients, trade coefficients, and regional I-O coefficients for a hypothetical four industry region

Parameters	
S	0.050
δ	0.050

λ^*, $S \cdot \lambda^*$ and Z^*	
λ^*	0.880
$S \cdot \lambda^*$	0.048
Z^*	0.028

Demanding industry	J	a_{Bj}^N
A	0.020	0.015
B	0.030	0.000
C	0.045	0.015
D	0.060	0.015

LQs (for supplying industry B)

Demanding industry	SLQ	CILQ	RLQ	FLQ	Conditions	Ranking in size
A	0.600	1.500	1.236	1.314	$J < Z$	CILQ > FLQ > RLQ > SLQ
B	0.600	1.000	0.885	0.876	$Z < J < S \cdot \lambda^*$	CILQ > RLQ > FLQ > SLQ
C	0.600	0.667	0.648	0.584	$S \cdot \lambda^* < J < S$	CILQ > RLQ > SLQ > FLQ
D	0.600	0.500	0.527	0.438	$J > S$	SLQ > RLQ > CILQ > FLQ

Trade coefficients (for supplying industry B)

Demanding industry	SLQ	CILQ	RLQ	FLQ	Equality conditions	Ranking in size
A	0.600	1.000	1.000	1.000	$CILQ, RLQ, FLQ > 1$	CILQ = FLQ = RLQ > SLQ
B	0.600	1.000	0.885	0.876		CILQ > RLQ > FLQ > SLQ
C	0.600	0.667	0.648	0.584		CILQ > RLQ > SLQ > FLQ
D	0.600	0.500	0.527	0.438		SLQ > RLQ > CILQ > FLQ

RIOCs (for supplying industry B)

Demanding industry	SLQ	CILQ	RLQ	FLQ	Equality conditions	Ranking in size
A	0.090	0.150	0.150	0.150	$CILQ, RLQ, FLQ > 1$	CILQ = FLQ = RLQ > SLQ
B	0.000	0.000	0.000	0.000	$a_{BB}^N = 0.000$	CILQ = RLQ = FLQ = SLQ
C	0.090	0.100	0.097	0.088		CILQ > RLQ > SLQ > FLQ
D	0.090	0.075	0.079	0.066		SLQ > RLQ > CILQ > FLQ

Sources: Own calculations

$$DA_{ij}^{AB} = a_{ij}^{A} - a_{ij}^{B} = t_{ij}^{A} \cdot a_{ij}^{N} - t_{ij}^{B} \cdot a_{ij}^{N} = \left(t_{ij}^{A} - t_{ij}^{B}\right) \cdot a_{ij}^{N} \tag{3.16}$$

$$= DT_{ij}^{AB} \cdot a_{ij}^{N}$$

The conclusion is that the same ranking in size applies to LQs, trade coefficients, and RIOCs, generated by alternative LQ methods (Table 3.2). The sign of the difference between LQs, trade coefficients, and RIOCs calculated between two alternative LQ methods depends on the *J*-value of the demanding industry, relative to S, λ^{*}, and Z^{*}. The only exceptions are situations where the LQs generated by two LQ methods are larger than one (conditions presented in Table 3.4) or when $a_{ij}^{N} = 0$. In those situations the RIOCs generated by two LQ methods are equal.

Table 3.5 shows the calculation of LQs, trade coefficients, and RIOCs for a hypothetical four industry regional economy, providing an illustration of these conclusions.

3.4 Ranking in size of total output multipliers

RIOCs (contained in the matrix A) form the basis of a regional I-O model. A technical operation on the A-matrix (Miller & Blair, 2009) leads to the Leontief inverse matrix (L)

$$L = (I - A)^{-1} \tag{3.17}$$

where L is the Leontief inverse matrix and I is the unity matrix. Equations 3.18 and 3.19 show that the Leontief inverse enables the calculation, for any level of final demand (Y) or change of final demand (ΔY), of the required level (X) or change (ΔX) in output in all industries of the regional economy:

$$X = L \cdot Y \tag{3.18}$$

$$\Delta X = L \cdot \Delta Y \tag{3.19}$$

Elements of the matrix L are so-called output multipliers (L_{ij}) showing the output in supplying industry i required to produce one unit of final demand of industry j. The sum of the output multipliers for demanding industry j (column total), i.e. the total output multiplier (L_j), shows the output required to produce one unit of final demand of industry j. As established in the previous sections the same ranking in size applies to LQs, trade coefficients, and RIOCs, for a demanding industry j. It is not necessarily the case that the same ranking in size also applies to total output multipliers. This is caused by the mathematics involved in the calculation of the Leontief inverse, whereby the value of each L_{ij} depends on all RIOCs a_{ij}. Dependent on the ranking in size of LQs of LQ methods A and B (LQ_{ij}^{A} and LQ_{ij}^{B}) there are three possible outcomes regarding the ranking in size of total output multipliers $\left(L_j^{A}\right.$ and $\left.L_j^{B}\right)$:

1. When all $LQ_{ij}^{A} \geq LQ_{ij}^{B}$ and at least one $a_{ij}^{A} > a_{ij}^{B}$, then $L_j^A \geq L_j^B$ for all demanding industries.[24]
2. When $LQ_{ij}^{A} < LQ_{ij}^{B}$ in some demanding industries and $LQ_{ij}^{A} > LQ_{ij}^{B}$ in other demanding industries, then $L_j^A \gtreqless L_j^B$. The empirical data (*J, I, S,* a_{ij}^{N}) and (for comparisons including FLQ) choice of δ determine whether or not the same ranking in size of LQ_{ij}^{A} and LQ_{ij}^{B} applies to L_j^A and L_j^B, for each demanding industry.
3. When all $LQ_{ij}^{A} = LQ_{ij}^{B}$ and/or when all $a_{ij}^{A} = a_{ij}^{B}$, then $L_j^A = L_j^B$ for all demanding industries.

When we combine these outcomes with the ranking in size in Table 3.2 and the fact that a region necessarily consists of some demanding industries for which $J < S$ and some demanding industries for which $J > S$[25] we know that outcome 2 must apply for any comparison between SLQ, RLQ, and FLQ. This is because the ranking in size is CILQ > RLQ > SLQ for demanding industries for which $J < S$ and CILQ < RLQ < SLQ for the demanding industries for which $J > S$. Outcome 1 applies for comparisons between FLQ and any of the other three LQ methods, when all demanding industries have $J > S \cdot \lambda^{*}$. Based on Table 3.2 we know this implies that FLQ leads to LQs equal or smaller than LQs of any other LQ method. When there are demanding industries for which $J < S \cdot \lambda^{*}$(demanding industries that are relatively poorly represented on the regional level), SLQ and/or RLQ produce LQs equal or smaller than FLQ, for these demanding industries we then face outcome 2. Outcome 3 is not relevant for comparisons between the four LQ methods[26]. The implication is that the ranking in size of total output multipliers is not necessarily the same as the ranking in size of LQs. The exception is the comparison between FLQ and any other LQ method, when all demanding industries have $J > S \cdot \lambda^{*}$.

This is illustrated in Table 3.6, which is a continuation of the calculations from Table 3.5. The Table shows the ranking in size of LQs, RIOCs, and total output multipliers. Although the ranking in size of total output multipliers is very similar to LQs we find a different ranking in size for the comparison between FLQ and SLQ in demanding industry C[27]. The conclusion is that, although the ranking in size based on Table 3.2, which applies for LQs, trade coefficients, and RIOCs, can apply for total output multipliers in many demanding industries, there is no guarantee it applies to all. This is dependent on the empirical data (*J, I, S,* a_{ij}^{N}) and choice of δ.

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24 Output multipliers L_{ij} consist of (1) a_{ij}; intermediate delivery of supplying sector *i* to demanding sector *j*, caused by the final demand for products of sector *j* (2) intermediary deliveries of supplying sector *i* to all demanding industries, caused by final demand for products of sector *j*, in addition to a_{ij}. An increase (decrease) of a_{ij} between any two supplying and demanding industries can increase (decrease) this factor, via the intersectoral relationships (3). For L_{ij} along the diagonal (L_{ii}) one is added, to account for direct output (Schaffer, 1999). We find $L_j^A > L_j^B$ for demanding industries in which there is at least one L_{ij} for which $a_{ij}^{A} > a_{ij}^{B}$ (factor one) and/or for which factor two is higher for LQ method A. We find $L_j^A = L_j^B$ in (1) demanding industries for which all $a_{ij}^{N} = 0$, implying that all $a_{ij}^{A} = a_{ij}^{B} = 0$ and $L_j^A = L_j^B = 1$ (2) demanding industries for which all $LQ_{ij}^{A}, LQ_{ij}^{B} > 1$ or all $LQ_{ij}^{A} = LQ_{ij}^{B}$, implying that all $a_{ij}^{A} = a_{ij}^{B}$, and for which for there is no L_{ij} for which factor 2 is higher for LQ method A (no intersectoral relationships between industries in which $a_{ij}^{A} > a_{ij}^{B}$ and industry *j*).

25 $S = \frac{x^R}{x^N} = \frac{\sum_{j=1}^{j=n} x_j^R}{\sum_{j=1}^{j=n} x_j^N}$ and $J = \frac{x_j^R}{x_j^N}$. When all $J > S$ then $\frac{\sum_{j=1}^{j=n} x_j^R}{\sum_{j=1}^{j=n} x_j^N} > S$ which conflicts the definition of S. An equivalent conflict is found when all $J < S$. A region necessarily consists of industries with $J < S$ and industries with $J > S$, except when $J = S$ for all industries.

26 There are three scenarios to find $LQ_{ij}^{A} = LQ_{ij}^{B}$ and/or all $a_{ij}^{A} = a_{ij}^{B}$: (1) All $a_{ij}^{N} = 0$ (2) $J = S$, for all industries (3) $LQ_{A}^{ij}, LQ_{B}^{ij} > 1$ or $LQ_{A}^{ij} = LQ_{B}^{ij}$ for all combinations between demanding and supplying industries. Formulas of SLQ, CILQ, RLQ, and FLQ and the presence of some demanding industries for which $J < S$ and some demanding industries for which $J > S$ imply the last scenario is impossible. The first two scenarios are (highly) unrealistic.

27 The ranking in size of total output multipliers of CILQ, FLQ, and RLQ in sector A changes back from equality (RIOCs) to the inequality of LQs. Differences between RIOCs of CILQ, FLQ, and RLQ for other combinations between industries lead to inequality between total output multipliers. In sector B $a_{iB}^{N} = 0$ and $a_{iB} = 0$. Production of output by industry *j* does not lead to any intermediary supplies. Total output multiplier are then equal to one.

Table 3.6 Location quotients, regional I-O coefficients, output multipliers, and total output multipliers for a hypothetical four industry region

Location quotients (for supplying industry B)						
Demanding industry	SLQ	CILQ	RLQ	FLQ	Conditions	Ranking in size
A	0.600	1.500	1.236	1.314	$J < Z^*$	CILQ > FLQ > RLQ > SLQ
B	0.600	1.000	0.885	0.876	$Z^* < J < S \cdot \lambda^*$	CILQ > RLQ > FLQ > SLQ
C	0.600	0.667	0.648	0.584	$S \cdot \lambda^* < J < S$	CILQ > RLQ > SLQ > FLQ
D	0.600	0.500	0.527	0.438	$J > S$	SLQ > RLQ > CILQ > FLQ
National I-O coefficients						
		Supplying industry				
Demanding industry	A	B	C	D		
A	0.200	0.150	0.100	0.050		
B	0.000	0.000	0.000	0.000		
C	0.200	0.150	0.100	0.050		
D	0.200	0.150	0.100	0.050		
Regional I-O coefficients (for supplying industry B)						
Demanding industry	SLQ	CILQ	RLQ	FLQ	Equality conditions	Ranking in size
A	0.090	0.150	0.150	0.150	CILW, RLQ, FLQ > 1	CILQ = FLQ = RLQ > SLQ
B	0.000	0.000	0.000	0.000	$a_{BB}^N = 0$	CILQ = RLQ = FLQ = SLQ
C	0.090	0.100	0.097	0.088		CILQ > RLQ > SLQ > FLQ
D	0.090	0.075	0.079	0.066		SLQ > RLQ > CILQ > FLQ
Total output multipliers						
Demanding industry	SLQ	CILQ	RLQ	FLQ		Ranking in size
A	1.397	1.706	1.633	1.644		CILQ > FLQ > RLQ > SLQ
B	1.000	1.000	1.000	1.000		CILQ = RLQ = FLQ = SLQ
C	1.397	1.467	1.448	1.404		CILQ > RLQ > FLQ > SLQ
D	1.397	1.367	1.377	1.311		SLQ > RLQ > CILQ > FLQ

Sources: Own calculations

3.5 Empirical case study: Antwerp (Belgium)

We applied the LQ methods to calculate RIOCs and total output multipliers for the region of Antwerp in Belgium. For FLQ we assumed δ to be 0.25. There is an on-going debate regarding the optimal value of δ (Flegg & Tohmo, 2011, 2013; Kowalewski, 2012). Flegg et al. (2011) have developed a regression equation, whereby the optimal value of δ depends on regional size, the region's propensity to import (relative to other regions) and the region's average use of intermediate inputs (relative to other regions). However, they also recommend using $\delta = 0{,}25$ as the best single value, when the data is lacking to calculate the optimal value of δ.

We applied the LQ methods to the national Belgian I-O table (Eurostat, 2012). According to Kronenberg (2007, 2009) non-survey methods can only be applied to I-O tables in which imports are included 'directly' i.e. there is an import row in the I-O table showing the aggregate imports of each industry in the column. For the Belgian I-O table Kronenberg's requirement is fulfilled. Because there was no data about regional output per industry national and regional employment (per industry) were used to calculate x_j^R, x^R, x_j^N and x^N, assuming that labour productivity per industry is equal on the regional and national level (Johns & Leat, 1987; Round, 1983). Employment data was obtained from BelgoStat (2012). National and regional employment data were only available for 16 aggregated industries (see Table 3.7). Therefore, the data in the national I-O table was first aggregated into these 16 industries, before applying the LQs.

Table 3.7 Aggregated industries

	Industries
A	Agriculture, forestry and fishery
B	Raw materials
C	Industry
D	Production and distribution of electricity, gas, stream, cooled air and water
E	Construction
F	Retail, reparation of computers and consumer articles
G	Accommodation and meals
H	Transport, storage, postal services and telecommunication
I	Financial services and insurances
J	Exploitation of trade and real estate
K	Business Services
L	Government, defence; social security
M	Education
N	Health care
O	Associations
P	Arts, amusement and recreation

Source: Belgostat (2012)

The first part of Table 3.8 shows the sum of RIOCs, per demanding industry J. Because the ranking in size of RIOCs (Table 3.2) depends on the J-value of demanding industries the same ranking in size applies to individual RIOCs and the sum of RIOCs, per demanding industry. Note that demanding industries are subdivided into three groups: Demanding industries for which $Z^* < J < (S \cdot \lambda^*)$, demanding industries for which $(S \cdot \lambda^*) < J < S$ and demanding industry for which $J > S$. Each group has a different ranking in size of the (sum of) RIOCs, which can be explained based on Table 3.2. Because there are two demanding industries for which $Z^* < J < (S \cdot \lambda^*)$ FLQ does not lead to the smallest (sum of) RIOCs for all demanding industries. This implies that outcome 2 (see section 3.4) applies for all comparisons between LQ methods and it depends on the empirical data and (for comparisons including FLQ) the choice of the weighting parameter δ whether or not the ranking in size of RIOCs also applies for the size of total output multipliers.

Nonetheless, the second part of Table 3.8, that presents total output multipliers for each demanding industry, shows that the ranking in size of total output multipliers matches the ranking in size of (sum of) RIOCs. The only exception is the ranking in size of SLQ and FLQ for the two demanding industries for which $Z^* < J < (S \cdot \lambda^*)$. Here we find that total output multipliers of SLQ are larger than total output multipliers of FLQ. For this empirical case study FLQ leads to the smallest total output multipliers, for all demanding industries. An I-O model based on FLQ will produce the smallest impacts, independently of the distribution of final demand over industries.

Table 3.8 Sum of regional I-O coefficients and total output multipliers for Antwerp

	B	L	A	I	G	J	M	P	E	F	D	K	C	H	N	O
	$Z^* < J < S \cdot \lambda$		$S \cdot \lambda < J < S$								$J > S$					
Sum of RIOCs																
SLQ	0.33	0.16	0.47	0.35	0.47	0.20	0.07	0.38	0.58	0.34	0.34	0.41	0.34	0.41	0.27	0.31
CILQ	0.37	0.17	0.50	0.41	0.48	0.22	0.08	0.40	0.60	0.34	0.34	0.40	0.33	0.38	0.23	0.14
RLQ	0.36	0.17	0.49	0.39	0.48	0.22	0.07	0.40	0.59	0.34	0.34	0.41	0.33	0.39	0.24	0.19
FLQ	0.36	0.17	0.48	0.35	0.46	0.19	0.07	0.34	0.49	0.30	0.27	0.31	0.25	0.29	0.17	0.11
	CILQ > RLQ > FLQ > SLQ		CILQ > RLQ > SLQ > FLQ								SLQ > RLQ > CILQ > FLQ					
Total output multipliers																
SLQ	1.52	1.26	1.74	1.55	1.73	1.33	1.11	1.62	2.02	1.55	1.56	1.67	1.54	1.67	1.42	1.50
CILQ	1.59	1.27	1.76	1.67	1.75	1.37	1.12	1.66	2.08	1.55	1.55	1.66	1.51	1.61	1.34	1.23
RLQ	1.58	1.27	1.76	1.63	1.75	1.36	1.12	1.65	2.06	1.55	1.55	1.66	1.52	1.63	1.37	1.31
FLQ	1.50	1.23	1.63	1.47	1.60	1.26	1.08	1.44	1.68	1.39	1.35	1.41	1.32	1.37	1.21	1.14
	CILQ > RLQ > SLQ > FLQ										SLQ > RLQ > CILQ > FLQ					

Source: Own calculations

3.6 Conclusions

In this chapter we have compared the four most used LQ methods: SLQ, CILQ, RLQ and FLQ. These LQ methods are used to generate a RIOT, which is requirement for a regional I-O analysis. The size of the RIOCs, which can be derived from the RIOT, directly influences the results of the analysis. An over- or underestimation of RIOCs can lead to over- or underestimation of economic impacts. It is therefore very important to understand the differences between LQ methods and the consequences for the RIOCs. This applies to any economic impact analysis, including analyses in the domain of tourism, where I-O models are commonly used.

Contrary to earlier studies, that have compared RIOCs generated by LQ methods to survey based RIOCs, to determine how close LQ methods come to replicating these survey based RIOCs, our objective was to provide an explanation for the sign of the difference between RIOCs calculated between two alternative LQ methods. This provides valuable insight for any researcher facing the choice between LQ methods.

We used the formulas of the LQ methods to establish a ranking in size of RIOCs generated by the four LQ methods (Table 3.2). This ranking in size shows, for any combination of demanding and supplying industry, if the use of a different LQ method would lead to smaller or larger RIOCs. The direction of change depends on the J-value of the demanding industry, relative to S, λ^* and Z^* and (whereby J is equal to the output of demanding industry j on the regional level divided by the output of demanding industry j on the national level). The only combination between demanding and supplying industries for which this ranking in size does not apply and for which a change between LQ methods leads to the same RIOC is when LQs generated by two LQ methods are larger than one (conditions presented in Table 3.4) and/or when the corresponding national I-O coefficient is zero.

Based on a RIOT we can derive total output multipliers. These total output multipliers play an important role in I-O analysis, because they show the output that is required (in all industries of the economy) to produce one unit of final demand of industry j. Our analysis has shown that the ranking in size of total output multipliers of LQ methods is not necessarily the same as the ranking in size of RIOCs. The exception is the comparison between FLQ and any other LQ method. When all demanding industries have J–values higher than $S \cdot \lambda^*$ the FLQ method, which was developed to avoid overestimation by making appropriate corrections for cross-hauling, leads to the lowest RIOCs and the lowest total output multipliers, for all combinations between demanding and supplying industries. For all other comparisons between LQ methods, or when there are demanding industries that have a J-value lower than $S \cdot \lambda^*$, it depends on the empirical data and (for comparisons including FLQ) the choice of the weighting parameter δ whether or not the ranking in size of RIOCs also applies for total output multipliers. In a hypothetical and empirical case study we found that the same ranking in size applies for many, but not all, demanding industries.

The added value of this chapter is that it provides a complete explanation for the direction of change of a RIOC, when choosing an alternative LQ method. It is however important to emphasize that we do not recommend choosing between LQ methods based solely on this ranking in size. It needs to be combined with a solid understanding of the equations and underlying assumptions of the LQ methods, as discussed in the second section. Furthermore, one need to be aware that other methods to generate RIOTs (survey, hybrid) can be preferable to LQ methods, when time, money, data, and knowledge allow for their application. There is a continuous debate regarding the appropriateness of LQ methods (Kronenberg, 2009) and some scholars criticise these methods

for not being able to capture the complex forces that determine actual RIOCs, e.g. spatial market orientations and differences between regional and national technologies (Brand, 1997; McCann & Dewhurst, 1998; Richardson, 1985). The relevance of this chapter is based on extensive usage of the LQ methods in the past and the likely continued usage in the future (Jensen, 1990), but this makes it even more important to be aware of their inherent limitations.

4. Economic impacts of medical tourism in Malaysia[28]

4.1 Introduction

Medical tourism, defined by Snyder et al. (2011, p. 530) as 'a growing industry that involves patients intentionally travelling abroad for non-emergency medical services', has been identified by governments of numerous middle- and low-income countries as an economic growth engine (Connell, 2013b). Policymakers as well as scholars (see, e.g., Bookman & Bookman, 2007) argue that destinations can benefit via income, employment, and expansion and improvement of medical services and expertise. At the same time, medical tourism may pose challenges, such as rural-urban brain-drain of medical professionals and diversion of resources essential for public health care to private health care (Ormond, 2014). A careful analysis of (potential) impacts of medical tourism on destinations is therefore a prerequisite for destination management in order to optimize the potentially positive and minimize the potentially negative impacts of this specific type of tourism.

However, analysis of medical tourism is cumbersome. Definitional incongruity means that 'most of the numbers attached to medical tourism, whether on flows, growth rates or income generated, are speculative, based on estimates, remarkably rounded (upwards) and optimistic' (Connell, 2013a). One problem is that medical tourism figures are generally released at national levels only, not permitting discrimination at more disaggregated levels (e.g., state or municipal), in spite of significant differences within destination countries. For example, Ormond (2013b) notes significant variation in, first, volume and origins of foreign patients receiving treatment in different parts of Malaysia and, second, policies and governance bodies involved in supporting and managing medical tourism within Malaysia. Likewise, Turner (2007), Reddy and Qadeer (2010) and Solomon (2011) have identified the cities of Chennai and Bangalore and the states of Goa, Kerala and Maharashtra in India, as more actively receiving and involved in promoting medical tourism than others, generating disparate effects throughout the country. These examples demonstrate the limitations of national-level data, as they obscure a range of important social, economic and political developments at sub-national level. In this paper we argue for the relevance of identifying sub-national impacts. Our choice of an analysis of economic impacts is not meant to emphasize the importance of economic impacts over other types of impacts (e.g., health equity). However, the official and widespread identification of medical tourism as an economic growth engine does make it very relevant to better understand economic impacts.

A range of figures has been reported regarding medical tourism's economic impacts on destinations (Table 4A.1). We note some important limitations regarding existing data, however. First, all figures reflect national-level values. Second, figures are limited to direct impacts (indirect impacts are not included). Third, often it is not specified whether figures reflect only medical expenditure or also include non-medical expenditure. Fourth, definitions, assumptions, and methods are often not (clearly) specified. Fifth, and related to the previous point, there are inconsistencies between numbers reported for the same country and year.

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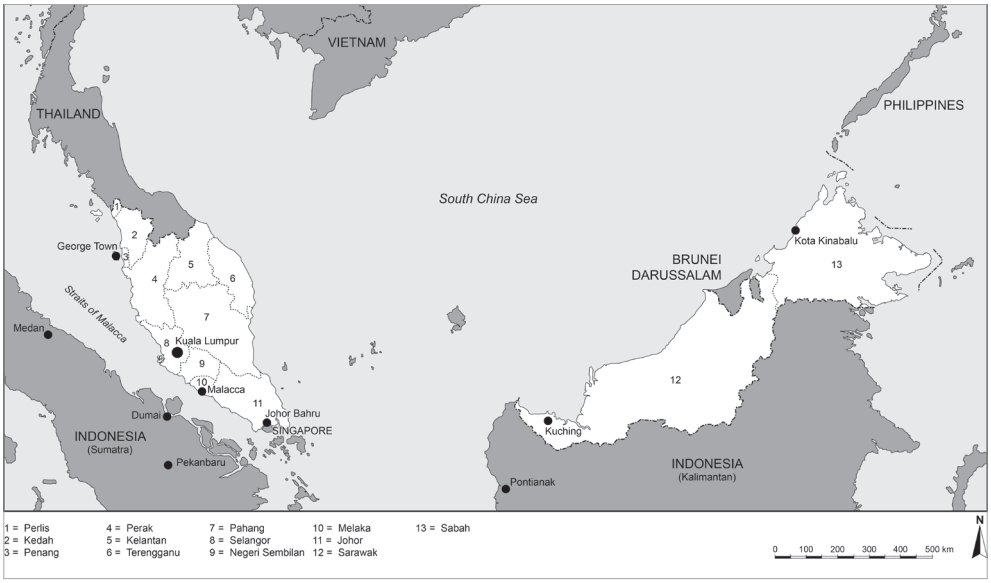
Our chosen case study, Malaysia, is ideal to analyze sub-national impacts. The country is comprised of different states, each of which has different tourism and economic profiles. For example, the states of Melaka, Penang and Selangor and the federal territory of Kuala Lumpur (geographically located within Selangor) are hubs for international tourism as well as zones with high-skilled knowledge-based industries (see figure 4.1). Furthermore, there are differences between states in the numbers, origins, and types of medical tourists they receive. Different types of medical tourists have different expenditure patterns and different impacts on local economies.

Figure 4.1 Malaysia



The objective of this paper is to analyze medical tourism's state-level economic impacts in Malaysia in order to provide information we consider to be essential for destination management. The method we used is Input-Output (I-O) analysis applied to state-specific I-O data and disaggregated foreign patient data provided by APHM (2008). I-O analysis can be used to calculate economic impacts caused by (elements of) final demand (e.g., demand for goods and services by medical tourists) and gives detailed insight into these impacts, showing separate impacts for each industry and state. To the best of our knowledge, I-O analysis has not yet been used in existing literature on medical tourism.

In the next section we introduce medical tourism in Malaysia and discuss the APHM (2008) dataset. In the third section we discuss I-O analysis and the methodology used to create state-level I-O tables. The methods used to calculate foreign patients' medical and non-medical expenditure, used as input for the I-O analysis, are presented in section four. Section five contains the results of the I-O analysis and the final section provides conclusions and recommendations.

4.2 Medical tourism in Malaysia

Malaysia ranks among the most recognized international medical tourism destinations (Ormond, 2013b). In 1998, in the midst of the Asian Financial Crisis, medical tourism was identified by the national government of Malaysia as a tool for economic development. The Malaysian Ministry of Health and the Association of Private Hospitals of Malaysia (APHM) assumed responsibility until 2009, when the newly-formed Malaysian Healthcare Travel Council (MHTC) took over the national management of medical tourism and the promotion of a select set of private and corporatized hospitals and clinics specifically endorsed by the Ministry of Health for medical tourism. At that time, Malaysian government development plans explicitly included medical tourism as among a range of means with which to transform Malaysia into an upper middle-income country with a knowledge-based economy. Health care became one of the country's twelve National Key Economic Areas – economic areas deemed to have 'the potential to directly and materially contribute a quantifiable amount of economic growth to the Malaysian economy' (Pemandu, 2012c, p. 69).

As a result, '[re]invigorating health travel through better customer experience, proactive alliances and niche marketing' (Pemandu, 2012a) now ranks alongside initiatives to develop the country's pharmaceutical and medical technology industries. It alone is intended to generate 9.6 billion Malaysian ringgit (MYR) (USD 2.7 billion[29]) in revenue, MYR 4.3 billion (USD 1.2 billion) in Gross National Income (GNI) and 5,300 more medical professionals by 2020 – the year by which Malaysia is meant to attain 'developed country' status (Ormond, Wong and Chan, 2014). MHTC has been charged with ensuring that these targets are met, increasing the overall number of beds in medical tourism-endorsed hospitals to cater to a desired 1.9 million foreign patients by 2020 (Pemandu, 2012a, 2012b). Medical tourism is seen as having the potential to spur growth in other industries such as pharmaceuticals, medical research and development, and non-medical industries. It is therefore very relevant to consider how medical tourism's demand impacts medical and non-medical industries.

