The impact of peak oil on tourism in Spain:
An input-output analysis of price, demand and economy-wide effects

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Abstract

This article examines the potential effects of peak oil on Spanish tourism and indirectly on the rest of the economy. We construct several scenarios of price increases in oil, related fossil fuels and their inflationary effects. These scenarios provide the context for an input-output (I/O) analysis which uses I/O tables extended with Tourism Satellite Accounts. The analysis comprises three steps: (1) applying an I/O price model to estimate the price change of tourism services in Spain due to an increase in the prices of oil and other fossil fuels; (2) assessing the effects of price changes on demand for tourism services; and (3) estimating the impacts of demand change on the country's economy using an I/O demand model. The results show that a decreased demand for tourism services results in the greatest fall in outputs in the tourism-related shares of air, water, land and railway transport sectors. These are followed by tourism agencies' activities, non-market recreational, cultural and sporting activities, restaurants, and hotels. Depending on the oil price scenario adopted, GDP decreases between -0.08% and -0.38% and the number of jobs lost through direct and indirect effects varies between approximately 20.000 and 100.000.

Keywords: energy, input-output model, oil price scenarios

1. Introduction

There is an increasing concern about the imminence of peak oil at a global scale and its effects on the world economy [1–10]. There are only few studies that deal with the impact of oil scarcity on tourism despite the importance of energy for tourism related activities [11–15]. The objective of this article is to contribute to this line of research.

Tourism is due to its inherent transport component highly dependent on the availability of oil. Oil depletion and the lack of alternatives, in particular for aviation and road transport, are likely to increase the prices of travel, resulting in a lower demand for tourism. However, there is little evidence that the tourism sector is concerned about peak oil and its implications. For example, tourism growth predictions and tourism planning usually do not take into account oil depletion and a possible oil price increase.

In 2010 Spain was the fourth tourism destination in the world according to the number of international tourist arrivals, which amounted to 52.7 million, and the second one according to international tourism receipts [16]. In 2007 tourism contributed €13.21 billion to the country's economy, which represented 10.8% of the GDP and created 7.3% of total employment [17].¹ Therefore, the Spanish economy relies heavily on tourism, which makes it vulnerable to various external factors that can cause a decline in international tourism demand (e.g., political instability at a destination, economic recession in countries of origin, or oil depletion).

This article develops various scenarios of a rise in the oil price and associated price changes in other fossil fuels (gas and coal). Scenarios are motivated by empirical studies found in the literature. Our analysis estimates the effect of price increases of energy carriers alone and in combination with an increase in the costs of primary inputs due to inflationary effects on the prices of Spanish tourism supply. To achieve this, an input-output (I/O) price model combined with Tourism Satellite Accounts

¹ The most recent data on tourism accounts for Spain are available for the year 2007.

(TSA) is applied. Based on the price elasticity of demand for Spanish tourism, a change in tourism demand due to the assessed price increase is estimated. Next, implications for the overall Spanish economy are evaluated using an I/O demand-driven model. This study hence observes the changes in both the cost structure of business operations and behavioural changes of tourists.

The remainder of this article is organized as follows. Section 2 explains the peak oil phenomenon and the degree of dependency of the Spanish economy on oil. Section 3 analyses the potential effects of a rise in the price of oil on the prices of tourism products and services in Spain and develops a set of scenarios. It consists of four subsections. Subsection 3.1 explains the I/O price model and I/O data for Spain. Subsection 3.2 describes six scenarios of price increase for different fossil fuels. Subsection 3.3 introduces an additional scenario of a price increase of primary inputs (labour and capital) due to inflation. Subsection 3.4 presents results of the I/O price model analysis, which show price increases of tourism and other economic sectors in Spain. Section 4 studies the effects of the resulting price changes on tourism demand. Section 5 examines the effects of a change in tourism demand on the Spanish economy. Section 6 concludes.

2. Peak oil and Spanish oil dependency

Oil production is usually graphically represented by a roughly symmetrical logistic distribution curve, known as the “Hubbert curve” (see Figure 1). This indicates that the aggregate oil production rate of a region, country or world gradually accelerates while easily extracted oil is available. Over time oil fields become fewer, smaller, deeper and therefore more difficult to drill, causing the production to slow down and eventually stops growing. It then starts declining until all the oil that can be extracted has been produced. Peak oil represents a point at which the production of conventional oil reaches a maximum yearly level, after which it terminally declines [18]. Bardi reviews the process of acceptance of peak oil theory [23].

[INSERT FIGURE 1 AROUND HERE]

Peaking of global conventional oil production does not mean that we are running out of oil. In fact, there is theoretical and empirical evidence that a region's or country's maximum oil production is usually reached when around half of the recoverable resource has been produced [3,5,24]. Peak oil does imply, however, that supply will start declining and will not be able to meet a rising or even constant demand. Hirsch *et al.* predict that as peaking is approached, liquid fuel prices and price volatility will increase dramatically [5]. This may have serious economic consequences as most modern industrial transport, agricultural, and industrial systems are highly dependent on relatively low-cost oil. Several studies further note that a spike in oil prices is usually followed by economic recession and that oil production and global economic growth are tightly linked [10,25,26]. Therefore, without timely mitigation, the economic, social, and political costs of peak oil are likely to be unprecedented [5].

Total world crude oil production has been stable at around 74 million barrels per day since 2005 [10,27,28]. Predictions about the timing of the world peak oil production vary considerably due to numerous uncertainties associated with these [29]. Forecasts which are optimistic about the timing of the global peak oil production indicate that it will occur after 2020 [6,30–34]. IEA recognizes that output of existing fields will drop by almost two-thirds while demand is expected to grow 42% by 2035 [34]. It, however, assumes that this gap will be replaced by fields yet to be developed or discovered. Some authors are more sceptical about new discoveries, pointing out that 60% of the world's oil is located in a few giant fields found before 1970 [35] and that the rate of global oil discovery has been declining since the 1960s despite all technological advances [3,36]. According to more “pessimistic” predictions, the peak has already occurred or will occur before 2020 [1–4,8,36–41]. If the latter is true, there is insufficient time to develop large-scale, commercially competitive alternative energy sources

that could replace oil. In addition, Hallock *et al.* estimate that the number of oil exporting countries will decrease from the current 35 to between 12 and 28 in 2030 [42]. This may aggravate the oil availability problem in the future.

High oil prices may lead to a substitution effect, i.e. stimulate demand for other energy sources, such as coal or liquefied natural gas. This substitution can, however, be only temporary since coal and natural gas are finite resources as well. There is, in fact, increasing evidence for a peak in gas supply occurring relatively shortly after the peak in oil supply [3,4,36]. In addition, Höök *et al.* predict a peak in world coal production between 2020 and 2050, depending on estimates of recoverable volumes [43]. The former estimate is based on actually reported reserves, while the latter assumes twice as large coal reserves. Heinberg and Fridley suggest that available coal is less abundant than has been assumed, which in combination with rapidly growing global demand (stimulated by peak oil) means that the peak in world coal production may be only years away [44]. Energy Watch Group anticipates a global peak in coal production to occur around 2025 [45].

Another alternative to oil are non-conventional oil sources (e.g., heavy oil, tar sand, shale oil, and other non-conventional liquids based on conversion processes). As the price of oil increases, their extraction becomes more profitable. However, several studies show that unconventional oil is unlikely to compensate for conventional oil fully and fast enough to avoid oil supply shortages due to peak oil [6,46,47]. Moreover, the energy return on energy invested (EROEI) of unconventional oil remains very low and environmental impacts of its extraction are more adverse than those of conventional oil.

The Spanish economy has been assessed as being more vulnerable to oil prices than many other oil-importing countries [13,48]. In 2009, oil represented 47.2% of the country's total primary energy supply. Its domestic oil production² was 2.1 kb/day whereas demand equalled 1466 kb/day [49].

² In thousands of barrels per day.

Therefore, the country's oil import dependency³ was 99.9%. In addition, Spain is one of the major tourism markets for air transport, which is the tourism-related activity that will be most affected by high oil prices [50]. The UNWTO has analysed the effects of rising oil prices on international tourism and particularly on air transport [50]. It concluded that the increase in oil prices over the last years did not affect international tourism as previous oil shocks (in 1974, 1979 and 1990) because of increased operating efficiency and a reduction of non-fuel costs (such as staff costs), which have compensated for a rise in fuel costs. Nevertheless, the oil prices have risen substantially since then, while further efficiency increases and non-fuel cost reductions are becoming more difficult. This is even more the case for low-cost airlines, whose market share in Spain in 2010 was 55.7% [51]. The fragility of such airlines is illustrated by the case of Spanair, which ended its operations in January 2012 due to financial problems.

