Open Skies: An Assessment of the US-EU Open Aviation Area Agreement

Everett B. Peterson*

Thea Graham

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Peterson is Associate Professor in the Department of Agricultural and Applied Economics, Virginia Tech; and Graham is with the United States Federal Aviation Administration. The views expressed in this paper are those of the authors and do not necessarily represent those of the FAA or the North Atlantic Traffic, Economic and Finance Group.

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Introduction

The deregulation of U.S. domestic commercial aviation market lead policymakers in the U.S. and Europe to explore ways to reduce regulation of air transportation between the U.S. and the European Union (EU) (Strober, 2003). On April 30, 2007, after years of negotiations, the U.S. and the EU signed a historic pact to liberalize air travel and open international transportation markets between the two regions over the Atlantic Ocean. The newly signed US-EU Open Skies agreement will deregulate air traffic over the Atlantic by (1) removing restrictions on air fares, (2) allowing air carriers to fly to any point in a partner country, (3) allowing air carriers to transport passengers between partner countries (5^{th} Freedom rights), (4) allowing airlines to create alliances, and (5) allowing airlines more freedom to cooperate in marketing arrangements such as leasing and other code-sharing arrangements.

This new agreement replaces a series of bilateral Open Sky agreements between the U.S. and 15 EU Member States. These previous agreements varied by country and included agreements concerning code-share alliances, nonstop flights, landing rights, destination restrictions, and connecting flight services. Thus, the US-EU Open Skies agreement will provide a greater harmonization of regulatory policies between the U.S. and EU Member States.

In addition to the Open Skies agreement, in 2006, the U.S. Federal Aviation Administration (FAA) began working in partnership with the North Atlantic Traffic Economic and Finance Group (NAT EFG) to consider the economic implications of operational improvements in the North Atlantic oceanic airspace. One option being considered is surveillance in the North Atlantic airspace. Lack of continuous and reliable surveillance in the North Atlantic airspace has resulted in large separation standards and limited oceanic clearances.

Data link communication capabilities are one promising option to increase efficiency in the airspace compared to the voice communications currently supported. These efficiencies include fuel savings for air carriers, better communication between flight information regions within the North Atlantic, better flight planning for air carriers, increased safety, rerouting and step climbs for more efficient flying, and increased utilization of airspace capacity. Other options being considered that would lower costs for air carriers include harmonization of charging schemes, and harmonization of air navigation service providers (ANSP) systems in the North Atlantic.

Open Skies Agreements and improved operations in the North Atlantic oceanic airspace will not only benefit passenger air carriers but also air cargo carriers. Kasarda and Green (2005) showed that between 1980 and 2000, the real value of air cargo increased by an average of 302% in 68 countries, while the real value of GDP and trade grew by 72% and 132% respectively. Because of this growing importance of air cargo, the impacts of deregulation and improved operations will affect industries that rely on air cargo services to get their products to consumers. Thus, the impacts of deregulation and improved operations will go beyond just the air transport industry.

The emissions of CO_2 and other greenhouse gases from the aviation industry are becoming a growing concern within the EU. Between 1990 and 2004, CO_2 emissions from international aviation in the EU25 increased by 86%, from 63.6 MT (million tonnes) to 118.4 MT (European Environment Agency, 2006). This increase in CO_2 emissions from aviation has canceled out almost one-quarter of the reductions made over the same period by other sectors in Europe under the terms of the Kyoto protocol. Thus, it is important to consider the environmental effects of the US-EU Open Skies agreement and the FAA/ NAT EFG working group. If deregulation leads to increased competition and lower fares, this may lead to an increased number of trans-Atlantic flights and CO_2 emissions. However, improved flight operations and the adoption of larger aircraft due to flight capacity constraints at major airports, could help offset some or all of effects of an increase in demand on CO_2 emissions.

Several previous studies have assessed the economic impacts of previous open skies agreements (Button, 2002; Mayor and Tol, 2002; Robyn *et al.*, 2002; Bucha, 2003; Strober, 2003; Whalen, 2005; Robyn *et al.*, 2005; inter-VISTA-ga[2], 2006; and Booz Allen Hamilton 2007). Most of these studies have used partial equilibrium models focuses on the aviation sector. In general, these studies have found that open skies agreements lead to increases the output of air transportation services (available seats), decrease in airline operating expenses, air fare price reductions, and an increase in the demand for air travel (passengers). Only Mayor and Tol (2002) have considered the impact of open sky agreements on CO_2 emissions.

The objective of this paper is to assess the economic and environmental impacts of the US-EU Open Sky agreement. This paper will extend previous research by investigating the impacts of deregulation and improve airspace operations on all sectors in the economy (not just the air transportation sector) and the impacts on CO_2 emissions.

International Airspace Regulation and Open Skies

Until recently, international air transportation has been one of the most regulated industries in the world. In 1944, the United Nations met with member nations to establish guidelines for a system of air service agreements between countries. The Chicago Convention, as it was called, established the International Civil Aviation Organization (ICAO) to oversee the system of bilateral air service agreements and to alleviate fears that the U.S., with its large fleet of commercial aircraft, would dominate global airspace (Strober 2003). The convention did not recommend any type of service structure, but established national sovereignty over the airspace and created an institution for oversight by instituting ICAO (Button and Drexler 2005).

Beginning in 1978, the United States removed the regulatory barriers to competition in its own domestic market. In reaction to this move by the United States, many other countries followed the lead. These countries saw the international regulation of air travel as an impediment to international trade, travel, and tourism. In response to these concerns, the U.S. began actively pursuing liberalization agreements with foreign aviation partners in the 1980's. The first bilateral agreement was signed with the Netherlands in 1992. Following the signing of the initial agreement, the U.S. entered into 80 agreements (Alford and Champley 2007), 15 of which included countries from the European Union (EU).

After years of negotiation, the EU and U.S. authorities signed an Open Skies accord on April 30, 2007. The agreement allows all EU airlines to operate direct flights between U.S. and any EU country, and allows U.S. airlines reciprocal rights, and ability to fly between EU city-pairs. The agreement stipulates that every U.S. and EU airline are authorized to:

- Fly between every city in the EU and every city in the US;
- Operate without restriction on the number of flights, aircraft, and routes;
- Set fares according to market demand; and
- Enter into cooperative arrangements, including codesharing, franchising, and leasing (Department of State briefing, March 9, 2007)

On March 30, 2008, the agreement replaced 22 bilateral air service agreements between the U.S. and the member states of the EU.

EU officials have made liberalized foreign control a prerequisite for the second stage of the agreement:

1. access to the lucrative U.S. domestic market as standalone and hub-feeder for cabotage rights, i.e., the right to operate foreign operated flights within the U.S. domestic market, currently only granted to U.S.- incorporated airlines and
2. Match the EU 49% foreign control restriction.

Proponents of the agreement have argued there are many economic benefits to the liberalization of air travel between the U.S. and EU. The economic benefits accrue to the air carriers as well as consumers. Reduction of international airline passenger fares is the greatest benefit to consumers in response to an increase in frequency of flights between U.S. and EU city pairs. In response to the Open Skies agreement, several studies estimated the impact of the agreement to increase in passengers demand between 9 to 35 percent and reduce fares between the EU and US between 18 and 28 percent. The next section summarizes the findings of those studies.

Open Skies Economic and Operational Impacts

The Brattle Group (Boaz Moselle et al., 2002) and Booz Allen Hamilton (2007) are two of many studies commissioned by the U.S. and EU on the benefits of Open Skies. The Brattle report estimated an increase in international passenger demand between 9% and 24%, depending upon the demand elasticity assumption (between 1.0 and 2.5) and assuming that all costs savings by the airlines were passed on to consumers. They also assumed that fares would decrease between 18% and 28% (Brueckner and Whalen 2000) and the frequency of the number of flights between the U.S.-EU increase by 10%.