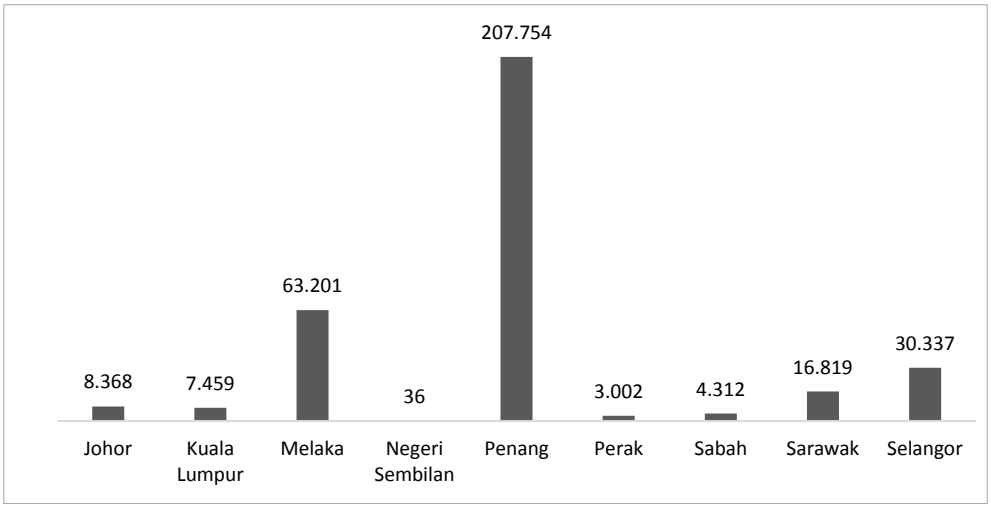
A state-level analysis of economic impact requires disaggregated data on the number of foreign patients and their medical expenditure. The data is provided by APHM (2008). Data are drawn from the 27 hospitals and clinics endorsed for medical tourism by the Malaysian Ministry of Health in 2007 that received the 341,288 foreign patients officially reported by the Malaysian government as 'medical tourists' that year. The Ministry-endorsed hospitals and clinics are located in nine states/territories: Johor, Kuala Lumpur (a federal territory), Melaka, Negeri Sembilan, Penang, Perak, Sabah, Sarawak and Selangor. The data therefore exclude foreign patients using non-endorsed public and private medical facilities. Furthermore, APHM (2008) data are based on patients with non-Malaysian passports. No distinction is made between people travelling across borders for medical treatment of their own volition, patients sent abroad by their home health systems, resident expatriates and foreign retirees, and people who fall ill while travelling in Malaysia for non-medical purposes (Rosenmöller et al., 2006). Therefore, our research encompasses more patients than those intentionally travelling abroad for non-emergency medical services (Snyder et al., 2011), the definition we presented at the beginning of this chapter. As such, we must speak here of 'foreign patients' instead of 'medical tourists', even though the Malaysian government reports these foreign patient figures as its official medical tourist figures. An advantage of the APHM (2008) data is that a patient is

29 Because our empirical analysis is for the year 2007 the exchange rate on 1 January 2007 (1 : 0.283) is used throughout the chapter to convert MYR to USD.

counted only once when registered at a hospital or clinic, thus ensuring that figures are not artificially inflated (Ormond, 2013b). The most recent year for which disaggregated foreign patient numbers are available is 2007.

The APHM (2008) data makes clear that the states of Penang and Melaka received most foreign patients in 2007 (figure 4.2), followed at some length by Selangor and Sarawak. Table 4.1 provides additional insight into the geographical distribution of foreign patients, by subdividing patient numbers in each state by nationality (separately identifying nationalities that comprise minimally 1% of the total number of foreign patients in Malaysia). Several factors can be identified in shaping the geographical distribution (numbers and nationalities). First, medical tourism-endorsed hospitals are concentrated more in some states than others. Second, types and specialties of medical tourism-endorsed hospitals are unevenly distributed. There is, for example, a high concentration of medical specialties in Selangor and Kuala Lumpur because of the area's status as the national capital. Third, the geographical and linguistic proximity of some states and their populations to different parts of Indonesia, the main source of Malaysia's foreign patients, plays a role. Penang and Melaka mainly attract Indonesians from Sumatra, while Sarawak attracts Indonesians from West Kalimantan (Ormond, 2013a, 2013b). Fourth, certain hospitals are more popular among foreign patients because of their prestige and/or brand recognition due to their (multi-national) parent companies and affiliated organizations (Leng, 2010). Fifth, the degree of ease with which foreign patients can travel to these locations is important. Patients from Europe, the Middle East and the USA often end up in Kuala Lumpur due in part to the presence of the Kuala Lumpur International Airport, while Melaka and Penang have established sea and air links with Sumatra. Sixth, some foreign patients have benefited from facilitated access at border crossings (see Ormond, 2013b, on cross-border mobility). Finally, the location of companies and industries in which expatriates are working and the locations in which expatriates have settled for retirement play a role (Ono, 2008).

Figure 4.2 Foreign patients per Malaysian state, 2007



Source: APHM (2008)

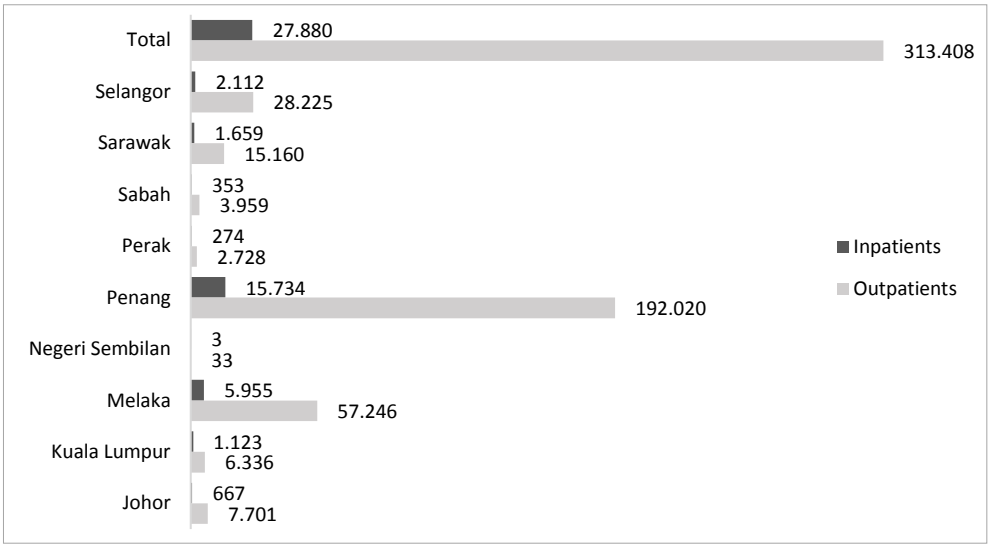
Table 4.1 Foreign patients receiving treatment in Malaysian hospitals endorsed for medical tourism, by Malaysian state and patient nationality (2007)

	Johor	Kuala Lumpur	Melaka	Negeri Sembilan	Penang	Perak	Sabah	Sarawak	Selangor	Total	
Indonesia	93.2%	32.9%	93.7%	55.6%	84.0%	22.5%	18.1%	84.0%	21.8%	266227	78.0%
Japan	0.1%	1.5%	0.1%	-	3.0%	6.3%	7.9%	0.3%	13.6%	11210	3.3%
Europe	0.4%	7.9%	0.1%	8.3%	2.5%	9.6%	13.1%	2.8%	6.8%	9219	2.7%
India	0.5%	8.2%	0.4%	-	1.1%	15.4%	5.1%	1.0%	7.2%	6132	1.8%
China	0.2%	14.3%	0.1%	-	0.9%	6.1%	5.6%	1.5%	4.7%	5099	1.5%
USA	0.2%	2.9%	0.0%	5.6%	1.5%	1.2%	4.2%	0.4%	1.9%	4178	1.2%
Singapore	3.4%	2.9%	0.9%	2.8%	0.4%	5.2%	3.9%	1.2%	4.5%	3812	1.1%
Australia	0.4%	1.9%	0.1%	2.8%	1.0%	3.8%	6.5%	0.8%	3.4%	3829	1.1%
Others	1.4%	27.6%	4.7%	25.0%	5.6%	29.8%	35.6%	8.3%	36.2%	31582	9.3%
Total	8,368	7,459	63,201	36	207,754	3,002	4,312	16,819	30,337	341,288	100%

Source: APHM (2008)

Figure 4.3 shows the numerical dominance of outpatients over inpatients in all nine states. Outpatients are patients who are not hospitalized overnight but who visit a hospital, clinic, or associated facility for diagnosis or treatment. Inpatients are admitted to a hospital and stay at least one night.

Figure 4.3 Foreign inpatients and outpatients (2007)



Source: APHM (2008)

4.3 I-O analysis

The starting point of I-O analysis is final demand. Final demand is the value of goods and services bought for the direct fulfilment of needs and wants (in contrast to goods and services used as an input in production processes). Final demand brings about a chain of production. First, goods and services that are part of final demand need to be produced. This requires production factors (i.e., capital and labour) as well as intermediate inputs. These intermediate inputs also need to be produced, again requiring production factors and a subsequent 'level' of intermediate inputs. This process continues for several rounds.

Combining final demand and all 'levels' of intermediate inputs, an I-O model enables calculation of the total production (=output) required to satisfy final demand. Moreover, production of a industry can be linked to the final demand of another industry (e.g., the amount of output from 'Agriculture' needed to enable final demand from medical tourists for medical services or other goods and services). Output can be translated into value added: the difference between the value of output and purchases of intermediate inputs. Alternatively, it is the income created in a industry. Value added is calculated assuming a fixed ratio between production and income created. Using a fixed ratio also enables us to calculate employment. The I-O model enables impacts on output, value added and employment to be subdivided into direct and indirect impacts. Direct impacts are impacts directly related to final demand (impacts in the industries supplying goods and services to medical tourists). Indirect impacts are impacts related to the production of intermediate inputs.

I-O analysis is well established in the scientific literature and is often applied (e.g., in tourism studies, Çela et al., 2009; Kashian & Pfeifer-Lucket, 2011; Hanly, 2012). In Malaysia, I-O analysis has been applied to calculate impacts of 'conventional' tourism (United Nations, 1991; Rashid & Rahman, 1993; Mazumder et al., 2011; Hassan & Jenggie, 2012). Outside of tourism, there are many examples of applications of both 'traditional' I-O models (Kwak et al., 2005; Spörri et al., 2007; He & Zhang, 2010) and more advanced versions (e.g., models in which not only economic but also energy and carbon impacts are considered (Lenzen & Murray, 2001; Machado et al., 2001; Wiedmann et al., 2010)). I-O models are also a popular 'tool' among consultancy firms. Despite its widespread use, discussion on the appropriateness of I-O models is on-going. The model is built on strong assumptions: absence of relative price changes, infinite availability of production factors, and usage of inputs in fixed I-O ratios (Briassoulis, 1991; Dwyer et al., 2004). Had the goal of our analysis been to model the impacts of change in final demand and the aforementioned assumptions not been met, a different research method would have been needed (e.g., a computable general equilibrium (CGE) model). In this chapter, however, our goal is to show the significance of medical tourism. For this, we use the I-O model as a descriptive tool rather than an economic model, and calculate the output, value added, and employment related to the expenditure of medical tourists.

The I-O model requires an I-O table. I-O tables are part of the national accounts and give a detailed overview of interrelationships between industries, deliveries to final users (i.e., final demand) and use of production factors. An I-O table is available for Malaysia for 2005. For a state-level analysis, however, we required I-O tables for each state. Flegg and Webber (1997) have developed a regionalization procedure to derive state-level I-O tables from national I-O tables, based on location quotients (LQs) and employment per industry, at national and state level.

Because national- and state-level employment data is not available for all 120 industries in the national I-O table, but only for 18 aggregated industries[30] (Department of Statistics Malaysia, 2011), the first step in the regionalization procedure was to aggregate data in the national I-O table into these 18 industries. Second, national I-O coefficients (a_{ij}^N) were calculated. These coefficients show, for each combination of industries, the part of the total input of industry j (X_j) coming from the intermediate input supplied by industry i (s_{ij}).

$$a_{ij}^N = {}^{s_{ij}}/_{X_j} \tag{4.1}$$

Third, Flegg's location quotients (FLQ_{ij}^R) were calculated. FLQ_{ij}^R show the degree to which industry i is present in state R to satisfy demand for intermediate inputs from industry j.

$$FLQ_{ij} = CILQ_{ij} \cdot \lambda^* \tag{4.2}$$

$$CILQ_{ij} = \frac{empl_i^R / empl_i^N}{empl_j^R / empl_j^N} \tag{4.3}$$

$$\lambda^* = \left(log_2 \left(1 + \frac{\sum_{i=1}^{n} empl_i^R}{\sum_{i=1}^{n} empl_i^N} \right) \right)^{\delta} \tag{4.4}$$

$empl_j^R$ and $empl_j^R$ represent state-level employment in, respectively, industries i and j and $empl_i^N$ and $empl_j^N$ represent national level employment in, respectively, industries i and j. Following Flegg and Webber (1997), we assume a δ of 0.3. Fourth, state-level I-O coefficients (a_{ij}^R) were calculated: a FLQ_{ij}^R greater than or equal to one implies that industry i is sufficiently present in state R to fulfil the needs of industry j. In that case the state-level I-O coefficient is equal to the national I-O coefficient (assuming that the production structure of the demanding industry is equal at national and state levels). A FLQ_{ij}^R less than one indicates that industry i is not sufficiently present in state R to fulfil the needs of industry j. The national I-O coefficient is revalued downwards through multiplication with FLQ_{ij}^R:

$$a_{ij}^R = \begin{cases} if FLQ_{ij} > 1, a_{ij}^R = a_{ij}^N \\ if FLQ_{ij} < 1, a_{ij}^R = a_{ij}^N \cdot FLQ_{ij} \end{cases} \tag{4.5}$$

30 'Agriculture, forestry, fishing', 'Mining and quarrying', 'Manufacturing', 'Electricity, gas, steam and air conditioning supply', 'Water supply, sewage, waste and remediation', 'Construction', 'Wholesale and retail trade, repair of motor vehicles and motorcycles', 'Transportation and storage', 'Accommodation and food services', 'Information and communication', 'Finance and insurance', 'Real estate activities', 'Professional, scientific and technical services', 'Public administration and defense; compulsory social security', 'Education', 'Human health and social work activities', 'Arts, entertainment and recreation', and 'Other service activities'.

This regionalization procedure is an approximation of intra-state inter-industry relations. One important assumption underlying the FLQ method is that national technology of an industry applies in all regions. For some industries this is a realistic assumption, though the technology of other industries is likely to differ between states. The actual intra-state inter-industry relations can only be identified by undertaking a detailed survey in all the states and industries, an exercise beyond the scope of this research. Finally, it is very important to note that inter-state flows are not taken into consideration: in this model, an increase in the production in one state does not lead to more production in other states.

Based on the I-O tables, we used matrix algebra to develop state-level I-O models. We perform a technical operation on the matrices containing state-level I-O coefficients (A_R) to develop 'Leontief inverse matrices' (L_R)

$$L_R = (I - A_R)^{-1} \tag{4.6}$$

where L_R is the Leontief inverse of state R, I is the unity matrix and A_R is the matrix containing state-level I-O coefficients a_{ij} of state R. I-O coefficients show the use of intermediate input i to produce one unit of output of industry j. Equation 4.7 shows that the Leontief inverse enables the calculation, for any level of final demand (Y_R), of the required output (X_R). Y_R and X_R are column vectors containing respectively final demand and required output, per industry of state R.

$$X_R = L_R \cdot Y_R \tag{4.7}$$

To apply the I-O model to medical tourism, medical tourists' expenditure, per industry and per state (the vectors Y_R), needs to be established. Below we describe, separately, the method used to calculate foreign patients' medical expenditure (assigned to the industry 'Human health and social works') and their expenditure in non-medical industries (assigned to other industries).

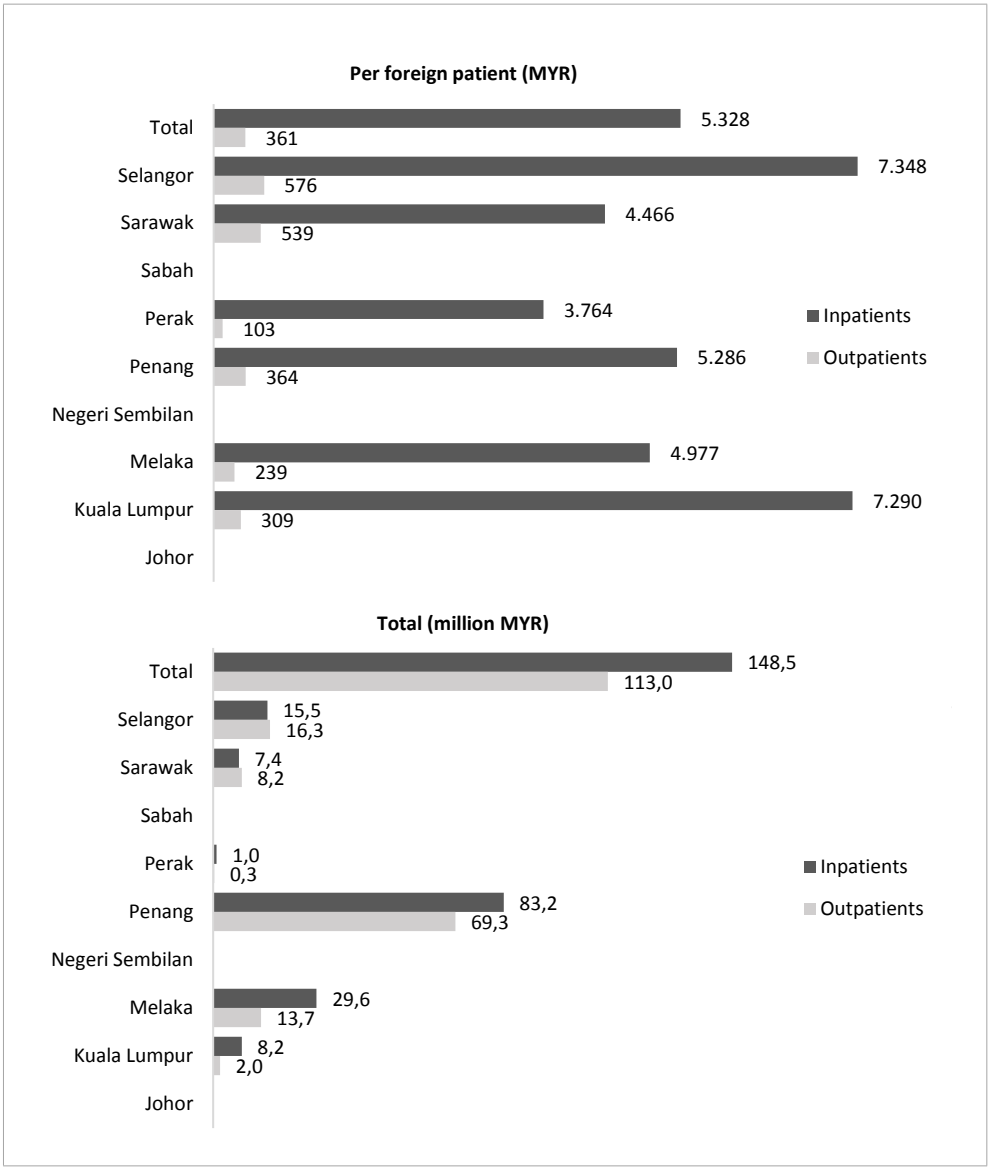
4.4 Foreign patients' expenditure

4.4.1 Foreign patients' medical expenditure

The APHM (2008) data contain data on foreign patient numbers and their medical expenditure at the level of individual states and for both inpatients and outpatients. On the left side of figure 4.4, we see that Kuala Lumpur and Selangor have the highest values for medical expenditure per inpatient, while Sarawak and Selangor have the highest values for medical expenditure per outpatient. With most medical specialists and high-tech equipment concentrated in Kuala Lumpur and Selangor, it follows that more complicated, higher-end inpatient procedures also happen more frequently in these locations. Geography provides an additional explanation: Kuala Lumpur/Selangor is the Peninsular Malaysian hub for many specialties, while Sarawak is a hub for specialties in East Malaysia (Malaysian Borneo). Although medical expenditure per inpatient is much higher than medical expenditure per outpatient, the numerical dominance of outpatients (figure 3) leads to relatively

small differences between total medical expenditure of the two groups, as shown on the right side of figure 4.

Figure 4.4 Foreign patients' medical expenditure (2007)[a]



a To assure anonymity medical expenditure per inpatient and outpatient are not shown for the three states for which there is only one hospital in the APHM (2008) dataset: Johor, Negeri Sembilan, and Sabah.
Source: APHM (2008)

4.4.2 Foreign patients' non-medical expenditure

The APHM (2008) dataset does not contain any information about foreign patients' non-medical expenditure. To the best of our knowledge, Musa et al. (2012) are the sole authors to have provided any information on foreign patients' non-medical expenditure in Malaysia. In their study, a relatively small sample of foreign inpatients in a selection of private hospitals endorsed for medical tourism in Kuala Lumpur was asked about their expenditure. The results of this study cannot be generalized to all medical tourists because, as indicated by APHM (2008) data, there are far fewer inpatients than outpatients throughout the country. Furthermore, the APHM (2008) data make clear that medical expenditure in Kuala Lumpur differs from expenditure in other parts of the country. This is most likely also true for non-medical expenditure. In spite of the sample's specificity, the data from Musa et al. (2012) can still be used to give an indication of inpatients' non-medical expenditure, by means of a four-step procedure.

First, expenditure categories identified by Musa et al. (2012) need to be assigned to industries of the I-O model. Table 4.2 shows which categories are assigned to which industries. Musa et al. (2012) have included a 'Miscellaneous' category. The choice was made to divide expenditure in this category equally over the industries 'Wholesale and retail trade', 'Repair of motor vehicles and motorcycles', 'Information and communication', 'Finance and insurance', 'Education' and 'Other service activities'. Each industry is assigned MYR 499 (USD 141). Foreign patients' expenditure on international airfares is not assigned to a industry as it is assumed that this expenditure does not lead to production in Malaysia. Potentially, this leads to a small underestimation, because some Malaysian airlines do benefit from medical tourism and are even involved in developing medical tourism packages (Ormond, 2013a).

Table 4.2 Allocating expenditure categories identified by Musa et al. (2012) to industries in I-O model (2007, MYR/USD)

Expenditure categories in Musa et al. (2012)	Mean expenditure (market prices)		Industries I-O model	Mean expenditure (market prices)	Mean expenditure (market prices), excluding direct imports	Mean expenditure (basis prices)	
	MYR	USD		MYR	MYR	MYR	USD
Shopping	2,505	710	Manufacturing	2,505	1,915	1,565	444
Domestic transportation	618	175	Transport and storage	618	502	561	159
Accommodation	3,257	923	Accommodation and food services	4,907	4,707	4,719	1,337
Food and beverages	1,650	468					
Healthcare services	12,260	3,475	Human health and social works activities	12,260	12,260	12,205	3,459
Organized tours	2,748	779	Arts, entertainment and recreation	3,836	3,824	3,337	946
Entertainment	1,088	308					
Miscellaneous	2,494	707	Wholesale and retail trade	499	499	752	213
			Information and communication	499	499	497	141
			Finance and insurance	499	499	497	141
			Education	499	499	497	141
			Other service activities	499	499	435	123
International airfares	3,743	1,061	x	x	x	x	X

Source: Musa et al. (2012); own calculations

Second, the expenditure data includes foreign patients' expenditure on goods and services which are not produced in Malaysia ('direct imports'). Because the I-O table is in the form of an 'I-O table for domestic production', this should not be included in final demand. The national make and use tables (Asian Development Bank, 2012) contain percentages per industry for direct imports which were used to exclude direct imports[31]. On the state level, this is likely to lead to an underestimation

31 There are three industries in which foreign patients spend part of their money and for which national percentages of direct imports are non-zero, namely 'Manufacturing' (36.9%), 'Transport and storage' (18.7%), and 'Arts, entertainment, and recreation' (0.3%). Using the national percentage for 'Manufacturing' (36.9%) to calculate direct imports for foreign patients would lead to overestimation, since foreign patients are unlikely to buy 'Basic metals' or 'General or special purpose machinery'. These are the sub-industries within 'Manufacturing' with the highest percentages of direct imports. Therefore, only the sub-industries 'Food, beverages, and tobacco', 'Clothing and wearing apparel, leather and leather product', 'Products of wood, paper and paper products', 'Fabricated metal products', and 'Other manufacturing' are included in the calculation of the relevant direct import percentage (23.5%).

of direct imports because inter-state direct imports are not taken into consideration in the national percentages. The data however do not permit us to correct for this.

Third, because the I-O table is expressed in 'basic prices' and expenditure data is in 'market prices', adjustments need to be made. Net indirect taxes and trade and transport margins need to be subtracted. Net indirect taxes should not be included in the calculations, while trade and transport margins are assigned respectively to 'Wholesale and retail trade' and 'Transport and storage'. The make and use tables (Asian Development Bank, 2012) contain percentages of net indirect taxes and trade and transport margins per industry, which are used to adjust the expenditure profile. It is assumed that trade and transport margins are also relevant for the direct imports.

Fourth, because the abovementioned specificities of the data reported by Musa et al. (2012) would, if generalized, lead to significant overestimation, we used the 2007 APHM (2008) data to adjust Musa et al.'s (2012) inpatients' expenditure profiles. Table 4.3 illustrates the required calculations, based on hypothetical data. We compared inpatients' expenditure on 'Healthcare Services' reported in Musa et al. (2012) to inpatients' medical expenditure reported for each state in the 2007 APHM (2008) dataset. This enables us to calculate a factor per state to compensate for overestimated medical expenditure in Musa et al. (2012). Our assumption was that the overestimation in Healthcare Services is representative for the overestimation in all industries. Expenditure in each non-medical industry, based on Musa et al. (2012) was multiplied by this factor, to arrive at adjusted inpatients' non-medical expenditure profiles. These expenditure profiles were multiplied with the number of inpatients per state, resulting in total inpatients' non-medical expenditure per state and industry.

Table 4.3 Calculation of inpatient's non-medical expenditure (MYR, hypothetical data)

Inpatients	Medical expenditure per inpatient in State X (APHM, 2008)	Expenditure profile in Kuala Lumpur (Musa et al., 2012)	Factor for State X (based on medical expenditure)	Adjusted inpatients' non-medical expenditure profile in State X	Nr. of inpatients in State X (APHM, 2008)	Total inpatients' non-medical expenditure in State X
Accommodation	-	100		50		5,000
Healthcare Services	100	200				
Catering	-	300		150		15,000
Total	100	600	100/200	200	100	20,000

Source: Own calculations

Musa et al.'s (2012) data are specifically for inpatients. Therefore, we have used different data sources and a different procedure to estimate outpatients' non-medical expenditure. Table 4.4 illustrates the calculations, based on hypothetical data. Based on the 2007 APHM (2008) data, we know outpatient' nationalities per state. Via the Malaysian Tourism Promotion Board (2008) information is available about the average expenditure profiles of all visitors to Malaysia in 2007, per nationality of the visitor. When we assume that the national expenditure profile of visitors to Malaysia (by nationality) can be used as an approximation of outpatients' non-medical expenditure (by nationality, independently of the state(s) visited), we can combine the two data sources and estimate

outpatients' non-medical expenditure profiles. The expenditure profiles were multiplied with the number of outpatients per state to arrive at total outpatients' non-medical expenditure per state and industry.

Table 4.4 Calculation of outpatients' non-medical expenditure (MYR, hypothetical data)

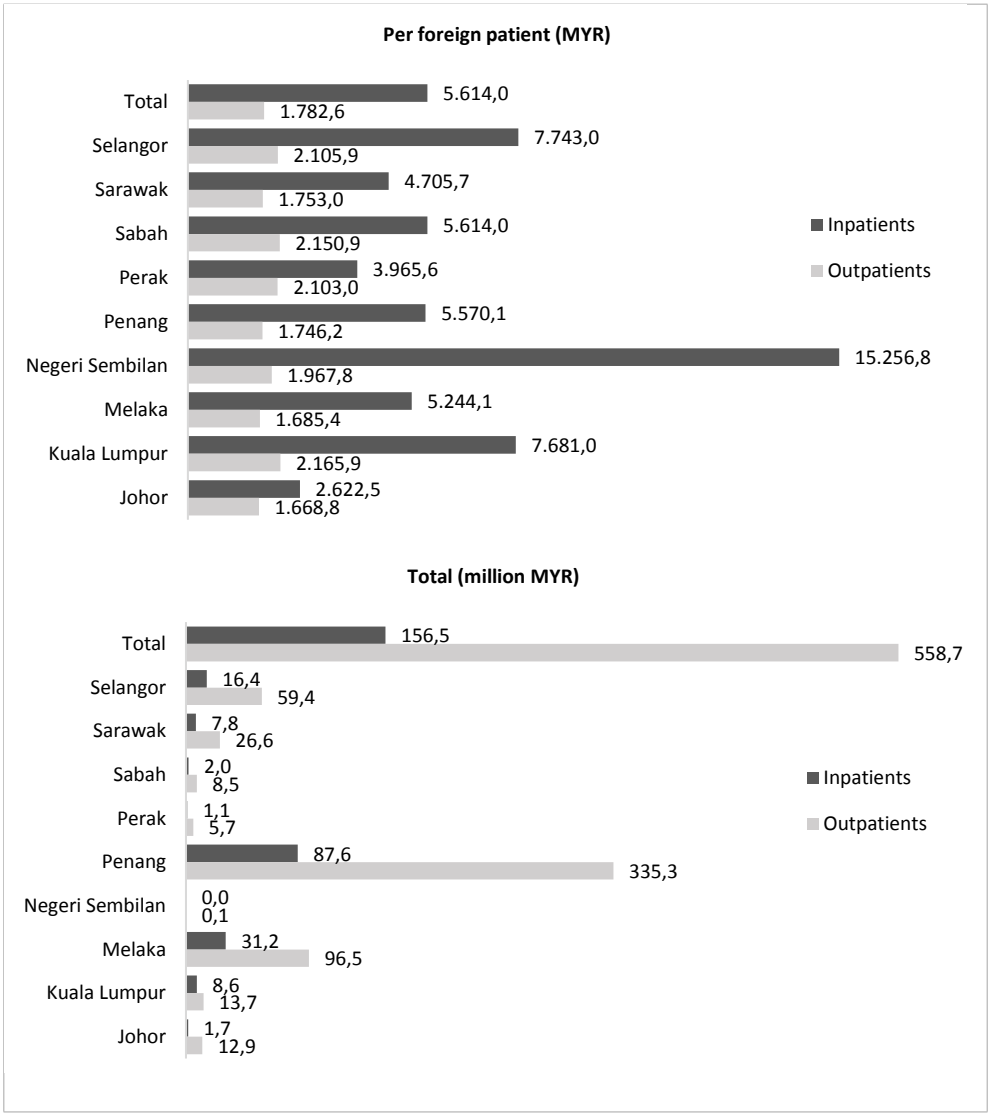
Outpatients	Nationality of patients in State X (APHM, 2008)		Tourists' expenditure profile (Malaysian Tourism Promotion Board, 2008)		Outpatients' non-medical expenditure profile in State X	Nr of outpatients in State X (APHM 2008)	Total outpatients' non-medical expenditure in State X
	European	Asian	European	Asian			
Accommodation			50	20	42.5		4,250
Transport			100	50	87.5		8,750
Catering			150	100	137.5		13,750
Total	75%	25%	200	120	267.5	100	26,750

Source: Own calculations

On the left side of figure 4.5, we see that the data and our calculations result in the highest non-medical expenditure per inpatient in the states of Negeri Sembilan, Kuala Lumpur, and Selangor. Taken together as a unit, Kuala Lumpur/Selangor comprises one of the country's most expensive areas and is also a principal tourism hub. For Negeri Sembilan there is only a very small number of observations in the APHM (2008) dataset (36 foreign patients in total), limiting the representativeness of the high expenditure figure for inpatients. For non-medical expenditure per outpatient, Kuala Lumpur, Sabah, and Selangor have the highest values.