3. Effects of the oil price increase on the prices of tourism services in Spain

3.1. The input-output price model for Spain

Research on tourism using I/O analysis is steadily increasing. A good example of current research is provided by a special issue of *Economic Systems Research* [52]. However, none of this work examines the interactions between tourism activities and energy issues. Therefore, this is to our knowledge the first study that uses I/O analysis to address the influence of oil prices on tourism, adopting a national perspective. Other studies that have empirically analysed the effects of peak oil on tourism have employed computable general equilibrium (CGE) models for Scotland and New Zealand [12,15]. An important difference between our and these two studies is that Scotland is a net oil exporter, while New Zealand's oil import dependency is 57% [53]. Therefore, none of the two countries depends as strongly on oil imports as Spain. Moreover, given that New Zealand is not a European country it receives

³ Calculated as one minus the ratio of domestic oil production to domestic oil consumption.

tourists from very different countries of origin compared to Spain. This factor can play an important role in determining the degree of vulnerability of a tourism destination to increasing oil prices [15].

The opinions on CGE versus I/O are divided. While some claim that CGE is better because it includes price and substitution mechanisms, others argue that CGE depends on debatable assumptions regarding rational behaviour, which means that the accuracy of its results is not perfect. Furthermore, CGE depends on many parameter values that are difficult to assess for each region and therefore often are taken from the literature. The advantage of I/O analysis over CGE is that it allows for a higher transparency of the model with regard to the assumptions and the underlying operational mechanism. It can also more easily handle a detailed sector disaggregation. Its disadvantage is the fixed nature of the technical or I/O coefficients, which describe the quantity of intermediate input required to produce one unit of output. The fixed coefficient assumption implies constant returns to scale and constant proportions of inputs. The latter reflects complementarity between inputs; that is, output cannot be increased by substituting one input for another [54]. This means that no technological change or substitution between different energy sources (e.g. oil and renewable energy) is assumed. For this reason, I/O models are often used to assess the short run economic impacts from an exogenous shock or policy, as in this case no fundamental changes affecting input proportions take place. This implies that the results of this study are more precise in the short than in the long run. Studies that have compared the estimates derived from I/O and CGE model applications include Alavalapati *et al.*, Kveiborg and Cassey *et al.* [55–57]. Dwyer and Forsyth do the same with a special focus on tourism [58]. These various studies draw different conclusions, so that it is difficult to generalize about the similarities of and differences between the outcomes of I/O and CGE approaches.

The method used here for analyzing the effect of higher oil prices on the prices of tourism products and services in Spain is the I/O price model. In this model quantities are fixed and prices change, which enables assessing the effects of a change in the value-added expenditures (i.e. a price

change of any primary input) or a change in import prices in one or more sectors on sectoral unit costs and output prices via the fixed production coefficients [59–61]. In the price model the final demand has no role in the price formation. So far no published study of peak oil impacts on the economy has used an I/O price model.⁴

The I/O price model can be expressed as:

$$\Delta P = [(I - A_D')]^{-1} [A_m' \Delta P_m + A_v' \Delta P_v] \quad (1)$$

where A_D is the matrix of domestic coefficients, A_m the matrix of import requirements per unit of output, A_v the matrix of primary input requirements (consisting of labour costs, net taxes, and gross operating surplus) per unit of output, ΔP_m and ΔP_v are vectors of assumed changes in imports and primary input prices, and ΔP is the resulting vector of changes in domestic output prices [59,64]. In this model, ΔP_m and ΔP_v are considered exogenous variables, which means that one can determine their changes and then quantify their effects on domestic output prices. The matrix of primary input requirements can further be expressed as the sum of the matrices of labour input requirements (A_l) and other primary input requirements, comprising net taxes and gross operating surplus (A_k). The price model then takes the following form:

$$\Delta P = [(I - A_D')]^{-1} [A_m' \Delta P_m + A_l' \Delta P_l + A_k' \Delta P_k] \quad (2)$$

In this study we assume an increase in the prices of intermediate imports from energy sectors and in one set of scenarios also a simultaneous increase in the prices of primary inputs (labour and capital) due to inflationary effects of a rise in oil price. The former approach provides insights into the short-term effects, while the latter one can be considered as offering a slightly longer-term perspective. Six

⁴ It was suggested though by Kerschner and Hubacek in a presentation at the International I/O association conference [62]. They showed a slide with some preliminary results of an I/O price model study. Furthermore, they used I/O analysis to assess the economic effects of peak oil, applying a supply-constrained model [63]. This allows for “exogenising” sectors that suffer a supply shortage and estimating the impact of reduced outputs of the supply-constrained sector(s) on unconstrained sectors. Their findings show that the most affected sectors in the countries analyzed (UK, Japan and Chile) are transportation, electricity production, financial services, and foreign trade.

distinct scenarios of price increase of imports from energy sectors are presented in Section 3.2. An additional scenario of an increase in the costs of labour (i.e. wages) and capital is formulated in Section 3.3.

Data used for the analysis include the Spanish I/O industry-by-industry tables in basic prices for 2005, which embrace 73 industries. All parts of this study used separate I/O tables for domestic production and for imports, which are provided by INE [65]. The energy sectors are classified as follows: (1) mining of coal and lignite, extraction of peat; (2) extraction of crude petroleum and natural gas, mining of uranium and thorium ores; (3) manufacture of coke, refined petroleum products, and nuclear fuel; (4) production and distribution of electricity; (5) manufacture of gas, distribution of gaseous fuels through pipes, steam and hot water supply. In order to observe the effect of an oil price change, we disaggregated the extraction of petroleum from that of natural gas. For this purpose, we employed use and supply tables for Spain for 2005 and assumed an industry-based technology. This implies that an industry has a uniform input structure, regardless of its output product mix (i.e. that any secondary or by-product of an industry is technically related to its main production), as opposed to a commodity-based technology assumption according to which a commodity has a uniform input structure in any industry in which it is produced [66].

In the I/O tables for Spain tourism is not classified as a separate industry, but rather embraces several industries which include both tourism and non-tourism activities. We used Spanish TSA for 2005 to determine the ratios of products and services corresponding to tourism activities within each economic sector. Tourism in this case comprises activities related to both domestic and foreign tourists. In 2005 foreign tourists contributed 44.9% to tourism revenues in Spain. Table 1 presents total outputs of each tourism-related sector and ratios of tourism activities in these sectors.

[INSERT TABLE 1 AROUND HERE]

3.2. Scenarios of price increases in energy carriers

From 1869 until 2009, the average world crude oil price adjusted for inflation was US\$23.42 per barrel [67]. Several oil shocks throughout history showed dramatic effects of oil and gas shortages on their prices. Between 1987 and 2001 the oil price oscillated around US\$15-20 per barrel, except for a spike in 1990 due to the Gulf War (see Figure 2). A combination of a weak dollar, rapidly growing demand, and possibly also speculation⁵ stimulated a rise in crude oil prices causing a record level of US\$144 on 3rd July 2008 (daily European Brent spot price). The subsequent global recession tumbled the oil price to US\$34 by December 2010. After economic recovery in certain parts of the world and continued boosting demand from developing countries such as China and India, the price of crude oil rose again sharply to US\$120 in April 2011 and remained above US\$100 until June 2012. It is expected that demand in developing countries will keep increasing in this decade as populations grow and incomes rise [69].

[INSERT FIGURE 2 AROUND HERE]

This study considers three different scenarios of a rise in oil price. Scenario 1 uses projections of the EIA and IEA, which are rather similar [33,34]. They assume that the oil price would increase by approximately 25% by the year 2035 compared to the 2008 levels (i.e. from US\$95 to around US\$119 per barrel). Since the Spanish I/O data used here are for 2005, they implicitly assume 2005 oil prices. In line with this, we choose as the baseline oil price level its average price in Europe in 2005, which was equal to US\$54.57. Hence, scenario 1 assumes that the price of oil imports increases by 110% compared to the 2005 levels (i.e. to US\$115). As EIA and IEA price projections are based on the future

⁵ Buyuksahin and Harris show that the high oil prices of 2008 were not due to speculation, but that speculation followed high prices [68]. Even though it is difficult to provide a definite proof for this, their finding supports the idea that oil prices are ultimately determined by real scarcity.

oil production trends and depletion rates which are strongly criticized for being overly optimistic by some authors [3,5,38,70], they can be considered as rather conservative estimations. This argument is supported by the current oil prices as well as by more recent EIA projections, in which oil price is predicted to reach US\$145 by 2035 [71]. As mentioned before, a number of studies predict the peak in oil production very soon and expect a substantial rise in oil price as a consequence. To reflect this, in scenarios 2 and 3 we assume considerably higher oil price, namely US\$150 and US\$200 per barrel (i.e. an increase of 175% and 267%), respectively. In this way, scenario 2 observes the effects of an oil price increase in the range of the one which took place in the summer 2008, while scenario 3 is aimed at investigating the consequences of a more extreme though not unrealistic rise in oil prices, which corresponds to the high oil price scenario of the U.S. Energy Information Administration [33,71].

Further, several assumptions about the effects of higher oil price on the prices of other energy sources have to be made. According to economic theory, the prices of natural gas and crude oil should be related as they are substitutes in intermediate production and are often complements (co-products) in extraction. Historical market behaviour indeed suggests that the price of natural gas is closely following the price of oil. In addition, empirical evidence has shown that crude oil and natural gas prices have a long-run co-integrating relationship [72–74]. These studies indicate that a permanent 1% increase in the oil price leads to a rise in the price of natural gas between 0.38% and 0.89%, with the majority of studies reporting natural gas price increase of 0.80% or higher. Moreover, if a price of oil increases by 1%, the price of coal increments between 0.34% and 0.63% [72,75]. Only Bachmeier and Griffin report that crude oil, coal, and natural gas markets are very weakly integrated [76].