Booz Allen Hamilton (BAH) estimated that Open Skies would increase the number of passengers traveling between the US and EU by 26 million passengers over five years. In addition, and the number of passengers transported between the EU and US would increase between 15 to 40 million passengers per year, due to competition and airline coordination. BAH used the same assumptions as the Brattle Group, except BAH based their forecast on US-UK flight data and extrapolated the estimate to the rest of EU-US air transport.

InterVISTAS-ga[2] (2006) estimated an increase in air traffic of 12 to 35 percent due to the Open Skies agreement. The traffic growth estimate was based on case studies that were not directly related to US-Europe traffic. The case studies included air traffic estimates on US-UK air traffic flows, Germany to UK to United Arab Emirates air traffic flows, Intra-Europe routes, Malaysia-Thailand routes, and routes between Australia and New Zealand. Using these case studies, they estimate that full liberalization (both stages of the agreement adopted) between US and EU results in a 29 percent increase in air traffic. The increase is attributable to lower fares and that any US city can fly to the UK.

A study by Whalen (2005), estimates the effects of code sharing, antitrust immunity and Open Skies agreements, on price, output, and capacity using a panel data of the US and EU. His estimates suggest that capacity expansions associated with Open Skies are due entirely to expansion by immunized carriers on routes between their hubs and not the actual agreement. Fares dropped 14 to 22 percent under immunized alliances and passenger demand increased between 51 to 88 percent. Code sharing agreements between air carriers resulted in fares falling between 14 and 23 percent and capacity increasing by 22 to 45 percent.

Under Open Skies agreements, Whalen estimates that fares increased between 3 to 5 percent increase without any capacity increases. His research concludes that Open Skies agreements may not lead to lower prices on connecting routes. The estimate used for this analysis only looked at the Open Skies agreement between the US and Germany, additional analysis may provide different answers. Whalen also indicates that the Department of

Transportation has requested an Open Skies agreement to exist between two countries before granting antitrust immunity to airline alliances and those two effects may be difficult to separate *apriori*.

Model Description

To assess the impact of the US/EU Open Skies agreement on CO_2 emissions, we employ an extended version of the static GTAP-E Model (Burniaux and Truong 2002). This model is based on the perfectly competitive, multi-region, multi-sector GTAP model (Hertel and Tsiagas 1997). Because the GTAP-E explicitly models substitution possibilities between energy inputs and between energy and capital; and also tracks CO_2 emissions, it has been frequently used in the analysis of climate change policies (e.g. Kremers et al. 2002, Nijkamp et al. 2005 or Kemfert et al. 2006).

Regional Household Demand

As in the standard GTAP model, there is a single aggregate household that in each region represents the consumption side of the GTAP-E model. This regional aggregate household collects all of the factor income and tax receipts and spends this income on private consumption of goods and services, government consumption, and savings. The utility function for the aggregate regional household consists of two levels. At the top-level, a Cobb-Douglas utility function is specified such that shares of private consumption, government consumption, and savings remain constant. At the second-level, a non-homothetic Constant Difference Elasticity of substitution utility function is used to represent preferences for private consumption. Also at the second-level, a Cobb-Douglas utility function is used to represent preferences for government consumption.

If the recently enacted Open Skies agreement between the US and EU leads to lower airline operating costs and air fares, which would lead to an increase in passenger travel between these regions and thereby also increasing travel related expenses such as lodging, restaurants, and recreation activities. To account for this link between the cost of air travel and other travel and tourism related expenditures, we introduce a "tourism sector" into the demand structure of the GTAP-E model. In this paper, the tourism sector is focused entirely on leisure travel because the relative cost of travel and income of the household are likely the key determinant of how much that household will spend on leisure travel activities. While relative cost is likely an important determinant for the level of business travel, there are also other important determinants, such as the need to meet personally with important clients that makes that modeling of such decisions more complicated.

As shown in figure 1, a nested Constant Elasticity of Substitution (CES) preference structure is used for tourism expenditures by the private household. The top of this structure represents the composite tourism commodity. Because households may travel domestically and internationally, the composite tourism commodity is a combination of these two types of tourism. Similar to the GTAP model, σ_D, which is the elasticity of substitution between domestic and foreign tourism commodities, denotes the extent to which private household may substitute between domestic and international travel as their relative cost changes. In addition, we allow the private household to substitute among alternative foreign destinations as their relative travel costs change. Similar to the GTAP model, σ_M denotes the elasticity of substitution between foreign destinations. Finally, to account for lodging, meals, transportation, recreation activities, and other travel related expenses, domestic tourism and tourism for each foreign destination is a CES composite of the tourism related GTAP sectors. For example, accommodations and restaurants are part of the GTAP *trd* sector; recreational activities are included in the *ros* sector; and automotive rentals are included in the *obs* sector. All transportation activities are included in the GTAP sectors *atp* (air transport), *wtp* (water transport), and *otp* (other transport). We assume that the individual tourism commodities are purchased in fixed proportions by the private household. This implies that leisure travel by the private household requires a fixed proportion of lodging, meals, transportation, and other tourism related goods and services. It is this additional nest in figure 1 that distinguishes the demand structure for tourism from the demand for all other commodities in the model.

To implement the tourism demand structure in figure 1 requires several new variables and equations to be added to the standard GTAP-E model. The new variables include a price index for domestic tourism (*pm_tour*), an aggregate price index for foreign tourism (*pim_tour*), a bilateral foreign tourism price index between regions (*pimb_tour*), the quantity of domestic tourism commodities purchased by the private household (*qpdt*), and the quantities of foreign tourism commodities purchased by the private household (*qpmt*). The domestic tourism price index for region *r* is defined as[1]:

$$pm\_tour(r) = \sum_{i \in tour} \frac{DTRA(i,r)}{\sum_{j \in tour} DTRA(j,r)} pm(i,r), \tag{1}$$

where $DTRA(i,r)$ is the expenditure on tourism commodity i in region r and $pm(i,r)$ is the market price of tourism commodity i in region r. The value of *DTRA* is equal to *pm* times *qpdt* for each domestic tourism commodity. The aggregate foreign tourism price index is defined as:

$$pim\_tour(r) = \sum_{i \in tour} \sum_{k \in reg} \frac{TTRA(i,k,r)}{\sum_{j \in tour} \sum_{s \in reg} TTRA(j,s,r)} pms(i,k,r), \tag{2}$$

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1 Following the conventions of the GTAP model, lower case expressions represent the percentage change in a variable and upper case expressions represent values or coefficients. See Hertel (1997).

where $pms(i,k,r)$ is the domestic price of tourism commodity i supplied from region r to region s and $TTRA(i,k,r)$ is the expenditure on tourism commodity i supplied from region r to region s. Note that $TTRA$ is equal to pms multiplied by $qpmt$. The bilateral foreign tourism price index is:

$$pimb\_tour(r,s) = \sum_{i \in tour} \frac{TTRA(i,r,s)}{\sum_{j \in tour} TTRA(j,r,s)} pms(i,r,s) . \tag{3}$$

The final two additional equations define the quantities of tourism commodities purchased by the private household. Because of the assumed of fixed proportions, the demand for ith domestic tourism commodity is equal to the aggregate demand for domestic tourism:

$$qpdt(i,s) = qpd(tour,r) . \tag{4}$$

However, because of the potential to substitute between foreign destinations, the expression for the demand for ith foreign tourism commodity is more complicated:

$$qpmt(i,r,s) = qpm(tour,s) + ESUBM(tour)\left[pim\_tour(s) - pimb\_tour(r,s) \right], \tag{5}$$

where $qpm(tour,s)$ is the aggregate demand for foreign tourism by the private household in region s and $ESUBM(tour)$ is the elasticity of substitution between foreign destinations, or σ_M in figure 1. Note that qpd and qpm are determined as any other commodity in the GTAP-E model.