It is obvious that the assumptions we are using to calculate foreign patients' non-medical expenditure are strong. This clearly points to the need to collect better data regarding non-medical expenditure. It also led to the choice to show separately, in Table 4.6 in the fifth section, the impacts related to medical and non-medical expenditure.

Figure 4.5 Foreign patients' non-medical expenditure (2007)



Sources: APHM (2008); Musa et al. (2012); Malaysian Tourism Promotion Board (2008); own calculations

4.4.3 Foreign patients' total expenditure

Taking together the inpatients' and outpatients' medical and non-medical expenditure, Table 4.5 shows total foreign patients' expenditure per industry and state. Medical expenditure is assigned to the industry 'Human health and social work activities'. Non-medical expenditure is assigned to the other industries. For the I-O model, each column in Table 4.5 represents a final demand vector (Y_R). Total required output X_R can be determined by multiplying the Y_R-vectors with the L_R-matrices.

Table 4.5 Total foreign patients' expenditure, by industry and Malaysian state (2007, million MYR, basic prices)

	Johor	Kuala Lumpur	Melaka	Negeri Sembilan	Penang	Perak	Sabah	Sarawak	Selangor	Total	Total (million USD)
Manufacturing	3.0	3.7	25.2	0.0	81.1	1.2	1.7	6.6	12.8	135.3	38.4
Wholesale and retail trade	0.9	1.1	7.9	0.0	24.5	0.3	0.4	2.0	3.3	40.4	11.5
Transportation and storage	1.6	2.3	12.6	0.0	44.9	0.9	1.3	3.6	9.4	76.7	21.7
Accommodation and food services	6.6	10.5	56.3	0.1	195.1	3.6	5.6	15.7	38.9	332.2	94.2
Information and communication	0.4	0.5	3.8	0.0	11.4	0.1	0.2	0.9	1.3	18.5	5.2
Finance and Insurance	0.4	0.5	3.8	0.0	11.4	0.1	0.2	0.9	1.3	18.5	5.2
Education	0.4	0.5	3.8	0.0	11.4	0.1	0.2	0.9	1.3	18.5	5.2
Human health and social work activities	2.8	10.1	43.3	0.2	153.0	1.3	3.3	15.6	31.8	261.5	74.1
Arts, entertainment and recreation	0.9	2.8	11.1	0.0	33.3	0.5	0.8	2.9	6.5	58.7	16.6
Other service activities	0.4	0.4	3.3	0.0	10.0	0.1	0.1	0.8	1.1	16.2	4.6
Total	17.4	32.5	171.0	0.3	576.0	8.1	13.8	50.0	107.6	976.7	276.8

Source: Own calculations

4.5 Results and discussion

Table 4.6 shows the state-level impacts of medical tourism in Malaysia. Impacts on total output were calculated using the I-O model. To arrive at impacts on value added and employment, total output in each industry and state was multiplied by industry-specific ratios between value added and output and employment and output. These ratios were calculated based on the I-O table and employment statistics, both at national level and for the year 2005. Also included are output multipliers and medical tourism's relative importance. Output multipliers are calculated by dividing total output by direct output, showing how much output is required in all industries for every MYR spent by foreign patients. The relative importance is calculated as the percentage of total state-level output that is produced because of medical tourism.

Table 4.6 Economic impacts of foreign patients' expenditure (2007, million MYR, basic prices)

	Johor	Kuala Lumpur	Melaka	Negeri Sembilan	Penang	Perak	Sabah	Sarawak	Selangor	Total	Total (million) USD
Direct output	-[a]	32.5	171.0	-	576.0	8.1	-	50.0	107.6	976.7	276.8
Medical	-	10.1	43.3	-	153.0	1.3	-	15.6	31.8	261.5	74.1
Non-medical	14.6	22.3	127.7	0.1	422.9	6.8	10.5	34.4	75.8	715.2	202.7
Indirect output	7.5	11.2	36.2	0.1	189.5	2.6	5.9	18.9	64.8	336.7	95.4
Medical	1.4	2.9	9.0	0.1	47.7	0.4	1.5	6.1	16.9	86.1	24.4
Non-medical	6.1	8.3	27.2	0.0	141.8	2.2	4.3	12.8	47.9	250.6	71.0
Total output	-	43.7	207.2	-	765.5	10.8	-	68.8	172.4	1,313.4	372.3
Medical	-	13.1	52.3	-	200.7	1.7	-	21.7	48.7	347.6	104.9
Non-medical	20.7	30.6	154.9	0.1	564.7	9.1	14.8	47.1	123.7	965.8	273.7
Value added	8.8	16.4	73.9	0.1	270.7	3.8	7.2	24.9	62.6	468.6	132.8
Employment (No. of jobs)	363.1	656.0	3,272.3	6.5	11,443.4	164.0	296.3	1,035.8	2,349.4	19,586.7	-
Multiplier	1.43	1.35	1.21	1.24	1.33	1.32	1.42	1.38	1.60	-	-
Relative importance	0.0%	0.1%	0.4%	0.0%	0.6%	0.0%	0.0%	0.1%	0.0%	0.1%	-

a To assure anonymity, output related to medical expenditure is not shown for the three states for which there is only one hospital in the APHM (2008) dataset: Johor, Negeri Sembilan, and Sabah.
Source: Own calculations

In 2007, the reported 341,288 foreign patients generated MYR 1.3 billion (USD 372.3 million) total output, MYR 468.6 million (USD 132.8 million) in value added and 19,586.7 jobs. To put these impacts into perspective: medical tourism's total output, value added and employment in the nine states included in our analysis represent, respectively, 0.1%, 0.1%, and 0.2% of total national output, value added and employment. We can compare our results to the government's targets for medical tourism for 2020 (revenue of MYR 9.6 billion (USD 2.7 billion), GNI of MYR 4.3 billion (USD 1.2 billion) and 5,300 more jobs for medical professionals) (Pemandu, 2012b, 2012c). Although the concepts are not necessarily equivalent, total output can be compared to revenue and value added to GNI[32]. When we assume that the government's targets include indirect impacts (which are not specified), we find a large gap between our 2007 results and the targets for 2020. If the targets actually relate only to direct impacts of medical tourism, then the gap is even larger. We acknowledge that the government targets are based on impacts in all 13 Malaysian states (not just the nine states included in our analysis) and there is also a large gap between the number of foreign patients upon which our

32 Gross national income is equal to gross domestic product (GDP = Value Added) plus factor incomes earned by residents in foreign economies, minus factor income earned in the domestic economic by non-residents.

2007 analysis is based (341,288) and the target for 2020 (1.9 million), but even when we base our calculations on this target number of foreign patients, the estimated total output (MYR 3.8 billion (USD 1.1 billion)) and value added (MYR 1.4 billion (USD 392.9 million)) are still significantly lower than the targets for revenue and GNI. The explanation is that targets are based on a significantly higher expenditure per foreign patient (MYR 5,053 per patient, versus the MYR 2,037 per patient in our calculations). Looking at jobs in 'Human Health and Social Works', our total for 2007 is 4,748.2 (subtracting jobs in other industries from 19,586.7). Given the ambition to attract more than five times as many foreign patients as in 2007, the 2020 employment target (5,300 more jobs for medical professionals) seems modest.

Table 4.6 subdivides total output into direct and indirect output and output related to medical and non-medical expenditure. The Table makes clear that the greatest impacts originate from non-medical expenditure. Total output of MYR 1,313.4 million (USD 372.3 million) comprises output related to non-medical expenditure of MYR 965.8 million (USD 273.7 million) and output related to medical expenditure of MYR 347.6 million (USD 104.9 million). Indirect impacts comprise a substantial part of total impacts. Total output comprises direct output of MYR 976.7 million (USD 276.8 million) and indirect output of MYR 336.7 million (USD 95.4 million). Table 4.7 subdivides total output in output related to inpatients and outpatients. Even though medical and non-medical expenditure per outpatient is logically lower than expenditure per inpatient (figure 4.4), the numerical dominance of outpatients leads to higher impacts on total output for outpatients.

Table 4.7 Subdivision of total output related to foreign patients' expenditure in output related to inpatients and outpatients (2007, million MYR, basic prices)

	Johor	Kuala Lumpur	Melaka	Negeri Sembilan	Penang	Perak	Sabah	Sarawak	Selangor	Total
Total output	24.9	43.7	207.2	0.4	765.5	10.7	19.7	68.9	172.4	1313.4
Inpatients	-[a]	22.3	73.8	-	227.8	2.8	-	21.1	50.2	408.6
	-	51%	36%	-	30%	26%	-	31%	29%	31%
Outpatients	-	21.5	133.4	-	537.6	8.0	-	47.8	122.2	904.8
	-	49%	64%	-	70%	75%	-	69%	71%	69%

a To assure anonymity, the subdivision is not shown for the three states for which there is only one hospital in the APHM (2008) dataset: Johor, Negeri Sembilan, and Sabah.
Source: Own calculations

Looking at the output multipliers (Table 4.6), Selangor, Johor, and Sabah have the highest values. In these states, foreign patients' expenditure leads to the highest level of indirect impacts. When we focus on medical expenditure, Table 4.6 shows that direct output of MYR 261.5 million (USD 74.1 million) leads to an indirect output of MYR 86.1 million (USD 24.4 million). Table 4.8 shows the subdivision of indirect output. The percentages indicate the proportion of the output of an industry to total indirect output. In the final column, showing totals for the nine states, we can see that most

of the indirect output is produced in the industries 'Human health and social works' (in addition to its direct output) and 'Manufacturing'. This same analysis could also be carried out for indirect impacts related to non-medical expenditure.

Table 4.8 Indirect output related to foreign patients' medical expenditure (2007, million MYR, basic prices)

	Johor	Kuala Lumpur	Melaka	Negeri Sembilan	Penang	Perak	Sabah	Sarawak	Selangor	Total	Total (Million) USD
Total indirect output	1.4	2.9	9.0	0.1	47.7	0.4	1.5	6.1	16.9	86.1	24.4
Human Health and Social Works	0.4	1.3	4.1	0.0	18.9	0.2	0.5	2.1	5.9	33.4	9.5
	30.3%	43.3%	45.7%	44.8%	39.6%	45.6%	33.0%	34.7%	34.8%	38.9%	
Manufacturing	0.6	0.4	3.0	0.0	19.8	0.1	0.4	1.8	5.4	31.5	8.9
	42.8%	14.7%	33.0%	27.5%	41.4%	30.2%	28.4%	29.5%	31.7%	36.6%	
Trade	0.1	0.4	0.8	0.0	3.3	0.0	0.2	0.8	1.4	7.2	2.0
	10.3%	14.5%	8.9%	9.5%	7.0%	9.3%	15.3%	12.8%	8.3%	8.3%	
Real Estate	0.0	0.2	0.1	0.0	1.3	0.0	0.1	0.1	0.7	2.4	0.7
	2.1%	6.4%	0.7%	3.1%	2.7%	1.0%	3.7%	1.0%	3.9%	2.7%	
Transport and Storage	0.0	0.1	0.2	0.0	1.0	0.0	0.1	0.2	0.7	2.2	0.6
	3.4%	2.8%	1.7%	2.9%	2.1%	1.9%	3.6%	3.5%	4.0%	2.6%	
Other	0.2	0.5	0.9	0.0	3.4	0.0	0.2	1.1	2.9	9.3	2.6
	11.1%	18.2%	9.8%	12.2%	7.1%	11.9%	16.1%	18.6%	17.4%	10.9%	

Source: Own calculations

Based on Table 4.6, we conclude that total output per state differs substantially. This is the result of differences between states in numbers of inpatients and outpatients (figure 4.3), expenditure per inpatient and outpatient (figure 4.4), and output multipliers (Table 4.6). As Table 4.6shows, Penang, Melaka, and Selangor have the highest total output. For Penang and Melaka, this is also reflected in the relative importance of medical tourism (0.6% and 0.4%, respectively), which is much higher than the relative importance of 0.1% at the national level. In Selangor, the relative importance of medical tourism is smaller (0.0%), which is attributable to the larger size of the state's economy. The top position of Penang and Melaka is explained most of all by the high number of foreign patients they receive. Selangor scores high on the number of foreign inpatients and outpatients and is the state with the highest expenditure per foreign inpatient, expenditure per foreign outpatient, and output multiplier.

4.6 Conclusions

The objective of this chapter was to analyze medical tourism's state-level economic impacts in Malaysia in order to provide information we consider as a prerequisite for destination management. In the nine states included in our analysis, medical tourism had, in 2007, impacts of MYR 1.3 billion (USD 373.3 million) in output, MYR 468.6 million (USD 132.8 million) in value added and 19,586.7 jobs. We have shown that impacts related to non-medical expenditure are more substantial than impacts related to medical expenditure and that indirect impacts make up a substantial part of total impacts. Both findings lead to the recommendation to not only focus on the maximization of economic and employment gains from medical tourism in the medical industry but also to take into account its impacts in other industries. Furthermore, our results illustrate the relevance of a sub-national perspective on medical tourism's impacts. No two medical tourism destinations within Malaysia are the same. Destinations receive different numbers and types of patients, with different needs and wants, different expenditure patterns, and different impacts on local economies.

To better respond to this diversity, we first recommend that medical and non-medical resources appropriate to the needs, demands, and interests of not only foreign patients but also local populaces be identified and developed (Mainil et al., 2012, 2013). This requires destinations to pay specific attention to the diverse ways in which different stakeholders (e.g., municipal, state and federal governments; civil society and citizens; private-sector industry; labour and consumers) are arranged in relation to, involved in and committed to the development of medical tourism throughout a country and the ways in which medical tourism is conceived and visualized. There is scope, therefore, for independent state- and municipal-level economic institutes, consumer and labour organizations, and health monitoring bodies, to play a much more significant role in reporting, monitoring and shaping sub-national policy on medical tourism instead of the current situation, where medical tourism policy is shaped predominantly by special federal government divisions and bodies (e.g., MHTC), private-sector hospital and travel associations, and individual hospitals.

While our analysis indicates that medical tourism clearly impacts Malaysia's economy in diverse ways, concentrating solely on its macro-economic value can lead to the commoditization of health care and envisioning health as a private instead of public good. Ethical and logistical questions abound about the relationship between medical tourism and equitable access to health care (Connell, 2013a). They challenge us to consider, for example, whether, and to what extent, local Malaysian patients benefit from medical tourism infrastructure in states where the medical tourism industry has or has not taken hold (Ormond et al., 2014).

Our findings further suggest that greater attention and sensitivity should be paid to real and potential implications of the high ratio of outpatients to inpatients for the development of Malaysia's medical tourism industry. Outpatients spend less on medical and non-medical expenditures but constitute by far the largest proportion of foreign patients in destinations throughout Malaysia. Outpatient-heavy demand – which, to date, has gone largely unexplored in literature on medical tourism (Horton & Cole, 2011) – has significant bearing on the ways in which we define and develop the supply of appropriate medical and non-medical infrastructure and human resources at both national and sub-national levels.

Throughout this chapter, we also noted some limitations to our approach, such as the assumptions required to estimate foreign patients' non-medical expenditure and allocation of this expenditure to industries of the I-O model. Besides Musa et al.'s (2012) study based on a small sample of inpatients

in Kuala Lumpur, no data are available on this. Additional studies could provide more insight into non-medical expenditure. Limited data availability also led to the choice to restrict ourselves to impacts of expenditure by foreign patients. There is no information available on the number of medical travel companions and their non-medical expenditure, though the impact of companions is acknowledged in recent literature (Casey et al., 2013). Regarding the 2007 APHM (2008) data, we noted that it excludes foreign patients using non-endorsed facilities and it does not provide a subdivision of foreign patients into the categories 'medical tourists' and non-nationals residing in Malaysia. Furthermore, because the most recent disaggregated information available is from 2007, we were not able to take into account that the geographical distribution of medical tourism-endorsed facilities and concentrations of foreign patients has shifted somewhat since 2007 (Ormond, 2013b). These all point to the importance of longitudinal studies of in- and outpatients' medical and non-medical expenditure by state, region and city in order to permit better response to foreign patient flows and strategic planning. Ideally, these studies would split foreign patients not covered by Malaysian health insurance schemes into subcategories such as 'medical tourists' and non-nationals residing in Malaysia. Realism would increase if recent survey-based state-level I-O tables were available. Furthermore, data on inter-state relationships between industries could enable analyses based on multi-regional I-O models in which inter-state trade flows are taken into account. Despite these limitations, with the I-O analysis, we were able to provide a useful model for generating a meaningful preliminary indication of medical tourism's state-level economic impacts in Malaysia.

5. Non-linear I-O model[33]

5.1 Introduction

Within tourism management it is still common practice to apply traditional Input-Output (I-O) models. These models are used by many consultants and academic researchers (e.g. Hanly, 2012; Kashian & Pfeifer-Luckett, 2011; Çela et al., 2009) despite their well-known limitations (e.g. Miller & Blair, 2009; Archer, 1989; Briassoulis, 1991; Sun, 2007; Wanhill, 1988). In I-O models relative prices are fixed, and therefore input substitution is not possible (i.e. Leontief production function). Moreover, production factors (capital and labour) are (infinitely) available. There is a linear relationship between direct and indirect impacts and an expansion (or reduction) of final demand leads, by definition, to an expansion (or reduction) of economic activity.

As an alternative for I-O models, several authors (Zhou et al, 1997; Dwyer et al, 2004; Blake et al, 2001) advocate the use of computable general equilibrium (CGE) models. CGE models are considered to provide a more accurate representation of economic reality. These models e.g. take into account that changes in final demand can lead to relative price changes[34] and input substitution. Within tourism there is now a substantial amount of literature on the application of CGE models. Examples on a national level or for large regions or islands are Dwyer et al. (2006); Li et al. (2013); Meng et al. (2013); Narayan (2004); Nowak and Sahli (2007); Polo and Valle (2008) and Pratt (2012). For an application of a small region see Burnett et al. (2007). A disadvantage of CGE models compared to I-O models is that, besides data on the I-O structure and final demand (i.e. an I-O table at the appropriate regional scale), data on who earns income, income transfers, and how income is spent are required (i.e. a Social Accounting Matrix (SAM) at the appropriate regional scale). Moreover, final demand has to be explicitly modelled (e.g. assuming utility maximization for consumers and modelling investment) and cannot any longer be exogenous. The additional data requirements, in particular, often make I-O models the only feasible option (chapter 2; West & Gamage, 2001; Zhou et al., 1997).

In the present study, we addressed the limitations of I-O models and 'upgraded' the I-O model, without introducing the complexity and data collection costs associated with a full CGE model. In our Non-linear I-O model (NLIO) model the main drawback of an I-O model, i.e. lack of input substitution, is accounted for by replacing Leontief production functions by a Constant Elasticity of Substitution (CES) production functions.

We applied the NLIO model to analyze regional economic impacts of tourism in the province of Zeeland in the Netherlands. This region was selected because of the availability of a regional I-O table (RIOT), sufficient data on the expenditure in tourism and because of the economic dependence of Zeeland on tourism. Zeeland attracts more than 1.3 million domestic tourists (8% of the total for the Netherlands; (Statistics Netherlands, 2009) who spend 8.1 million nights (9% of the total for the Netherlands). There are 40 million day visits (3% of total for the Netherlands; NBTC NIPO Research,

33 Published as Klijs, J., J. Peerlings, & W.J.M. Heijman. 2014. Usefulness of Non-Linear Input-Output Models for Economic Impact Analyses in Tourism and Recreation. *Tourism Economics*, 21(5), 931-956.

34 We use 'relative price' to refer to the ratio between prices of two inputs. 'Relative prices change' refers to a change of this ratio, compared to the benchmark situation. We use 'price change' to refer to a change of the prices of an input, compared to the price of this input in the benchmark situation.

(2011a) and more than 700,000 international tourists (7% of the total for the Netherlands; NBTC, 2009. North Sea beaches are the main attractions in Zeeland, for all three groups of visitors. Besides the beaches Zeeland also offers cultural attractions, such as (small) theme parks, museums, Delta works and historic cities such as Middelburg and Zierikzee.

We applied the NLIO model in three scenarios: (1) 10% increase in expenditure in tourism in Zeeland; (2) 10% increase in expenditure by visitors to one individual tourism attraction, namely Museum X[35]; (3) 20% decrease in the subsidy received by Museum X. The first two scenarios were meant to assess the usefulness of the NLIO model to analyze large and small changes in final demand, respectively. In the last scenario we focused on a change related to the present economic situation, lower subsidies, that cannot be analyzed in an I-O model.

In each scenario we applied three versions of the NLIO model, based on alternative assumptions regarding capacity constraints and factor mobility: (1) Factor inputs fixed per industry; (2) Factor inputs fixed for the total economy; (3) Factor inputs available in unlimited supply. Under the first two assumptions capacity constraints can cause relative price changes, leading to input substitution. Under the first assumption production factors can however not be substituted, because these are fixed per industry. Under the second assumption production factors are allowed to move between industries. Under the third assumption there are no capacity constraints, meaning there are no relative price changes, and therefore, no input substitution. The results in this case resemble those of the I-O model.

5.2 Integration of substitution into I-O models

As noted, I-O models are limited by not accounting for input substitution. Previous researchers have endeavoured to address this limitation in three different ways.

First, some researchers have made technical coefficients dependent on the output of demanding and/or supplying industries, see e.g. Duane Evans (1954); Sandberg (1973); Lahiri (1976); Chien and Chan (1979); Chander (1983) and Fujimoto (1986). These studies were all conceptual, and focused upon the theoretical possibility to develop such models and the equilibrium conditions. Empirical applications are scarce. Exceptions include Heen (1992) and Kama (2000). We were not able to identify any application of this type of model to tourism.

Second, some authors have used a linear I-O model but integrated input substitution by making adjustments to the data. Tilanus (1967), followed by Bryden (1973) and West and Gamage (2001) replaced average technical coefficients with marginal technical coefficients. Bryden replaced the technical coefficients in the hotel industry, while West and Gamage did the same with the coefficients for labour demand. Davis (1987) and Gordon et al. (2009), in contrast, used external data to update the values of the I-O table, whereby the new coefficients were meant to represent a changed consumption pattern as a consequence of capacity constraints, relative price changes and substitution. The new I-O table is then used in an otherwise 'traditional' I-O model.

Third, researchers have integrated non-linearity into I-O models by replacing the Leontief production function with other production functions, such as Generalized Leontief (Bonnici, 1983; Frenger, 1978; Kratena, 2005; Morrison, 1988), Cobb-Douglas (Zhao et al., 2006), CES (Okushima &

35 Although this case study is based on data for an actual Museum in Zeeland, the Museum has chosen to remain anonymous. We will refer to it as Museum X.

Tamura, 2009) or nested functions (Cardenete & Sancho, 2012; Tokutsu, 1994; Zhang, 2008). The usage of these production functions, combined with capacity constraints in factor markets, results in price-induced input substitution.

From a theoretical and empirical point of view this third approach to integrate input substitution is preferable, because the usage of inputs by an industry is now dependent on both output and prices and because substitution is endogenously determined. Furthermore, the inclusion of price-dependent input substitution makes the NLIO a logical 'upgrade' of the I-O model. Finally, this approach does not require ad hoc assumptions about the technical coefficients. To the best of our knowledge the only application of this type of NLIO model within the domain of tourism can be found in West and Jackson (2005). In their model substitution between domestic and imported inputs is possible. In our NLIO model substitution is possible between all inputs. Furthermore, in the model of West and Jackson (2005) labour productivity and household expenditure are endogenously determined, based on labour productivity and household expenditure elasticities. These additional elements are not included in our NLIO model, given our ambition to introduce minimal additional data requirements compared to the I-O model.

5.3 Data

For the analysis a RIOT for the province of Zeeland was used (available upon request). This table for 2009 was compiled by LEI (2011), making use of the Generating Regional I-O Tables (GRIT) method (Jensen et al, 1979) and is based on the national I-O table of the Netherlands. The RIOT contains 20 industries. There are separate rows for net taxes on commodities (total net taxes paid on intermediate input and import demand) and imports (total imports from the rest of Netherlands and the rest of the world). Value added consists of wages and salaries (including social premiums) and other income (capital income and profits). The table is in basic prices (excluding net taxes on commodities). Table 5.1 gives a schematic overview of the RIOT.

Table 5.1 Schematic overview of the regional I-O table of Zeeland

		Intermediate demand			Final demand	Total demand
		1	(…)	21		
Intermediate supply	1					
	(…)					
	21					
Imports						
Net taxes on products						
Added Value	Capital					
	Labour					
Total supply						

We analyzed the impacts for the total economy of Zeeland and the impacts for one specific 'industry', namely 'Museum X'. To enable the latter analysis we included 'Museum X' as a separate industry in the RIOT. Appendix 5A show the steps involved.

The second column of Table 5.2 present expenditures in tourism in Zeeland. The third column contains the expenditure of Museum X's visitors (both in basic prices). The data for tourism in Zeeland cover a period of one year starting in 2010 and ending in 2011, except for the data on international visitors, which is for the year 2009. The data for the Museum are from 2010. Calculations are shown in appendices 5B and 5C.

Table 5.2 Yearly expenditure in tourism in Zeeland and expenditure by Museum X's visitors (2010 / 2011, basic prices)

Industries	Tourism in Zeeland (million Euros)	Museum X's visitors (thousand Euros)
Industry	49.8	54.7
Transport and storage	191.5	-
Hotels	149.5	-
Catering	308.6	249.7
Culture, sports, recreation (CSR)	71.4	33.5
Museum X	0.2	219.6
Trade and transport margins	12.6	13.9
Total	783.6	571.3

Sources: NBTC (2009); NBTC NIPO Research (2011a; 2011b); Museum X's administration (2011); Statistics Netherlands (2009)

5.4 Empirical model

In our NLIO model the production structure is described by a CES production function (Arrow et al., 1961). There are j industries in the economy and each industry produces one homogenous commodity ($j = 1, ..., J$). This output is sold to each other industry as intermediate input and goes to final demand. Each commodity j is produced using intermediate inputs, imports and production factors. For each industry j, the total number of inputs (intermediate inputs, production factors and imports) is n ($n = 1, ..., N, N > J$).

The model employs standard neoclassic economic assumptions, common in I-O and CGE models: a perfectly competitive economy with constant returns to scale and market clearing. Because of constant returns to scale cost minimization is assumed to describe the behaviour of the industries. The outcome of cost minimization, given a CES production function, is the CES cost function

$$C_j = y_j \cdot \Gamma_j^{-1} \cdot \left(\sum_{n=1}^{N} \alpha_{nj}^{\sigma_j} \cdot w_{nj}^{1-\sigma_j} \right)^{\frac{1}{1-\sigma_j}} \tag{5.1}$$

$$\begin{matrix} 0 < \sigma_j < \infty \\ \propto_{nj} > 0 \end{matrix} \quad n = 1, \dots, N \quad j = 1, \dots J$$

C_j are the production costs of industry j, y_j, is the output quantity of industry j, Γ_j is the scale or efficiency parameter of industry j, α_{nj} is the distribution coefficient of input n in industry j, w_{nj} is the price of input n in industry j, and σ_j is the substitution elasticity of industry j.

Using Shephard's lemma (Varian, 1992) the (conditional) input demand function in each industry can be obtained.

$$x_{nj} = y_j \cdot \Gamma_j^{-1} \cdot \alpha_{nj}^{\sigma_j} \cdot w_{nj}^{-\sigma_j} \cdot \left(\sum_{n=1}^{N} \alpha_{nj}^{\sigma_j} \cdot w_{nj}^{1-\sigma_j} \right)^{\frac{\sigma_j}{1-\sigma_j}} \tag{5.2}$$

$$n = 1, \dots, N \quad j = 1, \dots J$$

where x_{nj} is the conditional demand for input n in industry j.

In addition, because of perfect competition, zero profit is assumed for all industries. This implies that, for each industry, the total value of inputs is equal to the total value of intermediate inputs plus the value of production factors and imports:

$$y_j \cdot p_j = \sum_{n=1}^{N} x_{nj} \cdot w_{nj} \tag{5.3}$$

$$j = 1, \dots J$$

p_j is the output price of industry j.

Moreover, total intermediate demand plus final demand equals total demand.

$$y_j^{TD} = \sum_{i=1}^{I} x_{ji} + y_j^{FD} \tag{5.4}$$

$$j = 1, \dots, J \; I = J$$

y_j^{TD} is the total demand for commodity j, y_j^{FD} final demand for commodity j, and x_{ji} intermediate demand for input j in industry i.