Based on these studies, we consider two different scenarios of correlation between natural gas and crude oil prices. In the first scenario (scenario A), the natural gas price increase equals 50% of the crude oil price increase, while in the second scenario (scenario B) the natural gas price follows the crude oil price increase completely (100%). As for the relationship between oil and coal prices, we

assume that a 1% increase in both oil prices would lead to a 0.5% increase in coal prices. Nevertheless, a more extreme increase in oil and gas prices (scenarios 2B and 3B) is likely to cause a shift towards a higher demand for coal, leading to a more than proportional increase in the price of coal in relation to oil and gas prices. For this reason, in these two scenarios we assume that a 1% increase in oil prices would induce a 0.75% increase in coal prices.

Next, a change in the price of electricity production and distribution sector because of an increase in the oil price is determined based on the proportions of different energy sources used in electricity production in Spain (Table 2). In 2007, 30.5% of electricity was produced from natural gas, 24.5% from coal, 6.1% from oil, while the rest came from other energy sources [77]. Therefore, in scenario 2A, for example, the portion of the electricity production and distribution sector based on oil (6.1%) is assumed to increase its price by 175%, while the portion of this sector which is dependent on gas and coal ($30.5+24.5=55\%$) is assumed to follow an increase in gas and coal prices (87.5%). The remaining part of the sector is assumed to not undergo a price change. Such a combination of price increases results in an average price increase of 58.8% of the electricity production and distribution sector in scenario 2A. Similar calculations lead to the percentage changes reported in Table 2. Finally, with the increase in oil, gas, coal, and electricity prices one could expect that the nuclear and renewable energy prices would also rise as their equipment needs fossil fuels. However, we assume that their prices do not change. In this sense, our estimates can be considered as conservative.

[INSERT TABLE 2 AROUND HERE]

3.3. Scenario of price increases in primary inputs

Apart from examining the effects of an increase in the prices of energy carriers only (i.e. assuming that the prices of all primary inputs remain unchanged), we introduce a scenario in which the prices of

primary inputs increase in addition to energy prices due to inflationary effects. A reason for this is that the oil price increase is quickly passed on to consumer prices, leading to inflation [78,79]. This scenario therefore provides a slightly longer-term perspective than the scenario which assumes only an increase in energy prices. The primary inputs, i.e. the value-added expenditures, include labour costs (such as wages, salaries and social contributions), taxes less subsidies, and gross operating surplus of economic sectors.

Álvarez *et al.* show that a 10% rise in the price of oil would lead to an inflation of 0.24% or 0.38% in Spain within 2 years, depending on the model used for the analysis [80]. Llop and Pié analyze the effect of a 10% tax on intermediate energy use on the economy of Catalonia (a Spanish Autonomous Community), which is expected to have similar effects as a 10% increase in the price of energy imports [81]. They conclude that such a tax would increase consumption prices by 0.51% (0.75%) under a competitive (mark-up) price formulation option. LeBlanc and Chinn assessed the effect of an oil price increase on inflation in G-5 countries, namely UK, France, Germany, Japan, and USA [82]. In their most general model specifications, the inflationary effect of a 10% oil price increase varies between 0.1% for France, which mainly relies on nuclear energy, and 2.5% for the UK. A similar study for Turkey found that a 20% increase in crude oil price leads to a general price level increase of 2.01% when wages are adjusted while other income factors are fixed [83].

The expectations-augmented Phillips curve model implies that wages and prices are causally related with feedback in both directions, which is often referred to as Granger-causality [84]. However, some studies found that causality is running only from prices to wages. In any case, most of them report a cointegrating relationship between inflation and nominal wages [85–87]. This means that wages rise in response to inflation, making labour as productive input more costly. This effect might be even more prominent in Spain because more than 75% of Spanish workers are covered by wage indexation clauses, while this percentage is less than 25% in most other EU countries [88]. In addition,

49% (70%) of Spanish firms take into account past (past or expected) inflation when setting wages, which is also considerably higher than in the euro area (22% and 30%, respectively) [89]. Álvarez *et al.* estimated that a 10% increase in oil price would cause an increase in unit labour costs of 0.42% within 3 years [80]. Based on the findings of these studies, we assume an increase in labour costs due to energy price increases, according to which a 100% increase in oil price causes a 5% increase in the price of labour input.

The effect of oil price increase on the cost of capital is somewhat less clear, although there are many studies that have analyzed the impact of oil price increase on interest rates [90–95]. Most of these find that higher oil prices lead to an increase in long-term interest rates, while its effect on short-term interest rates is less clear. The magnitude of the effect varies substantially between different studies and for different countries, depending largely upon the monetary policy which a country's central bank adopts as a response to high oil prices. Nevertheless, the assumption of a 2.5% increase in capital costs due to a 100% increase in the oil price seems reasonable based on the above-mentioned literature and is thus used for the purpose of this study.

3.4. Results of the input-output price model analysis

An overview of the price increases of outputs in each sector of the Spanish economy resulting from price increases in imports of energy carriers alone and in combination with labour and capital cost increases is presented in Table 3. Specific assumptions about price increases of natural gas and coal relative to those of oil do not play an important role, which means that scenarios A and B yield very similar results. For that reason, we report only scenarios A, which represent more conservative estimates.⁶ The highest price increase occurs in energy sectors, especially in those related to manufacturing of refined petroleum products and gas, as expected. These are followed by transport

⁶ The results of the six B scenarios are available from the authors upon request.

sectors, in particular air, water, and other land transport (including transport via pipelines) as they are very oil-intensive. On the other hand, railway transport and support and auxiliary transport activities are less oil-intensive and thus experience more moderate price increases. The next most affected groups of sectors embrace manufacturing (e.g., of chemicals, cement, glass) and fishing. The price increase of primary inputs (particularly labour) has, as may be expected, the largest impact in the sectors which are service-based. For example, among tourism activities transport sectors are driven more by the energy price increase, while labour-intense sectors, such as hotels, restaurants and recreational, cultural and sports activities are driven more by increases in primary input (i.e. labour) prices. The results for tourism sectors show that the highest price increases in outputs occur in air transport;⁷ water transport; other land transport and transport via pipelines; support and auxiliary transport activities; and railway transport. Apart from transport sectors, the most substantial price increases occur in travel agency activities; non-market recreational, cultural and sporting activities; and restaurants.

[INSERT TABLE 3 AROUND HERE]

4. Response of demand for Spanish tourism to a change in tourism prices

In this section a change in the international tourism demand for Spain due to a price increase of tourism products and services is estimated through its price elasticity. In the literature which deals with the price elasticity of international tourism demand, tourism prices have most frequently been represented by the Consumer Price Index (CPI). This has been widely accepted since the mix of goods and services consumed by tourists is not too different from the mix constituting the CPI [96,97]. However, it is less clear whether absolute prices (prices in one country) or relative prices (ratio of prices in different

⁷ The ranking of sectors from most to least affected is based on the results of the least extreme scenario of oil price increase (110%), labour cost increase (0%) and capital cost increase (0%).

countries) should be used and if relative prices are used whether they should be related to the prices in origin country or to the prices in competitor countries. Different studies apply distinct definitions of tourism price causing the specification of the price variable in the models to vary [96,98]. It should also be noted that tourism demand can vary considerably over time due to changes in economic conditions or preferences. Its price elasticity is hence not constant. For this reason, a distinction is generally made between short- and long-term elasticities of tourism demand.

Studies that analyze tourism demand for Spain coming from a single origin country mainly focus on Germany and UK, which represent the two largest international tourist market segments in Spain. The short (long)-term price elasticity of German demand for tourism in Spain was estimated at -1.06 (-2.16) for the period 1991-2003 [99]. Song *et al.* investigated UK tourism demand for 12 countries including Spain between 1965 and 1994 [100]. The price elasticity for Spain turned out to be relatively inelastic both in the short and long term, taking values -0.491 and -0.496 , respectively. De Mello *et al.* observed UK demand for tourism in France, Spain and Portugal [101]. The results showed that the tourism demand elasticity to price changes in Spain was -1.82 in the period 1969-1979 and -1.93 in the period 1980-1997.

Studies that embrace total inbound tourism of a destination country provide a more complete estimate of the overall demand because price elasticities are likely to vary by country of origin [102–104]. One of them assessed the price elasticity of Spanish tourism based on 17 countries of origin [105]. These countries represented 92.5% of the Spanish tourist source market measured in the share of nights spent in Spanish hotels in 1994. The authors calculated that the price elasticity of demand for tourism in Spain is -0.30 in the period 1985-1995. Another study estimated the effects of a change in tourism prices in Spain relative to prices in seven countries of origin, which together generate 72% of tourist visits to Spain [106]. It found that a 1% price increase would lead to a decrease of 0.55% in the number of tourists and 0.61% in tourism expenditures, *ceteris paribus*, in the period 1979-1991. More

generally, meta-analysis of tourism demand show that the price elasticity of demand for Southern/Mediterranean Europe is -0.64 [102]. The same approach indicates that the effect of tourism prices on tourist arrivals/departures is -0.69 and on tourism expenditures -0.47 [107].