Production

Similar to the GTAP-E model, a nested CES production structure, as illustrated in Figure 2, is specified in the model. Each sub-nest in the production structure represents the potential for substitution between individual or composite inputs. Each composite input is composed of the commodities at the next lower level in the tree structure of Figure 1. Beginning at the top of the production structure, firms produce output by using non-energy intermediate inputs and a primary factor composite (or value added). Typically, the elasticity of substitution between the primary factor composite and non-energy intermediate inputs (σ_T) is assumed to equal zero. This implies a constant per-unit-of-output input use of all non-energy intermediate inputs and the primary factor composite. The primary factor composite is composed of land, skilled labor, unskilled labor, natural resources, and a capital-energy composite with a constant elasticity of substitution (σ_{VA}) between them. Within the capital-energy composite, there are three inter-fuel substitution possibilities: (a) electricity versus non-electricity composite (σ_{ELY}); (b) coal versus non-coal composite (σ_{COAL}); and (c) between oil, gas, and petroleum products (σ_{FU}). For example, producers may substitute coal for non-coal fuel (a composite of oil, gas and petroleum products) when coal becomes more expensive than non-coal fuels. Firms may also substitute the energy composite (σ_{KE}) for capital when the aggregate energy price decreases relative to the capital rental rate. As pointed out by Burniaux and Truong (2002), the advantages to this specification is that it allows for substitution between fuels and the potential for capital and energy to be either substitutes or complements, depending on the values of the elasticities of substitution chosen.

Addition Equation Revisions

In addition to the new quantity and price index equations listed above, several existing equations and formulas must be modified. The formula for the value of domestic sales at market prices (*VDM*) must be revised for all tourism commodities to:

$$VDM\left(i,r\right) = VDPM\left(i,r\right) + VDGM\left(i,r\right) + \sum_{j \in prod} VDFM\left(i,j,r\right) + DTRA\left(i,r\right), \tag{6}$$

where, *VDPM* is the value of domestic non-tourism sales to the private household, *VDGM* is the value of domestic sales to the government, and *VIFM* is the value of domestic sales to firms (intermediate inputs), and value of domestic tourism sales to the private household in region *r*. Note that as shown in equation (6), not all expenditures on tourism related commodities, such as trade services, are necessarily tourism related.

Next, the market clearing conditions for imported and domestic tourism related commodities must be modified to include the new tourism commodity demands. The import market clearing condition for all tourism related commodities is specified as:

$$qim(i,r) = SHRIPM(i,r) * qpm(i,r) + SHRIGM(i,r)\, qgm(i,r) + \sum_{j \in prod} SHRIFM(i,j,r)\, qfm(i,j,r) + \sum_{s \in reg} SHRITM(i,s,r)\, qpmt(i,s,r), \tag{7}$$

where *SHRIPM*, *SHRIGM*, *SHRIFM*, and *SHRITM* are the share of import commodity *i* used by the private household for non-tourism uses, by the government, by firms, and for tourism related uses. Similarly, the market clearing condition for the domestic tourism related commodities is:

$$qds(i,r) = SHRDPM(i,r) * qpd(i,r) + SHRDGM(i,r)\, qgd(i,r) + \sum_{j \in prod} SHRDFM(i,j,r)\, qfd(i,j,r) + \sum_{s \in reg} SHRDTM(i,s,r)\, qpdt(i,s,r), \tag{8}$$

where *SHRDPM*, *SHRDGM*, *SHRDFM*, and *SHRDTM* are the share of domestic commodity *i* used by the private household for non-tourism uses, by the government, by firms, and for tourism related uses.

Data and Model Aggregation

The data used to implement the model is based on version 6.0 the GTAP data base, including the energy data base that contains information on regional CO_2 emissions by energy commodities. An eighteen region and 21 sector/commodity aggregation is used in this paper. Within the EU, we identify individual EU Member States whose airlines provide significant services over the North Atlantic airspace and/or who do not have existing bilateral Open Sky agreements with the United States. These Member States include Denmark, France, Germany, Ireland, the Netherlands, Portugal, Spain, and the United Kingdom. The remaining EU Member States are aggregated into the rest of the EU15 (REU15) and twelve recently admitted Eastern Europe Member States (REU) due to higher per-capita income in the REU15 Member States and therefore, higher tourism expenditures. In addition to the United States, other North Atlantic regions that may be affected by the Open Skies agreement, Canada and the Rest of EFTA (XEF), are identified. The remaining five regions are composites of geographic proximity: Australia and New Zealand (ANZ), Rest of Europe and Former Soviet Union (REFSU), Central and South America (CSAM), Middle East and Africa (MEAF), and the Rest of Asia (ASIA). Table 1 provides a detailed description of the regional aggregation.

Five sectors are identified in the model as tourism related: trade (*trd*), North Atlantic air transport (*atp_na*), other air transport (*atp_o*), other transport (*o_tran*), and tourism related services (*tour_serv*). As mentioned earlier, the trade sector includes all hotels, motels, and other accommodations along with all restaurants and other establishments that serve food. Tourism related services is an aggregation of the following GTAP sectors: recreational and other services (*ros*), business services nec (*obs*), communication (*cmn*), insurance (*isr*), and financial services nec (*ofi*). Business services nec is included as tourism related sector because it includes automotive rental activities. Communications include any telecommunications services purchased while traveling or postage to ship purchases back home. Insurance and financial services nec would include any travel or other insurance (e.g., car or health insurance) or financial services, such as currency conversion, utilized while traveling. As discussed below, since the purchase of any of these services by a resident of a foreign country while traveling in another country is usually considered as an export of the country visited, the trade flows of these five GTAP sectors are likely to be mainly tourism related. Other travel related activities, such as the purchase of gasoline and souvenirs are not included due to a lack of data on how to allocate expenditures between tourism and non-tourism activities.

For the remaining sectors, coal, oil, gas, refined petroleum (*p_c*), and electricity are energy commodities identified by the GTAP-E model. All service sectors not related to tourism are aggregated into a single sector (*oth_serv*). The manufacturing sectors are aggregated based on their use of air transport services. The sectors with more intensive use, such as textiles and apparel (*tex_app*) and chemicals, rubber, and plastics (*crp*), are identified with little or no aggregation. Agriculture is treated as a single sector because of the limited use of air transport services. Table 2 provides a description of the commodity/sector aggregation.

Disaggregating the Air Transport Sector

Because the US/EU Open Skies agreement will affect flights over the North Atlantic only, any reduction in operating expenses and fares will apply only to those flights. Thus, it is necessary to disaggregate the air transport sector into a North Atlantic air transport (*atp_na*) and all other air transport (*atp_o*). For the US, data on air revenue by region from the Bureau of Transportation Statistics were utilized to disaggregate the air transport sector. The share of air revenue for U.S. carriers (both passenger and freight) from Atlantic operations ranged from slightly more than 10 percent in 2007 to nearly 13 percent through the first nine months of 2007. In this paper, we assume that North Atlantic operations generated 13 percent of all air revenue for U.S. carriers and allocate 13 percent of the total sales and cost of the original air transport in the GTAP data base to *atp_na*, with the remaining 87 percent allocated to *atp_o*. Using notation for the standard GTAP and GTAP-E models[2], the value of total sales is defined as the value of commodity output at market prices (*VOM*):

$$VOM_{ir} = VDM_{ir} + \sum_{s} VXMD_{isr} + VST_{ir} \quad (9)$$

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2 Abbrevations in parentheses are nomenclature used in standard GTAP and GTAP-E models. See Hertel (1997) for a glossary of GTAP notation.

where *VDM* is the value of domestic sales, *VXMD* is the value of export sales, and *VST* is sales for international transport use. Note that *VDM* is defined in equation (6). Total cost is defined as the value of output at agents' prices (*VOA*):

$$VOA_{ir} = \sum_{j \in prod} \left(VDFA_{ijr} + VIFA_{ijr} \right) + \sum_{e \in endow} EVFA_{er} \, , \tag{10}$$

where *VDFA* is the value of purchases by firms for domestic inputs, *VIFA* is the value of imported inputs, and *EVFA* is the value of primary factors purchased by the firms. We are currently working on obtain data on air revenues by region for EU Member States, Canada, Norway, and Iceland (the main XEF countries). In this paper, and we assume as revenue share of 20 percent for these regions.