Finally, as a result of the market clearing assumption, total quantity demanded for a specific commodity is equal to its total quantity supplied.

$$y_j^{TD} = y_j \tag{5.5}$$

We assume that an industry as a seller (i.e. a row industry in the I-O table) charges the same output price for all demand categories (i.e. column industries in the I-O table and final demand). This assumption implies that industries produce homogenous commodities. Industries buying a specific input pay different prices, depending on net taxes on products. Net taxes on products create a price wedge between the price suppliers actually receive and the price demanders have to pay. Because of lack of data it is assumed that the ad valorem tax rate is identical for all intermediate inputs and imports demanded by an industry. For each industry, the price relation between intermediate inputs and output is given by

$$w_{ij} = \left(1 + t_j\right) \cdot p_j \tag{5.6}$$

$$i = 1, \ldots, I, j = 1, \ldots, J$$

where w_{ij} is the price of intermediate input i in industry j and t_j is the ad valorem tax rate of industry j.

The 'small country assumption' implies that import prices are determined by world market prices. Given that Zeeland is a relatively small area this seems a reasonable assumption. Thus the price equation for imports is

$$w_{mj} = \left(1 + t_j\right) \cdot p_{mj} \tag{5.7}$$

$$j = 1, \ldots J$$

where p_{mj} is the world market price of imported commodity m in industry j.

The NLIO model is modelled in the General Algebraic Modelling System (GAMS). In the first step the model is calibrated. Next, the model is specified and finally it can be solved for alternative values of the exogenous variables. The GAMS-file of the model can be obtained upon request.

Parameters in the model are calibrated such that the model replicates the benchmark data. First, the substitution elasticity σ in case of CES input demand functions must be exogenously defined. We assume values of 0.5. Then, for each industry, the substitution parameters (ρ_j), distribution coefficients of input n (α_{nj}) and scale or efficiency parameters Γ_j are calculated.

$$\rho_j = \frac{1}{\sigma_j} - 1 \tag{5.8}$$

$$\alpha_{nj} = \frac{w_{nj} \cdot x_{nj}^{1/\sigma_j}}{\sum_{n=1}^{N} w_{nj} \cdot x_{nj}^{1/\sigma_j}} \tag{5.9}$$

$$\Gamma_j = y_j \Big/ \left(\sum_{n=1}^{N} \alpha_{nj} \cdot x_{nj}^{-\rho_j} \right)^{-\frac{1}{\rho_j}} \tag{5.10}$$

Next, we explain the determination of tax rates and input prices. For each industry we divide the tax value by the sum of the intermediate inputs and imports to get the value of the ad valorem tax rate, which determines the relation between the input price and output price of a commodity, and between the price of an imported input and the import price. Consequently, tax revenue equals

$$\sum_{i=1}^{I} x_{ij} \cdot t_j \cdot p_j + x_{mj} \cdot t_j \cdot p_{mj} \tag{5.11}$$

Since the total number of variables in the model is larger than the number of equations, some variables must be declared exogenous. The ad valorem tax rates are fixed to its calibrated benchmark value. Furthermore, final demand is set equal to its initial benchmark equilibrium values. Finally, prices or quantities of production factors are assumed to be fixed.

The Harberger convention is used throughout, so that the model is calibrated such that all output prices and import prices are equal to one in the benchmark equilibrium. Because the model is homogenous of degree zero a price numeraire must be selected. Import prices are assumed to be fixed. The consequence of the Harberger convention is that price changes not only refer to changes compared to prices in the benchmark equilibrium (all equal to one), but also compared to the price numeraire (assumed fixed at one).

In our NLIO model, substitution between inputs is caused by relative price changes. These relative price changes are introduced into the model by creating capacity constraints in factor markets. In our empirical analysis we applied three version of the NLIO model, based on three 'stylized' assumptions. First, we assumed that quantities of capital and labour are fixed by industry, causing shadow prices of production factors to reflect changes in profitability. Given the rigidities on factor markets in the Netherlands this assumption could be realistic for the short term (Model 1). Second, we assumed quantities of capital and labour are fixed for the total economy, but mobility between industries is possible. Differences in profitability of production factors (reflected in differences between shadow prices) lead to mobility of labour and capital from one industry to another, until differences between shadow prices disappear. The end result is one economy-wide shadow price of capital and one shadow price of labour (Model 2). Third, we assumed that production factors are available in unlimited supply: There is a reservoir of labour and capital from which, without any restriction, extra labour and capital can be extracted (or disposed) (Model 3). In an I-O model this is the standard assumption.

In I-O tables it is common to include subsidies as a negative value added. For Museum X, however, this would lead to a total negative value added. Our NLIO model does not allow for this (i.e. it would imply a negative input). Therefore, in Model 3, we include the subsidy into the model as an addition equation 5.3.

$$y_j \cdot p_j = \sum_{n=1}^{N} x_{nj} \cdot w_{nj} - t_{subs} \cdot y_j \cdot p_j \qquad (5.12)$$

$$j = 19\ ('Museum\ X')$$

t_{subs} is the amount of subsidy received by Museum X per Euro output.

The value of t_{subs} is based on the values of the output and the governmental subsidy of Museum X in the benchmark equilibrium, and is assumed fixed. This means that we assume, in line with the I-O model which Model 3 is meant to represent, that the subsidy changes proportionally to the value of the output of Museum X. In Models 1 and 2 the subsidy is equal to its value calculated in Model 3. The goal is to enable a meaningful comparison between the three models, whereby the only difference is the assumption regarding production factors.

An important exogenous variable in the model is the substitution elasticity for each industry. In empirical work, including the present study, the elasticity is often not known. We used a substitution elasticity of 0.5 in Models 1 and 2. In the next section we consider alternative values of the elasticity, in a sensitivity analysis. Varying the substitution elasticity does not have any consequences for Model 3, given the absence of relative price changes.

5.5 Scenarios

We used the NLIO model, described above, to calculate impacts of:

- A 10% increase in expenditure on tourism in Zeeland;
- A 10% increase in expenditure by Museum X's visitors only;
- A 20% decrease in the subsidy to Museum X.

Impacts are shown by calculating percentage changes in quantities and prices for intermediate demand and supply, imports, production factors, and output compared to values of the benchmark equilibrium, in which there is no change in expenditure.

The first two scenarios were based on a 10% increase in expenditure because expenditure of domestic tourists in Zeeland has increased from 205,358 to 224,888 million Euro (9.51%) from 2007 (the beginning of the economic crisis) until 2011. Table 5.3 is based on data from Continu Vakantie Onderzoek (2002 until 2011) (available upon request). CVO data has as a limitation that it includes all expenditure by domestic visitors related to their holidays, also expenditure outside Zeeland. For this period there are no comparable data available for the expenditure by domestic day visitors and international visitors.

The reason for the third scenario is that, in 2012, Museum X faced a decline of 20% of its subsidy. In this scenario we use, in equation 5.12 of Model 3, a value of t_{subs} which is 80% of the benchmark value. When this is multiplied with benchmark values of y_i and p_i this gives the total value of the subsidy. This same value is used in Models 1 and 2.

Table 5.3 Nights spent and expenditure by domestic tourists in Zeeland

	Nights spent by domestic visitors (x1,000)	Yearly expenditure by domestic tourists (thousand Euros)
2007	8,055	205,358
2008	7,811	205,511
2009	8,090	213,956
2010	8,369	222,401
2011	7,635	224,888

Sources: CVO (2002- 2011)

5.6 Results

5.6.1 Scenario 1

For scenario 1, Table 5.4 shows percentage changes in quantities and prices. The results are presented for seven industries. Four of these industries are closely related to tourism, namely 'Hotels', 'Catering', 'Culture, Sport, Recreation (CSR)', and 'Museum X'. A large proportion of their output is supplied to tourists and excursionists. We also selected one industry that supplies commodities to all four tourism industries ('Electricity and Gas'), one industry that supplies to none ('Extractive industries'), and the industry that produced the largest output in the economy ('Industry').

The results of Model 3 (Prices of production factors fixed) resemble those of the I-O model. As factor prices were fixed there were no relative price changes and therefore also no substitution. The necessary expansion of production was realized while maintaining fixed proportions between inputs. The final column shows the resulting percentage increases of the usage of intermediate inputs (0.39%), imports (0.32%), labour (0.47%) and capital (0.39%) that are relevant for the total economy.

In Model 1 (Quantities of production factors fixed per industry) the increase in demand for production factors resulted in higher shadow prices of these inputs. In six of the seven industries increasing demand for output and substitution away from production factors led to an increase in the demand for intermediate inputs. Only for 'Extractive Industries' was there a decrease in the usage of intermediate inputs (-0.03%). Output of this industry increased with only 0.07%; demand for commodities supplied by this industry does not increase much, because it is remote from the tourism industries in terms of inter-industry relationships in the RIOT[36]. For the total economy the increase

36 The percentage change of intermediate demand needs to be interpreted in the correct manner. Real quantities of intermediate inputs used are not known, since the RIOT only contains values (prices x quantities). In the NLIO model quantities are determined by assuming base year prices of 1 (Harberger convention). As a consequence the tables show percentage

of the usage of intermediate inputs (0.44%) and the usage of imports (0.97%) were higher than for Model 3. The usage of production factors remained constant. Although responses of individual industries differed, these percentages indicate that, overall, substitution takes place from production factors to intermediate inputs and imports.

In Model 2 (Quantities of production factors fixed for the economy as a whole) factor mobility between industries ascertains that the increase in prices of production factors is spread out equally over all industries - instead of being mostly concentrated in the tourism industries, as in Model 1. Compared to this Model factor usage in the tourism industries is higher, leading to less substitution from production factors to intermediate inputs and imports. As a result, the overall increase in the usage of intermediate inputs (0.38%) was lower than in the I-O model.

Table 5.5 shows the impacts of the change analyzed in the first scenario on the industry 'Museum X'[37]. In Model 3 the percentage increases in quantities and values were the same for all inputs. In Model 1 increasing demand for production factors led to a strong increase in the shadow prices of these inputs (31.93%). Prices of intermediate inputs also increased and relative price changes led to substitution. As marginal cost increased the output price also increased. Final demand is exogenous, and therefore remained fixed at +10.00%, but the increase of the output price did stimulate a strong decrease in intermediate demand (-40.48% and -38.07%). In Model 2 the price increase of production factors is less dramatic, because it was spread out over all industries. The price increases for intermediate inputs were also less strong. As a result, relative price changes were smaller, there was less substitution, and the rise in marginal costs and the output price of Museum X were less dramatic.

In this first scenario the differences between the three models, on the level of the total economy, appear to be modest. For example, the change of output was 0.41% in Model 1, 0.39% in Model 2 and 0.39% in Model 3, representing a difference of less than 0.02%. The inclusion of substitution did not lead to fundamentally different results. Based on this we might conclude that the application of a NLIO model does not add much value compared to the application of an I-O model (Kratena, 2005). However, our result also shows that for individual industries differences between models are substantial. In the industry 'Catering', for example, price changes and changes in quantities are 6.16% and 14.43% respectively (Model 1); 7.30% and 1.97% (Model 2); and 7.29% and 0% (Model 3). Furthermore, when we look at actual values instead of percentages, the change in the values of output and value added, for the total economy, were 669.1 and 341.1 million (Model 1); 649.1 and 324 Million (Model 2); and 118.8 and 50.7 million (Model 3). The difference between Models 1 and 2 on the one hand and Model 3 on the other was substantial, showing that the inclusion of substitution does lead to strikingly different results, for the total economy as well. The evidence from our findings suggests, therefore that in conditions of a large change in final demand the application of a NLIO is useful. Relative price changes are likely to lead to input substitution. For this type of analysis we therefore confirm the conclusions of Bonnici (1983); Davis (1987) and Frenger (1978) that the introduction of input substitution into I-O model has added value.

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change in quantities, as measured in base year prices. These can be different from percentage changes of real quantities. Furthermore, percentages for intermediate demand are actually a weighted average of percentage changes of quantities of intermediate inputs supplied to an industry. Usage of some inputs increases and usage of others decreases, depending on relative price changes.

37 When using the NLIO model to analyze possible responses of an individual industry (such as Museum X) it is important to keep in mind the Model assumes (economic) behavior to be based solely on profit maximizing / cost minimizing.

Several scholars (Bryden, 1973; Cardenete & Sancho, 2012; Wanhill, 1988; West & Gamage, 2001) have concluded that the introduction of capacity constraints is likely to lead to lower impacts. In contrast, our analysis shows that the introduction of capacity constraints leads to mixed results. In Model 1 and 2 the overall change of production factors is less than in the unconstrained Model 3. It is namely zero (by assumption). In both constrained models the demand for imports is higher than in Model 3. Relative prices changes and substitution lead to lower demand for some intermediate inputs and higher demand for others. For Model 1 the overall demand for intermediate inputs is higher than in Model 3, while in Model 2 it is lower.

Comparison of Models 1 and 2 makes clear that the results of a NLIO model are strongly influenced by the assumption on factor mobility. This is true not only for the total economy, but especially for individual industries. Notice, for example, the large difference between the output price of Museum X in Models 1 and 2. Therefore, we also confirm the conclusion of McGregor (1995) that it is essential in which manner factor mobility is introduced into a NLIO model.

Table 5.4 Impacts of a 10% increase in expenditure in tourism in Zeeland

		Extractive industries	Industry	Electricity and gas	Hotels	Catering	CSR	Museum X	Intermediate supply
Benchmark equilibrium (2009, basic prices, million Euros)									
Quantities (based on base year prices)	Intermediate demand	56	2,523	771	36	123	183	0.50	10,402
	Import	39	2,793	644	54	91	28	0.74	8,072
	Labour	13	1,417	104	50	119	79	1.35	6,214
	Capital	288	744	516	40	96	57	0.38	4,735
	Output	397	7,652	2,224	184	436	356	0.24	30,143
Prices, incl. taxes	Intermediate demand	1.004	1.033	1.134	1.036	1.036	1.044	1.010	
	Import	1.004	1.033	1.134	1.036	1.036	1.044	1.010	
	Labour	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
	Capital	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
	Output	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

		Extractive industries	Industry	Electricity and gas	Hotels	Catering	CSR	Museum X	Intermediate supply
Model 1 (Quantities of production factors fixed per industry, % changes compared to benchmark equilibrium)									
Quantities	Intermediate demand	-0.03%	0.08%	0.32%	15.04%	12.43%	3.09%	13.33%	0.44%
	Import	0.76%	0.81%	0.88%	16.17%	13.56%	4.94%	14.86%	0.97%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Output	0.07%	0.33%	0.41%	7.40%	6.16%	2.02%	5.51%	0.41%
Prices, incl. taxes	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	1.53%	1.63%	1.76%	34.95%	28.96%	10.12%	31.93%	
	Capital	1.53%	1.63%	1.76%	34.95%	28.96%	10.12%	31.93%	
	Output	1.39%	0.96%	0.92%	16.99%	14.43%	5.80%	187.16%	
Model 2 (Quantities of production factors fixed in the economy, % changes compared to benchmark equilibrium)									
Quantities	Intermediate demand	0.24%	0.11%	0.17%	8.31%	7.40%	2.75%	8.58%	0.38%
	Import	1.11%	0.96%	0.99%	9.24%	8.35%	3.83%	9.76%	0.93%
	Labour	-0.38%	-0.53%	-0.50%	7.63%	6.75%	2.30%	8.14%	0.00%
	Capital	-0.31%	-0.47%	-0.44%	7.70%	6.82%	2.36%	8.21%	0.00%
	Output	-0.10%	0.25%	0.26%	8.27%	7.30%	2.67%	8.62%	0.39%
Prices, incl. taxes	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	3.01%	3.01%	3.01%	3.01%	3.01%	3.01%	3.01%	
	Capital	2.89%	2.89%	2.89%	2.89%	2.89%	2.89%	2.89%	
	Output	2.44%	1.42%	1.45%	1.81%	1.97%	2.26%	18.68%	
Model 3 (Prices of production factors fixed, % Changes compared to benchmark equilibrium)									
Quantities	Intermediate demand	0.09%	0.20%	0.21%	8.26%	7.29%	2.70%	9.31%	0.39%
	Import	0.09%	0.20%	0.21%	8.26%	7.29%	2.70%	9.31%	0.32%
	Labour	0.09%	0.20%	0.21%	8.26%	7.29%	2.70%	9.31%	0.47%
	Capital	0.09%	0.20%	0.21%	8.26%	7.29%	2.70%	9.31%	0.45%
	Output	0.09%	0.20%	0.21%	8.26%	7.29%	2.70%	9.31%	0.39%
Prices, incl. taxes		All 0.00%							

Table 5.5 Impacts of a 10% increase in expenditure in tourism in Zeeland on the industry 'Museum X' (% changes compared to benchmark equilibrium)

	Model 1			Model 2			Model 3		
	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value
Income									
Final demand	187.16%	10.00%	215.87%	18.68%	10.00%	30.55%	0.00%	10.00%	10.00%
Intermediate demand									
Education	187.16%	-40.48%	70.93%	18.68%	-6.98%	10.40%	0.00%	0.01%	0.01%
CSR	187.16%	-38.07%	77.82%	18.68%	-4.69%	13.11%	0.00%	2.70%	2.70%
Total demand	187.16%	5.51%	202.99%	18.68%	8.62%	28.91%	0.00%	9.31%	9.31%
Subsidy	-	-	9.31%	-	-	9.31%	-	-	9.31%
Total	-	-	25.03%	-	-	10.90%	-	-	9.31%
Expenditures									
Intermediate purchases									
Extractive industries	1.39%	N.A.[a]	N.A.[a]	2.44%	N.A.[a]	N.A.[a]	0.00%	N.A.[a]	N.A.[a]
Industry	0.96%	14.31%	15.41%	1.42%	8.99%	10.53%	0.00%	9.31%	9.31%
Electricity and gas	0.92%	14.33%	15.39%	1.45%	8.97%	10.55%	0.00%	9.31%	9.31%
Hotels	16.99%	6.19%	24.23%	1.81%	8.78%	10.74%	0.00%	9.31%	9.31%
Catering	14.43%	N.A.	N.A.	1.97%	N.A.	N.A.	0.00%	N.A.	N.A.
CSR	5.80%	11.67%	18.14%	2.26%	8.54%	10.99%	0.00%	9.31%	9.31%
Import	0.00%	14.86%	14.86%	0.00%	9.76%	9.76%	0.00%	9.31%	9.31%
Value added									
Labour	31.93%	0.00%	31.93%	3.01%	8.14%	11.40%	0.00%	9.31%	9.31%
Capital	31.93%	0.00%	31.93%	2.89%	8.21%	11.33%	0.00%	9.31%	9.31%
Total	-	-	25.03%	-	-	10.90%	-	-	9.31%

a Because there are no commodities supplied by this industry to Museum X in the benchmark equilibrium percentage changes cannot be calculated.
Source: Own calculations

5.6.2 Scenario 2

For scenario 2, Table 5.6 shows percentage changes in quantities and prices. Because the change in final demand in scenario 2 (a 10% increase in expenditure by Museum X's visitors) is much smaller than in scenario 1 percentage changes in prices and quantities were also much smaller. The only industry for which the change in the shadow prices of production factors is larger than 0.02% is 'Museum X' in Model 1. Changes in output prices were also very small, apart from Museum X. Nonetheless, it is important to be aware that although a price increase of, for example, 0.01% for labour (such as in Model 2) may seem very small, it does apply to every unit of labour, used in every industry in the economy and throughout the entire region of Zeeland. The same is true for price changes of capital and output. In terms of value this creates substantial impacts. In this second scenario, in which we analyze a small change of final demand price changes – and the resulting impacts – are unlikely to appear in real world situations, especially not in industries in which there are only indirect impacts.

Table 5.7 shows the impacts on the industry 'Museum X'. In Model 3, there are proportional increases in the quantities and values of all inputs. Increases in quantities and values in Model 2 were only slightly different from Model 3. Price changes were so small (0.01%) that substitution was barely noticeable. The small change in prices of all inputs used did lead to higher marginal costs, leading to a higher output price (0.08%) and lower intermediate demand (-0.03%). In Model 1 price changes of the intermediate inputs were again very small, but the increases of the shadow prices of the production factors were substantial (29.96%). As a consequence, production factors were substituted for imports and intermediate inputs. Museum X faced substantially higher marginal costs, leading to a higher output price (169.33%) and lower intermediate demand (-39.06%).

In sum, for a small change in final demand Models 1 and 2 did not provide realistic results. It is not likely that there would be relative price changes and substitution, at least not to degree predicted by the models. Model 3, in which production factors are available in unlimited supply and prices are fixed (leading to the same results as the I-O model), offers a more realistic option.

The added value of the NLIO in this second scenario is in forcing the researcher to carefully consider relative price changes. The researcher must come to a conclusion about whether or not these have to be taken into account and explicitly choose for the most appropriate assumption about factor markets – the assumption of unlimited availability of production factors (Model 3) is only one of the options, while it is the only option in an I-O model.

The conclusions above are in line with Dwyer et al. (2004). We confirm their conclusion that an I-O model is an appropriate choice when relative price changes are not likely to result from the final demand change. Their argument, however, is that regional size is the most important factor to consider: In a small region it is more appropriate to assume that relative prices are exogenously determined (outside the regional economy). Not denying the importance of regional size, we maintain that the size of the final demand change should also influence the decision whether or not to use a model that takes into account relative price changes.

Table 5.6 Impacts of a 10% increase in expenditure by Museum X's visitors (% changes compared to benchmark equilibrium)

		Extractive industries	Industry	Electricity and gas	Hotels	Catering	CSR	Museum X	Intermediate supply
Model 1 (Quantities of production factors fixed per industry)									
Quantities (based on base year prices)	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	14.00%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	14.00%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	5.43%	0.00%
Prices (incl. taxes)	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	29.96%	
	Capital	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	29.96%	
	Output	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	169.33%	
Model 2 (Quantities of production factors fixed in the economy)									
Quantities	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	9.07%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.06%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.07%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
Prices (incl. taxes)	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
	Capital	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
	Output	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.08%	
Model 3 (Prices of production factors fixed)									
Quantities	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	9.07%	0.00%
Prices (incl. taxes)		All 0.00%							

Source: Own calculations

Table 5.7 Impacts of a 10% increase in expenditure in Museum X on the industry 'Museum X' (% changes compared to benchmark equilibrium

	Model 1			Model 2			Model 3		
	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value
Income									
Final demand	169.33%	10.00%	196.27%	0.08%	10.00%	10.08%	0.00%	10.00%	10.00%
Intermediate demand									
Education	169.33%	-39.06%	64.12%	0.08%	-0.03%	0.04%	0.00%	0.00%	0.00%
CSR	169.33%	-39.06%	64.13%	0.08%	-0.03%	0.05%	0.00%	0.00%	0.00%
Total demand	169.33%	5.43%	183.96%	0.08%	9.07%	9.15%	0.00%	9.07%	9.07%
subsidy	-	-	9.07%	-	-	9.07%	-	-	9.07%
Total	-	-	23.27%	-	-	9.08%	-	-	9.07%
Expenditures									
Intermediate purchases									
Extractive industries	0.00%	N.A.	N.A.	0.01%	N.A.	N.A.	0.00%	N.A.	N.A.
Industry	0.00%	14.00%	14.00%	0.01%	9.07%	9.07%	0.00%	9.07%	9.07%
Electricity and gas	0.00%	14.00%	14.00%	0.01%	9.07%	9.07%	0.00%	9.07%	9.07%
Hotels	0.00%	14.00%	14.00%	0.01%	9.07%	9.07%	0.00%	9.07%	9.07%
Catering	0.01%	N.A.	N.A.	0.01%	N.A.	N.A.	0.00%	N.A.	N.A.
CSR	0.02%	13.99%	14.01%	0.01%	9.07%	9.08%	0.00%	9.07%	9.07%
Import	0.00%	14.00%	14.00%	0.00%	9.07%	9.07%	0.00%	9.07%	9.07%
Value added									
Labour	29.96%	0.00%	29.96%	0.01%	9.06%	9.08%	0.00%	9.07%	9.07%
Capital	29.96%	0.00%	29.96%	0.01%	9.07%	9.08%	0.00%	9.07%	9.07%
Total	-	-	23.27%	-	-	9.08%	-	-	9.07%

Source: Own calculations

5.6.3 Scenario 3

For scenario 3, Table 5.8 shows percentage changes in quantities and prices. All changes in prices and quantities are 0.00%, except for the industry 'Museum X' and a change of 0.01% of the price of the industry 'CSR'.

Table 5.9 shows the percentage changes in quantities and prices in the industry 'Museum X'. For this scenario the results of Model 3 were no longer equal to the I-O model. An increase of the output price of Museum X (190.17%) was necessary to compensate for the 20% decrease of the subsidy. However, because Museum X is relatively small compared to the total economy and because the output of Museum X is used as an input by only two industries the impact of this price change on relative prices and substitution is minimal. The results of Model 3 therefore almost reflect those of the traditional I-O Model, apart from the price change of the Museum. In Model 2 the decrease in the demand for production factors by Museum X led to slightly lower prices of labour and capital, throughout the whole economy. This change caused (minimal) differences between Models 2 and 3. In Model 1, lowering the subsidy led to lower shadow prices of production factors. The increase of the output prices was lower than in Models 2 and 3.

For this scenario an I-O model, which can only be used to analyze changes in final demand, was not an option. A more flexible model, such as the NLIO is required. Because the change of the subsidy in Museum X is unlikely to lead to lower shadow prices of production factors Model 3 seems to be the most realistic option, as it is in the second scenario.

Table 5.8 Impacts of a 20% decrease in the subsidy to Museum X (% changes compared to benchmark equilibrium)

		Extractive industries	Industry	Electricity and gas	Hotels	Catering	CSR	Museum X	Intermediate supply
Model 1 (Quantities of production factors fixed per industry)									
Quantities (based on base year prices)	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-6.54%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-6.54%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.85%	0.00%
Prices (incl. taxes)	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-12.66%	
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-12.66%	
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	107.96%	
Model 2 (Quantities of production factors fixed in the economy)									
Quantities	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.85%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
Prices (incl. taxes)	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	190.14%	
Model 3 (Prices of production factors fixed)									
Quantities	Intermediate demand	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.85%	0.00%
	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.84%	0.00%
Prices (incl. taxes)	Import	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Labour	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Capital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Output	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	190.14%	

Source: Own calculations

Table 5.9 Impacts of a 10% increase in expenditure in Museum X on the industry 'Museum X' (% changes compared to benchmark equilibrium)

	Model 1			Model 2			Model 3		
	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value	Prices, incl. taxes	Quantities	Value
Income									
Final demand	107.96%	0.00%	107.96%	190.14%	0.00%	190.14%	190.17%	0.00%	190.17%
Intermediate demand									
Education	107.96%	-30.66%	44.21%	190.14%	-41.29%	70.33%	190.17%	-41.30%	70.34%
CSR	107.96%	-30.65%	44.21%	190.14%	-41.29%	70.34%	190.17%	-41.29%	70.35%
Total demand	107.96%	-2.85%	102.02%	190.14%	-3.84%	178.98%	190.17%	-3.84%	179.01%
subsidy	-	-	-20.00%	-	-	-20.00%	-	-	-20.00%
Total	-	-	-10.09%	-	-	-3.85%	-	-	-3.84%
Expenditures									
Intermediate purchases									
Extractive industries	0.00%	N.A.	N.A.	0.00%	N.A.	N.A.	0.00%	N.A.	N.A.
Industry	0.00%	-6.54%	-6.54%	0.00%	-3.84%	-3.85%	0.00%	-3.84%	-3.84%
Electricity and gas	0.00%	-6.54%	-6.54%	0.00%	-3.85%	-3.85%	0.00%	-3.84%	-3.84%
Hotels	0.00%	-6.54%	-6.55%	0.00%	-3.84%	-3.85%	0.00%	-3.84%	-3.84%
Catering	0.00%	N.A.	N.A.	0.00%	N.A.	N.A.	0.00%	N.A.	N.A.
CSR	0.01%	-6.55%	-6.54%	0.01%	-3.85%	-3.84%	0.01%	-3.85%	-3.84%
Import	0.00%	-6.54%	-6.54%	0.00%	-3.85%	-3.85%	0.00%	-3.84%	-3.84%
Value added									
Labour	-12.66%	0.00%	-12.66%	0.00%	-3.84%	-3.85%	0.00%	-3.84%	-3.84%
Capital	-12.66%	0.00%	-12.66%	0.00%	-3.84%	-3.85%	0.00%	-3.84%	-3.84%
Total	-	-	-10.09%	-	-	-3.85%	-	-	-3.84%

Source: Own calculations

5.6.4 Sensitivity analysis

A sensitivity analysis was used to analyze what happens to the values of Model 1 and 2 when we increased the substitution elasticity. This made it easier for industries to respond to relative price changes, and substitute away from expensive production factors. Decreasing demand then led to lower shadow prices of these inputs. This partly compensated the original increase in prices, leading to smaller relative price changes. The final results of increasing the substitution elasticity depended on the assumption regarding factor mobility: In Model 1 a higher substitution elasticity led to smaller increases of the usage of intermediate inputs, imports, and of output. In Model 2 a higher substitution elasticity led to lower imports, but slightly higher usage of intermediate inputs and output.

5.7 Data demand and complexity

Table 5.10 uses the criteria specified in chapter 4 and the information from this chapter to compare the I-O and NLIO models. This Table shows that, contrary to the I-O model, the NLIO model can be used in situations where there is a desire to carry out sensitivity analyses regarding parameters and functions, when the assumption of 'no scarcity of production factors' is rejected, and when impacts need to be analysed of other 'shocks' than final demand changes.