In all the above-mentioned studies the price elasticity of demand for Spanish tourism is negative, as expected from economic theory. However, there are considerable differences in the magnitude of the estimates. For this reason we apply three different scenarios based on the results of the mentioned studies, reflecting price elasticities -0.5 , -1.0 , and -2.0 . It is likely that price elasticities for different tourism activities vary, meaning that the demand for various tourism products and services would change at different rates. However, this information is to our knowledge unavailable. We therefore assume an equal reduction in demand for all tourism activities, which can be considered as an “average approach”.

5. Implications of a change in tourism demand for the Spanish economy

This section assesses the repercussions of a change in the demand for tourism in Spain on the country’s overall economy by applying a traditional Leontief I/O model. This model is often referred to as demand-driven model because the final demand vector drives the model entirely and determines total outputs as well as intermediate and primary inputs. This approach is usually applied to examine how a change in the final demand of one or more exogenous sectors would affect the total output of all sectors, taking into account intermediate deliveries necessary to satisfy the new level of demand. This makes the model perfectly suitable for our next research question: how does a change in tourism demand translate into economy-wide effects? The traditional Leontief model can be specified as:

$$X = [I - A]^{-1} Y \quad (3)$$

where X represents the vector of gross outputs of sectors, $[I - A]^{-1}$ is the Leontief inverse, and Y is the vector of final demand. The latter consists of the vectors of domestic final demand (h) and exports (e), from which the vector of imports (m) is deducted. The model can therefore be written as:

$$X = [I - A]^{-1} [h + e - m] \quad (4)$$

Imports appear with a negative sign because they represent a part of demand which is not met by domestic production. However, this approach is problematic because m represents intermediate import demand and one cannot know how large this is until X has been estimated. We thus adopted an alternative approach to deal with imports, as proposed in Bulmer-Thomas [59]. Accordingly, the equation for domestic supply and demand is solved as:

$$X = [I - A_D]^{-1} [h_D + e] \quad (5)$$

where A_D is a matrix of domestic I/O coefficients and h_D is a home final demand for domestically produced goods and services. First we introduce the new, decreased levels of domestic final demand (h_D) and exports (e), resulting from the output price increases determined in Section 3.4 combined with the three different price elasticities of demand for Spanish tourism discussed in Section 4. Furthermore, in scenarios which account for an increase in the costs of primary inputs we assume that a rise in wages would to some extent compensate for a rise in the prices of outputs, hence moderating a decrease in demand. We introduce this in the model by dividing the percentage decrease in demand by factor 1.05. The figure was selected based on an assumed rise in wages of 5% in relation to the oil price increase. Equation (6) then allows us to assess new domestic output levels stemming from diminished demand. These results then enter the following equation to calculate the new levels of imports:

$$m = A_m X + h_m \quad (6)$$

where A_m is a matrix of import requirements per unit of output and h_m is a vector of domestic final demand for imports. Because of a lack of data on price increases of imported products and services and

price elasticities of demand for imports, h_m is assumed to remain unchanged, which again implies that our estimates are in a conservative direction.

We consider two sets of scenarios here, each one comprising 12 sub-scenarios (although only six sub-scenarios corresponding to scenario A are presented in the article). In the first set of scenarios only the demand for tourism activities decreases, while in the second one demand for all economic sectors diminishes. Changes in domestic outputs discussed further in this section are based on the assumption that the price elasticity of demand is -0.5 in both sets of scenarios. From all the calculations we performed it follows that domestic outputs change proportionally to the price elasticity. This means that when the price elasticity is assumed to be -1.0 (-2.0), changes in outputs are double (four times higher) compared to the ones at the price elasticity of -0.5 .

In the first set of scenarios demand for tourism activities falls, while that for other sectors stays unchanged. In such a case, sectors related to tourism activities experience the greatest reductions in domestic outputs. The air transport sector suffers the largest reduction in outputs,⁸ followed by water transport; other land transport and transport via pipelines; railway transport; travel agencies' activities; non-market recreational, cultural and sporting activities; restaurants; hotels; and support and auxiliary transport activities. All output changes refer only to that part of the sector which is associated with tourism activities. Apart from the tourism sectors, notable output decreases are observed for air transport from non-tourism activities; renting of machinery, personal and household goods; manufacture of coke, refined petroleum products and nuclear fuel; extraction of crude petroleum; and manufacture of beverages. The estimates of this set of scenarios are conservative as in theory one could expect that demand for all economic sectors decreases when their prices go up.

⁸ The least extreme scenario of oil price increase (110%), labour cost increase (0%) and capital cost increase (0%) serves as a basis for ranking of sectors.

Therefore, the second set of scenarios assumes that demand for all economic sectors decreases. As it is very difficult to know price elasticities of aggregate products and services for all sectors in the economy, we have applied a low price elasticity scenario (-0.5) in order to ensure conservative estimates. The resulting changes in domestic outputs are presented in Table 4. The most prominent output decrease takes place in the manufacture of coke, refined petroleum products and nuclear fuel; extraction of crude petroleum; extraction of natural gas, mining of uranium and thorium ores; air transport; water transport; manufacture of gas, distribution of gaseous fuels through pipes, steam and hot water supply; manufacture of chemicals and chemical products; production and distribution of electricity; other land transport and transport via pipelines; and mining of coal and lignite and extraction of peat. These results show that in this set of scenarios energy and transport sectors (both from tourism and non-tourism activities) are the most affected ones. Changes in domestic outputs of the tourism sectors are rather similar for most sectors under the two sets of scenarios with slightly more prominent decreases in the second set due to additional indirect effects throughout the economy.

[INSERT TABLE 4 AROUND HERE]

Furthermore, import levels will change as they need to be adjusted to the new domestic output levels. Therefore, in the second step of our I/O demand model new import levels of all economic sectors are calculated based on their new domestic outputs by applying equation (7). A change in the import levels is likely to be underestimated because we assume that domestic final demand for imports remains unchanged. In the first set of scenarios (only demand for tourism sectors decreases) the most substantial reductions in imports occur in the following sectors: renting of machinery, personal and household goods; support and auxiliary transport activities; travel agencies' activities; restaurants; hotels; manufacture of coke, refined petroleum products and nuclear fuel; water transport; and air transport.

Changes in the import levels for the second set of scenarios (where demand for all economic sectors falls) are shown in Table 5. The greatest fall in imports is observed in energy sectors, particularly in the extraction of crude petroleum; manufacture of coke, refined petroleum products and nuclear fuel; and extraction of natural gas, mining of uranium and thorium ores. Next most affected sectors embrace renting of machinery, personal and household goods; support and auxiliary transport activities; and manufacture of chemicals and chemical products. Decreases in imports of tourism sectors are not among the most prominent ones, but are greater than in the majority of other economic sectors. In addition, in the second set of scenarios tourism sectors experience decreases in imports of double or higher order of magnitude than in the first set of scenarios.

[INSERT TABLE 5 AROUND HERE]

Finally, the corresponding reductions in GDP and in the number of jobs for both sets of scenarios are reported in Table 6. In the first (second) set of scenarios GDP decreases between -0.08% and -0.38% (-1.13% and -6.74%) and the number of jobs lost including both direct and indirect effects varies between 19 553 and 100 250 (316 493 and 1 959 751), depending on the adopted scenarios of an increase in oil price and primary inputs. Decreases in GDP might be slightly underestimated due to underestimated reductions in import levels.

[INSERT TABLE 6 AROUND HERE]

6. Conclusions

This study analyzes the potential effects of peak oil on Spanish tourism sectors and consequently on the Spanish economy using the price and demand models of the input-output (I/O) analysis. After reaching

the maximum point of the conventional oil production at the global level, it is expected that the oil prices will rise sharply due to the inability of (constant or reduced) supply to meet (increasing) demand. There is a growing amount of evidence that peak oil is either already underway or will occur within this decade. Record-high oil prices in 2008 and 2012 are possibly signs of the peak oil era. The increase in oil prices is likely to induce higher prices of travel, which in turn would reduce demand for tourism. Since Spain is one of the top tourism destinations in the world and tourism represents one of its most important economic activities, its economy may be strongly affected by the peak oil phenomenon. The results obtained for Spain can serve as an indication of the magnitude of impacts caused by oil price increases on tourism sectors in other countries as well, particularly those which also strongly depend on tourism activities and oil imports.

This article considers various oil price scenarios (US\$115, US\$150, and US\$200 per barrel), and related scenarios assuming price increases of other energy sources and their inflationary effects on the economy. It analyzes (1) how much would prices of Spanish tourism supply change due to the oil price increase according to a price I/O model, (2) how would such price increase affect demand for Spanish tourism considering its price elasticity, and (3) what would be the effects of a reduced demand for tourism (and of a reduced demand for all economic sectors) on the whole Spanish economy by using the demand I/O model.

The results show that prices of Spanish tourism supply would rise most considerably in transport sectors. This most of all holds for air, water, and other land (including pipelines) transport sectors because they are the most oil-intensive tourism activities. Different studies have shown that the price elasticity of demand for Spanish tourism varies between -0.30 and -2.16 . This study presents results for the price elasticity -0.5 , which can be considered as conservative. When elasticities of -1.0 and -2.0 are applied, domestic outputs change proportionally.