After establishing target values for total sales of *atp_na*, we proceed to allocate total sales between domestic use, exports, and international transport use. First, all bilateral exports between the US, EU, Canada, and XEF are allocated to the *atp_na* sector, with the remaining exports allocated to *atp_o*. Similarly, the international air transport margins are allocated between North Atlantic and other regions using the initial values of *VTWR* in the GTAP data base. All air transport margins between the US, EU, Canada, and XEF are assumed to be provided by the *atp_na* sector. Since the GTAP data base does not identify which country/region provides the international air transport margin between export/import region pairs, we compute the share of international air transport margins for trade among the US, EU, Canada, and XEF in total international air transport margins and multiply that share by the initial value of *VST* for air transport in the GTAP data base. This yields the amount of international air transport margin provided by the *atp_na* and *atp_o* sectors. Given the values of exports and international air transport margins, the value of domestic sales (*VDM*) for each sector is a residual. Domestic sales to the private household (*VDPM*), the government (*VDGM*), and to firms (*VDFM*) are allocated based on the share of *VDM* for each air transport sector.

After allocating domestic sales, the next step is to allocate the sales of imported air transport services to ensure consistency with the trade data in the GTAP data base. First, we begin by allocating air transport imports among the US, EU, Canada, and XEF to the *atp_na* sector, with all other imports allocated to *atp_o* sector using the initial value of imports at market prices (*VIMS*) from the GTAP data base. The total air transport imports are allocated between users, *VIPM*, *VIGM*, and *VIFM* based on import shares across users in the initial data base. The sales of imported air transport services to firms, (e.g., the *atp* row in the *VIFM* matrix) are allocated based on the share of total imports for each air transport sector.

Finally, to ensure that total sales equal total cost, we next allocate input usage by the air transport sector in *VDFA, VIFA,* and *EVFA* among the *atp_na* and *atp_o* sectors. This entails disaggregating the *atp* column in the *VDFA, VIFA,* and *EVFA* matrices in the original GTAP data base. Initially, the values in each row of the *atp* column is allocated to the *atp_na* sector based on the revenue share for each region. However, because the own-use of domestic and imported air transport services is both an input use and a sale, the values in the row and columns of *VDFM* and *VIFM* may need to be adjusted to ensure that the sales and cost targets are maintained.[3]

Tourism Expenditure

Because the GTAP data base does not explicitly identify tourism expenditure and the tourism related sectors in the GTAP also include non-tourism activities, secondary data on tourism expenditure is necessary to implement the model. Data on tourism is available from

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[3] A complete description of the disaggregation process is available from the authors upon request.

statistical agencies in many countries and the World Tourism Organization (United Nations), but the type of data available varies widely across countries. For example, data on the number of inbound visitors by country of residence is available for many regions, but the level of expenditures by inbound visitors in the host country are not as readily available. Some sources, like the World Tourism Organization, provide information on total tourism expenditure by inbound (and outbound) visitors, but not by country of residence, nor for domestic tourism. Other regions, such as the United States (Bureau of Economic Analysis) and Norway (Statistics Norway) provide tourism data that are linked to the region's National Input/Output Accounts.

In addition to the problem of availability, any secondary tourism data utilized must be consistent with the underlying GTAP data base. For example, purchases of lodging, meals, and transportation by a resident of a foreign country is usually considered as an export of these services in the I/O accounts of the country visited. Conversely, travel expenditures by domestic residents in foreign countries are considered an import. Thus, any data on bilateral tourism expenditure, if available, would need to be consistent with the existing bilateral trade flows in the GTAP data base unless one wished to modify those trade flows.

Because of the lack of bilateral data on international tourism expenditure and the need to maintain consistency with the underlying GTAP trade data, we assume that all expenditures by the private household on imported trade services (*trd*), all transportation services (*atp_na*, *atp_o*, and *o_tran*), and tourism related services (*tour_serv*) are tourism related. Since bilateral trade expenditure data in the GTAP data base only reported as a total (in *VIMS*) and not for each agent, we allocate the bilateral trade data in *VIMS* to tourism expenditures by the private household based on the share of *VIPM* in total imports. Table 3 lists the expenditure share for foreign tourism expenditures by the private household in each region based on our assumption. It ranges from a low of 0.008 for the USA to 0.036 for Ireland. However, as shown in Table 4, for the United States, the United Kingdom, Portugal, and the Netherlands, who provide tourism expenditure by inbound and outbound tourist, using the GTAP bilateral trade data underestimates foreign tourism expenditures. In addition, for the United States and the Netherlands, the implied balance of "tourism trade" using the GTAP proxy has the opposite sign of the country level data.

Secondary data on the total value of domestic tourism expenditure is available for three regions: the U.S. (Bureau of Economic Analysis), the U.K. (National Statistics), and the Netherlands (Statistics Netherlands). As a share of total income (GDP), total tourism expenditures from these three regions ranged from 2.1 percent for the Netherlands, to 3.6 percent for the U.S., to 5.6 percent for the United Kingdom. For the remaining regions, we assume that total tourism expenditure ranges from 3 percent of GDP for lower per-capita income regions, such as MEAF, CSAM, and ASIA, to 5 percent for higher per-capita regions, such as Germany. Total domestic tourism expenditures were not allowed to exceed the expenditures by the private household (*VDPM*) on the tourism related sectors in each region.

Once that total level of domestic tourism expenditure is determined, it must be allocated to the four tourism related sectors: *trd*, *atp_o*, *o_tran*, and *tour_serv*. Note that since the *atp_na* sector provides international flights over the North Atlantic, there are no domestic tourism expenditures for this sector. For the U.S., data on domestic tourism expenditure by sector/commodity are available from the U.S. Travel and Tourism Satellite Accounts (Bureau of Economic Analysis). After aggregating the U.S. data to the appropriate GTAP sector definitions and excluding all expenditure on non-tourism related sectors in our model, approximately 45.9 percent of U.S. domestic tourism expenditure is for trade services (*trd*), 16.6 percent of air transport (*atp_o*), 11.6 percent for other transport (*o_tran*), and 25.9 percent for tourism related services (*tour_serv*).[4] For the remaining regions, the U.S. shares were the initial starting point to allocate domestic tourism expenditures among the four domestic tourism related sectors. Because these sectors also include non-tourism related activities, no more than 90 percent of expenditures for domestic trade services (*trd*), 95 percent of expenditures for air transport services (*atp_o*), or 50 percent of other transport (*o_tran*) in the initial GTAP data is allocated to domestic tourism.[5] The resulting domestic tourism expenditure shares by region are given in table 5.

Tourism Parameter Values

Because tourism is identified as a new commodity purchased by the private household, new substitution and expansion parameters, *SUBPAR* and *INCPAR*, must be specified. With little empirical evidence to guide our choice of own-price and income elasticities for tourism, we use two alternative approached. The first approach used an average of the compensated and income elasticities for trade (*trd*), all air transport (*atp*), other transport (*o_tran*), and tourism related services (*tour_serv*) in the initial GTAP data base. Table 6 presents the compensated own-price and income elasticities for the private household in each region.

Other Parameter Values

The production, margin, and trade elasticities of substitution used in the model are listed in table 7. No substitution is allowed between non-energy intermediate inputs and value-added (σ_T). The elasticities of substitution among the components of value-added (σ_{VA}) are set equal to

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4 Expenditures on trade, air transport, other transport, and tourism related services account for approximately 70 percent of total domestic tourism expenditures by U.S. resident households.

5 No restrictions were placed on the share of *tou_serv* sector because the estimated tourism expenditures were always a relatively small share of total expenditure for this sector in all regions.

those values in the GTAP version 6.0 data base. Because we believe that the elasticities of substitution between energy and capital (σ_{KE}), electricity and non-electricity (σ_{ELY}), and coal and non-coal (σ_{COAL}), and between non-coal energy intermediate inputs (σ_{FU}) in Burniaux and Truong (2002) are too large for the short to intermediate run, we set these parameters equal to 0.25.[6] Following Burniaux and Truong (2002), we do not allow for substitution among energy commodities or between energy and capital in the mining and refining of fossil fuels (i.e., σ_{KE}, σ_{ELY}, σ_{COAL}, and σ_{FU} are set equal to zero for coal, oil, gas, and petroleum and coal products). We also do not allow substitution between electricity and non-electricity in the electricity sector. Finally, the elasticities of substitution between domestic and the composite imported commodity (σ_D) and between imported commodities (σ_M) equal the values in the GTAP v6 data base with the exception of oil, where the trade elasticities are set equal to 30, reflecting the belief that crude oil is a more homogeneous commodity.