In contrast to the I-O model, the NLIO model requires assumptions to be made regarding capacity constraints of production factors and production factor mobility between industries. Furthermore, the production function needs to be specified and its parameters determined, including substitution elasticity. Making assumptions regarding production factors can be difficult because the truth is often somewhere in between the three 'stylized' assumptions. Our results demonstrate that this choice, difficult as it may be, is very important. Results differ between the three models, especially in terms of impacts on value added. In the I-O model, the only option is an assumption of unlimited availability of production factors, which is not always optimal. This same argument is relevant for the substitution elasticity. The NLIO model forces the researcher to specify the substitution elasticity, instead of implicitly making a choice of an elasticity of zero. Most realistic results can be achieved when estimating the substitution elasticity based on actual data, which does require extra effort in the form of data collection and interpretation. Compared to a CGE model the NLIO model offers the advantage that it is not dependent on the existence of a SAM on the appropriate spatial scale while the production structure is identical.

Regarding complexity, the NLIO model requires the EIA researcher to use specialized software (e.g. GAMS) and to understand and being able to explain, to a certain degree, micro-economic and mathematical concepts such as production functions, marginal products, supply and demand functions, elasticities, (relative) price changes, differentiation, and optimization. This introduces substantially more complexities in an EIA compared to the usage of the I-O model. Using a CGE model would introduce additional complexity as it would require the specification of the relationships between income and final demand, including issues such as income transfers and income taxation.

Table 5.10 Comparison of I-O and NLIO

Outcomes, appropriateness, standardisation, and comparability	IO	NLIO
Outcomes		
Indirect impacts on output, value added, income and/or employment per industry	X	X
Induced impacts, spatial and temporal consideration, social impacts, environmental impacts, and economic externalities	N.A.	
Sensitivity analysis of outcomes regarding parameters and functions		X
Appropriateness		
Assumption 'no scarcity of production factors' (production factors are not scarce, implying no relative price changes, input substitution or redistribution)	X	
Assumption 'no scarcity of production factors' rejected (production factors potentially scarce)		X
Assumption 'no productivity changes' accepted	X	
Assumption 'no productivity changes' rejected: Quasi productivity changes		X
Assumption 'no productivity changes' rejected: Real productivity changes		
Impacts of final demand changes	X	X
Impacts of other 'shocks'		X
Standardisation and comparability		
Standardisation	X	
Comparability to results of other EIAs	X	
Data		
(Regional) I-O table	X	X
Final demand (change), per industry	X	X
Assumptions regarding capacity constraints of production factors and production factor mobility between industries		X
Specification and parameters of production functions (substitution elasticity)		X
Complexity		
Understanding how to change raw data into useable input for the I-O / NLIO model	X	X
Understanding and being able to explain, to a certain degree, advantages and disadvantages of the model and consequences of underlying assumptions	X	X
Standardized software (e.g. Microsoft Excel)	X	
Specialized software (e.g. GAMS)		X
Understanding and being able to explain, to a certain degree, economic and mathematical concepts such as output, value added, income, employment, direct impacts, indirect impacts, and matrix algebra	X	X
Understanding and being able to explain, to a certain degree, micro-economic and mathematical concepts such as production functions, marginal products, supply and demand functions, elasticities, (relative) price changes, differentiation, and optimization		X

5.8 Conclusions

The goal of this study was to show the usefulness of a NLIO model for economic impact analysis in tourism. We applied a NLIO model, in which input substitution is explicitly included, in three scenarios: (1) 10% increase in expenditure in tourism; (2) 10% increase in expenditure by visitors to one tourism attraction; (3) 20% decrease in the subsidy received by a tourism attraction. In each scenario we applied three version of the NLIO model, differing in the assumption regarding capacity constraints in factor markets and factor mobility. In Model 1 production factors were fixed per industry, in Model 2 production factors were fixed for the total economy, but were allowed to move between industries, and in Model 3 production factors were available in unlimited supply. Model 3 was based on the same assumptions as the I-O model.

We found that for large changes of final demand (as in the first scenario) a NLIO model is more useful than an I-O model. Relative prices changes were likely, leading to substitution. The NLIO takes this into account and can be used to show impacts on prices, usage of production factors, imports, intermediate inputs, and production of outputs. Impacts could be higher or lower than in the I-O model, depending on the assumption about capacity constraints and factor mobility and substitution elasticity.

To analyze a small change of final demand (as in the second scenario) it is less realistic to assume that relative price changes and substitution take place, to the degree predicted by the model. In a NLIO most realistic results are achieved by choosing for the assumptions of unlimited supply in factor market and fixed prices (Model 3) – which leads to the same results as a I-O model.

To analyze a change of subsidies (as in the third scenario) an I-O model is not an option. A more flexible model is required, such as a NLIO model.

For all three types of analysis researchers are forced to make a choice about the assumptions regarding factor markets. Making this choice can be difficult because the truth is often somewhere in between the three 'stylized' assumptions. Our results demonstrate that this choice, difficult as it may be, is very important. Results differ between the three models, especially in terms of impacts on value added. In the I-O model the only option is an assumption of unlimited availability of production factors, which is not always optimal. This same argument is relevant for the substitution elasticity. The NLIO model forces the researcher to specify the substitution elasticity, instead of implicitly making a choice of an elasticity of zero. Most realistic results can be achieved when estimating the substitution elasticity based on actual data, which does require extra effort in the form of data collection and interpretation.

For all three types of analyses, researchers are forced to make a choice about the assumptions regarding factor markets, and to specify substitution elasticities. Our results demonstrate that these choices, difficult as they may be, are very important. The NLIO model produces significantly different outcomes contingent on these choices.

In the future it might be an option to construct a Social Accounting Matrix for the Province of Zealand and build a CGE model. An explicit link between income creation and spending could thus be established, helping practitioners formulate more realistic scenarios and perform welfare analyses. Because this would lead to significant additional data demands and complexity this did not match the ambitions set for the research underlying this chapter and this thesis.

6. Labour productivity in a Non-linear I-O model[38]

6.1 Introduction

Employment generation is widely considered to be one of the most direct and beneficial impacts of tourism. Tourism is labour intensive (e.g. Kelliher, 1989; Surugiu et al., 2012), can offer employment in regions that have few other options or in which other industries are performing poorly (e.g. Szivas et al., 2003; Vaugeois & Rollins, 2007; Zampoukos & Ioannides, 2011), and offers work to a wide variety of employee functions[39]. Potential impacts on employment are therefore often the main argument for investments in tourism (Ladkin, 2011; Sun & Wong, 2010; Thomas & Townsend, 2001). To estimate these impacts, both ex ante and ex post, appropriate techniques should be applied. In tourism management Input-Output (I-O) models are often applied for this purpose (Sun & Wong, 2014).

However, in calculating economic impacts, including employment impacts, I-O models have well-known limitations, such as fixed relative prices, unlimited availability of factors of production, and absence of substitution (Briassoulis, 1991; Miller & Blair, 2009; Sun & Wong, 2014). These limitations imply that increases in output are translated into proportional increases in labour. The ratio of output to labour remains constant, which implies constant labour productivity. In chapter 5 it was shown how input substitution due to an increase in final demand leading to relative price changes can be included in an I-O model, creating a Non-Linear Input Output (NLIO) model. Substitution from and to labour will automatically lead to a change in the ratio of output to labour, that is, a a labour productivity increase. However, input substitution is a quasi-labour productivity increase as one unit of labour ceteris paribus still produces the same output. A final demand increase can also cause a real labour productivity increase, whereby one unit of labour ceteris paribus does produce more output. Employees can work longer, harder and/or more efficiently (Sun, 2007). In the past this second type of labour productivity increases, which we refer to as 'real labour productivity increases', have been integrated into NLIO and Computable General Equilibrium (CGE) models. Examples outside of tourism include Hanson and Rose (1997); Peerlings (1993), and Smulders and de Nooij (2003). To the best of our knowledge, Blake, Sinclair, and Soria (2006) is the only application of a CGE model with real labour productivity increases in tourism. However, in their paper the change in productivity is exogenously specificied and not related to a change of final demand. West and Jackson (2004, 2005) propose a NLIO model for tourism, including exogenously specified labour productivity elasticities.

The goal of this paper is to include labour productivity changes, caused by a change in final demand, into a NLIO model. To illustrate the model the consequences of a 10% change in expenditure in tourism in the province of Zeeland (Netherlands) is analyzed. We compare the results of the NLIO model with labour productivity changes to the results of the original NLIO model. The

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39 Tourism offers employment to different types of employees such as males and females (Ladkin, 2011; Parsons, 1987), migrants / minorities (e.g. Lundmark, 2006; Riley, 2008), skilled and low skilled employees (Ladkin, 2011; Szivas et al., 2003), young employees (Surugiu et al., 2012), and new entrants to the labour market (Parsons, 1987; Surugiu et al., 2012; Wong, 2004)

region of Zeeland was selected as a case study because of the availability of a regional I-O table (RIOT), sufficient data on the expenditure in tourism, and because of the economic dependence of Zeeland on tourism. Zeeland attracts more than 1.3 million or 8% of the total domestic tourists in the Netherlands; (Statistics Netherlands, 2012) who stay for 8.1 million nights or 9% of the total for the Netherlands. Zeeland also receives 40 million or 3% of the total day visits in the Netherlands (NBTC NIPO Research, 2011a) and more than 700,000 or 7% of the international tourists to the Netherlands (NBTC, 2009).

In tourism productivity changes are likely to be different for core and peripheral labour. We define core labour as the group of full-time and/or permanent employees providing skills essential to the survival and growth of an organization and peripheral labour as part-time and/or temporal employees, undertaking important but non-vital day-to-day activities, that are dispensed of in less affluent times or when demand is low (e.g. Johnson, 1985; Krakover, 2000; Zampoukos & Ioannides, 2011). The subdivision between core and peripheral labour and the relationships that exist between final demand and productivity changes, differentiating between the two types of labour, are discussed in the literature review. In the section Model we present the NLIO model and in the section Data we discuss the details of the RIOT, the data on core and peripheral labour, and the final demand change. In Results and Discussion we present the results of the NLIO model. The last section, Conclusions, presents the main findings.

6.2 Literature review

6.2.1 Core and peripheral labour

Demand for products and services produced by the tourism 'industry' fluctuates strongly, both in the short run and long run (Krakover, 2000; Lin et al., 2011; Sun & Wong, 2014). It also involves both predictable and unpredictable demand changes (e.g. Adenso-Díaz et al., 2002; Riley & Szivas, 2009). A second characteristic of tourism is simultaneous production and consumption (Sun, 2007). Because the tourism industry mostly produces services (Kleijweg & Thurik, 1988; Sun & Wong, 2014; Sun, 2007), which are inherently perishable (Sigala et al., 2005; Smeral, 2003; Sun, 2007), it is not possible to create stocks (Adenso-Díaz et al., 2002; Kelliher, 1989). This implies that production needs to take place at the moment there is a demand from tourists and the required inputs, including labour, need to be available at that moment. Finally, the tourism industry consists mainly of small and middle-sized firms (e.g. Riley, 2008; Vaugeois & Rollins, 2007; Zampoukos & Ioannides, 2011) which face high competition (Zampoukos & Ioannides, 2011) and for whom labour is the main cost (Zampoukos & Ioannides, 2011).

These characteristics create a division between core and peripheral labour. Core labour consists of employees that carry out activities that need to be fulfilled independently of the level of final demand and that have the skills to assure continuity within the organisation (Cho & Wong, 2001; Johnson, 1985). As a result, the number of core employees is usually very stable. Peripheral labour consists of employees that are used in a flexible manner, both in the number of employees and the number of hours they work (Kelliher, 1989; Krakover, 2000; Parsons, 1987), allowing an efficient allocation of labour services (e.g. Addessi, 2014; Ortega & Marchante, 2010), and cost minimisation (Adenso-Díaz et al., 2002; Kelliher, 1989). Flexilibity in peripheral labour is facilitated by high labour supply, short training periods, temporal contracts, and relatively low demands on new entrants (Kelliher, 1989).

The differentiation between the two types of labour, which is of course a simplification of a complex reality (Thomas & Townsend, 2001; Walmsley, 2004), can also be seen in other industries. It is however very prominent in tourism (Krakover, 2000; Walmsley, 2004). Table 6B.1 gives an overview of the characteristics of core and peripheral labour, based on a literature review of scientific papers published in the domain of tourism.

6.2.2 Labour productivity in tourism

Most of the literature on (labour) productivity in tourism deals with the measurement of productivity. Studies have been done to measure productivity on the micro level, such as for hotels (Barros & Alves, 2004; Chen, 2007; Hu & Cai, 2004; Kim, 2010); travel agencies (Botti & Briec, 2010; Sellers-Rubio & Nicolau-Gonzálbez, 2009), and restaurants (Reynolds & Thompson, 2007). However, there are also studies on higher spatial scales, such as tourism destinations (Cracolici et al., 2008; Sun et al., 2014) and national tourism industries (Hadad et al., 2012; Peypoch & Solonandrasana, 2008).

In this paper we take a different perspective. We include productivity changes in an economic impact model. Our approach is similar to the one used by Blake, Sinclair, and Soria (2006) and West and Jackson (2004, 2005), who include productivity changes in, respectively, a CGE and NLIO model. Furthermore, Sun (Sun & Wong, 2010, 2014; Sun, 2007) criticises the linearity assumption of the I-O model in a situation where an increase of final demand can be absorbed by an increase of capacity utilization, leading to an increase of labour productivity. In this paper we advance on previous research by endogenously including labour productivity drivers in a NLIO model, thereby establishing a relationship between final demand changes (which is the exogenous shock put into the model) and labour productivity. Thereby, we define labour productivity as the ratio between output and labour (e.g. Blake, Sinclair, & Soria, 2006; Botti & Briec, 2010; Hadad et al., 2012). Analysing the relationship between final demand changes and labour productivity is complex. Empirically, it would be hard to differentate between changes in labour productivity that are caused by final demand changes and labour productivty changes that have a different causes (such as stragic investmest by the hotel in the productivity of the employees, out of a desire to increase productivity and profit). In this chapter we look at these issues from a theoretical perspective and use the literature to develop our own ideas about this relationship. In the next section these ideas, which can be seen as preliminary hypotheses, are integrated into the NLIO model. When subsequent research leads to refinments and/or rejection of these hypotheses, changes can be made in the specification of the model. An important first step is to distinguish between quasi and 'real' productivity changes.

A final demand increase can lead to changes in relative prices, which can result in input substitution. This leads to an increase of labour productivity in the case of:

- Substitution of labour by capital, e.g. replacing manual labour by ICT applications (e.g. Brida et al., 2010; Cho & Wong, 2001; Li, 2014). This type of substitution is limited in tourism, however (e.g. Riley & Szivas, 2009; Riley, 2008). Tourism is characterised by 'embodied services' (Smeral, 2003) that require physical proximity and flexible personal contact between customers and employees (e.g. Li, 2014; Surugiu et al., 2012; Zampoukos & Ioannides, 2011).
- Substitution of labour by intermediary inputs and imports: In their study about the tourism industry in Taiwan Sun and Wong (2014) did not observe this type of substitution. Nonetheless, outsourcing or subcontracting of activities previously caried out by own staff (e.g. Kim, 2010; Marchante & Ortega, 2011), such as catering, maintenance, cleaning, and administration

(Kleijweg & Thurik, 1988), is generally recognized as a growing phenomenon in tourism (Smeral, 2003). Subcontracting is a more realistic option for tasks carried out by peripheral labour than core labour, given that at least some tasks of core labour are of a more strategic nature (Riley & Szivas, 2003; Zampoukos & Ioannides, 2011).

- Substitution between the two types of labour. Muñoz-bullón (2012) has concluded that individuals who are engaged in the tourism industry and who were hired on a temporary basis for at least 50 percent of their labour history face a reduced likelihood of receiving an open-ended contract. This 'temporality trap' (Muñoz-bullón, 2012) would imply limited substitution of peripheral by core labour.

Because substitution leads to higher labour productivity, but one unit of labour ceteris paribus still produces the same output, we refer to this type of labour productivity increase as a quasi-productivity increase.

A final demand increase can also cause 'real' labour productivity increases, whereby one unit of labour ceteris paribus does produce more output. Based on the literature we established two relationships between final demand increases and such labour productivity increases:

- An increase in final demand can lead to an increase in the price of inputs, including the wages paid for labour. According to efficiency wage theory, this stimulates investments in labour productivity (e.g. Acemoglu, 2003; Riley & Szivas, 2003; Surugiu et al., 2012). Investments in labour productivity may take the form of additional training of employees, improved planning of working hours, or facilitating inter-employee cooperation (e.g. Blake et al., 2006; Li, 2014; Riley & Szivas, 2003). Table 6B.1 shows that wages for peripheral labour are relatively low and stable while wages for core labour are higher and more variable. This implies that we can expect most labour productivity investments to take place in core labour. Companies invest less in productivity of peripheral labour (Addessi, 2014) because of high turnover (Blake, Sinclair, & Soria, 2006), less benefit from training (Budría & Telhado-Pereira, 2009), and lower perceived needs for training, given the simplicity of the tasks carried out (Ortega & Marchante, 2010).
- In tourism the amount of output that is produced by a given level of inputs can be lower than the potential output, because of the absence of customers (e.g. Riley & Szivas, 2009; Sellers-Rubio & Nicolau-Gonzálbez, 2009; Sun, 2007). There can be a suboptimal occupancy rate and excess capacity (Kleijweg & Thurik, 1988). In this context, a final demand increase does not have to lead to an increase of labour demand. Instead it leads to an increase of labour productivity (Krakover, 2000; Roget, 2006; Sun & Wong, 2010, 2014). It is likely that the labour productivity increase via this route is higher for core labour than for peripheral labour (Sun, 2007). The fact that the amount of core labour is fixed implies that part of core labour is underused in a situation with a low occupancy rate. There is potential for productivity increases, also referred to as 'idle time' (Kelliher, 1989), 'maladjustment' (Krakover, 2000), 'slack' (Sun, 2007), or 'labour hoarding' (Addessi, 2014; Kleijweg & Thurik, 1988). In contrast, the number of peripheral employee adjusts to demand fluctuations. This implies that underutilization is less relevant and there is less potential for productivity increases. An increase of final demand is therefore less likely to lead to productivity increases for peripheral labour. There can still be productivity increases, however. Some underutilization can exist because of lags and costs in 'hiring and firing' peripheral staff (Cho & Wong, 2001; Krakover, 2000). Moreover, an increase

of final demand always creates some opportunities to make better use of existing staff, e.g., by increasing the number of customers serviced by one waiter or waitress (Krakover, 2000; Sun & Wong, 2010).

Note that the literature discusses a wide range of other factors that can influence labour productivity in tourism[40]. However, in our model we focus exclusively on labour productivity changes as a consequence of an increase in final demand.

6.3 Labour productivity in a Non-linear I-O model

The NLIO model we use is described in chapter 5. However, we make three changes to this model to include labour productivity.

First, to model the interaction between the two types of labour and all other inputs we introduce a nested production structure (top part of figure 1). Substitution takes place between core and peripheral labour, between all other inputs and, on a higher level, between the aggregated labour input and aggregated other input. We assume all substitution elasticities equal 0.5, except for the tourism industries[41]. In the tourism industries we assume the substitution elasticities between core and peripheral labour and between aggregated labour input and aggregated other input to equal 0.25. In tourism we expect, based on the literature review, limited substitution between the two types of labour and between labour and other inputs. Our choice for substitution elasticities lower than one is supported by many other studies (e.g. Acemoglu, 2003; Carraro & Cian, 2013; Jalava & Pohjola, 2006; Klump et al., 2007b; León-Ledesma et al., 2012; Raval, 2010; Young, 2013). The usage of uniform substitution elasticities, except for the tourism industries, is of course a simplification of a complex reality, where substitution elasticities can vary between each combination of inputs and between industries (Young, 2013). Note that in I-O models a substitution elasticity of 0 is assumed due to use of Leontief production functions. The use of Cobb-Douglas production functions would imply substitution elasticities equal to 1.

Second, also based on the literature review, we have assumed a fixed price for peripheral labour, i.e. a horizontal labour supply curve (Hammes, 1994). Industries can satisfy increased demand for peripheral labour without an increase in wages. For core labour the price is determined at the intersection of the demand and supply function. For the supply function a Constant Elasticity of Transformation (CET) labour supply function is selected:

40 Other influences on labour productivity include, but are not limited to, the level of service (e.g. Jones & Siag, 2009; Marchante & Ortega, 2011), the age, design and type of the facility (e.g. Hu & Cai, 2004; Marchante & Ortega, 2011; Sigala et al., 2005), the location (Chen, 2007; Marchante & Ortega, 2011; Sigala et al., 2005), marketing initiatives (Barros & Alves, 2004; Peypoch & Solonandrasana, 2008; Sigala et al., 2005), the level of economic development (Lin et al., 2011; Sun et al., 2014), ownership and management arrangements (Chen, 2007; Kim, 2010; Sigala et al., 2005), the competitive environment (Blake, Sinclair, & Soria, 2006; Such & Zamora, 2006), and a focus on leisure or business visitors (Chen, 2007).

41 Tourism is not included as a separate industry in the I-O table underlying the I-O model. To facilitate our analysis we made the choice to define the three industries most closely related to tourism, namely "Catering", "Hotels" and "Culture, Sport (CSR)", as the 'tourism industries'.

$$SCL_j = CL \cdot \Psi_j^{-1} \cdot \delta_j^{-\eta} \cdot wCL_j^{\eta} \left(\sum_{j=1}^{J} \delta_j^{-\eta} \cdot wCL_j^{1+\eta} \right)^{\frac{\eta}{\eta-1}} \quad (6.1)$$

where SCL_i is the supply of core labour to industry j, CL is the total quantity of core Labour ψ_j, is the scale or efficiency parameter of core labour in industry j, δ_j is the distribution coefficient of core labour in industry j, wCL is the price of core labour in industry j, and η is the elasticity of transformation for core labour. This function implies core labour can move between industries, stimulated by wage differences, but core labour used in one industry first needs to be transformed into core labour that can be used in another industry. Adaptation is needed to adjust human capital to the requirement of a new industry (Szivas et al., 2003). We assume a constant elasticity of transformation of -0.5. The closer this elasticity is to zero, the more core labour in one industry needs to be sacrificed to increase core labour in another industry. The benchmark data are used to calibrate the substitution parameters (ϕ_j), distribution coefficients of input n (δ_{nj}) and scale or efficiency parameters (ψ_j) of the CET labour supply function

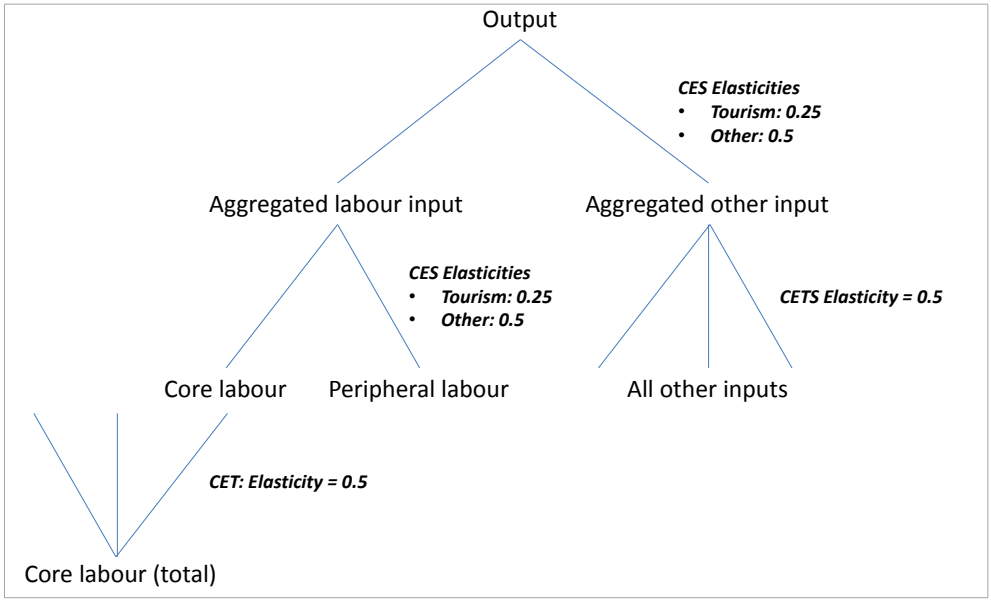
$$\phi_j = \frac{1}{\eta_j} - 1 \quad (6.2)$$

$$\delta_j = \frac{wCL_j \cdot xCL_j^{1/\eta_j}}{\sum_{n=1}^{N} wCL_j \cdot xCL_j^{1/\eta_j}} \quad (6.3)$$

$$\Gamma_j = CL \Big/ \left(\sum_{n=1}^{N} \delta_j \cdot xCL_j^{-\phi_j} \right)^{-\frac{1}{\phi_j}} \quad (6.4)$$

where xCL is the quantity of core labour in industry j. In the lower part of Figure 6.1 the supply function for core labour is introduced in the production structure.

Figure 6.1 Production structure of an industry



Source: Composed by authors

Third, besides input substitution, which causes quasi-productivity changes, we want to include real labour productivity changes into the model. We thus introduce factor augmenting technological change (FATC) into the input demand functions for core and peripheral labour in the tourism industries. For this we use the CES production function specification introduced by David and Van de Klundert (1965). This leads to the following demand function for labour type L (core and peripheral labour) in tourism industry j

$$DL_{Lj} = DAL_j \cdot \Pi_j^{-1} \cdot \varphi_{Lj}^{\theta_j} \cdot \tau_{Lj}^{\theta_j - 1} \cdot w_{Lj}^{-\theta_j} \cdot \left(\sum_{n=1}^{N} \varphi_{Lj}^{\theta_j} \cdot \tau_{Lj}^{\theta_j - 1} \cdot w_{Lj}^{1-\theta_j} \right)^{\frac{\theta_j}{1-\theta_j}} \tag{6.5}$$

where DL_{Lj} is the demand for labour type L in industry j, DAL_j is the demand for aggregated labour input in industry j, Π_j is the scale or efficiency parameter of industry j, φ_{Lj} is the distribution coefficient of labour type L in industry j, θ_j is the elasticity of substitution between core labour and peripheral labour, τ_{Lj} is the FATC of labour type L in industry j, and w_{Lj} is the price of labour type L in industry j. Our choice to apply FATC solely for labour demand functions was determined by our

focus on labour productivity in tourism. Moreover, labour augmenting technological change is also generally considered to be most relevant in the literature (e.g. Klump et al., 2007b; Kohli, 2011; Young, 2013). Following Carraro and Cian (2013) FATC is endogenously determined[42]. Based on the literature review FATC is assumed to increase with:

- An increase of the price of labour. This increase represents investments in productivity stimulated by a relative price increase. Note that we do not take into account the costs made to increase productivity and that the price of peripheral labour is assumed fixed;
- An increase in the quantity of output. This represents usage of previously excess capacity.

These relationships are integrated into the model using the following equations for labour type L (core and peripheral labour) in tourism industry j

$$\beta_{Lj} = a_{1j} \cdot w_{Lj} + a_{2j} \cdot \frac{y_j}{yo_j} \tag{6.6}$$

$$\tau_{Lj} = \tau min_{Lj} + \left(\tau max_{Lj} - \tau min_{Lj}\right) \cdot \left(\frac{1}{1 + e^{\vartheta_{Lj} \cdot (1 - \beta_{Lj})}}\right) \tag{6.7}$$

where y_j is the output in industry j, yo_j is the benchmark output in industry j, a_{1j} and a_{2j} are the weighing factors in industry j, τmin_{Lj} is the minimum value of FATC for labour type L in industry j, τmax_{Lj} is the maximum value of FATC for labour type L in industry j and ϑ_{Lj} is the factor that determines the speed at which FATC moves towards its minimum or maximum.

In equation 6.6 we combine and weigh the two influences on FATC. β_{Lj} depends on the price of labour type L and the change of output of industry j compared to the output of industry j in the situation before the final demand change (benchmark situation). We use the weighing factors a_{1j} and a_{2j}, whereby $a_{1j} + a_{2j} = 1$ and assume a_{1j} and a_{2j} to be equal to 0.5 in all tourism industries. (Equation 6.7 shows that FATC (τ_{Lj}) is based on a logistic function (e.g. Klump et al., 2007a; Kohli, 2011). Specifically, we used an S-shape Sigmoid function. The consequence is that FATC increases quickly for small changes in β_{Lj} and approaches the maximum or minimum value for larger changes in β_{Lj}. In other words, after some initial "quick wins," increasing productivity becomes increasingly more difficult. In the benchmark situation FATC is assumed to be halfway between its minimum and maximum value ($\beta_{Lj} = 1$). For core labour the minimum value of FATC (τmin_{Lj}) is set at 0.90 and the maximum value (τmax_{Lj}) at 1.10. For peripheral labour the minimum is set to 0.95 and the maximum is set to 1.05 for all tourism industries. The reason for the difference between the two types of labour is that, based on the conclusions of the literature review, we have assumed there is less room

42 A basic assumption of the NLIO model is constant returns to scale, based on which the behavior of industries can be modeled as cost minimization. Endogenous FATC alters this: the productivity increase caused by FATC implies that a doubling of inputs will now lead to more than double the amount of output. Although this fulfils the definition of increasing returns to scale the difference is that increasing returns in our model are not considered as a fundamental property of the production process (whereby industries would have the incentive to increase output indefinitely) but as a consequence of productivity increases, that are in turn caused by increases in input usage because of exogenous increases in final demand. This difference with 'real' increasing returns to scale allows us to maintain the model structure based on cost minimization.

for productivity increases in peripheral labour. The minimum and maximum values were chosen arbitrarily. Equally arbitrary are our choices for equal weighing of each labour productivity driver for all tourism industries ($a_{1j} = a_{2j} = 0.5$) and an equal adjustment speed of FATC for both types of labour and all tourism industries (ϑ_{Lj}) of 10.0. In the result section we will perform a sensitivity analysis on these values.