If one assumes a decrease in demand for tourism sectors only, the greatest reductions in outputs are observed in tourism-related part of air transport (−8.0% to −20.8%), water transport (−5.0% to −13.2%), other land transport (−1.7% to −5.3%), railway transport (−1.5% to −6.8%), travel agencies' activities (−1.3% to −5.5%), non-market recreational, cultural and sporting activities (−0.8% to −6.6%), and restaurants (−0.8% to −5.8%). GDP decreases by −0.08% to −0.38% and number of jobs by 19 553 to 100 250. The ranges correspond to the least and the most extreme scenarios of price increases of oil and its inflationary effects on the costs of primary inputs (i.e. labour and capital). One can note that output reductions vary substantially depending on the oil price and primary input cost scenarios. If demand for all economic sectors is assumed to fall, energy and transport sectors (from both tourism and non-tourism activities) will suffer the most prominent reductions in domestic outputs. In that case, the range of output reductions between the least and most extreme scenarios of oil and primary inputs' price increase is −24.4% to −58.5% for manufacture of coke, refined petroleum products and nuclear fuel; −19.8% to −48.3% for the extraction of crude petroleum; −9.0% to −23.9% for the extraction of natural gas, mining of uranium and thorium ores; −8.3% to −22.1% for air transport; and −5.7% to −16.2% for water transport sectors. GDP in this case declines by −1.13% to −6.74% and number of jobs by 316 493 to 1 959 751.

Of course, one should be aware that there are other factors apart from prices which may affect demand for tourism. For example, despite currently high oil prices and the ongoing global economic crisis, political instability in the Middle East has led to an increased demand for tourism in Spain. Moreover, I/O analysis cannot predict which markets (i.e. countries of origin) would experience stronger or weaker changes in demand, but one would expect that in the case of very high oil prices the demand of tourists coming from more distant countries would be more affected.

In conclusion, the tourism industry in Spain should be concerned about the impact of peak oil because transport sectors related to tourism activities will be among the most affected economic sectors

in Spain by high oil prices. Effects on other, less oil-intensive sectors, such as hotels and restaurants, depend largely on the price increases of primary inputs, particularly labour. We believe that these findings are likely to be valid for many other countries which rely on tourism activities and are net oil importers. Therefore, serious attention for this issue is needed from policy makers to develop adaptation strategies to high energy prices in tourism. In addition, more research on (likely heterogeneous) price elasticities of demand for different tourism products and services is useful as this could improve the accuracy of estimations of the impacts of peak oil on tourism.

References

- [1] Campbell, C.J., Laherrère, J.H. (1998). The end of cheap oil. *Scientific American*, 279 (3): 78-83.
- [2] Deffeyes, K.S. (2001). *Hubbert's peak: the impending world oil shortage*. Princeton, New Jersey: Princeton University Press.
- [3] Bentley, R.W. (2002). Global oil and gas depletion: an overview. *Energy Policy*, 30 (3): 189-205.
- [4] Aleklett, K., Campbell, C.J. (2003). The peak and decline of world oil and gas production. *Minerals & Energy – Raw Materials Report*, 18 (1): 5-20.
- [5] Hirsch, R.L., Bezdek, R.H., Wendling, R.M. (2005). *Peaking of world oil production: effects, mitigation, and risk management*. U.S. Department of Energy NETL, www.hilltoplancers.org/stories/hirsch0502.pdf.
- [6] Greene, D.L., Hopson, J.L., Li, J. (2006). Have we run out of oil yet? Oil peaking analysis from an optimist's perspective. *Energy Policy*, 34 (5): 515-531.
- [7] Leder, F., Shapiro, J.N. (2008). This time it's different. An inevitable decline in world petroleum production will keep oil product prices high, causing military conflicts and shifting wealth and power from democracies to authoritarian regimes. *Energy Policy*, 36 (8): 2850-2852.

- [8] Hall, C.A.S., Day, J.W. (2009). Revisiting the limits to growth after peak oil. *American Scientist*, 97 (2): 230-237.
- [9] Friedrichs, J. (2010). Global energy crunch: how different parts of the world would react to a peak oil scenario. *Energy Policy*, 38 (8): 4562-4569.
- [10] Murray, J., King, D. (2012). Oil's tipping point has passed. *Nature*, 481 (7382): 433-435.
- [11] Becken, S. (2008). Developing indicators for managing tourism in the face of peak oil. *Tourism Management*, 29 (4): 695-705.
- [12] Yeoman, I., Lennon, J.J., Blake, A., Galt, M., Greenwood, C., McMahon-Beattie, U. (2007). Oil depletion: what does it mean for Scottish tourism? *Tourism Management*, 28 (5): 1354-1365.
- [13] Becken, S. (2011). A critical review of tourism and oil. *Annals of Tourism Research*, 38 (2): 359-379.
- [14] Becken, S. (2011). Oil, the global economy and tourism. *Tourism Review*, 66 (3): 65-72.
- [15] Becken, S., Lennox, J. (2012). Implications of a long-term increase in oil prices for tourism. *Tourism Management*, 33 (1): 133-142.
- [16] UNWTO (2011). *Tourism Highlights*. United Nations World Tourism Organization, <http://www.unwto.org/facts/eng/highlights.htm>.
- [17] INE (2009). *Cuenta satélite del turismo de España. Base 2000. Serie contable 2000-2007. Aportación del turismo al PIB de la economía española: por valor absoluto/porcentaje/índice, tipo de indicador y periodo & Aportación del turismo a la economía: Efectos directos y efectos totales por periodo, PIB y sus componentes y clases de efectos*. Instituto Nacional de Estadística, www.ine.es.
- [18] Grant, L.K. (2007). Peak oil as a behavior problem. *Behavior and Social Issues*, 16 (1): 65-88.
- [19] Campbell, C.J. (2002). *Forecasting global oil supply 2000-2050*. Hubbert Center Newsletter 2002/3, www.oilcrisis.com/campbell/Campbell_02-3.pdf.

- [20] Harper, F. (2004). *Oil peak – a geologist's view*. BP, www.aspo-australia.org.au/PPT/HarperBP.ppt.
- [21] USGS (2000). *U.S. Geological survey world petroleum assessment 2000 - description and results*. United States Geological Survey, <http://www.usgs.gov/>.
- [22] Wikipedia (2007). *Hubbert's curve on ultimate oil reserves*. User: Tom Ruen / Peak Oil, http://en.wikipedia.org/wiki/User:Tomruen/PeakOil#Peak_oil_and_Hubbert.27s_curve.
- [23] Bardi, U. (2009). Peak oil: the four stages of a new idea. *Energy*, 34 (3): 323-326.
- [24] Höök, M., Söderbergh, B., Jakobsson, K., Aleklett, K., (2009). The evolution of giant oil field production behaviour. *Natural Resources Research*, 18 (1): 39-56.
- [25] Hirsch, R.L. (2008). Mitigation of maximum world oil production: shortage scenarios. *Energy Policy*, 36 (2): 881-889.
- [26] Tverberg, G.E. (2012). Oil supply limits and the continuing financial crisis. *Energy*, 37 (1): 27-34.
- [27] Kerr, R.A. (2009). How much coal remains? *Science*, 323 (5920): 1420-1421.
- [28] EIA (2012). *World crude oil production (including lease condensate)*. U.S. Energy Information Administration: International Energy Statistics, <http://www.eia.gov/ipm/supply.html>.
- [29] McGlade, C.E. (2012). A review of the uncertainties in estimates of global oil resources. *Energy*, 47 (1): 262-270.
- [30] Adelman, M.A., Lynch, M.C. (1997). Fixed view of resource limits creates undue pessimism. *Oil & Gas Journal*, 95 (14): 56-60.
- [31] Odell, P.R. (1999). Dynamics of energy technologies and global change. *Energy Policy*, 27 (12): 737-742.
- [32] Davis, G. (2003). Meeting future energy needs: choices and possibilities. *The Bridge*, 33 (2): 16-21.