Results

As stated earlier, the primary benefit of Open Skies agreements is a reduction in airfares, through increased competition or improvements in air operations such as better coordination of flights and the use of larger planes. Because it is not possible to investigate the potential impacts of increased competition using a perfectly competitive model, we will focus on the impacts of increased efficiency. Better flight coordination and the use of larger planes would potentially lead to being able to fly more passengers with less than a proportional increase in input costs. Without on how inputs costs may decrease per passenger, we assume a neutral technical change will occur. Because increased efficiency would only account for a portion of the total potential

6 In a recent micro-panel econometric study of industrial companies, Arberg and Bjørner (2007) find that electricity and other energy inputs are complements with capital rather than substitutes.

reduction in air fares, we assume the agreement would lead to a 10 percent neutral technical change in the *atp_na* sector, which is on the low end of the estimated reductions in air fares in Mayor and Tol (2007).

Table 8 presents the percentage changes in the market prices of the tourism related commodities (*trd*, *atp_na*, *atp_o*, *o_tran*, and *tour_serv*), and the aggregate domestic tourism price (*pm_tour*), the aggregate foreign tourism price (*pim_tour*), and the aggregate overall tourism price [*pp*(*tour*)]. Due to the neutral technical change, the market price for the North Atlantic air transport sector (*atp_na*) in general decreases between 9 and 10 percent. A larger decrease for Denmark and the Netherlands reflects relatively large own-use cost shares for *atp_na* in those regions. Because the North Atlantic air transport sector is relatively small in all regions, changes in it price and level of output have very small effects on all other sectors. This is shown by the very small market price changes for trade (*trd*), other air transport (*atp_o*), other transport (*o_tran*), and tourism related services (*tour_serv*). These small price changes, along with the *atp_na* sector providing only international air service, the domestic tourism price (*pm_tour*) index remains virtually unchanged in all regions. However, due to the decrease in the market price of *atp_na*, the foreign tourism price index (*pim_tour*) decreases in all regions, from 0.06 percent in the Netherlands to 1.17 percent in the United States. The magnitude of this decrease depends on the amount of *atp_na* purchased by the private household in each region. Finally, the overall aggregate tourism price for the private household (*pp*) is the share weighted average of the percentage change in the domestic and foreign tourism price indices. Since domestic tourism is a relatively large share of total tourism in most regions, the decrease *pp* is much smaller than the decrease in the foreign tourism price index. The decrease in *pp* ranges from 0.01 percent for the REU15 to 0.37 percent for the United Kingdom.

The last three columns in table 8 present the percentage changes in the aggregate demand for tourism. Because the decreases in the aggregate tourism price index is fairly small in the U.S and EU Member States, the increase in the aggregate demand for tourism is also small, ranging from 0.03 percent in Ireland to 0.27 percent for the United Kingdom. With the price of foreign tourism declining relative to domestic tourism, the demand for foreign tourism increases relative to domestic tourism in the EU and the United States. For the U.S. U.K., Spain, and the REU, this substitution effect dominated the expansion effect, leading to a decrease in the demand for domestic tourism.

Because of changes in the relative cost of air transport and other tourism relative expenses between regions, there are bilateral shifts in the demand for foreign tourism. As shown in first column of table 9, there is an increase in foreign tourism from the U.S. to the EU while foreign tourism to all other regions from the U.S. decreases.[7] This reflects the lower cost of air transport across the North Atlantic for US residents relative to other foreign destinations. For EU residents, because the US/EU Open Sky agreement only lowers the cost of air transport over the North Atlantic and not between EU Member States, foreign tourism from the EU to the U.S. increases while foreign tourism within the EU and all non-U.S. regions decreases. Not shown in table 9, while there is an increase in foreign tourism from the EU in the U.S., this is offset somewhat by a decrease in foreign tourism from all non-EU regions to the United States. This decrease occurs because the aggregate price of foreign tourism in the U.S. increases relative to other foreign destinations for all non-EU residents.

With the changes in bilateral foreign tourism demand and domestic tourism demand, the impacts on the quantity of tourism related services produced in each region is not clear. For

7 Remember, purchasing an import of a tourism related commodity represents the private household's purchases of these commodities while traveling in a foreign country.

trade (*trd*), other transport (*o_tran*) and tourism related services (*tour_serv*), there is no net change in exports or domestic tourism uses. Overall, as shown in table 10, production of these three commodities remains virtually unchanged across all regions. Because of the decrease in cost, the production of *atp_na* increases significantly in the U.S. and the EU to meet the additional tourism demand between the U.S. and the EU. Output of *atp_na* increases from 1.69 percent for Germany to 10.05 percent for the Netherlands. However, the output of other airt transport (*atp_o*) decreases in almost every region because of the shift in foreign tourism away from intra-EU tourism, tourism between the US, EU, and rest of the world, and domestic tourism. Output changes for all other sectors are very small.

Even with increases in North Atlantic air transport output, the emissions of CO_2 decline slightly in the U.S. and most EU regions (last column of table 10). This reduction is due to two reasons. First, the assumption of neutral technical change implies that 10 percent less fuel (*p_c*) is required for all North Atlantic flights. Second, the reduction in *atp_o* output in the U.S. and EU also contributes to a reduction in CO_2 emissions. However, if the US/EU Open Sky agreement leads to a reduction in air fares due to increased competition without any improvements in efficiency, this result could easily be reversed.

Table 11 provides the changes in equivalent variation (EV) by region. While both the U.S. and the EU has substantial gains from implementing this policy, overall the U.S. gains approximately $743 million more than the EU. This difference is mainly due to the U.S. enjoying a $415 million improvement in its terms-of-trade, while the EU has an overall deterioration of $321 million in its term-of-trade. Not surprisingly, all other regions experience small reductions in equivalent, mainly due to a deterioration in their terms-of-trade.

Conclusions

In assessing the impacts of the US/EU Open Sky agreement, this paper has extended previous research by considering the impacts of deregulation and improved airspace operations on all sectors in the economy, not just the air transportation sector, the impacts on the agreement on CO_2 emissions, and incorporating a tourism module into the standard GTAP-E model. Results from the model indicate that the welfare gains from the U.S. and EU are substantial, nearly a combined $4.5 billion. If the agreement leads to improved airspace operations and flight coordination, which leads to the use of large, more fuel efficient planes (on a per passenger basis), then the increased in flights over the North Atlantic caused by this policy change need not increase CO_2 emissions.

There are two major limitation of this research. The first limitation is that the tourism expenditure data that we have used in this paper is in the early stages of development. Collecting tourism data from individual countries is a time consuming process and data do not always exist on inbound and outbound tourism expenditure by country of resident or destination. In addition, any data collected from secondary sources must be consistent with the trade flows in the underlying GTAP data base. This is because purchases by a foreign resident of a tourism related good or services is treated as an export by the country where the purchased occurred. For some countries, particularly the Netherlands, the importation of tourism related services, such as trade services, are very low in the GTAP data base and may be at odds with the secondary tourism data.

The second limitation is also a data issue. To assess the impact of the US/EU Open Sky agreement required that the transport sector (*atp*) in the GTAP data base be split into two sectors. Currently, we only have information on air carrier revenues by region for the only the United

States. Additional information is needed for EU countries in order to develop a better disaggregation of this sector.