6.4 Data

To investigate the consequences of introducing FATC into the NLIO, we applied the model to a change of final demand in tourism in the province of Zeeland in the Netherlands.

For this province there exists a RIOT for the year 2009 (available upon request). This table was compiled by LEI (2011), making use of the Generating Regional I-O Tables (GRIT) method (Jensen et al., 1979) and is based on the national I-O table of the Netherlands. The RIOT contains 20 industries. There are separate rows for net taxes on commodities (total net taxes paid on intermediate input and import demand) and imports (total imports from the rest of Netherlands and the rest of the world). Value added consists of wages and salaries (including social premiums) and other income (capital income and profits). The table is in basic prices, which implies that net taxes on commodities are excluded. As is commonly the case, tourism is not included as a separate industry; goods and services provided to tourists and excursionists are 'hidden' within the output of many industries (Parsons, 1987; Sun, 2007). To facilitate our analysis we made the choice to define the three industries most closely related to tourism, namely "Catering", "Hotels" and "Culture, Sport, and Recreation (CSR)", as the 'tourism industries'.

To enable productivity changes in core and peripheral labour to be separately identified the two types of labour need to be defined as separate inputs in the RIOT. For this we used national data regarding the number of permanent and temporal employees per industry and their average salaries (Statistics Netherlands, 2008). This allows us to calculate national percentages for the payments to the two types of employees per industry (Table 6A.1). These percentages are then applied to the wages and salaries paid per industry in Zeeland in the RIOT, thereby assuming that national percentages also apply on this spatial scale and can be used as a proxy for the difference between core and peripheral labour.[43]

6.5 Scenario

Our analysis is based on a 10% increase in expenditure in tourism in Zeeland. The expenditure of domestic tourists in Zeeland has increased from 205,358 to 224,888 million Euro (9.51% increase) from 2007, the beginning of the economic crisis, to 2011 (Table 6.1), inspiring this scenario. Note that an accurate assessment of the impacts of the increase in expenditure would require a correction

43 Two adjustments were needed before we could apply the percentages to the RIOT. First, the employment data does not differentiate between the industries "Hotels" and "Catering", but includes one industry "Hotels and Catering". Therefore we assumed that the same percentages can be applied to both industries of the RIOT. Second, the employment data differentiates between two types of Business Services, while this is only one industry in the RIOT. Therefore we combine the totals for the two types of Business services, to calculate new overall percentages for permanent (72%) and temporal (28%) contracts.

to be made for inflation. Because we only use this data as a justification for the 10% increase of expenditure in our scenario no such corrections were made.

Table 6.1 Nights spend and expenditure by domestic tourists in Zeeland (2007 / 2011)

	Nights spend by domestic visitors (x1,000)	Yearly expenditure by domestic tourists (thousand Euros)
2007	8,055	205,358
2008	7,811	205,511
2009	8,090	213,956
2010	8,369	222,401
2011	7,635	224,888

Source: CVO (2002- 2011)

Table 6.1 is based on data from panel study known as the Continu Vakantie Onderzoek (2002 until 2011) (available upon request). There are no comparable data for the change in expenditure by domestic day visitors and international visitors. Therefore we assume that the expenditure of these two groups, and thereby the total yearly expenditure in tourism (of which figures are available for 2010 / 2011, as shown in Table 6.2), has increased by 10% as well.

Table 6.2 Yearly expenditure in tourism in Zeeland (2010 / 2011, basic prices)

Industries	Tourism in Zeeland (million Euros)
Manufacturing	49.8
Transport and storage	191.5
Hotels	149.5
Catering	308.6
Culture, sports, recreation	71.6
Trade and transport margins	12.6
Total	783.6

Sources: NBTC (2009); NBTC NIPO Research (2011a; 2011b); Statistics Netherlands (2009) – Calculations described in appendix 5D

6.6 Results and discussion

The first part of Table 6.3 gives an overview of the impacts of the 10% final demand change, calculated using the NLIO model with FATC. All impacts are given as percentage changes compared

to the benchmark situation and are presented for the three tourism industries, "Manufacturing" (an industry that supplies to all three tourism industries), and "Extractive Industries" (an industry that does not supplying to any of the tourism industries). Differences are marked in grey when the NLIO model with FATC leads to higher impacts compared to the NLIO model without FATC. The results of the latter model are shown in the second part of Table 6.3.

Table 6.3 Impact of 10% increase in expenditure in tourism in Zeeland (% changes compared to Benchmark)

		Tourism industries			Other Industries	
		Hotels	Catering	CSR	Manufacturing	Extractive Industries
NLIO model with FATC						
Quantities	Core Labour	3.58	3.14	1.01	-0.19	-0.11
	Peripheral Labour	7.64	6.78	2.70	0.67	0.83
	Output	8.23	7.25	2.66	0.24	-0.08
Prices	Core Labour	9.55	8.61	4.18	1.72	1.88
	Peripheral Labour	-[a]	-	-	-	-
	Output	1.66	1.68	1.50	0.86	1.82
FATC	Core Labour	3.42	3.07	1.30	-	-
	Peripheral Labour	1.29	1.15	0.45	-	-
Labour productivity	Core Labour	4.49	3.99	1.63	0.03	0.42
	Peripheral Labour	0.55	0.44	-0.04	-0.90	-0.43
NLIO model without FATC						
Quantities	Core Labour	5.49	4.81	1.64	-0.25	-0.16
	Peripheral Labour	9.01	7.95	3.09	0.72	0.89
	Output	8.14	7.12	2.52	0.24	-0.08
Prices	Core Labour	14.02	12.55	5.84	1.95	2.12
	Peripheral Labour	-	-	-	-	-
	Output	3.28	3.15	2.24	0.96	1.96
FATC	Core Labour	-	-	-	-	-
	Peripheral Labour	-	-	-	-	-
Labour productivity	Core Labour	2.50	2.20	0.87	0.08	0.49
	Peripheral Labour	-0.80	-0.77	-0.55	-0.96	-0.48

a The symbol "-" implies there is no change compared to the benchmark equilibrium
Source: Own calculations

When we first consider the three tourism industries the comparison between the two models makes clear that taking into account FATC leads as expected to a labour productivity increase. The increase in demand for labour is partly offset by the increase in labour productivity, which is akin to having more effective labour doing the work (e.g. Carraro & Cian, 2013; Raval, 2010; Thomas & Townsend, 2001). This shift results in lower wage increases for core labour and lower increases of the usage of core and peripheral labour. The increase in output is higher. This last result can be explained by looking at the output prices. In the model with FATC the increase of productivity leads to lower costs and a lower output price. As a result, the output of these industries is more interesting for other industries to use as an input, and the quantity of output increases.

In the other industries there is a lower decrease of core labour. Taking FATC into account leads to lower wage increases of core labour and less substitution of core labour by other inputs, such as peripheral labour. The fact that labour productivity in other industries is different for the models with and without FATC is caused by the close interaction between quasi and real productivity changes (Carraro & Cian, 2013; León-Ledesma et al., 2009): The introduction of real productivity changes in the tourism industries via FATC leads to relative price changes and substitution, which causes quasi productivity changes in the other industries.

In the literature is it often mentioned that tourism is represented by relatively low labour productivity and that this is the main cause for low wages (e.g. Riley & Szivas, 2009; Riley, 2008; Surugiu et al., 2012). These statements are supported by the optimality condition whereby the value of the marginal product, which is the marginal product of labour multiplied by the output price, equals the wage. Low labour productivity, leading to a low marginal product of labour and a low value of the marginal product (Braun, n.d.), must therefore lead to a low wage (Brida et al., 2010; Hammes, 1994; Thrane, 2008). Based on this line of reasoning we might expect that an increase of labour productivity would lead to a higher wage. In our model, however, we find that the increase of labour productivity caused by the introduction of FATC leads to a lower wage. The explanation for this apparent contradiction is that the increase in wage only takes place if everything else is held constant. Our model takes into account that an increase of labour productivity leads to a change of the output price, however. This impacts the value of the marginal product of labour. Furthermore, the wage for core labour is not solely determined by the output price and marginal product but also by the supply function. To conclude, it may be true that low labour productivity is a cause of low wages in tourism, but it is not necessarily true that an increase of labour productivity leads to higher wages. This depends on the labour market and the response of the tourism industries to the change of productivity.

To analyse the sensitivity of the NLIO model with FATC regarding the exogenous parameters Table 6.4 presents four alternative versions of the model. In the first model the ranges of the FATC are doubled: For core labour FATC is allowed to vary between 0.20 and and for peripheral labour between 0.90 and 1.10. In the second model the adjustment speed of FATC is doubled to $\vartheta_{L,I} = 2.0$. In the third model all labour is considered to be peripheral labour. In the fourth model all elasticities of substitution and transformation are increased from 0.5 and 0.25 to 2.0.

The first two models illustrate the flexibility of the NLIO model with FATC in adjusting to different hypotheses and/or empirical findings regarding the size of productivity changes in tourism. Table 6.4 shows that the differences in outcomes are relatively large. In the last two analyses we also find relatively large differences compared to the original NLIO model with FATC. This makes clear the importance of including the differentiation between core and peripheral labour. Considering all

labour as peripheral labour results in a much lower productivity and price changes. Moreover, the levels of substitution and transformation elasticities are relevant. Lower values may represent short-term changes while large values may represent long-term changes.

Table 6.4 Sensitivity analysis (% changes compared to benchmark equilibrium)

		Tourism Industries			Other Industries	
		Hotels	Catering	CSR	Manufacturing	Extractive Industries
Original NLIO model with FATC						
Quantities	Core Labour	3.58	3.14	1.01	-0.19	-0.11
	Peripheral Labour	7.64	6.78	2.70	0.67	0.83
	Output	8.23	7.25	2.66	0.24	-0.08
Prices	Core Labour	9.55	8.61	4.18	1.72	1.88
	Peripheral Labour	-	-	-	-	-
	Output	1.66	1.68	1.50	0.86	1.82
FATC	Core Labour	3.42	3.07	1.30	-	-
	Peripheral Labour	1.29	1.15	0.45	-	-
Labour productivity	Core Labour	4.49	3.99	1.63	0.03	0.42
	Peripheral Labour	0.55	0.44	-0.04	-0.90	-0.43
Alternative version 1: Ranges of τ_{Lj} for core and peripheral labour are 0.4 and 0.2 respectively						
Quantities	Core Labour	2.38	2.08	0.61	-0.15	-0.07
	Peripheral Labour	6.54	5.83	2.36	0.63	0.79
	Output	8.29	7.34	2.75	0.23	-0.08
Prices	Core Labour	6.79	6.16	3.12	1.57	1.73
	Peripheral Labour	-	-	-	-	-
	Output	0.64	0.75	1.02	0.80	1.73
FATC	Core Labour	5.66	5.08	2.15	-	-
	Peripheral Labour	2.42	2.16	0.85	-	-
Labour productivity	Core Labour	5.77	5.15	2.13	-0.00	0.38
	Peripheral Labour	1.65	1.43	0.38	-0.85	-0.40
Alternative version 2: Speed of adjustment of τ_{Lj} is $\vartheta_{Lj} = 20.0$						
Quantities	Core Labour	2.54	2.19	0.61	-0.15	-0.08
	Peripheral Labour	6.66	5.92	2.37	0.63	0.79
	Output	8.29	7.33	2.75	0.23	-0.08
Prices	Core Labour	7.14	6.42	3.15	1.59	1.74

		Tourism Industries			Other Industries	
		Hotels	Catering	CSR	Manufacturing	Extractive Industries
	Peripheral Labour	-	-	-	-	-
	Output	0.77	0.85	1.04	0.80	1.74
FATC	Core Labour	5.36	4.87	2.14	-	-
	Peripheral Labour	2.30	2.08	0.84	-	-
Labour productivity	Core Labour	5.60	5.03	2.13	0.00	0.39
	Peripheral Labour	1.53	1.34	0.37	-0.86	-0.40
Alternative version 3: Only peripheral labour						
Quantities	Peripheral labour	7.27	6.45	2.48	0.33	0.48
	Output	8.28	7.32	2.73	0.21	-0.05
Prices	Peripheral labour	-	-	-	-	-
	Output	0.04	0.10	0.31	0.24	1.05
FATC	Peripheral labour	1.27	1.13	0.43	-	-
Labour productivity	Peripheral labour	0.94	0.82	0.25	-0.52	-0.12
Alternative version 4: $\sigma_j = 2.0$ **and** $\eta = 2.0$						
Quantities	Core Labour	4.97	4.41	1.55	-0.22	-0.15
	Peripheral Labour	10.14	9.11	3.86	0.66	0.81
	Output	8.31	7.37	2.75	0.23	-0.08
Prices	Core Labour	3.02	2.74	1.33	0.44	0.48
	Peripheral Labour	-	-	-	-	-
	Output	0.10	0.14	0.27	0.21	0.44
FATC	Core Labour	2.65	2.38	0.93	-	-
	Peripheral Labour	1.49	1.34	0.55	-	-
Labour productivity	Core Labour	3.18	2.83	1.18	0.07	0.45
	Peripheral Labour	-1.66	-1.59	-1.08	-0.88	-0.42

Source: Own calculations

6.7 Data demand and complexity

Table 6.5 is based on the criteria specified in chapter 2 and the information from this chapter to compare NLIO models with and without FATC. Logically, the main difference is that in the second model the assumption of no productivity changes is rejected. The second model can thus be used in situations where real productivity changes are expected as a consequence of a final demand change. Choosing this model does create the need to specify the FATC and, in the model as we

used it, specify labour supply functions, determine their parameters, and determine the division of income between core and peripheral labour per industry. The second model thus introduces both additional complexity and data demands. Compared to a CGE model, the NLIO model with FATC has the advantages of not being dependent on the existence of a Social Accounting Matrix and the need to specify the relationships between income and final demand.

Table 6.5 Comparison of NLIO and NLIO with FATC

Outcomes, appropriateness, standardisation, and comparability	NLIO	NLIO (FATC)
Outcomes		
Indirect impacts on output, value added, income and/or employment per industry	X	X
Induced impacts, spatial and temporal consideration, social impacts, environmental impacts, and economic externalities	N.A.	
Sensitivity analysis of outcomes regarding parameters and functions	X	X
Appropriateness		
Assumption 'no scarcity of production factors' (production factors are not scarce, implying no relative price changes, input substitution or redistribution)		
Assumption 'no scarcity of production factors' rejected (production factors potentially scarce)	X	X
Assumption 'no productivity changes' accepted		
Assumption 'no productivity changes' rejected: Quasi productivity changes	X	X
Assumption 'no productivity changes' rejected: Real productivity changes		X
Impacts of final demand changes	X	X
Impacts of other 'shocks'	X	X
Standardisation and comparability		
Standardisation		
Comparability to results of other EIAs		
Data		
(Regional) I-O table	X	X
Final demand (change), per industry	X	X
Assumptions regarding capacity constraints of production factors and production factor mobility between industries	X	X
Specification and parameters of production functions (substitution elasticity)	X	X
Specification and parameters of FATC functions		X
Specification and parameters of labour supply functions (transformation elasticity)		X
Division of income between core and peripheral labour, per industry		X
Complexity		
Understanding how to change raw data into useable input for the I-O / NLIO model	X	X
Understanding and being able to explain, to a certain degree, advantages and disadvantages of the model and consequences of underlying assumptions	X	X
Standardized software (e.g. Microsoft Excel)		
Specialized software (e.g. GAMS)	X	X
Understanding and being able to explain, to a certain degree, economic and mathematical concepts such as output, value added, income, employment, direct impacts, indirect impacts, and matrix algebra	X	X
Understanding and being able to explain, to a certain degree, micro-economic and mathematical concepts such as production functions, marginal products, supply and demand functions, elasticities, (relative) price changes, differentiation, and optimization	X	X

6.8 Conclusions

The motivation underlying this research was the absence of labour productivity changes in I-O, NLIO, or CGE models applied to calculate economic impacts of tourism. Our goal was to determine which factors explain labour productivity changes in tourism as a consequence of a change of final demand, integrate these into a NLIO model, and analyse the consequences of this addition.

A literature review was used to identify which labour productivity changes can be expected as a consequence of a final demand change. A division was made between quasi productivity changes and real productivity changes. When the change of final demand leads to substitution of labour by other inputs this automatically leads to a quasi-productivity changes. Real productivity changes enable the production of more output per unit of labour (ceteris paribus). Real productivity changes were integrated into the NLIO model by introducing Factor Augmenting Technical Change (FATC), for which we used an endogenous specification, while substitution was already part of the original NLIO model. The literature review has shown the importance of differentiating between productivity increases that can be expected for core labour, i.e. full-time and/or permanent employees providing skills essential to the survival and growth of an organization, and peripheral labour, i.e. part-time and/or temporal employees, undertaking important but non-vital day-to-day activities, that are dispensed of in less affluent times or when demand is lower. This was translated into the NLIO model in the form of smaller ranges between which FATC for peripheral labour can vary, implying less room for productivity increases compared to core labour.

We applied the NLIO model with and without FATC to calculate impacts of an increase in final demand, specifically, a 10% increase of expenditure in tourism in the province of Zeeland in the Netherlands. The analysis showed that accounting for FATC leads to less usage of labour in the tourism industries as productivity increases allow output to be produced using less inputs. Productivity improvements imply lower costs, which can lead to lower output prices. These relative input and output price changes stimulate substitution and therefore quasi productivity changes.

The NLIO model with FATC leads to a more realistic estimation of economic impacts of tourism compared to a model that does not include labour productivity changes. However, the degree of realism depends vitally on the specification of the FATC function, the choice of the parameters regarding the ranges and speed of adjustment of FATC, and the differentiation between core and peripheral labour. More empirical research can lead to more realistic assumptions here.

A limitation of the model used in this study is the absence of a link between relative prices changes and final demand for tourism. The introduction of such a link, which would upgrade the NLIO model to a CGE model, could create more insight into the relationship between productivity improvements and changing output levels. However, this is only possible if the available data (i.e. a SAM on the appropriate spatial scale) is available. In spite of this caveat our analysis has shown that the NLIO with FATC is a useful addition to the 'toolbox' containing models to calculate regional economic impacts of tourism.

7. Conclusions and discussion

7.1 Specific research objectives

This section discusses how each of the specific research objectives has been reached. This provides the input for the discussion, recommendations and the general conclusions.

Criteria for the selection of economic impact models of tourism

Chapter 2 discussed criteria to choose between economic impact models, when carrying out an economic impact analysis (EIA) in tourism. Based on the literature review 52 potential criteria were identified. After consulting experts in tourism and/or EIAs 24 of these 52 criteria were identified as essential. Table 2.6 (repeated below as Table 7.1) gives an overview of these criteria and uses these to compare the five economic impact models that are most used in tourism; Export Base, Keynesian, Ad hoc, Input-Output (I-O), and Computable General Equilibrium (CGE) models.

Table 7.1 shows that CGE models are the preferred choice for many criteria. Their detail and flexibility potentially lead to more realistic outcomes. However, CGE models do not 'score' high on transparency, efficiency, and comparability. Multiplier models (Keynesian, Export Base and Ad Hoc) score high on these criteria, but the realism of their results is limited.

I-O models are an "in-between" option for many criteria, which explains their extensive usage in EIAs in tourism. Nonetheless, I-O models have some important disadvantages, most notably their strong assumptions ('no scarcity of production factors' and 'no productivity changes'), which limit the realism of their results. Although the choice of a model should always depend on the specific context of each EIA, the general conclusion is that an 'ideal model' for many applications could be found somewhere in between I-O and CGE. The challenge, however, is to extend the I-O model, while keeping the complexity and data demands to a minimum. This conclusion provided the motivation for the application and further development of a non-linear I-O (NLIO) model.

Difference between regional I-O coefficients calculated by alternative location quotient methods

When an I-O table is not available on the appropriate spatial scale, it can be created using location quotient (LQ) methods. The four most used LQ methods are Simple Location Quotient (SLQ), Cross Industry Location Quotient (CILQ), Round's Location Quotient (RLQ), and Flegg's Location Quotient (FLQ). The size of the regional I-O coefficients (RIOCs), which are derived from the regional I-O table (RIOT), directly influences the results of an EIA. An over- or underestimation of RIOCs can lead to over- or underestimation of economic impacts. It is therefore very important to understand the differences between LQ methods and the consequences for the RIOCs.

Table 7.1 Scores of models on essential criteria

Rank	Criteria	Export base	Keynes	Ad hoc	I-O	CGE
1	Direct impacts					
2	Transparent results	1st	1st	1st	2nd	
3	Spending in traditional tourism industries				2nd	1st
4	Impact on value added				2nd	1st
5	Impact on employed persons				2nd	1st
6	Impact per visitor category				2nd	1st
7	Spending in all industries				2nd	1st
8	Impact on employed FTEs				2nd	1st
9	Data-efficiency	1st	2nd	2nd		
10	Trust in model	2nd	2nd	1st	1st	
11	Impact on tax income				2nd	1st
12	Compare tourism destinations			2nd	1st	
13	Impact on production				2nd	1st
14	Cost-efficiency	1st	2nd	2nd		
15	Appropriate model				2nd	1st
16	Temporal comparison			2nd	1st	
17	Time-efficiency	1st	2nd	2nd		
18	Indirect impacts	2nd	2nd	2nd	1st	
19	Standardisation	2nd	1st	2nd	1st	
20	Compare geographical levels			2nd	1st	
21	Negative externalities					
22	Sensitivity analysis of model				2nd	1st
23	Sensitivity analysis of definitions				2nd	1st
24	Disequilibrium / market imperfections					1st

1st: The model is the 1st choice preference on this criterion
2nd: The model is the 2nd choice preference on this criterion
Blank cell: A model is not the 1st or 2nd choice preference on this criterion

Chapter 3 showed that the ranking in size of the RIOCs generated by the four LQ methods, depends on the J-value of demanding industries (output of industry j on regional level divided by output of industry j on national level). The conditions were calculated under which FLQ, the LQ method which was developed to avoid overestimation, leads to the lowest RIOCs[44]. Although

44 FLQ leads to the lowest RIOCs for all combinations between demanding and supplying industries for which demanding industries have J–values higher than $S \cdot \lambda^*$. Furthermore, for regions where all industries have J-values higher than $S \cdot \lambda^*$ it must be that FLQ leads to the lowest total output multipliers (output that is required, in all industries of the economy, to produce one unit of final demand of a specific industry) $\lambda^* = [LOG_2 (1+S)]^\delta$; S is regional output relative to national output x^R/x^N; δ is a regional scalar.

this chapter does not provide a complete answer to question which LQ method to use in an EIA it does show that a choice for the FLQ method could be motivated by the wish to estimate regional economic impacts carefully and to avoid or limit overestimation.

Medical tourism's state-level economic impacts in Malaysia

In chapter 4 the FLQ method was used to create RIOCs for nine Malaysian states. These RIOCs were used to calculate state-level economic impacts of medical tourism, based on regional I-O models. It was shown that impacts related to non-medical expenditure of medical tourists (USD 273.7 million) are larger than impacts related to medical expenditure (USD 104.9 million) and that indirect impacts (USD 95.4 million) make up a substantial part of total impacts (USD 372.3 million). Limitations of existing data implied that strong assumptions were required to estimate final demand by medical tourists, specifically regarding their non-medical expenditure and allocation of this expenditure to industries of the I-O model.

'Upgrading' the I-O model to a Non-linear I-O model

In chapter 5 the I-O model was "upgraded" to a NLIO model, by replacing the Leontief production function by a Constant Elasticity of Substitution (CES) production function. Thereby the main drawback of the I-O model, the absence of input substitution, was removed.

The analysis has shown that, for large changes of final demand, a NLIO model is more useful than an I-O model because relative prices changes are likely, leading to substitution. The NLIO takes this substitution into account. Impacts may be higher or lower than in the I-O model, depending on assumptions about capacity constraints, factor mobility and substitution elasticities. For a small change of final demand, relative price changes and substitution are less likely. In that case the most realistic results are achieved by choosing for the assumptions of unlimited supply of labour and capital, as in case of the I-O model. To analyze impacts of other types of 'shock' than final demand changes, such as a change of subsidies, an I-O model is not an option. A more flexible model is required, such as an NLIO model.

An NLIO model requires additional assumptions and/or data. First, researchers need to choose the appropriate assumption regarding the functioning of factor markets and production factor mobility between industries. Second, the NLIO model forces the researcher to specify the substitution elasticities, instead of implicitly assuming an elasticity of zero (as in the I-O model).

Including labour productivity changes into a non-linear I-O model

In chapter 6 labour productivity changes, as a consequence of final demand changes, were included in the NLIO model. A differentiation was made between real and quasi productivity changes and productivity changes for core and peripheral labour. Real productivity changes (changes that enable the production of more output per unit of labour) were integrated by introducing Factor Augmenting Technical Change (FATC) based on an endogenous specification. Quasi productivity changes (substitution of labour by other inputs which automatically leads to higher labour productivity) were already integrated into the NLIO based on the CES production function. The differentiation between core and peripheral labour was integrated by a smaller potential change of FATC for peripheral labour, which implies less room for productivity changes.

The NLIO model with and without FATC was applied to calculate impacts of a 10% increase of expenditure in tourism in the province of Zeeland in the Netherlands. Accounting for FATC leads to

less usage of labour in the tourism industries as productivity increases allow output to be produced using fewer inputs. This implies lower marginal costs, which leads to lower output prices. These relative input and output price changes stimulate substitution and quasi productivity changes.

To what degree the NLIO with labour productivity changes leads to more realistic results than the model without productivity changes depends vitally on the specification of FATC, the differentiation between core and peripheral labour, and the labour supply function. All these elements require additional assumptions and/or data.

Table 7.2 uses the essential criteria specified in chapter 2 to compare the I-O, NLIO, and NLIO with FATC. This Table, which is a combination of Table 5.10 and Table 6.5, can be used to determine in which contexts each of these models is the preferred choice. Note that the Table is based on the NLIO and NLIO with FATC as they were developed in this thesis.

Table 7.2 Comparison of I-O, NLIO and NLIO with FATC on the essential criteria

Outcomes, appropriateness, standardisation, and comparability	IO	NLIO	NLIO (FATC)
Outcomes			
Indirect impacts on output, value added, income and/or employment per industry	X	X	X
Induced impacts, spatial and temporal consideration, social impacts, environmental impacts, and economic externalities		N.A.	
Sensitivity analysis of outcomes regarding parameters and functions		X	X
Appropriateness			
Assumption 'no scarcity of production factors' (production factors are not scarce, implying no relative price changes, input substitution or redistribution)	X		
Assumption 'no scarcity of production factors' rejected (production factors potentially scarce)		X	X
Assumption 'no productivity changes' accepted	X		
Assumption 'no productivity changes' rejected: Quasi productivity changes		X	X
Assumption 'no productivity changes' rejected: Real productivity changes			X
Impacts of final demand changes	X	X	X
Impacts of other 'shocks'		X	X
Standardisation and comparability			
Standardisation	X		
Comparability to results of other EIAs	X		

Data	IO	NLIO	NLIO (FATC)
(Regional) I-O table	X	X	X
Final demand (change), per industry	X	X	X
Assumptions regarding capacity constraints of production factors and production factor mobility between industries		X	X
Specification and parameters of production functions (substitution elasticity)		X	X
Specification and parameters of FATC functions			X
Specification and parameters of labour supply functions (transformation elasticity)			X
Division of income between core and peripheral labour, per industry			X
Complexity			
Understanding how to change raw data into useable input for the I-O / NLIO model	X	X	X
Understanding and being able to explain, to a certain degree, advantages and disadvantages of the model and consequences of underlying assumptions	X	X	X
Standardized software (e.g. Microsoft Excel)	X		
Specialized software (e.g. GAMS)		X	X
Understanding and being able to explain, to a certain degree, economic and mathematical concepts such as output, value added, income, employment, direct impacts, indirect impacts, and matrix algebra	X	X	X
Understanding and being able to explain, to a certain degree, micro-economic and mathematical concepts such as production functions, marginal products, supply and demand functions, elasticities, (relative) price changes, differentiation, and optimization		X	X

7.2 Discussion and recommendations

This section discusses the findings for the specific objectives in the light of the literature and their implications for practical situations.

7.2.1 Non-Linear I-O models compared to I-O models

Table 7.2 shows that the NLIO offers an improvement in comparison to the I-O model in EIAs of other 'shocks' than final demand changes, EIAs for which the assumption 'no scarcity of production factors' is rejected, and/or EIAs for which the assumption 'no productivity changes' is rejected.

Determining whether or not the assumption 'no scarcity of production factors' can be rejected, implying that production factors are relative scarce and there are relative price changes, input substitution, and input redistribution, depends on several considerations:

1. Large versus small regions: In a large region it can be assumed that relative prices are determined inside the regional economy. A NLIO model is then more appropriate (Dwyer et al., 2004) (see chapter 5).

2. Large versus small changes of final demand: A large change of final demand is more likely to result in economy-wide changes of relative prices of production factors, and therefore, a NLIO model is more appropriate (see chapter 5).