- [33] EIA (2010). *Annual Energy Outlook 2011. Early release overview*. U.S. Energy Information Administration, www.eia.gov/forecasts/aeo/pdf/0383er%282011%29.pdf.
- [34] IEA (2010). *World Energy Outlook 2010*. International Energy Agency, www.worldenergyoutlook.org/docs/weo2010/WEO2010_ES_English.pdf.
- [35] Duncan, R.C. (2003). Three world oil forecasts predict peak oil production. *Oil & Gas Journal*, 101 (21): 18-21.
- [36] Campbell, C.J. (2003). Industry urged to watch for regular oil production peaks, depletion signals. *Oil & Gas Journal*, 101 (27): 38-45.
- [37] Bakhtiari, A.M.S. (2004). World oil production capacity model suggests output peak by 2006-07. *Oil & Gas Journal*, 102 (16): 18-20.
- [38] Jakobsson, K., Söderbergh, B., Höök, M., Aleklett, K. (2009). How reasonable are oil production scenarios from public agencies? *Energy Policy*, 37 (11): 4809-4818.
- [39] Maggio, G., Cacciola, G. (2009). A variant of the Hubbert curve for world oil production forecasts. *Energy Policy*, 37 (11): 4761-4770.
- [40] Aleklett, K., Höök, M., Jakobsson, K., Lardelli, M., Snowden, S., Söderbergh, B. (2010). The peak of the oil age – analyzing the world oil production reference scenario in World Energy Outlook 2008. *Energy Policy*, 38 (3): 1398-1414.
- [41] Nashawi, I.S., Malallah, A., Al-Bisharah, M. (2010). Forecasting world crude oil production using multicyclic Hubbert model. *Energy Fuels*, 24 (3): 1788-1800.
- [42] Hallock, J.L., Tharakan, P.J., Hall, C.A.S., Jefferson, M., Wu, W. (2004). Forecasting the limits to the availability and diversity of global conventional oil supply. *Energy*, 29 (11): 1673-1696.
- [43] Höök, M., Zittel, W., Schindler, J., Aleklett, K. (2010). Global coal production outlooks based on a logistic model. *Fuel*, 89 (11): 3546-3558.
- [44] Heinberg, R., Fridley, D. (2010). The end of cheap coal. *Nature*: 468 (7322), 367-369.

- [45] Energy Watch Group (2007). *Coal: resources and future production*. EWG Paper No. 1/07, www.energywatchgroup.org/fileadmin/global/pdf/EWG_Report_Coal_10-07-2007ms.pdf.
- [46] Söderbergh, B., Robelius, F., Aleklett, K. (2007). A crash programme scenario for the Canadian oil sands industry. *Energy Policy*, 35 (3): 1931-1947.
- [47] de Castro, C., Javier Miguel, L., Mediavilla, M. (2009). The role of non conventional oil in the attenuation of peak oil. *Energy Policy*, 37 (5): 1825-1833.
- [48] Gupta, E. (2008). Oil vulnerability index of oil-importing countries. *Energy Policy*, 36 (3): 1195-1211.
- [49] IEA (2011). *Oil & gas security – Emergency response of IEA countries – Spain 2011*. International Energy Agency, www.iea.org/papers/security/spain_2011.pdf.
- [50] UNWTO (2006). *The impact of rising oil prices on international tourism*. Madrid: United Nations World Tourism Organization.
- [51] IET (2010). *Compañías aéreas de bajo coste. Informe anual 2010*. Madrid: Instituto de Estudios Turísticos, Ministerio de Industria, Turismo y Comercio, Gobierno de España.
- [52] Los, B., Steenge, A.E. (eds). (2010). Special issue: Tourism studies and input-output analysis. *Economic Systems Research*, 22 (4).
- [53] Ministry of Economic Development (2012). *New Zealand energy data file*. Information and Modelling group, Ministry of Economic Development, www.med.govt.nz.
- [54] Hoekstra, R. (2005). *Economic growth, material flows and the environment: new applications of structural decomposition analysis and physical input-output tables*. Cheltenham, UK: Edward Elgar.
- [55] Alavalapati, J.R.R., Adamowicz, W.L., White, W.A. (1998). A comparison of economic impact assessment methods: the case of forestry developments in Alberta. *Canadian Journal of Forest Research*, 28 (5): 711-719.

- [56] Kveiborg, O. (2005). *A comparison of economic impacts from pricing schemes on heavy vehicles in transport*. 15th International Conference on Input-Output Techniques, Beijing, China.
- [57] Cassey, A.J., Holland, D.W., Razack, A. (2011). Comparing the economic impact of an export shock in two modeling frameworks. *Applied Economic Perspectives and Policy*, 33 (4): 623-638.
- [58] Dwyer, L., Forsyth, P. (2006). *International handbook on the economics of tourism*. Cheltenham, UK: Edward Elgar.
- [59] Bulmer-Thomas, V. (1982). *Input-output analysis in developing countries: sources, methods and applications*. Chichester: John Wiley & Sons Ltd.
- [60] Dietzenbacher, E. (1997). In vindication of the Ghosh model: a reinterpretation as a price model. *Journal of Regional Science*, 37 (4): 629-651.
- [61] Miller, R.E., Blair, P.D. (2009). *Input-output analysis: Foundations and extensions*. Cambridge: Cambridge University Press.
- [62] Kerschner, C., Hubacek, K. (2007). *Towards a multi-method analysis of the potential economic effects of peak oil induced petroleum supply disruptions: the quantity and the price dimension*. 16th International Input Output Association Conference, Istanbul, Turkey.
- [63] Kerschner, C., Hubacek, K. (2009). Assessing the suitability of input-output analysis for enhancing our understanding of potential economic effects of peak oil. *Energy*, 34 (3): 284-290.
- [64] Llop, M., Manresa, A. (2004). Influencia de los precios de los factores y de las importaciones en la economía catalana (1994). *Investigaciones Regionales*, 4: 115-129.
- [65] INE (2009). *Contabilidad Nacional de España. Base 2000. Marco input-output. Tabla simétrica, Año 2005*. Instituto Nacional de Estadística, www.ine.es.
- [66] Miller, R.E., Blair, P.D. (1985). *Input-output analysis: Foundations and extensions*. New Jersey: Prentice-Hall.
- [67] WTRG Economics Inc. (2011). *Oil price history and analysis*. www.wtrg.com/prices.htm.

- [68] Kerr, R.A. (2011). Peak oil production may already be here. *Science*, 331 (6024): 1510-1511.
- [69] Buyuksahin, B., Harris, J.H. (2011). Do speculators drive crude oil futures prices? *The Energy Journal*, 32 (2): 167-202.
- [70] Sorrell, S., Speirs, J., Bentley, R., Miller, R., Thompson, E. (2012). Shaping the global oil peak: a review of evidence on field sizes, reserve growth, decline rates and depletion rates. *Energy*, 37 (1): 709-724.
- [71] EIA (2012). *Annual Energy Outlook 2012. Early release overview*. U.S. Energy Information Administration, www.eia.gov/forecasts/aeo/er/pdf/0383er%282012%29.pdf.
- [72] Yücel, M.K., Guo, S. (1994). Fuel taxes and cointegration of energy prices. *Contemporary Economic Policy*, 12 (3): 33-41.
- [73] Villar, J.A., Joutz, F.L. (2006). *The relationship between crude oil and natural gas prices*. U.S. Energy Information Administration manuscript, www.eia.doe.gov/pub/oil_gas/natural_gas/feature_articles/2006/reloilgaspri/reloilgaspri.pdf.
- [74] Panagiotidis, T., Rutledge, E. (2007). Oil and gas markets in the UK: evidence from a cointegrating approach. *Energy Economics*, 29 (2): 329-347.
- [75] Chaudhuri, K. (2001). Long-run prices of primary commodities and oil prices. *Applied Economics*, 33 (4): 531-538.
- [76] Bachmeier, L.J., Griffin, J.M. (2006). Testing for market integration: crude oil, coal, and natural gas. *The Energy Journal*, 27 (2): 55-72.
- [77] IEA (2010). *Electricity/heat data in Spain in 2007*. International Energy Agency: Energy Statistics, www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=ES.
- [78] Wu, M.-H., Ni Y.-S. (2011). The effects of oil prices on inflation, interest rates and money. *Energy*, 36 (7): 4158-4164.

- [79] Jacquinot, P., Kuusmanen, M., Mestre, R., Spitzer, M. (2009). An assessment of the inflationary impact of oil shocks in the Euro area. *The Energy Journal*, 30 (1): 49-84.
- [80] Álvarez, L.J., Hurtado, S., Sánchez, I., Thomas, C. (2011). The impact of oil price change on Spanish and euro area consumer price inflation. *Economic Modelling*, 28 (1-2): 422-431.
- [81] Llop, M., Pié, L. (2008). Input-output analysis of alternative policies implemented on energy activities: an application for Catalonia. *Energy Policy*, 36 (5): 1642-1648.
- [82] LeBlanc, M., Chinn, M.D. (2004). *Do high oil prices presage inflation? The evidence from G-5 countries*. Santa Cruz: University of California, Santa Cruz Center for International Economics (SCCIE) working paper no. 04-4.
- [83] Berument, H., Taşçi, H. (2002). Inflationary effect of crude oil prices in Turkey. *Physica A*, 316 (1-4): 568-580.
- [84] Mehra, Y.P. (1991). Wage growth and the inflation process: an empirical note. *The American Economic Review*, 81 (4): 931-937.
- [85] Barth, J.R., Bennett, J.T. (1975). Cost-push versus demand-pull inflation: some empirical evidence. *Journal of Money, Credit and Banking*, 7 (3): 391-397.
- [86] Groshen, E.L., Schweitzer, M.E. (1997). *The effects of inflation on wage adjustments in firm-level data: grease or sand?* Working Paper No. 94-18. Federal Reserve Bank of Cleveland, <http://ssrn.com/abstract=993908>.
- [87] Schmidt, M.B. (2000). The dynamic behavior of wages and prices: cointegration tests within a large macroeconomic system. *Southern Economic Journal*, 67 (1): 123-138.
- [88] Du Caju, P., Gautier, E., Momferatou, D., Ward-Warmedinger, M. (2009). *Institutional features of wage bargaining in 23 European countries, the US and Japan*. Working Paper Series 974. European Central Bank, www.ecb.int/pub/pdf/scpwps/ecbwp974.pdf.