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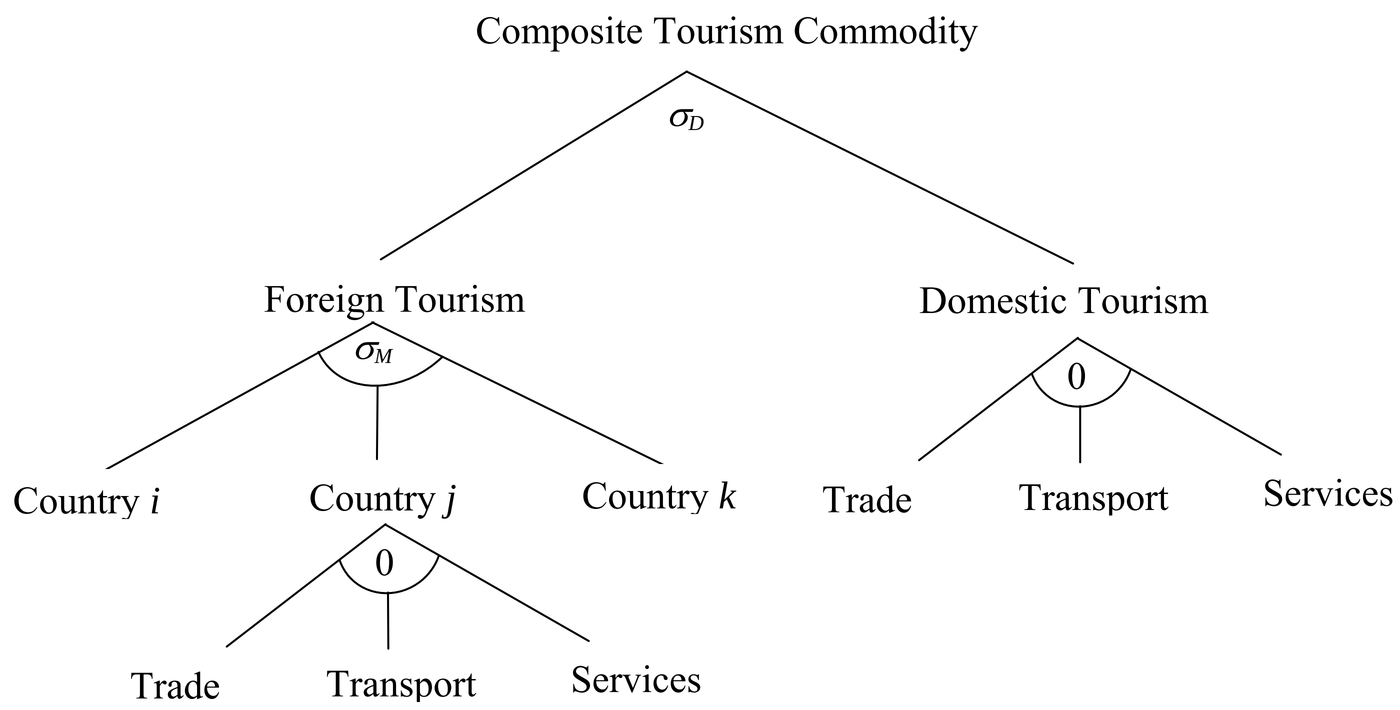

Figure 1 Preference Structure for Tourism by Private Household

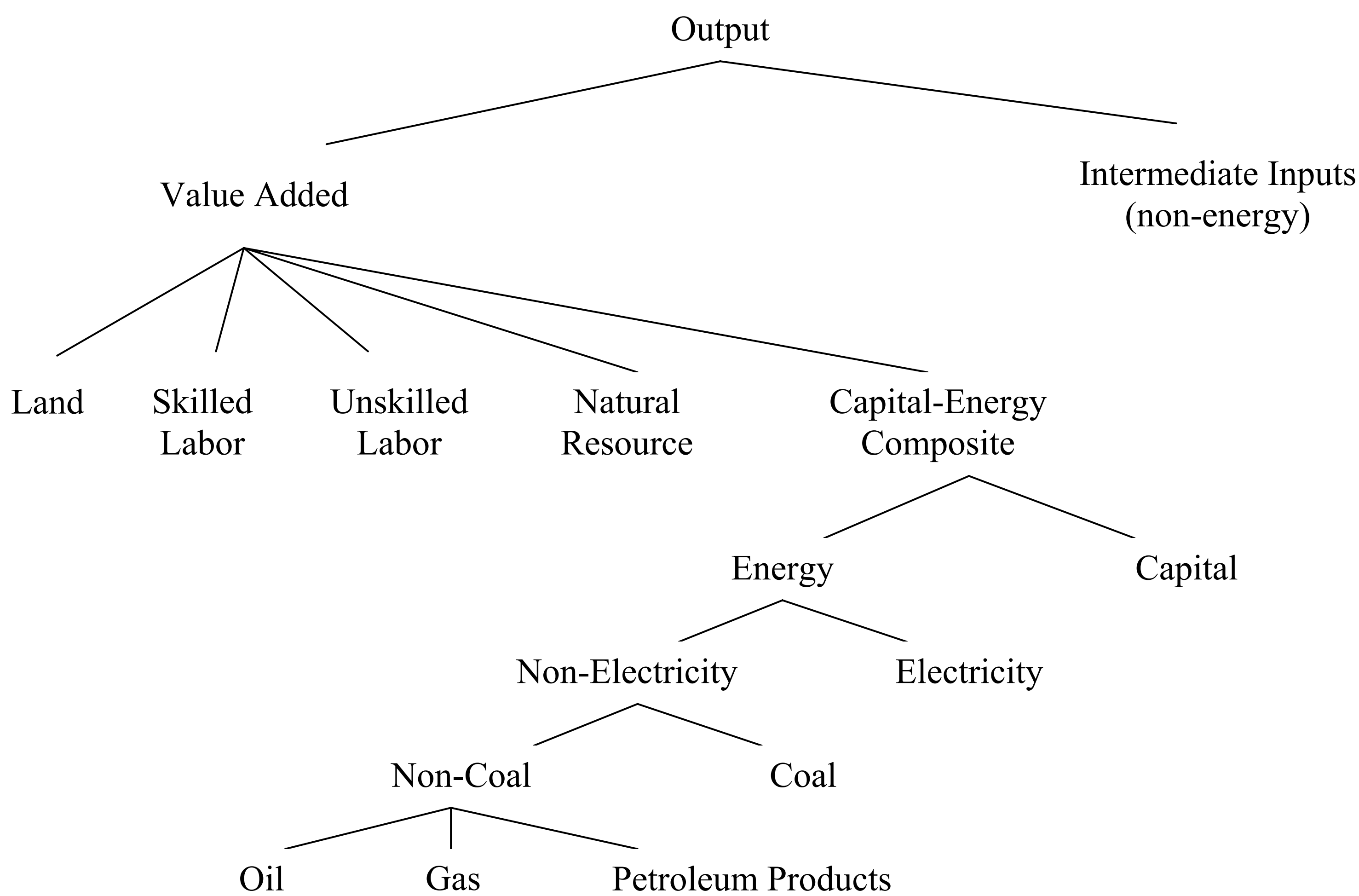

Figure 2. Production Structure in GTAP-E Model

Table 1. Regional/country Aggregation

Region	Description	GTAP Regions
ANZ	Australia/New Zealand	aus, nzl, xoc
USA	United States	usa
CAN	Canada	can
DNK	Denmark	dnk
FRA	France	fra
DEU	Germany	deu
UK	United Kingdom	gbr
IRL	Ireland	irl
NLD	Netherlands	nld
PRT	Portugal	prt
ESP	Spain	esp
XEF	Rest of EFTA	xef
REU15	Rest of EU15	aut, bel, fin, grc, ita, lux, swe
REU	Rest of EU	bgr, cyp, cze, hun, mlt, pol, rom, svk, svn, est, lva, ltu
REFSU	Rest of Eastern Europe & Former Soviet Union	che, xer, alb, hrv, rus, xsu
MEAF	Middle East & Africa	tur, xme, mar, tun, xnf, bwa, zaf, xsc, mwi, moz, tza, zmb, zwe, xsd, mdg, uga, xss
CSAM	Central & South America	mex, xna, col, per, ven, xap, arg, bra, chl, ury, xsm, xca, xfa, xcb
ASIA	Rest of Asia	jpn, chn, hkg, ind, kor, twn, xea, idn, mys, phl, sgp, tha, vnm, xse, bgd, lka, xsa