When these findings are related to the literature on the choice between I-O, NLIO and/or CGE model, four other considerations arise:

1. Factor markets: NLIO models are preferred in regions where there is limited or no unused labour and capital. In these regions increases in labour demand are likely to lead to wage changes (e.g. Dwyer et al., 2004; Jackson et al., 2005; Loveridge, 2004; Oosterhaven & Polenske, 2009).
2. Long versus short term: NLIO models are preferred for analyses of long term economic impacts. In the long term final demand changes are likely to lead to changes of relative prices, as factor markets have the time to adjust and reach a new equilibrium (Abelson, 2011; Jackson et al., 2005).
3. Degree of production factor mobility between regions: The openness of a region determines to what degree production factors leave or enter a region. When a region is less open it is less likely that an increase in demand for labour and capital will lead to import of these production factors. In those situations an NLIO model is preferred. Although this consideration is related to the size of the region, as discussed above, there is no perfect match. There may be small regions with limited factor mobility (e.g. a remote island) and large regions with high factor mobility from and to other regions (Abelson, 2011; Nowak & Sahli, 2007).
4. Significance versus impact analysis: An I-O model is preferred in significance analyses, in which impacts are calculated of (a part of) final demand – not a change. I-O models can lead to very unrealistic outcomes in impact analysis, when final demand changes are likely to lead to relative prices changes, input substitution, and redistribution of production factors between industries. In those situations a NLIO model may be preferred (Dwyer et al., 2004; Martínez-Roget et al., 2013; Zhang et al., 2007)

All considerations require judgment by the researcher and thus introduce some subjectivity. For example, small and large and short term and long term are not clearly defined. Even the last consideration, which appears to be the most objective, introduces complexities. The difference between significance and impact analysis may be arbitrary. Calculating impacts of events may be considered as impact analysis (increase in output caused by organizing an event) (Bonn and Harrington 2008; Li and Song 2013) or significance analysis (significance of expenditure by event visitors). When calculating impacts related to expenditure by a specific group of tourists (e.g. academic tourists) it seems logical to consider this significance analysis, unless the focus is on changes of impacts when attracting more or fewer tourists from this group (Pratt, 2012). When the analysis specifically deals with impacts of a 'shock' (e.g. caused by favourable or unfavourable events, policies, price changes, etc.) it seems logical to consider the calculation as an impact analysis.

Based on these six considerations it is possible to be critical about our choice of Zeeland as a case study to test the NLIO model (chapters 5 and 6). It can be questioned to what degree relative prices are determined within the province of Zeeland, given its relatively small size and the ease with which production factors and products can move across provincial borders. Although this does not reduce the validity of our conclusions, which are not specific for Zeeland, it does show that deciding when

to accept or reject the assumption of 'no scarcity of production factors' is not as straightforward as it might seem.

Deciding whether or not to accept the 'no productivity' assumption requires expert judgment as well. Specifically, a researcher must determine to what degree labour productivity changes can be expected as a result of a final demand change. This may require differentiating between labour productivity changes that are caused by

- strategic choices made as a result of final demand change;
- strategic choices that lead to final demand changes;
- and/or strategic choices that are made independently of final demand changes.

Strategic choices can e.g. be investments in labour (training, planning, and measures to improve cooperation, effort, motivation, and loyalty) (chapter 6), making use of previously unused labour potential (chapter 6), changes in final product prices (Sun & Wong, 2010), changes in the level of service (e.g. Jones & Siag, 2009; Marchante & Ortega, 2011), changes in the design and type of tourism facilities (e.g. Hu & Cai, 2004; Marchante & Ortega, 2011; Sigala et al., 2005), changes in location (Chen, 2007; Marchante & Ortega, 2011; Sigala et al., 2005), marketing initiatives (Barros & Alves, 2004; Peypoch & Solonandrasana, 2008; Sigala et al., 2005) and a focus on different types of visitors, e.g. leisure or business (Chen, 2007). These strategic choices can be made as a result of, lead to, or be made independently of final demand changes. These distinctions determine whether or not they should be taken into consideration in an EIA.

The NLIO (with FATC) offers an improvement compared to the I-O model because it does not require the assumptions 'no scarcity of production factors' and 'no productivity changes' to be accepted, and therefore represents at least a partial solution to 'problems' of I-O models expressed by authors such as Sun (2007), Sun and Wong (2010, 2014), Blake et al. (2006), Dwyer et al. (2004), and Briassoulis (1991). However, as is true for any model, the NLIO still depends on assumptions: Output is homogenous (industries charge one price to all customers), there are constant returns to scale, and there is perfect competition (which implies market clearing, zero profit, and all actors using a strategy of cost minimization). Although authors have questioned the assumptions of homogeneity (Kronenberg, 2009), constant returns to scale (Shi & Smyth, 2012; Sun, 2007), and perfect competition (Caccomo & Solonandrasana, 2001; Li et al., 2013), and these assumption have been relaxed in extended CGE models (Li et al., 2013), they are regarded and generally accepted as a basic framework underlying all economic impact models (multiplier, I-O, CGE, etc.).

Rejecting assumptions of 'no scarcity of production factors' and 'no productivity changes' could lead to the choice of a CGE model. The most important difference between a NLIO and a CGE model is that the former does not include a link between incomes earned and final demand. Thus, induced impacts are not taken into consideration in an NLIO model. Whether or not this is problematic depends on the specific context of an EIA. When measuring, for example, the significance of recreation (instead of tourism), circular reasoning can result from the inclusion of induced impacts of recreation expenditure by locals. Recreation expenditure leads to income for locals, which leads to recreation expenditure by locals, and so on. This would lead to overestimation, as the analysis already started with total recreation expenditure by locals (Jókóvi, 1996). For some EIAs in tourism it can be important to include induced impacts, but this requires very careful considerations of the changes to

the income and expenditure of locals in the absence of the development for which the impacts are being measured (Delpy & Li, 1998; Jókóvi, 1996; Tyrrell & Johnston, 2001).

7.2.2 Data demands

As shown in Table 7.2, all three models (I-O, NLIO and NLIO with FATC) require an estimation of (the change in) final demand. This is true for any EIA, independent of the model used. As explained in the introduction, this thesis does not contain an integral discussion of all questions, problems, and possible solutions related to the collection and interpretation of data on final demand, although chapters 4 and 5 did discuss some case-specific solutions to deal with the missing data.

In spite of the limited attention to the issue in this thesis, the importance of collecting relevant information on final demand must be mentioned here. Selecting a very detailed, complex and data-intensive model can be of limited value, when the assessment of visitor expenditure only provides a crude estimate of (the change in) final demand. Nonetheless, attention to the calculation of visitor expenditure in the scientific literature is limited. Although this step is included in scientific articles in which economic impacts are measured, the emphasis in these articles often is on the calculation of indirect impacts, as is the case in this thesis. There are few methodological or theoretical articles which focus specifically on the measurement of visitor expenditure (Sainaghi, 2012; Stynes & White, 2006). For subsequent research we therefore recommend more attention to this issue.

Another data requirement for all three models is an I-O table on the appropriate spatial scale. In this research LQ methods were applied to generate RIOCs (chapters 3 and 4). Some authors criticize these methods for not being able to capture the complex forces that determine the actual RIOCs, e.g. spatial market orientations and differences between regional and national technologies (Brand, 1997; Kronenberg, 2009; McCann & Dewhurst, 1998; Richardson, 1985). Nonetheless, the usage of LQ methods remains an important method when there is no I-O table or Social Accounting Matrix (SAM) on the appropriate spatial scale, and more data intensive methods to generate such tables cannot be applied, as is often the case in EIAs in tourism.

In addition to the data requirement of the I-O model the NLIO model requires a researcher to make assumptions regarding the scarcity of production factors, to specify production functions and the function of FATC, and to estimate or assume values for substitution and transformation elasticities. Difficult as this may be, it does represent an improvement over the I-O model, in which these functions and parameters are implicitly assumed. Future research could use (historical) data and econometric analysis to evaluate different functional forms and estimate their parameters and FATC (e.g. Carraro & Cian, 2013) to determine guidelines on functional forms and parameters in practical ('non-academic') research. The major advantages of the NLIO over the CGE model, in relation to data requirements, is that it does not depend on the existence of a SAM.

The choice was made to differentiate between productivity changes for two types of employees: core employees and peripheral employees. National data was used regarding the number of permanent (core) and temporal (peripheral) employees per industry and their average salaries. As shown in Table 6B.1, the difference between these two types of employees also depends on other criteria, and the difference between temporal and permanent contracts is certainly not a perfect way to define the two groups. Future research could examine consequences of alternative subdivisions of labour. Furthermore, it could be investigated to what degree productivity changes can be expected for other inputs than labour. Given the labour intensity of tourism (e.g. Kelliher, 1989; Surugiu et al., 2012) and limited substitution of labour for capital (e.g. Riley & Szivas, 2009; Riley, 2008; Smeral,

2003) it might be expected that productivity changes in capital are limited, but empirical studies can address this hypothesis.

7.2.3 Complexity

As shown in Table 7.2 the NLIO model requires skills and knowledge that surpass those of the I-O model. The NLIO model requires specialized software and knowledge about microeconomics, e.g. profit maximization, production functions, marginal products, (relative) price changes, and elasticities. This is not necessarily a problem, as long as the researchers working with the NLIO possess the required skills and knowledge and are able to explain the results to their commissioners. Furthermore, it can be argued that researchers working with an I-O model should also be aware of the more advanced economic and mathematical concepts and relationships underlying economic impacts estimation. Just because these concepts do not explicitly play a role in I-O models does not mean they should not be taken into consideration when choosing for this model or interpreting the results.

One illustration of difficulties that manifest themselves when working with the NLIO model, that are 'hidden' when working with the I-O model, is the difference between values, quantities, and prices. The NLIO model is based on a production function that shows relationships between the quantity of output and quantities of inputs. Nonetheless, use is made of I-O tables that are based on values. The Harberger convention, whereby all base year prices are assumed to be one, is used to convert the values in the I-O table to quantities. The consequence of this assumption is that the changes of quantities that result from the NLIO should be interpreted as changes of quantities in base year prices[45]. Furthermore, final demand change should be entered into the model as the change of the quantity of products bought, also measured in base year prices. In reality, final demand changes are often measured as value changes (quantity x prices). Converting these values into quantities is complex, as it would involve making a correction for inflation, including the inflation caused by the final demand change itself (which is actually the result of the model). In this research such corrections were not made. The value change of final demand was interpreted as a quantity change as empirical final demand changes were only used as a justification for scenarios. It is important to be aware that the differentiation between values, prices and quantities is not specific for the NLIO model. This differentiation also applies to I-O models[46] and CGE model, although there are very few I-O studies that explicitly mention it.

45 For example, when industry A buys products from industry B for a value of 100 Euro in the benchmark situation, the NLIO model assumes that 100 products are bought for a price of 1 Euro each. When the NLIO then calculates that a final demand change will lead to a new quantity of products of 125, i.e. an increase of 25%, this does not necessarily mean that industry A will buy 25 more products. In reality it could be that industry A bought 10 products of 10 Euro each, in the benchmark situation. An increase of 25% means that the industry buys 2.5 products more.

46 Like the NLIO the I-O model is based on an I-O table. Such a table contains values, while the Leontief production function is based on quantities. The Harberger convention is used to convert values into quantities. The use of this assumption implies that outcomes of the I-O model are quantity changes measured in base year prices and that final demand changes should be entered as (changes of) quantities of products bought, in base year prices. To convert outcomes of the I-O model to values changes the quantity changes need to be multiplied by the new prices. Although the I-O is based on the assumption there are no relative price changes this does not imply that prices do not change. In fact, the I-O model results in a proportional change of all prices (Miller & Blair, 2009).

7.2.4 Policy relevance

This research is based on the importance of EIAs for different types of stakeholders. It can be argued that all of these stakeholders benefit from improvements in EIAs, as impacts are calculated more realistically. However, in reality, not all of these stakeholders have realism as their highest priority. EIAs are often part of a political process and are meant to convince other stakeholders of a certain position (Crompton et al., 2001; Crompton, 1995, 2006). Some of the solutions provided by this thesis, such as selecting a LQ method that leads to a careful estimation of economic impacts (avoiding or limiting underestimation) and choosing for a NLIO instead of an I-O model, can lead to lower impacts (e.g. the introduction of productivity changes can lead to lower employment impacts). This might be problematic when stakeholders need to compete for government subsidies with other stakeholders that apply an I-O model. The government then needs to be convinced of the added realism offered by the EIA.

Finally, it is important to emphasize once more that economic impacts are only one of the impacts of tourism. Scholars have discussed many other impacts, such as social and environmental impacts (Gössling et al., 2012; Peeters & Eijgelaar, 2014) and impacts on the overall quality of life of inhabitants (e.g. Andereck & Nyaupane, 2011; van den Berg et al., 1995). Decision making in tourism requires a careful consideration of all of these impacts and their interrelatedness. For some impact analyses it is recommend to combine an EIA with other impact estimation tools such as a cost benefit analysis.

7.3 General conclusion

The overall objective of this thesis was to improve the measurement of regional economic impacts of tourism by (1) establishing criteria based on which an appropriate economic impact model can be selected for an economic impact analysis in tourism and (2) providing solutions for those situations where

- an Input Output table on the appropriate spatial scale is not available;
- analysis is required of different 'shocks' than final demand changes;
- the assumption 'no scarcity of production factors' cannot be accepted;
- the assumption 'no productivity changes' cannot be accepted.

without introducing prohibitive complexity and data demands.

The criteria to select a model for application in an economic impact analysis were discussed in chapter 2. This resulted in a list of 24 essential criteria. Although the decision which criteria to consider, and how to weigh these criteria, should always be made on a case-specific basis, these 24 criteria provide a good starting point for a researcher faced with the decision which model to apply in an economic impacts analysis in tourism.

When the choice is made to apply an Input Output model (or any other model dependent on the existence of a regional Input Output table, such as the Non-Linear Input Output or Computable General Equilibrium model) and a regional Input Output table is not available, such a table can be created using Location Quotient methods, of which there are four basic variants. Although this thesis does not provide a complete answer to question which Location Quotient method to use in an EIA

it provides additional insights into the differences between the regional Input Output coefficients and total output multipliers. Furthermore, it was shown that a choice for Flegg's Location Quotient could be motivated by the wish to estimate regional economic impacts carefully and to avoid or limit overestimation.

The desire to measure impacts of different 'shocks' than final demand change and to reject the assumptions 'no scarcity of production factors' and 'no productivity changes' led to the development of a Non-linear Input-Output model with endogenous factor augmenting technical change. This thesis contains the first application of such a model to the domain of tourism. In applying this model, a researcher needs to weigh the added realism compared to the traditional Input-Output model against the need to make additional assumptions, collect additional data, and deal with the more complex nature of this model. In this perspective the NLIO model compares favourably to the General Equilibrium Model, often presented as a more realistic alternative to the Input Output model, because it does not depend on data on the relationship between income and final demand (i.e. the need for a Social Accounting Matrix).

Appendices

Appendices chapter 3

Appendix 3A Values of Z^* for different values of δ and S

Table 3A.1 Values of Z^* for different values of δ and S

	δ		
S	**0.2**	**0.25**	**0.3**
0.1	-[a]	-	-
0.2	0.043	-	-
0.3	0.119	0.080	0.049
0.4	0.211	0.171	0.140
0.6	0.448	0.391	0.386
0.8	0.739	0.668	0.666

a The symbol "-" indicates that a solution cannot be found using Microsoft Excel's target seek function
Source: Own calculations

Appendices chapter 4

Appendix 4A Economic impacts of medical tourists in Asian countries

Table 4A.1 Economic impacts of medical tourists in Asian countries

Country	Year	Value (USD millions / market prices)	Direct / Total	Indicator	Type of expenditure included	Actual data / Prognosis	Sources
Thailand	2003	1,600	Direct	Expenditure	Not specified	Actual	Pers. Comm. → Newspaper article → Scientific Article (Connell, 2006)
	2006	803	Direct	Revenue	Not specified	Actual	Source not specified → Comm. Website (Mitra, 2007)
	2007	1,366	Direct	Revenue	Not specified	Actual	Report → Book (Kanchanachitra et al., 2012)
	2008	1,500 to 1,700	Direct	Revenue	Medical	Actual	Data Ministries of Commerce, Own calculations → Bulletin WHO (NaRanong & NaRanong, 2011)
	2008	1,950 to 2,150	Direct	Revenue	Total	Actual	
	2008	1,200 to 1,400	Direct	Value Added	Total	Actual	
	2012	2,000 to 3,700	Direct	Value Added	Total	Prognosis	
	?	13,000	Direct	Not specified	Not specified	Prognosis	Strategic Plan → Paper / Book chapter (Pleumarom, 2012)
Philippines	2005	1,650	Not specified	Value Added	Not specified	Actual	Pers. Comm. → Paper (Porter et al., 2008)
	?	2,000	Not specified	Not specified	Not specified	Prognosis	Report → (Castillo & Conchada, 2010)
India	2006	333	Direct	Revenue	Not specified	Actual	Source unknown → Commercial Website (Mitra, 2007)
	2012	1,100 to 2,200	Direct	Revenue	Not specified	Actual	Source unknown → Comm. Website → Report (Porter et al., 2008)
	2012	2,000	Direct	Not specified	Not specified	Prognosis	Report → Report (Lunt et al., 2011)
	2012	2,200	Direct	Revenue	Not specified	Prognosis	Report → Scientific Article (Kim et al., 2013)
Singapore	2004	271	Direct	Revenue	Medical	Actual	Report (Singapore Tourism Board 2004-2008)
	2005	397	Direct	Revenue	Medical	Actual	
	2006	540	Direct	Revenue	Medical	Actual	
	2006	900	Direct	Revenue	Not specified	Actual	Source unknown → Commercial Website (Mitra, 2007)
	2007	671	Direct	Revenue	Medical	Actual	Report (Singapore Tourism Board 2004-2008)
	2008	723	Direct	Revenue	Medical	Actual	
	2009	1,400	Direct	Revenue	Not specified	Actual	Online news item → Scientific Article (Kim et al., 2013)
	2012	1800	Direct	Revenue	Medical	Prognosis	Newspaper article → Scientific Article (Connell, 2006)

Country	Year	Value (USD millions / market prices)	Direct / Total	Indicator	Type of expenditure included	Actual data / Prognosis	Sources
	2012	3000	Direct	Revenue	Not specified	Prognosis	Source unknown → Commercial Website (Mitra, 2007)
Korea	2006	50.9	Direct	Revenue	Medical	Actual	Online news item → Scientific Article (Yu et al., 2011)
	2010	30	Direct	Revenue	Medical (inpatients)	Actual	Report → Scientific Article (Kim et al., 2013)
	2010	60	Direct	Revenue	Medical (outpatients)	Actual	

Appendices chapter 5

Appendix 5A Inclusion of 'Museum X' as an industry in the RIOT

The data required to include 'Museum X' as a separate industry (row and column) in the RIOT comes from the Museum X's administration (2011). To determine the values in the column, Museum X's intermediate purchases are assigned to industries. Museum X's administration is expressed in market prices (excluding VAT). Before including the values in the RIOT they are converted into basic prices. A table from Statistics Netherlands which contains net taxes on commodities per industry has been used for this purpose (Statistics Netherlands 2009). The appropriate values of the intermediate purchases, converted into basic prices, are presented on the right side of Table 5A.1.

Table 5A.1 Receipts and payments of Museum X (2011, Euros)

Receipts	
Final demand	
Tickets	78,032
Souvenirs	68,291
Arrangements	2,397
Museum Card	70,844
Intermediate supply	
Education	993
CSR	21,549
Subsidies	
Municipalities	227,413
Province	1,843,600
Other	232,636
Funds & Sponsoring	436,704
Total	**2,982,459**

Payments	
Intermediate purchases	
Industry	43,608
Electricity & gas	37,807
Water	35,886
Transport & storage	19,061
Hotels	16,870
Information and communication	6,386
Real Estate	90,760
Business services	194,470
Education	12,654
Health and wellbeing	4,606
CSR	28,770
Trade & transp. margins	8,975
Import	738,502
Net taxes on products	12,970
Value Added	
Wages & salaries (incl. social contributions)	1,350,967
Other payments (e.g. interest, depreciation)	232,320
Profit	147,847
Total	**2,982,459**

Sources: Museum X's administration (2011); Statistics Netherlands (2009)

Also the other receipts and payments of Museum X in Table 5A.1 need to be assigned to appropriate cells of the RIOT. Wages and salaries and social contributions are taken together in one

row, just like other payments and profit. To avoid a negative value added the subsidy is assigned to a separate row.

A final change then needs to be made to the RIOT: Including 'Museum X' as an industry should not have any influence on the total level of output in the economy. Therefore the values in the row and column of the industry 'CSR' are reduced by the values of 'Museum X'. It is as if we have 'filtered out' the industry 'Museum X' from this industry.

Appendix 5B Expenditure in tourism

The expenditure on tourism is estimated using data from SIT 2009 (NBTC, 2009) for the number of nights spend and expenditure of international visitors, CVO 2010/2011 (NBTC NIPO Research, 2011a) for the number of nights spend and expenditure of domestic visitors, and CVTO 2010/2011 (NBTC NIPO Research, 2011b) for the number of leisure trips and expenditure per leisure trip (all sources available upon request). CVO 2010/2011 and CVTO 2010/2011 contain data for the year starting respectively on the 1st of May 2010 and 1st of October 2010. Data for the expenditure of international visitors is not available for this period, so for international visitors we use data for the year 2009 instead.

The top part of Table 5B.1 shows total expenditure per category of tourism. These expenditure data can be assigned to individual industries. Expenditure in retail should not be fully assigned to Zeeland, because not all of commodities bought are produced in the Province. Since no data are available, it is assumed that 50% is produced in Zeeland and 50% is imports. Expenditure in Museum X (see the next paragraph) is not assigned to 'CSR' but to the newly created industry. In the last row the values are converted to basic price, using the same table as before (Statistics Netherlands, 2009). Assumption are made for VAT-percentages: 19% in Industry, 6% in 'Transport and storage', 6% in 'Hotels', 19% in 'Catering', 6% in 'CSR' and 6% in 'Museum X'. The last row shows total expenditure in tourism in Zeeland, in basic prices.

Table 5B.1 Total yearly expenditure in tourism in Zeeland (2010 / 2011, million Euros)

Categories			Retail	Transport	Acco-mmodation	Catering	Entrance fees / Other		
4,992 mm	Dutch guest	Hotel	4.6	2.5	9.7	7.9	0.9	-	-
		Holiday Home	16.6	9.0	34.8	28.3	3.3	-	-
		Camping	11.6	6.3	24.2	19.7	2.3	-	-
		Other	4.8	2.6	10.0	8.1	0.9	-	-
		Regular guests	3.0	1.6	6.3	5.1	0.6	-	-
	International guests		17.7	35.3	74.0	60.1	6.9	-	-
Day visitors	Outdoor recreation		33.6	68.1	-	54.4	4.1	-	-
	Water recreation		2.7	5.5	-	6.9	2,1	-	-
	Visiting sports matches		0.0	0.1	-	0.2	0.1	-	-
	Wellness / beauty		8.7	2.6	-	-	1.2	-	-
	Visiting attractions		4.2	10.9	-	16.4	1.2	-	-
	Visiting events		19.0	7.2	-	11.8	8.7	-	-
	Fun shopping		-	13.0	-	9.1	1.3	-	-
	Culture		1.6	16.4	-	7.5	16.4	-	-
	Going out		6.6	33.4	-	14.5	4.7	-	-
Total (market prices)			152.4	198.6	159.0	381.0	75.6	-	-
Total (including Museum X)			152.4	198.6	159.0	381.0	75.4	0.2	-
Total (basic prices)			49.8	191.5	149.5	308.6	71.4	0.2	12.6
Industries			**Industry**	**Transport**	**Hotels**	**Catering**	**CSR**	**Museum**	**Margins**

Sources: NBTC (2009); NBTC NIPO Research (2011a; 2011b); Museum X's administration (2011); Statistics Netherlands (2009)

Appendix 5C Expenditure by Museum X's visitors

For Museum X information is available on the number of visitors and their expenditure profile, for the year 2010. In that year the number of visitors was 36,111 (Museum X's Administration, 2011). The average expenditure profile is shown in the 2nd column of (TNS NIPO, 2011).

Table 5C.1 Yearly expenditure by Museum X's visitors (2010, Euros)

	Exp. Profile	Adjusted exp. profile	Total (market prices)	Industries	Margins	Net taxes on production	Total (basic prices)
Food outside Museum X	4.28	4.28	154,555	Catering	-	-58,583	249,748
Food in Museum X	3.04	4.25	153,775				
Entrance + Other expenditure in Museum X	3.82	4.38	158,213 (+70,844 = 229,057)	Museum X	-	-9,493	148,720 (+ 70,844 = 219,564)
Other attractions	0.98	0.98	35,389	CSR	-	-1,888	33,501
Other expenditure	4.63	4.63	167,194 (x 50% = 83,597)	Industry	-13,873	-15,068	54,656
				Margins	-	-	13,873
Total	**16.75**	**19.19**	**585.529**		**-13,873**	**-85.032**	**571.342**

Sources: Museum X's Administration (2011); TNS NIPO (2011)

When this average expenditure profile is combined with information from Museum X's administration two adjustments can be made, as visible in the 3rd column. In 2010 entrance and other expenditure in Museum X amounted to 4.38 Euro per visitor. Moreover, according to the records of the Museum Cafe in reality 4.25 Euro per visitor was spent, instead of 3.04. In the 4th column the expenditure is assigned to industries. It is assumed that other expenses relate to purchasing goods and that half of this relates to imported goods and the other half to goods produced in Zeeland (Industry). Market prices are converted to basic prices, using once more the table from Statistics Netherlands (2009). Here however also VAT needs to be deducted. Therefore the following rates are assumed: 19% in 'Industry', 19% in 'Catering', 6% in 'CSR' and 6% in 'Museum X'. In 2010 Museum X also received 70,844 Euro due to visitors with a Museum Card. This is not included in the expenditure profile (visitors do not spend this money directly), but it is included in the totals in market and basic prices.

Appendices chapter 6

Appendix 6A Labour contracts per industry in the Netherlands

Table 6A.1 Netherlands, Permanent and temporal labour contracts (2009)

Industries	Permanent contracts			Temporal contracts			Total	
	Nr. (x 1,000)	Average Salary	Total salary (x 1,000,000)	Nr. (x 1000)	Average Salary	Total salary (x 1,000,000)	Permanent (%)	Temporal (%)
Agriculture, Forestry, Fishery	73	21,501	1.57	32	14,420	0.46	77	23
Extractive Industries	7	76,490	0.54	1	49,590	0.05	92	8
Manufacturing	671	39,023	26.18	122	26,220	3.20	89	11
Electricity and Gas	19	57,070	1.08	3	36,490	0.11	91	9
Water	32	41,250	1.32	6	30,670	0.18	88	12
Construction	327	40,079	13.11	59	28,950	1.71	88	12
Trade	866	29,516	25.56	417	13,700	5.71	82	18
Transport and storage	286	36,610	10.47	96	20,960	2.01	84	16
Hotels & Catering	184	14,017	2.58	135	9,750	1.32	66	34
Inform. and Comm.	186	50,268	9.35	48	30,560	1.47	86	14
Fin. Services	238	54,966	13.08	32	32,320	1.03	93	7
Real Estate	60	39,712	2.38	16	27,650	0.44	84	16
Specialised Business Services	406	49,327	20.03	115	28,160	3.24	86	14
Other business services	317	24,922	7.90	524	14,620	7.66	51	49
Government	429	43,640	18.72	83	29,710	2.47	88	12
Education	403	37,169	14.98	117	22,630	2.65	85	15
Health and well-being	935	27,076	25.32	302	17,920	5.41	82	18
Culture, Sport, Recreation	83	23,948	1.99	46	16,660	0.77	72	28
Other services	102	27,401	2.79	43	19,800	0.85	77	23

Source: Statistics Netherlands (2008)

Appendix 6B Core and peripheral labour in tourism

Table 6B.1 Characteristics of core and peripheral labour in tourism

Peripheral labour	Core labour	
Employment Status		
Part time	Full time	Cho and Wong (2001), Krakover (2000), Muñoz-bullón (2012), Parsons (1987), Sun & Wong (2010), Thomas and Townsend (2001), Walmsley (2004), and Zampoukos and Ioannides (2011)
Temporal contracts	Permanent contracts	Cho and Wong (2001), Krakover (2000), Muñoz-bullón (2012), Sun and Wong (2010), Walmsley (2004), and Cho and Wong (2001)
Season based / standby employees	Whole year employment	Muñoz-bullón (2012), Parsons (1987), Sun & Wong (2010), Thomas & Townsend (2001), Walmsley (2004), and Zampoukos and Ioannides (2011)
Quantity and turnover		
High percentage of total staff	Low percentage of total staff	Krakover (2000), Lin et al. (2011), Muñoz-bullón (2012), Riley & Szivas (2009), Thomas & Townsend (2001), and Zampoukos and Ioannides (2011)
High turnover (relative rate at which an employer gains and looses staff)	Low(er) turnover	
Employees leaving involuntary because of flexibility (number of employees adjusted to fluctuations in demand)	Limited flexibility (rigid core staff size)	Addessi (2014), Adenso-Díaz et al. (2002), Kelliher (1989), Krakover (2000), Ortega & Marchante (2010), Parsons (1987), Riley & Szivas (1999), Riley (2008), Sun and Wong (2010) and Walmsley (2004)
Employees leaving voluntarily because of negative aspects of tourism (e.g. high workloads, low wages, few career opportunities, unsatifying labour-management relations, infrequent and long shifts, and job insecurity) and constant presence of alternative jobs.	Strong(er) push and pull factors needed before core employees voluntarily change jobs.	Cho and Wong (2001), Johnson (1985), Krakover (2000), Ladkin (2011), Muñoz-bullón (2012), Parsons (1987), Riley & Szivas (2003, 2009), Riley (2008), Szivas et al. (2003), Thomas & Townsend (2001), Vaugeois & Rollins (2007), Walmsley (2004), Wong (2004), and Zampoukos & Ioannides (2011)
Type of jobs		
Executive level	Executive and management level	Krakover (2000) and Zampoukos & Ioannides (2011)
No involvement in management decisions	Key persons within departments	Johnson (1985) and Zampoukos & Ioannides (2011)
Limited number of repetitive, low skilled tasks / Little need for training / Limited potential for personal development	Broad range of high(er) skilled tasks / Need for training / Potential for personal development	Kelliher (1989), Krakover (2000), Muñoz-bullón (2012), Riley & Szivas (2003, 2009), Riley (2008), Walmsley (2004) and Zampoukos and Ioannides (2011)
Type of employees		
Female	Male and Female	Parsons (1987), Riley and Szivas (2003), Thomas and Townsend (2001), and Zampoukos and Ioannides (2011)
(Temporal) immigrants	Permanent inhabitants	Hammes (1994), Riley and Szivas (2003), and Zampoukos and Ioannides (2011)

Peripheral labour	Core labour	
Employees who have previously worked in other industries or will work in other industries in the future (high inter-industry mobility)	Employees with prior working experience in tourism (less inter-industry mobility)	Hammes (1994), Parsons (1987), and Riley (2008)
Employees with limited (industry or firm specific) skills / Limited or not educated / Young people / New entrants to the labour market	Employees with more (industry or firm specific) skills / Higer(er) educated	Kelliher (1989), Krakover (2000), Parsons (1987), Riley and Szivas (2003), Riley (2008), and Zampoukos and Ioannides (2011)
Salaries		
Low and relatively stable salaries:	High(er) and more flexible salaries:	
Low skilled jobs (organisation specific skills can be acquired quickly and easily)	Partly consists out of high(er) skilled jobs	Riley and Szivas (2003) and Riley (2008)
High labour supply (many people possess the skills required)	Low(er) labour supply	Krakover (2000), Riley and Szivas (2003; 2008), Riley (2008), and Walmsley (2004)
Loyalty not rewarded (organisation specific skills are acquired quickly and productivity is not strongly related to tenure)	Loyalty rewarded (acquisition of industry / firm specific skills valued)	Riley and Szivas (2003, 2009) and Riley (2008)
Low salaries accepted as 'industry norm' (type of employee who is willing to work for less / low salaries compensated for by attractive aspects of working in tourism such as travelling, meeting and working with people, learning languages, flexibility, attractive environment, dynamic industry', sense of 'not factory', working in tourism as 'way of life')	Less acceptance of lower salaries, although core employees may well have their pay (partly) determined by the deflationary pressures maintained by the peripheral employees	Cataldi et al. (2012), Ladkin (2011), Muñoz-bullón (2012), Riley and Szivas (2003), Riley (2008), Szivas et al.(2003), Vaugeois & Rollins (2007), Walmsley (2004), and Zampoukos and Ioannides (2011).
Because of lower bargaining power of flex employees wages are not or only to a small degree adjusted to the level of job effort; an increase in demand leads to an increase in workload or the number of peripheral employees – usually not to higher wages although there can be some compensation in the form of higher pay for overtime and tipping.	Core employees have a relatively equal 'effort – reward' ratio: because of higher bargaining power they can negotiate higher salaries when they have to work harder (wage flexibility)	Cataldi et al. (2012), Johnson (1985), and Riley and Szivas (2003)

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Summary

Tourism can have a broad range of impacts, including impact on the economy, on the natural and built environment, on the local population, and on visitors themselves. This PhD thesis discussed the measurement of regional economic impacts of tourism, including impacts on output, value added, and employment caused by visitor expenditure. The focus was on the choice between models that can be used to calculate these regional economic impacts and the data requirements, usage, and further development of one specific model; the Input-Output (I-O) model.