- [89] Druant, M., Fabiani, S., Kezdi, G., Lamo, A., Martins, F., Sabbatini, R. (2009). *How are firms' wages and prices linked: survey evidence in Europe*. Working Paper Series 1084. European Central Bank, www.ecb.int/pub/pdf/scpwps/ecbwp1084.pdf.
- [90] Bernanke, B.S., Gertler, M., Watson, M., Sims, C.A., Friedman, B.M. (1997). Systematic monetary policy and the effects of oil price shocks. *Brookings Papers on Economic Activity*, 1997 (1): 91-157.
- [91] Brown, S.P.A., Yücel, M.K. (1999). Oil prices and aggregate economic activity: a question of neutrality. *Federal Reserve Bank of Dallas Economic and Financial Review*, Second Quarter: 16-23.
- [92] Sadorsky, P. (1999). Oil price shocks and stock market activity. *Energy Economics*, 21 (5): 449-469.
- [93] Leduc, S., Sill, K. (2004). A quantitative analysis of oil-price shocks, systematic monetary policy, and economic downturns. *Journal of Monetary Economics*, 51 (4): 781-808.
- [94] Jiménez-Rodríguez, R., Sánchez, M. (2005). Oil price shocks and real GDP growth: empirical evidence for some OECD countries. *Applied Economics*, 37 (2): 201-228.
- [95] Cologni, A., Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30 (3): 856-888.
- [96] Crouch, G.I. (1992). Effect of income and price on international tourism. *Annals of Tourism Research*, 19 (4): 643-664.
- [97] Morley, C.L. (1994). The use of CPI for tourism prices in demand modelling. *Tourism Management*, 15 (5):342-346.
- [98] Witt, S.F., Witt, C.A. (1995). Forecasting tourism demand: a review of empirical research. *International Journal of Forecasting*, 11 (3): 447-475.

- [99] Garín-Muñoz, T. (2007). German demand for tourism in Spain. *Tourism Management*, 28 (1): 12-22.
- [100] Song, H., Romilly, P., Liu, X. (2000). An empirical study of outbound tourism demand in the UK. *Applied Economics*, 32 (5): 611-624.
- [101] De Mello, M., Pack, A.I., Sinclair, M.T. (2002). A system of equations model of UK tourism demand in neighboring countries. *Applied Economics*, 34 (4): 509-521.
- [102] Crouch, G.I. (1995). A meta-analysis of tourism demand. *Annals of Tourism Research*, 22 (1): 103-118.
- [103] Cortés-Jiménez, I., Blake, A. (2011). Tourism demand modeling by purpose of visit and nationality. *Journal of Travel Research*, 50 (4): 408-416.
- [104] Schiff, A., Becken, S. (2011). Demand elasticity estimates for New Zealand tourism. *Tourism Management*, 32 (3): 564-575.
- [105] Garín-Muñoz, T., Pérez Amaral, T. (2000). An econometric model for international tourism flows to Spain. *Applied Economics Letters*, 7 (8): 525-529.
- [106] González, P., Campbell, P. (1995). An analysis of the international tourism demand in Spain. *International Journal of Forecasting*, 11 (2): 233-251.
- [107] Lim, C. (1999). A meta-analytic approach of international tourism demand. *Journal of Travel Research*, 37 (3): 273-284.

Figure 1. Hubbert curves including the historical pattern and future projections of world oil production and associated peaks

Source: Based on data obtained from Wikipedia [22]

Figure 2. Crude oil prices (European Brent spot price FOB) in the period 1987 to 2012

Source: Based on data from the U.S. Energy Information Administration

Table 1. Proportion of tourism activities within, and energy intensity of, tourism-related sectors

Tourism-related sectors	Total output of a sector (million €)	Proportion of tourism activities ⁱ
Hotels ⁱⁱ	16126.8	0.9872
Restaurants	85295.3	0.2851
Railway transport	2456.1	0.6177
Other land transport; transport via pipelines	41298.1	0.0583
Water transport	2802.3	0.1496
Air transport	7800.6	0.9476
Support and auxiliary transport activities	28511.1	0.1352
Travel agencies' activities	9174.3	0.5510
Market recreational, cultural and sporting activities	29434.7	0.0736
Non-market recreational, cultural and sporting activities	8543.4	0.0722

Source: Own calculations based on the Spanish I/O tables and Tourism Satellite Accounts for 2005.

Notes:

ⁱ Based on Tourism Satellite Accounts.

ⁱⁱ Activities in this category are considered tourist-based except for persons who use hotel establishments as their regular accommodation.

Table 2. Scenarios of an increase in the prices of imports from different energy sectors in the input-output price model in relation to 2005 levels

	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B	Scenario 3A	Scenario 3B
Oil price in absolute terms (% change relative to 2005)	US\$115 (110%)	US\$115 (110%)	US\$150 (175%)	US\$150 (175%)	US\$200 (267%)	US\$200 (267%)
Mining of coal and lignite; extraction of peat	55%	55%	87.50%	131.25%	133.50%	200.25%
Extraction of crude petroleum	110%	110%	175%	175%	267%	267%
Extraction of natural gas; mining of uranium and thorium ores	55%	110%	87.50%	175%	133.50%	267%
Manufacture of coke, refined petroleum products and nuclear fuel	110%	110%	175%	175%	267%	267%
Production and distribution of electricity	36.96%	53.74%	58.80%	96.21%	89.71%	146.78%
Manufacture of gas; distribution of gaseous fuels through pipes; steam and hot water supply	55%	110%	87.50%	175%	133.50%	267%

Table 3. Percentage price increase of domestic outputs in the 20 most affected and other tourism sectors under different scenarios of energy and primary input price increases relative to 2005

		SCENARIOS					
		Prices of primary inputs remain unchanged			Price of labour (capital) input follows oil price increase by 5% (2.5%)		
		1A ⁱ	2A	3A	1A	2A	3A
Rank ⁱⁱ	Sector	Percentage changes (%)					
1	Manufacture of coke, refined petroleum products and nuclear fuel	81,44	129,56	197,67	82,25	130,86	199,65
2	Manufacture of gas; distribution of gaseous fuels through pipes; steam and hot water supply	35,15	55,92	85,32	36,29	57,73	88,07
3-4	Air transport (tourism activities) ⁱⁱⁱ	20,10	31,98	48,79	22,54	35,85	54,70
3-4	Air transport (non-tourism activities)	20,10	31,98	48,79	22,54	35,85	54,70
5	Production and distribution of electricity	18,75	29,83	45,51	21,16	33,66	51,36
6-7	Water transport (tourism activities)	15,21	24,19	36,91	17,50	27,85	42,49
6-7	Water transport (non-tourism activities)	15,21	24,19	36,91	17,50	27,85	42,49
8-9	Other land transport; transport via pipelines (tourism activities)	9,90	15,75	24,02	13,18	20,97	31,99
8-9	Other land transport; transport via pipelines (non-tourism activities)	9,90	15,74	24,02	13,18	20,96	31,99
10	Manufacture of chemicals and chemical products	9,57	15,23	23,23	11,72	18,64	28,44
11-12	Extraction of crude petroleum	9,52	15,15	23,12	12,76	20,30	30,98
11-12	Extraction of natural gas; mining of uranium and thorium ores	9,52	15,15	23,12	12,76	20,30	30,98
13	Other mining and quarrying	7,85	12,49	19,06	10,94	17,40	26,55
14	Fishing	6,91	10,99	16,77	10,31	16,40	25,03
15	Manufacture of cement, lime and plaster	6,14	9,77	14,90	9,21	14,66	22,37
16	Mining of coal and lignite; extraction of peat	6,07	9,66	14,73	9,82	15,62	23,84
17	Manufacture of glass and glass products	5,20	8,27	12,62	8,41	13,38	20,41
18	Manufacture of other non-metallic mineral products	4,86	7,74	11,80	7,98	12,70	19,38
19	Manufacture of ceramic products	4,63	7,37	11,25	8,03	12,78	19,50
20-21	Support and auxiliary transport activities (tourism activities)	4,39	6,98	10,66	7,73	12,30	18,77
20-21	Support and auxiliary transport activities (non-tourism activities)	4,39	6,98	10,65	7,73	12,30	18,77
23-24	Railway transport (tourism activities)	3,86	6,14	9,36	7,71	12,27	18,72
31-32	Travel agencies' activities (tourism activities)	2,88	4,58	6,99	5,57	8,86	13,52
51-52	Non-market recreational, cultural and sporting activities (tourism activities)	1,69	2,69	4,10	5,69	9,05	13,80
56-57	Restaurants (tourism activities)	1,56	2,48	3,79	5,09	8,10	12,35
72-73	Hotels (tourism activities)	1,07	1,70	2,60	4,71	7,49	11,43
79-80	Market recreational, cultural and sporting activities (tourism activities)	0,64	1,01	1,54	4,06	6,46	9,86

ⁱ See Table 2 for an explanation of the energy price scenarios 1A, 2A and 3A.