Table 2. Commodity/sector Aggregation

Sector	Description	GTAP Sector
agr	Agriculture	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh
coal	Coal	coa
oil	Oil	oil
gas	Gas	gas, gdt
meat	Meat products	cmt, omt
o_food	Other food	vol, mil, pcr, sgr, ofd
tex_app	Textiles and apparel	tex, wap, lea
wood	Wood products	lum, ppp
p_c	Petroleum and coal products	p_c
crp	Chemicals, rubber, plastic products	crp
nmm	Other mineral products	nmm
i_s	Ferrous metals	i_s
o_man_h	Other manufacturing – high air transport	omn, b_t, nfm, fmp, mvh
o_man_l	Other manufacturing – low air transport	otn, ele, ome, omf
ely	Electricity	ely
trd	Trade	trd
atp_na	North Atlantic air transport	atp
atp_o	Other air transport	atp
o_tran	Other transport	wtp, otp
tour_serv	Tourism related services	cmn, ofi, isr, obs, ros
oth_serv	Other services	wtr, cns, osg, dwe

Table 3. Tourism Expenditure Shares by Region

Region	Imports	Domestic	Total
Australia/New Zealand	0.022	0.043	0.065
United States	0.008	0.040	0.047
Canada	0.025	0.036	0.061
Denmark	0.034	0.026	0.060
France	0.015	0.059	0.074
Germany	0.019	0.055	0.075
United Kingdom	0.035	0.042	0.077
Ireland	0.036	0.043	0.079
Netherlands	0.019	0.015	0.034
Portugal	0.020	0.046	0.066
Spain	0.006	0.053	0.059
Rest of EFTA	0.016	0.044	0.060
Rest of EU15	0.010	0.069	0.079
Rest of EU	0.018	0.028	0.046
Rest of Europe and Former Soviet Union	0.029	0.017	0.046
Central and South America	0.013	0.025	0.038
Middle East and Africa	0.022	0.020	0.042
Rest of Asia	0.018	0.030	0.047
All Regions	0.015	0.039	0.053

Table 4. Comparison of Country Tourism Data and GTAP Trade Data

	Country Tourism Data			GTAP Data	
Country	Year	Imports	Exports	Imports	Exports
			($ millions)		
United States[a]	2001	60,200	71,893	52,272	41,415
United Kingdom[b]	2004	54,772	24,240	33,389	19,148
Portugal[c]	2001	2,606	6,238	1,289	1,731
Netherlands[d]	2003	11,049	9,169	3,953	7,931

[a] Travel expenditure only. Source: U.S. Department of Commerce, International Trade Administration, Office of Travel and Tourism Industries.

[b] Source: National Statistics (2007)

[c] Source: World Tourism Organization

[d] Statistics Netherlands (CBS)

Table 5. Domestic Tourism Expenditure Share by Commodity

	Tourism Sector			
Country/Region	*trd*	*atp_o*	*o_tran*	*tour_serv*
Australia/New Zealand	0.459	0.166	0.116	0.259
United States	0.459	0.166	0.116	0.259
Canada	0.400	0.400	0.100	0.100
Denmark	0.483	0.253	0.168	0.096
France	0.195	0.051	0.118	0.636
Germany	0.308	0.036	0.178	0.479
United Kingdom	0.459	0.166	0.116	0.259
Ireland	0.175	0.046	0.072	0.707
Netherlands	0.459	0.166	0.116	0.259
Portugal	0.228	0.026	0.201	0.545
Spain	0.513	0.066	0.130	0.290
Rest of EFTA	0.459	0.166	0.116	0.259
Rest of EU15	0.536	0.026	0.136	0.303
Rest of EU	0.518	0.057	0.131	0.293
Rest of Europe/Former Soviet Union	0.459	0.166	0.116	0.259
Central/South America	0.459	0.166	0.116	0.259
Middle East/Africa	0.459	0.166	0.116	0.259
Rest of Asia	0.459	0.166	0.116	0.259

Table 6. Tourism Own-Price and Income Elasticities of Demand

Country/Region	Comp	Uncomp	Income
Australia/New Zealand	-0.589	-0.656	1.156
United States	-0.751	-0.798	1.082
Canada	-0.629	-0.708	1.163
Denmark	-0.756	-0.842	1.146
France	-0.661	-0.754	1.188
Germany	-0.641	-0.741	1.181
United Kingdom	-0.655	-0.734	1.148
Ireland	-0.682	-0.780	1.136
Netherlands	-0.642	-0.678	1.156
Portugal	-0.530	-0.623	1.276
Spain	-0.555	-0.619	1.199
Rest of EFTA	-0.789	-0.866	1.124
Rest of EU15	-0.614	-0.710	1.176
Rest of EU	-0.375	-0.430	1.171
Rest of Europe/Former Soviet Union	-0.481	-0.530	1.102
Central/South America	-0.367	-0.414	1.174
Middle East/Africa	-0.309	-0.359	1.144
Rest of Asia	-0.591	-0.643	1.140

Table 7. Production and Trade Elasticities of Substitution

	Production						Trade	
Sectors	σ_T	σ_{VA}	σ_{KE}	σ_{ELY}	σ_{COAL}	σ_{FU}	σ_D	σ_M
agr	0.0	0.233	0.25	0.250	0.250	0.250	2.419	4.933
coal	0.0	0.200	0.0	0.0	0.0	0.0	3.050	6.100
oil	0.0	0.200	0.0	0.0	0.0	0.0	10.000	30.000
gas	0.0	0.619	0.0	0.0	0.0	0.0	11.027	33.040
meat	0.0	1.120	0.25	0.250	0.250	0.250	4.151	8.348
o_food	0.0	1.120	0.25	0.250	0.250	0.250	2.458	4.851
tex_app	0.0	1.260	0.25	0.250	0.250	0.250	3.776	7.584
wood	0.0	1.260	0.25	0.250	0.250	0.250	3.102	6.317
p_c	0.0	1.260	0.0	0.0	0.0	0.0	2.100	4.200
crp	0.0	1.260	0.25	0.250	0.250	0.250	3.300	6.600
nmm	0.0	1.260	0.25	0.250	0.250	0.250	2.900	5.800
i_s	0.0	1.260	0.25	0.250	0.250	0.250	2.950	5.900
o_man_h	0.0	1.146	0.25	0.250	0.250	0.250	2.812	5.949
o_man_l	0.0	1.260	0.25	0.250	0.250	0.250	4.149	8.347
ely	0.0	1.260	0.25	0.0	0.250	0.250	2.800	5.600
trd	0.0	1.680	0.25	0.250	0.250	0.250	1.900	3.800
atp_na	0.0	1.680	0.25	0.250	0.250	0.250	1.900	3.800
atp_o	0.0	1.680	0.25	0.250	0.250	0.250	1.900	3.800
o_tran	0.0	1.680	0.25	0.250	0.250	0.250	1.900	3.800
tour_serv	0.0	1.260	0.25	0.250	0.250	0.250	1.900	3.800
oth_serv	0.0	1.290	0.25	0.250	0.250	0.250	1.914	3.820
tourism							1.000	3.000
CGDS	0.0	1.000	0.0	0.0	0.0	0.0		

Table 8. Percentage Change in the Market Prices and Quantities Demanded for Tourism and Tourism Related Commodities