The starting point of an I-O model is final demand, which is the value of goods and services bought by final users for the direct fulfilment of their needs and wants. In tourism this refers to the value of the goods and services bought by visitors. Final demand brings about a chain of production. First, goods and services that are part of final demand need to be produced. This requires production factors (i.e., capital and labour) as well as intermediate inputs. These intermediate inputs also need to be produced, again requiring production factors and a subsequent 'level' of intermediate inputs. Combining final demand and all 'levels' of intermediate inputs, an I-O model enables calculation of the total output required to satisfy final demand. An I-O model can be an appropriate choice for an economic impact analysis (EIA) in the following context:

a. Relevant data exist on (the change of) final demand, i.e. visitors expenditure per industry;
b. There is an I-O table on the appropriate spatial scale;
c. Impacts are analysed of (a change in) final demand;
d. The assumption 'no scarcity of production factors' is acceptable (which implies there are no relative prices changes, input substitution and redistribution of production factors among industries);
e. The assumption 'no productivity changes' is acceptable (final demand changes do not lead to productivity changes, e.g. employees working longer, harder or more efficiently);
f. There is interest in indirect impacts on output, value added, income and/or employment per industry, while there is little interest in induced impacts, spatial considerations, temporal consideration, social impacts, environmental impacts, and economic externalities. Indirect impacts are impact generated by the production of intermediary inputs.

Not all EIAs in tourism will be carried out within such a context. In some EIAs one or more of these conditions are not met. The overall goal of this research was to improve the measurement of the regional economic impacts of tourism by

1. Establishing criteria based on which an appropriate economic impact model can be selected for an EIA in tourism and;
2. Providing solutions for those situations where
    - an Input Output table on the appropriate spatial scale is not available;
    - and/or analysis is required of different 'shocks' than final demand changes;
    - and/or the assumption 'no scarcity of production factors' cannot be accepted (which implies there can be relative prices changes, input substitution and/or redistribution of production factors among industries);
    - and/or the assumption 'no productivity changes' cannot be accepted

without introducing prohibitive complexity and data demands to an I-O model.

This overall objective was subdivided into the following specific objectives:

1. Provide an overview and evaluation of the criteria for the selection of economic impact models.
2. Provide an explanation for the sign of the difference between regional I-O coefficients calculated between two alternative location quotient (LQ) methods, for all combinations of demanding and supplying industries.
3. To analyze medical tourism's state-level economic impacts in Malaysia.
4. Address the limitations of I-O models and 'upgrade' the I-O model, without introducing the complexity and data collection costs associated with a full Computable General Equilibrium (CGE) model.
5. To include labour productivity changes, caused by a change in final demand in the tourism industries, into a non-linear I-O (NLIO) model.

Each of these specific objectives was discussed in a separate chapter. Chapter 2 discussed criteria to choose between economic impact models, when carrying out an EIA in tourism. Based on the literature review 52 potential criteria were identified. After consulting experts in tourism and/or EIAs 24 of these 52 criteria were identified as essential. These essential criteria were used to compare the five economic impact models that are most used in EIAs in tourism; Export Base, Keynesian, Ad hoc, I-O, and CGE models. The results show that CGE models are the preferred choice for many of the criteria. Their detail and flexibility potentially lead to more realistic outcomes. However, CGE models do not 'score' high on criteria related to transparency, efficiency, and comparability. Multiplier models (Keynesian, Export Base and Ad Hoc) score high on these criteria, but the realism of their results is limited. I-O models are an "in-between" option for many criteria, which explains their extensive usage in EIAs in tourism. Nonetheless, I-O models have some important disadvantages, most notably their strong assumptions ('no scarcity of production factors' and 'no productivity changes'), which limit the realism of their results. Although the choice of a model should always depend on the specific context of each EIA, the general conclusion is that an 'ideal model' for many applications could be found somewhere in between I-O and CGE. The challenge, however, is to extend the I-O model, while keeping the complexity and data demands to a minimum. This conclusion provided the motivation for the application and further development of an NLIO model, in chapters 5 and 6.

Both I-O and NLIO models require the existence of an I-O table on the appropriate spatial scale. For a regional I-O analysis an I-O table needs to be available for the specific region. When such a table is not available, it can be created using LQ methods. The four most used LQ methods are Simple Location Quotient, Cross Industry Location Quotient, Round's Location Quotient, and Flegg's Location Quotient (FLQ). The size of the regional I-O coefficients (RIOCs), which are derived from a regional I-O table, directly influences the results of an EIA. An over- or underestimation of RIOCs can lead to over- or underestimation of economic impacts. It is therefore very important to understand the differences between LQ methods and the consequences for the RIOCs. Chapter 3 showed that the ranking in size of the RIOCs, generated by the four LQ methods, depends on the J-value of demanding industries (output of industry j on regional level divided by output of industry j on national level). The conditions were calculated under which FLQ, the LQ method which was developed to avoid overestimation, leads

to the lowest RIOCs[47]. Although this chapter does not provide a complete answer to question which LQ method to use in an EIA it does show that a choice for the FLQ method could be motivated by the wish to arrive at a careful estimate of regional economic impacts and to avoid or limit overestimation.

In chapter 4 the FLQ method was used to create RIOCs for nine Malaysian states. These RIOCs were used to calculate state-level economic impacts of medical tourism based on regional I-O models. It was shown that impacts related to non-medical expenditure of medical tourists (USD 273.7 million) are larger than impacts related to medical expenditure (USD 104.9 million) and that indirect impacts (USD 95.4 million) make up a substantial part of total impacts (USD 372.3 million). Data limitations implied that strong assumptions were required to estimate final demand by medical tourists, specifically regarding their non-medical expenditure and allocation of this expenditure to industries of the I-O model.

In chapter 5 the I-O model was "upgraded" to a NLIO model, by replacing the Leontief production function, underlying the I-O model with a Constant Elasticity of Substitution (CES) production function. Thereby the main drawback of the I-O model, the need to accept the assumption of 'no scarcity of production factors' was thus eliminated. The analysis performed showed that, for large changes of final demand, an NLIO model is more useful than an I-O model because relative prices changes are likely, leading to substitution and redistribution of production factors between industries. The NLIO takes this into account. Impacts can be higher or lower than in the I-O model, depending on assumptions about capacity constraints, production factor mobility and substitution elasticities. Relative price changes, substitution, and redistribution are less likely for a small change of final demand. In that case most realistic results are achieved by accepting assuming 'no scarcity of production factors', as in case of the I-O model. To analyze impacts of other types of 'shock' than final demand changes, such as a change of subsidies, an I-O model is not an option. A more flexible model is required, such as a NLIO model. A NLIO model requires additional assumptions and/or data. First, researchers need to choose the appropriate assumption regarding the functioning of factor markets and production factor mobility between industries. Second, the NLIO model forces the researcher to specify the substitution elasticities, instead of implicitly assuming an elasticity of zero (as in the I-O model). Compared to a CGE model, the NLIO model offers the advantage that it is not dependent on the existence of a Social Accounting Matrix (SAM) on the appropriate spatial scale, while the production structure is identical. Furthermore, using a CGE model introduces additional complexity as it requires the specification of the relationships between income and final demand, including issues such as income transfers and income taxation.

In chapter 6 labour productivity changes, that result from final demand changes were included into the NLIO model, thereby integrating productivity changes. A differentiation was made between real and quasi productivity changes and productivity changes for core and peripheral labour. Real productivity changes (changes that enable the production of more output per unit of labour) were integrated by introducing Factor Augmenting Technical Change (FATC) based on an endogenous specification. Quasi productivity changes (substitution of labour by other inputs which automatically leads to higher labour productivity) were already integrated into the NLIO based on the CES production function. The differentiation between core and peripheral labour was integrated by a

47 FLQ leads to the lowest RIOCs for all combinations between demanding and supplying industries for which demanding industries have J–values higher than $S \cdot \lambda^*$. Furthermore, for regions where all industries have J-values higher than $S \cdot \lambda^*$ it must be that FLQ leads to the lowest total output multipliers (output that is required, in all industries of the economy, to produce one unit of final demand of a specific industry). $\lambda^* = [LOG_2 (1+S)]^{\delta}$; S is regional output relative to national output x^R/x^N; δ is a regional scalar.

smaller potential change of FATC for peripheral labour, implying less room for productivity changes. The NLIO model with and without FATC was applied to calculate impacts of a 10% increase of expenditure in tourism in the province of Zeeland in the Netherlands. Accounting for FATC leads to less usage of labour in the tourism industries as productivity increases allow output to be produced using fewer inputs. This implies lower marginal costs, which leads to lower output prices. These relative input and output price changes stimulate substitution and quasi productivity changes. To what degree the NLIO with FATC leads to more realistic results than the NLIO without FATC depends vitally on the specification of FATC, the differentiation between core and peripheral labour, and the labour supply function. All these elements require additional assumptions and/or data.

For some EIAs the NLIO is an improvement compared to the I-O model because it does not require the assumption 'no scarcity of production factors' to be accepted. In the NLIO with FATC neither the assumption of 'no scarcity of production factors' nor the assumption of 'no productivity changes' is required. In chapter 7 are discussed considerations related to the acceptance or rejection of these two assumptions. Rejection of 'no scarcity of production factors' can be appropriate in EIAs in large regions, of large changes of final demand, in regions with limited or no unused labour and capital, in long term analyses, in regions with low factor mobility from and to other regions, and for impact analyses (instead of significance analyses). Acceptance or rejection of the assumption 'no productivity changes' depends on the degree to which labour productivity changes can be expected as a result of a final demand change, a consideration which requires expert judgment.

This research makes several contributions to the measurement of the regional economic impacts of tourism:

- 24 essential criteria that can be used to select a model for application in an economic impact analysis. Although the decision which criteria to consider, and how to weigh these criteria, should always be made on a case specific basis the essential criteria provide a good starting point
- This thesis provides additional insights into the differences between the regional I-O coefficients and total output multipliers generated by the four LQ methods. Furthermore, it was shown that a choice for FLQ could be motivated by the wish to avoid or limit overestimation of regional economic impacts.
- The NLIO model with endogenous factor augmenting technical change enables a calculation of economic impacts of tourism in contexts where the I-O model is not the most appropriate choice. The NLIO model namely allows for measurement of different 'shocks' than final demand changes and can be applied in context where the assumptions 'no scarcity of production factors' and/or 'no productivity change' are untenable. When applying an NLIO model, the added realism compared to the I-O model needs to be weighed against the need to make additional assumptions, collect additional data, and deal with the more complex nature of this model. In this perspective the NLIO model does compare favourably to the CGE Model, often presented as a more realistic alternative to the I-O model, because it does not depend on data on the relationships between income and final demand (i.e. the need for a SAM).

Samenvatting

Toerisme kan veel verschillende soorten impacts hebben. Impact op de economie, de natuurlijke en gebouwde omgeving, de lokale bevolking en de bezoekers zelf. Dit proefschrift besprak de berekening van de regionaal economische impacts van toerisme; impact op output, toegevoegde waarde en werkgelegenheid, veroorzaakt door bestedingen van bezoekers. De focus lag op de keuze welk model te gebruiken om deze regionaal economische impacts te berekenen en de databehoeften, het gebruik en doorontwikkeling van een specifiek model; het Input-Output (I-O) model.

Het startpunt van dit model is finale vraag; de waarde van goederen en diensten gekocht door consumenten voor de directe vervulling van hun behoeften. Binnen toerisme heeft dit betrekking op de waarde van de goederen en diensten gekocht door bezoekers. De finale vraag leidt tot productie op verschillende 'niveaus'. Ten eerste moeten de goederen en diensten worden geproduceerd die deel uitmaken van de finale vraag. Dit vereist productiefactoren (kapitaal en arbeid) en intermediaire inputs. Deze intermediaire inputs moeten ook geproduceerd worden, waarvoor wederom productiefactoren en een volgend 'niveau' van intermediaire inputs benodigd zijn. Het I-O model combineert de finale vraag en alle 'niveaus' van intermediaire inputs en berekent de totale output die benodigd is om te voorzien in de finale vraag. Een I-O model kan een geschikt model zijn in een economische impact analyse (EIA) in toerisme, in de volgende context:

a. Data is beschikbaar over de finale vraag; de bestedingen door bezoekers per sector.
b. Er bestaat een I-O tabel op de juiste geografische schaal.
c. Impact worden geanalyseerd van (een verandering van) finale vraag.
d. De veronderstelling 'geen schaarste van productiefactoren' wordt geaccepteerd. Dit betekent dat finale vraagveranderingen niet leiden tot relatieve prijsveranderingen, input substitutie of herverdeling van productiefactoren tussen sectoren.
e. De veronderstelling 'geen productiviteitsveranderingen' wordt geaccepteerd. Finale vraagveranderingen leiden niet tot veranderingen van arbeidsproductiviteit (bijvoorbeeld, werknemers die langer, harder of efficiënter werken).
f. Men is geïnteresseerd in indirecte impacts op output, toegevoegde waarde, inkomen en/of werkgelegenheid per sector en minder of niet in geïnduceerde impacts, ruimtelijke en temporale overwegingen, sociale en milieu-impacts en economische externaliteiten. Indirecte impacts zijn de impacts die voortkomen uit de productie van intermediaire inputs.

Niet alle EIAs binnen toerisme worden uitgevoerd binnen een dergelijke context. Het doel van dit proefschrift was om de berekening van de regionaal economische impacts van toerisme te verbeteren door

1. Het vaststellen van criteria op basis waarvan het meest geschikte economische impactmodel geselecteerd kan worden
2. Het bieden van oplossingen voor situaties waarbij een onderzoek geconfronteerd wordt met de onderstaande context:

    - Een I-O tabel is niet beschikbaar op de juiste geografische schaal;

- en/of een analyse is vereist van andere 'schokken' dan veranderingen van finale vraag;
- en/of de veronderstelling 'geen schaarste productiefactoren' wordt niet geaccepteerd (er kan sprake zijn van relatieve prijsveranderingen, inputsubstitutie en/of herverdeling van productiefactoren);
- en/of de veronderstelling 'geen productiviteitsverbeteringen' wordt niet geaccepteerd.

met een zo beperkt mogelijke toename van complexiteit en databehoeften ten opzichte van het I-O model.

Dit doel is onderverdeeld in de volgende specifieke doelstellingen:

1. Geven van een overzicht en evaluatie van criteria voor de keuze van een economische impactmodel.
2. Verklaren van het teken van het verschil tussen de regionale I-O coëfficiënten berekend op basis van alternatieve locatie quotiënt (LQ) methoden, voor alle combinaties van ontvangende en leverende sectoren.
3. Een analyse van de economische impacts van medisch toerisme, per staat van Maleisië.
4. Aanpakken van de beperkingen van I-O modellen door het 'upgraden' van het I-O model, zonder dat dit gepaard gaat met de complexiteit en databehoeften van een Computable General Equilibirum (CGE) model..
5. Opnemen in een niet-lineair I-O (NLIO) model van productiviteitsveranderingen, veroorzaakt door finale vraagveranderingen binnen de toeristische sectoren.

Elke specifieke doelstelling is besproken is een afzonderlijk hoofdstuk. Hoofdstuk 2 besprak de criteria voor de keuze van een economisch impactsmodel voor een EIA in toerisme. Op basis van literatuuronderzoek zijn 52 potentiele criteria vastgesteld. Na consulatie van experts in toerisme en/of recreatie zijn 24 daarvan geïdentificeerd als essentieel. Deze essentiële criteria zijn vervolgens gebruikt voor een vergelijking van de vijf modellen die het vaakste gebruikt worden binnen toerisme: Export Base, Keynesiaanse, Ad hoc, I-O en CGE modellen. Voor veel van de criteria is het CGE model de geprefereerde keuze, hoewel het model niet hoog 'scoort' op criteria gerelateerd aan transparantie, efficiëntie en vergelijkbaarheid. Multiplier modellen (Keynesiaans, Export Base en Ad Hoc) scoren wel hoog op deze criteria, hoewel de resultaten minder realistisch zijn. I-O modellen komen voor veel criteria als compromis naar voren (voor veel toepassingen zijn ze bijvoorbeeld niet zo realistisch als CGE modellen, maar ook niet zo onrealistisch als multiplier modellen). Dit verklaart het veelvuldig gebruik van I-O modellen in EIA's in toerisme. Desondanks hebben I-O modellen een aantal belangrijke nadelen. Dit betreft vooral de sterke veronderstellingen ('geen schaarste van productiefactoren' en 'geen productiviteitsveranderingen'). Hoewel de keuze voor een model altijd af moet hangen van de specifieke context van een EIA, is de algemene conclusie dat een 'ideaal model' voor veel toepassingen gevonden kan worden ergens tussen I-O en CGE modellen. Daarbij is de uitdaging om I-O modellen uit te breiden terwijl complexiteit en databehoeften zo veel mogelijk beperkt wordt. Deze conclusie leidde tot de ontwikkeling en toepassing van een niet-lineair I-O (NLIO) model, in hoofdstukken 5 en 6.

I-O (en NLIO) modellen vereisen de aanwezigheid van een I-O tabel, op de juiste geografische schaal. Bij een regionale I-O analyse moet voor de betreffende regio een I-O tabel beschikbaar zijn. Wanneer een dergelijk tabel niet beschikbaar is kan deze gecreëerd worden door middel van locatie quotiënt (LQ) methoden. De vier meest gebruikte LQ methoden zijn Simple Location Quotient, Cross

Industry Location Quotient, Cross Industry Location Quotient en Flegg's Location Quotient (FLQ). De grootte van de regionale I-O coëfficiënten (RIOCs), die afgeleid worden uit de regionale I-O tabel, heeft direct invloed op de resultaten van een EIA. Over- of onderschatting van RIOC kan leiden tot onder- of overschatting van economische impacts. Daarom is het heel belangrijk om te begrijpen wat de verschillen zijn tussen de LQ methoden en de consequenties voor de RIOCs. Hoofdstuk 3 laat zien dat de ranking qua grootte van de RIOCs, gegenereerd door de vier LQ methoden, afhangt van de *J*-waarden van de ontvangende sector (output van sector *j* op het regionale niveau gedeeld door de output van sector *j* op het nationale niveau). Het hoofdstuk besprak de voorwaarden onder welke FLQ, speciaal ontwikkeld om overschatting te voorkomen, leidt tot de laagste RIOCs[48]. Hoewel dit hoofdstuk geen compleet antwoord geeft op de vraag welke LQ methode gebruikt moet worden in een EIA, laat het wel zien dat de keuze voor FLQ gerechtvaardigd kan worden vanuit de ambitie te komen tot een voorzichtige schatting van economische impacts, waarbij overschatting wordt beperkt of voorkomen.

In hoofdstuk 4 is de FLQ methode gebruikt om RIOCs te creëren voor negen Maleisische staten. De RIOCs zijn vervolgens gebruikt voor de berekening van de regionaal- economische impacts van medisch toerisme, op basis van regionale I-O modellen. Databeperkingen zorgden ervoor dat sterke veronderstellingen nodig waren om de finale vraag door medisch toeristen in te schatten, vooral wat betreft hun niet-medische uitgaven en de toewijzing van deze uitgaven aan sectoren van het I-O model.

Hoofdstuk 5 bespreekt een upgrade van het I-O model naar een NLIO model, door de onderliggende Leontief productiefunctie te vervangen door een Constant Elasticity of Substitution (CES) productiefunctie. Hierdoor wordt de belangrijkste beperking van het I-O model weggenomen, namelijk de noodzaak de veronderstelling 'geen schaarste van productiefactoren' te accepteren. Een NLIO model kan meer geschikt zijn dan het I-O model bij grote veranderingen van de finale vraag – omdat er hierbij relatieve prijsveranderingen, substitutie en herverdeling van productiefactoren tussen sectoren te verwachten zijn. De berekenende impacts kunnen dan hoger of lager zijn dan die van het I-O model, afhankelijk van de veronderstellingen met betrekking tot de schaarste en mobiliteit van productiefactoren en substitutie-elasticiteiten. Prijsveranderingen, substitutie en herverdeling zijn minder waarschijnlijk voor kleine veranderingen van de finale vraag. In dit geval zijn de meest realistische resultaten te behalen door de veronderstelling 'geen schaarste van productiefactoren' te accepteren, zoals in een I-O model. Voor de analyse van impacts van andere 'schokken' dan finale vraagveranderingen, zoals een verandering van subsidies, is het I-O model geen optie. Daarvoor is een meer flexibel model vereist, zoals een NLIO model. Ten opzichte van het I-O model vereist een NLIO additionele veronderstellingen en/of data. Ten eerste zijn er veronderstellingen nodig met betrekking tot de capaciteit en mobiliteit van productiefactoren. Ten tweede dwingt het NLIO model onderzoekers om de substitutie-elasticiteit te definiëren, in plaats van impliciet uit te gaan van een elasticiteit van nul (zoals in het I-O model). In vergelijking met het CGE model biedt het NLIO model het voordeel dat het niet afhankelijk is van het bestaan van een Social Accounting Matrix (SAM), op het juiste geografische niveau, terwijl de productiestructuur identiek is. Ook is een CGE model

48 FLQ leidt tot de laagste RIOCs voor alle combinaties tussen ontvangende en leverende sectoren waarvoor de ontvangende sectoren een *J*-waarde hebben hoger dan $S \cdot \lambda^*$. In regio's waar alle sectoren *J*-waarden hebben hoger dan $S \cdot \lambda^*$ leidt FLQ bovendien tot de laagste totale output multipliers voor alle sectoren (output benodigd in alle sectoren van de economie voor de productie van een eenheid finale vraag door een specifieke sector) $\lambda^* = [LOG_2 (1+S)]^\delta$; S. is regionale output gedeeld door nationale output x^R/x^N; δ is een regionale factor.

complexer in de zin dat de relaties tussen inkomen en finale vraag gespecificeerd moeten worden, inclusief zaken als inkomensoverdrachten en –belasting.

In hoofdstuk 6 is het NLIO model uitgebreid met productiviteitsveranderingen die optreden ten gevolge van finale vraagveranderingen, waarbij dus de veronderstelling 'geen productiviteitsverandering' werd verworpen. Daarbij is onderscheid gemaakt tussen werkelijke en quasi productiviteitsveranderingen en productiviteitsveranderingen voor kern- en perifere arbeid. Werkelijke productiviteitsveranderingen (veranderingen waardoor er meer output wordt geproduceerd per eenheid arbeid) zijn in het model opgenomen door middel van Factor Augmenting Technical Change (FATC), gebaseerd op een endogene specificatie. Quasi productiviteitsveranderingen (substitutie van arbeid door andere inputs, wat automatisch leidt tot een hogere arbeidsproductiviteit) waren al opgenomen in het NLIO model, door de CES productiefunctie. Het verschil tussen kern- en perifere arbeid is geïntegreerd door een kleinere potentiele verandering van FATC voor perifere arbeid, wat inhoudt dat er minder ruimte is voor productiviteitsveranderingen. Het NLIO model met en zonder FATC is toegepast om de impacts te berekenen van een 10% toename van bestedingen in toerisme in de provincie Zeeland in Nederland. De introductie van FATC leidt tot minder gebruik van arbeid in toeristische sectoren, omdat output geproduceerd wordt op basis van minder inputs. Dit leidt to lagere marginale kosten en lagere outputprijzen. Deze veranderingen stimuleren vervolgens substitutie en quasi productiviteitveranderingen. In welke mate de introductie van FATC leidt tot meer realistische resultaten hangt af van de specificatie van FATC, het onderscheid tussen kern- en perifere arbeid en de aanbodscurve van arbeid. Al deze elementen vereisen additionele veronderstellingen en/of data.

Voor sommige EIAS is het NLIO een verbetering ten opzichte van het I-O model, omdat de veronderstelling 'geen schaarste productiefactoren' niet langer geaccepteerd hoeft te worden. In het NLIO met FATC hoeven de veronderstellingen 'geen schaarste productiefactoren' en 'geen productiviteitsveranderingen' beiden niet langer geaccepteerd te worden. Hoofdstuk 7 besprak de overwegingen die een rol spelen bij de acceptatie of verwerping van deze veronderstellingen. Het verwerpen van de veronderstelling 'geen schaarste productiefactoren' kan de juiste keuze zijn in EIA's in grote regio's, bij grote veranderingen van finale vraag, in regio's met beperkt of geen ongebruikte arbeid en kapitaal, in lange termijn analyses, in regio's met beperkte mobiliteit van productiefactoren van en naar andere regio's, en in impactsanalyses (in plaats van significantieanalyses). Accepteren of verwerpen van de veronderstelling 'geen productiviteitsverbetering' hangt ervan af productiviteitsveranderingen verwacht kunnen worden als resultaat van een finale vraagverandering – dit vereist een oordeel door een expert.

Dit onderzoek levert verschillende bijdragen aan het meten van de regionaal economische impacts van toerisme:

- 24 essentiële criteria kunnen gebruikt worden om een model te selecteren voor een economische impactsanalyse. Hoewel de keuze welke criteria te gebruiken, en hoe deze te wegen, altijd afhankelijk moet zijn van de specifieke context van een EIA zijn de essentiële criteria een goed vertrekpunt.
- Deze scriptie geeft aanvullende inzichten in de verschillen tussen de regionale I-O coefficienten en total output multipliers die gegenereerd worden door de vier LQ methoden. Ook is aangetoond dat een keuze voor FLQ gemotiveerd kan worden door de wens overschatting van regionaal economische impacts te beperken of voorkomen.

- Het NLIO model (met FACT) stelt onderzoekers in staat om de economische impacts van toerisme te berekenen, in contexten waar het I-O model niet de meest geschikte keuze is. Het NLIO model maakt het namelijk mogelijk de impacts te berekenen van andere 'schokken' dan finale vraagveranderingen en kan toegepast worden in EIAs waarvoor de veronderstellingen 'geen schaarste van productiefactoren' en 'geen productiviteitsveranderingen' verworpen worden. Net zoals het I-0 model vereist het NLIO model een I-O model op de juiste geografische schaal. Een dergelijke I-O tabel kan gegenereerd worden op basis van LQ methoden. Gebaseerd op de criteria voor de keuze van een economisch impactmodel kan een onderzoeker uitkomen bij het NLIO model. Daarbij moet de toegenomen realisme in vergelijking met het I-O model worden afgewogen tegen de noodzaak tot aanvullende veronderstellingen, verzameling van aanvullende data en de meer complexe aard van dit model. Vanuit deze optiek biedt het model voordelen ten opzichte van het CGE model, vaak gezien als meer realistisch alternatief voor het I-O model, omdat het NLIO model niet afhankelijk is van het bestaan van data over de relatie tussen inkomen en finale vraag (een SAM).

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