ⁱⁱ From the most to the least affected sector based on scenario 1A and the assumption of unchanged prices of primary inputs.

ⁱⁱⁱ Shaded rows denote tourism sectors.

Table 4. Percentage changes in domestic outputs in the 20 most affected and other tourism sectors under different scenarios of energy and primary input prices relative to 2005, assuming a price elasticity of demand for all economic sectors equal to -0.5

		SCENARIOS					
		Prices of primary inputs remain unchanged			Price of labour (capital) input follows oil price increase by 5% (2.5%)		
		1A ⁱ	2A	3A	1A	2A	3A
Rank ⁱⁱ	Sector	Percentage changes (%)					
1	Manufacture of coke, refined petroleum products and nuclear fuel	-24,40	-38,83	-59,24	-24,12	-38,37	-58,54
2	Extraction of crude petroleum	-19,84	-31,57	-48,17	-19,91	-31,68	-48,33
3	Extraction of natural gas; mining of uranium and thorium ores	-8,99	-14,30	-21,82	-9,83	-15,65	-23,87
4-5	Air transport (tourism activities)	-8,26	-13,14	-20,05	-9,12	-14,51	-22,13
4-5	Air transport (non-tourism activities)	-8,26	-13,14	-20,05	-9,12	-14,51	-22,13
6-7	Water transport (tourism activities)	-5,71	-9,09	-13,87	-6,68	-10,63	-16,22
6-7	Water transport (non-tourism activities)	-5,71	-9,09	-13,87	-6,68	-10,63	-16,22
8	Manufacture of gas; distribution of gaseous fuels through pipes; steam and hot water supply	-5,08	-8,08	-12,33	-6,20	-9,87	-15,06
9	Manufacture of chemicals and chemical products	-3,50	-5,57	-8,49	-4,56	-7,25	-11,06
10	Production and distribution of electricity	-3,22	-5,12	-7,81	-4,57	-7,28	-11,10
11-12	Other land transport; transport via pipelines (tourism activities)	-2,82	-4,49	-6,85	-4,25	-6,76	-10,31
11-12	Other land transport; transport via pipelines (non-tourism activities)	-2,82	-4,49	-6,85	-4,25	-6,76	-10,31
13	Mining of coal and lignite; extraction of peat	-2,69	-4,28	-6,53	-4,08	-6,49	-9,90
14	Fishing	-2,58	-4,11	-6,26	-4,07	-6,47	-9,88
15-16	Support and auxiliary transport activities (tourism activities)	-2,24	-3,56	-5,43	-3,68	-5,85	-8,93
15-16	Support and auxiliary transport activities (non-tourism activities)	-2,24	-3,56	-5,43	-3,68	-5,85	-8,93
17-18	Railway transport (tourism activities)	-1,93	-3,07	-4,68	-3,60	-5,73	-8,74
17-18	Railway transport (non-tourism activities)	-1,93	-3,07	-4,68	-3,60	-5,73	-8,74
19	Collection, purification and distribution of water	-1,70	-2,70	-4,12	-3,27	-5,20	-7,94
20	Mining of metal ores	-1,68	-2,68	-4,09	-3,13	-4,97	-7,59
22-23	Travel agencies' activities (tourism activities)	-1,57	-2,49	-3,80	-2,83	-4,51	-6,88
59-60	Non-market recreational, cultural and sporting activities (tourism activities)	-0,84	-1,34	-2,05	-2,71	-4,31	-6,57
62-63	Restaurants (tourism activities)	-0,79	-1,26	-1,92	-2,44	-3,87	-5,91
66-67	Hotels (tourism activities)	-0,76	-1,21	-1,85	-2,41	-3,83	-5,84
79-80	Market recreational, cultural and sporting activities (tourism activities)	-0,57	-0,91	-1,39	-2,20	-3,50	-5,34

ⁱ See Table 2 for an explanation of the energy price scenarios 1A, 2A and 3A.

ⁱⁱ From the most to the least affected sector based on scenario 1A and the assumption of unchanged prices of primary inputs.

ⁱⁱⁱ Shaded rows denote tourism sectors.

Table 5. Percentage changes in imports in the 20 most affected and other tourism sectors under different scenarios of energy and primary input prices relative to 2005, assuming a price elasticity of demand for all economic sectors equal to -0.5

		SCENARIOS					
		Prices of primary inputs remain unchanged			Price of labour (capital) input follows oil price increase by 5% (2.5%)		
		1A ⁱ	2A	3A	1A	2A	3A
Rank ⁱⁱ	Sector	Percentage changes (%)					
1	Extraction of crude petroleum	-24,14	-38,41	-58,61	-23,87	-37,98	-57,95
2	Manufacture of coke, refined petroleum products and nuclear fuel	-7,72	-12,28	-18,74	-8,66	-13,77	-21,01
3	Extraction of natural gas; mining of uranium and thorium ores	-4,97	-7,91	-12,07	-6,11	-9,72	-14,83
4	Renting of machinery, personal and household goods	-4,59	-7,31	-11,15	-5,80	-9,23	-14,08
5-6	Support and auxiliary transport activities (tourism activities)	-4,47	-7,10	-10,84	-5,67	-9,01	-13,75
5-6	Support and auxiliary transport activities (non-tourism activities)	-4,47	-7,10	-10,84	-5,67	-9,01	-13,75
7	Manufacture of gas; distribution of gaseous fuels through pipes; steam and hot water supply	-3,22	-5,12	-7,81	-4,57	-7,28	-11,10
8	Production and distribution of electricity	-3,16	-5,03	-7,67	-4,53	-7,20	-10,99
9	Mining of coal and lignite; extraction of peat	-2,99	-4,76	-7,27	-4,35	-6,92	-10,56
10	Other mining and quarrying	-1,78	-2,83	-4,31	-3,23	-5,14	-7,84
11	Manufacture of chemicals and chemical products	-1,71	-2,72	-4,15	-2,68	-4,27	-6,51
12-13	Other land transport; transport via pipelines (tourism activities)	-1,65	-2,62	-4,00	-3,04	-4,83	-7,37
12-13	Other land transport; transport via pipelines (non-tourism activities)	-1,65	-2,62	-4,00	-3,04	-4,83	-7,37
14	Research and development	-1,59	-2,52	-3,85	-2,84	-4,52	-6,90
15-16	Restaurants (tourism activities)	-1,56	-2,49	-3,80	-2,83	-4,51	-6,88
15-16	Restaurants (non-tourism activities)	-1,56	-2,49	-3,80	-2,83	-4,51	-6,88
17-18	Travel agencies' activities (tourism activities)	-1,56	-2,49	-3,80	-2,83	-4,51	-6,88
17-18	Travel agencies' activities (non-tourism activities)	-1,56	-2,49	-3,80	-2,83	-4,51	-6,88
19-20	Hotels (tourism activities)	-1,45	-2,31	-3,52	-2,80	-4,46	-6,80
19-20	Hotels (non-tourism activities)	-1,45	-2,31	-3,52	-2,80	-4,46	-6,80
30-31	Water transport (tourism activities)	-1,04	-1,66	-2,53	-1,89	-3,01	-4,59
35-36	Air transport (tourism activities)	-0,97	-1,55	-2,36	-1,74	-2,76	-4,22
41-42	Railway transport (tourism activities)	-0,82	-1,30	-1,99	-1,63	-2,59	-3,96
51-52	Market recreational, cultural and sporting activities (tourism activities)	-0,54	-0,86	-1,32	-1,82	-2,89	-4,42
67-84	Non-market recreational, cultural and sporting activities (tourism activities)	0	0	0	0	0	0

ⁱ See Table 2 for an explanation of the energy price scenarios 1A, 2A and 3A.

ⁱⁱ From the most to the least affected sector based on scenario 1A and the assumption of unchanged prices of primary inputs.

ⁱⁱⁱ Shaded rows denote tourism sectors.

Table 6. Reductions in GDP and in the number of jobs under different scenarios of price increases of imports from energy sectors and primary inputs

	ONLY DEMAND FOR TOURISM ACTIVITIES DECREASES (AT PRICE ELASTICITY OF -0.5)					
	Prices of primary inputs remain unchanged			Price of labour (capital) input follows oil price increase by 5% (2.5%)		
	1A ⁱ	2A	3A	1A	2A	3A
GDP (%)	-0.08	-0.13	-0.19	-0.16	-0.25	-0.38
Number of lost jobs in full-time equivalents (direct and indirect effects)	19 553	31 106	47 457	41 303	65 708	100 250
	DEMAND FOR ALL ECONOMIC SECTORS DECREASES (AT PRICE ELASTICITY OF -0.5)					
	Prices of primary inputs remain unchanged			Price of labour (capital) input follows oil price increase by 5% (2.5%)		
	1A ⁱⁱ	2A	3A	1A	2A	3A
GDP (%)	-1.13	-1.80	-2.75	-2.78	-4.42	-6.74
Number of lost jobs in full-time equivalents (direct and indirect effects)	316 493	503 510	768 212	807 389	1 284 482	1 959 751

ⁱ See Table 2 for an explanation of the energy price scenarios 1A, 2A and 3A.