	Tourism Related Commodities					Aggregate Tourism Prices			Aggregate Quantities Demanded		
Region[a]	*trd*	*atp_na*	*atp_o*	*o_tran*	*tour_serv*	*pm_tour*	*pim_tour*	*pp*	*qp*	*qpd*	*qpm*
anz	-0.02	0.00	-0.03	-0.03	-0.02	-0.03	-0.02	-0.02	0.00	0.00	-0.01
usa	0.01	-9.66	0.00	0.00	0.01	0.00	-1.17	-0.18	0.17	-0.02	1.17
can	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.94	-0.40	0.20	-0.10	0.76
dnk	0.01	-10.13	0.00	-0.05	0.02	0.00	-0.25	-0.10	0.13	0.03	0.28
fra	0.01	-9.57	-0.03	-0.03	0.00	0.00	-0.38	-0.07	0.07	0.00	0.38
deu	0.00	-9.26	-0.01	-0.04	0.01	0.00	-0.26	-0.06	0.06	0.00	0.26
gbr	0.00	-9.33	-0.02	-0.02	-0.01	-0.01	-0.80	-0.37	0.27	-0.09	0.71
irl	0.01	-9.29	-0.03	-0.02	0.01	0.01	-0.07	-0.02	0.03	0.00	0.08
nld	0.03	-11.88	-0.03	-0.01	0.01	0.01	-0.06	-0.03	0.07	0.03	0.10
prt	-0.04	-9.45	-0.02	-0.04	0.00	-0.02	-0.30	-0.09	0.08	0.00	0.29
esp	0.00	-9.81	-0.02	-0.02	-0.01	-0.01	-0.67	-0.07	0.05	-0.01	0.66
xef	0.01	-0.51	-0.01	-0.10	0.02	0.00	-0.41	-0.09	0.12	0.03	0.44
reu15	0.02	-9.48	-0.01	-0.04	0.02	0.01	-0.15	-0.01	0.04	0.02	0.18
reu	-0.01	-9.27	-0.01	-0.02	0.00	-0.01	-0.23	-0.09	0.05	-0.03	0.20
refsu	-0.02	0.00	-0.03	-0.02	-0.02	-0.02	-0.01	-0.02	-0.01	0.00	-0.01
csam	-0.03	0.00	-0.03	-0.03	-0.03	-0.03	-0.01	-0.03	-0.01	0.00	-0.02
meaf	-0.03	0.00	-0.03	-0.03	-0.03	-0.03	-0.01	-0.02	-0.02	-0.01	-0.03
asia	-0.02	0.00	-0.03	-0.03	-0.02	-0.02	-0.01	-0.02	0.00	0.00	-0.01

[a] See table 1 for regional definitions and table 2 for sector definitions.

Table 9. Bilateral Changes in Demand for Foreign Tourism by Selected Regions

	Region to										
Region from	usa	dnk	fra	deu	gbr	irl	nld	prt	esp	reu15	reu
anz	-2.27	-0.39	-0.68	-0.45	-1.60	-0.05	0.00	-0.53	-1.28	-0.20	-0.43
usa	-2.36	3.28	4.81	3.10	10.73	1.13	0.31	3.70	9.81	1.92	2.98
can	-2.08	-0.19	-0.48	-0.25	-1.41	0.16	0.19	-0.33	-1.08	0.00	-0.23
dnk	11.35	-0.49	-0.76	-0.53	-1.69	-0.16	-0.02	-0.63	-1.36	-0.28	-0.52
fra	4.68	-0.45	-0.74	-0.51	-1.65	-0.12	-0.04	-0.59	-1.32	-0.26	-0.49
deu	6.52	-0.48	-0.76	-0.51	-1.67	-0.13	-0.04	-0.61	-1.35	-0.29	-0.51
gbr	5.58	-0.45	-0.73	-0.50	-1.65	-0.10	-0.05	-0.58	-1.32	-0.26	-0.48
irl	5.01	-0.50	-0.78	-0.55	-1.68	-0.12	-0.09	-0.63	-1.37	-0.31	-0.53
nld	9.63	-0.48	-0.76	-0.53	-1.67	-0.15	-0.07	-0.61	-1.34	-0.29	-0.52
prt	7.28	-0.44	-0.70	-0.47	-1.61	-0.07	0.02	-0.58	-1.29	-0.23	-0.46
esp	4.42	-0.42	-0.72	-0.48	-1.65	-0.09	-0.03	-0.56	-1.31	-0.24	-0.47
xef	-2.02	-0.31	-0.50	-0.33	-1.06	-0.11	0.09	-0.44	-0.87	-0.12	-0.32
reu15	1.48	-0.51	-0.78	-0.54	-1.70	-0.17	-0.04	-0.64	-1.36	-0.30	-0.54
reu	2.71	-0.45	-0.73	-0.50	-1.66	-0.10	-0.03	-0.58	-1.33	-0.25	-0.48
refsu	-2.28	-0.41	-0.69	-0.46	-1.62	-0.06	-0.01	-0.55	-1.29	-0.22	-0.45
csam	-2.26	-0.38	-0.66	-0.43	-1.59	-0.03	0.02	-0.51	-1.26	-0.18	-0.41
meaf	-2.26	-0.38	-0.67	-0.43	-1.59	-0.03	0.02	-0.52	-1.27	-0.19	-0.42
asia	-2.28	-0.40	-0.69	-0.46	-1.62	-0.05	-0.01	-0.54	-1.29	-0.21	-0.44

Table 10. Changes in Output of Tourism Related Sectors and CO_2 Emissions

	Sector					CO_2
Region	*trd*	*atp_na*	*atp_o*	*o_tran*	*serv_h*	Emissions
anz	0.00	0.00	-0.14	0.00	0.01	-0.01
usa	0.01	5.80	-0.03	-0.03	0.01	-0.03
can	0.01	-18.09	-0.05	0.00	0.03	-0.07
dnk	0.02	4.13	-0.23	0.02	0.00	-0.09
fra	0.01	2.34	-0.10	-0.04	0.01	-0.10
deu	0.01	1.69	-0.14	-0.01	0.01	-0.02
gbr	0.01	2.56	-0.06	-0.02	0.01	-0.05
irl	0.01	1.75	-0.22	-0.05	0.00	-0.17
nld	0.01	10.05	-0.08	0.01	0.03	0.01
prt	0.01	2.03	-0.18	-0.10	0.01	-0.03
esp	0.00	3.65	-0.18	-0.02	0.02	-0.06
xef	0.03	-22.85	0.01	0.09	0.00	-0.10
reu15	0.01	2.23	-0.14	0.00	0.01	0.00
reu	0.00	1.42	-0.17	-0.01	0.01	0.00
refsu	0.00	0.00	-0.18	0.00	0.02	0.00
csam	0.00	0.00	-0.07	0.00	0.01	0.01
meaf	0.00	0.00	-0.14	0.00	0.02	0.00
asia	0.00	0.00	-0.14	0.00	0.01	0.00

Table 11. Changes in Equivalent Variation by Region

Region	Allocative Efficiency	Capital Goods	Technical Change	Terms of Trade	Other	Total
			($ millions)			
anz	-2.082	-1.906	0.000	-6.409	0.010	-10.387
usa	26.515	213.053	1957.789	415.146	-1.644	2610.859
can	-26.906	1.421	0.000	-2.419	-0.283	-28.187
dnk	2.523	-7.493	123.550	-59.259	0.346	59.667
fra	-26.424	-9.214	336.170	-28.080	2.557	275.009
deu	3.694	-37.799	358.098	25.924	4.189	354.106
gbr	-33.856	22.349	431.250	13.788	-6.162	427.369
irl	-4.798	-10.338	41.436	-8.467	0.098	17.931
nld	30.673	4.227	252.169	-157.845	0.098	129.322
prt	0.372	6.921	38.520	-21.040	0.245	25.018
esp	-12.295	5.833	201.151	-111.304	-0.323	83.062
xef	-4.921	-14.401	0.000	71.973	0.347	52.998
reu15	24.814	-14.785	360.193	63.524	3.299	437.045
reu	3.969	10.181	83.498	-38.379	-0.657	58.612
refsu	-8.175	-17.996	0.000	-21.872	0.050	-47.993
csam	-9.084	-2.921	0.000	-77.991	-0.086	-90.082
meaf	-6.169	-8.140	0.000	-135.694	-0.088	-150.091
asia	4.026	-138.997	0.000	78.392	0.024	-56.555