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THE ECONOMIC IMPACT OF HAWAII'S CRUISE INDUSTRY

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The cruise industry worldwide has increased rapidly since the beginning of the millennium. Hawaii is no exception to this. Since the 1970s, cruise ships periodically visited the Hawaiian Islands, yet overnight cruising among the islands was rare. From 2001 to 2004, cruise ships sailing to and around Hawaii were solely foreign-flagged ships, including those home based in Hawaii. This meant much of the tourism revenue and taxes did not accrue to the local economy. Since July 2004, in addition to the foreign-flagged ships, a U.S.-flagged ship has been home-ported in the islands, paying Hawaii taxes and hiring U.S. crews with two more U.S.-flagged ships being added to the fleet in 2005 and 2006. This article uses a computable general equilibrium (CGE) model to estimate the economywide economic impact of the cruise industry on the state of Hawaii. Using the 2002 intercounty input–output table as a benchmark, the multiregion CGE model takes the direct expenditure estimates of cruise passengers, expenditure by cruise crews, and the direct expenditures by the cruise lines, as computed by the State of Hawaii and uses these direct impacts as simulations in the CGE model. Gross value added and welfare are calculated for each county and the state as a whole. Some regions benefit more than others.

Key words: Economic impacts; Cruise industry; Regional tourism; Hawaii

Introduction

Cruising worldwide has grown from 3.8 million cruise tourists in 1990 to more than 11.2 million cruisers in 2005. The annual growth rate in cruise tourism has averaged 7.6% from 1980 to 2005, approximately twice the average rate of other forms of tourism (CLIA, 2006). The cruise industry contributed US$16.4 billion in direct output to the U.S. economy in 2005, an increase of 10.0% on the previous year. Not only has demand grown but supply has also increased over the last few years in the United States with a net increase of eight new vessels introduced in both 2003 and 2004. In 2005, the cruise industry's fleet remained unchanged at 192 vessels, but the combined capacity increased to 245,755 lower berths (an increase of 2.2% over the previous year) as older vessels were replaced with vessels with larger capacity (CLIA, 2006). While the cruise industry has

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experienced strong growth in the last two decades, more recently the state of Hawaii has become a rapidly expanding destination market. Hawaii has increased its share of the cruise industry's impact in the United States. From 2003 to 2005, the 50th state of the United States rose in rankings from 15th to 8th in terms of the value of direct impact to the North American cruise industry.

This article estimates the economic impact of the cruise industry on the state of Hawaii using a computable general equilibrium (CGE) model. The multiregion CGE model takes the 2002 intercounty input–output table as a benchmark and the direct expenditure estimates of three types of additional demand sources associated with the cruise industry, namely, out-of-state cruise passenger visitors, cruise crew members, and cruise lines and computes economic impacts by county as well as statewide impacts. The next section reviews past research that has been conducted into the economic impacts of tourism and examines some of the previous studies of the cruise industry. The third section places the research in context, explaining some of the characteristics of the cruise industry in Hawaii. The fourth section describes the methodology used in the modeling, including the function forms for the underlying equations. The next section explains the data used in the modeling, both the input–output table and the direct impacts used in the counterfactual simulations. The penultimate section, the sixth section presents the results, and the last section concludes.

Economic Impact Studies of Tourism

There is now an extensive literature on evaluating the economic impacts of tourism. This literature shows how the impact of changes in tourism expenditure leads to income generation and employment through direct, indirect, and induced effects, typically measured through input–output models (Archer, 1982, 1984, 1995; Archer & Fletcher, 1996; Archer & Owen, 1971; Fletcher, 1989; Polo & Valle, 2008a) and also through price, wage, and resource redistribution effects, the total effects of which are typically measured through CGE models (Adams & Parmenter, 1992a, 1992b; Blake, 2000; Blake, Durbarry, Sinclair, & Sugiyarto, 2001; Blake & Sinclair, 2003; Blake, Sinclair, & Sugiyarto, 2001; Dwyer, Forsyth, Madden, & Spurr, 2000; Dwyer, Forsyth, & Spurr, 2004; Dwyer, Forsyth, Spurr, & Van Ho, 2003; Gooroochurn & Milner, 2004; Narayan, 2004; Polo & Valle, 2008b; Zhou, Yanagida, Chakravorty, & Leung, 1997). While CGE models are a newer approach that more appropriately assesses the impact of additional (or a reduction in) tourism demand (Dwyer et al., 2004), the use of input–output models still persists, using techniques that only measure some of the channels through which tourism spending moves, often because the geographic scale or time scale involved is erroneously used as a reason to discount price, wage, and resource redistribution effects (e.g., Croes & Severt, 2007), even though these scale effects do not discount price, wage, and resource reallocation effects (Dwyer, Forsyth, & Spurr, 2006).

With continued growth since the 1960s, the cruise industry has been the subject of much research. This literature involves research into both the economic impact of the cruise industry and other noneconomic characteristics of cruise passengers. Cruise passengers' characteristics have been widely researched using various statistical techniques such as logistic regression (de la Vina & Ford, 2001), chi-squared analysis (Field, Clark, & Koth, 1985; Marti, 1986; Morrison, Yang, O'Leary, & Nadkarni, 1996), and multidimensional scaling (Moscardo, Morrison, Cai, Nadkarni, & O'Leary, 1996). Demographics, travel attitudes, trip planning characteristics, benefits experienced, and tourism activities undertaken have been compared and contrasted across travel types (Morrison et al., 1996; Moscardo et al., 1996). Petrick (2005) analyzes how price sensitive cruise passengers are. Social interaction among cruise passengers engaged in a group tour context has been explored (Yarnal & Kerstetter, 2005). The issue of perceived value and the role that hedonics, control, and novelty play in influencing customer satisfaction for cruise vacationers is the subject of Duman and Mattila's (2005) research. Along the same lines, Petrick (2004) examines the relationship among satisfaction, perceived value, and quality in cruise passengers' intentions to repurchase and positive word-of-mouth publicity. Repurchase intentions of cruise passengers is the focus of Petrick, Tonner, and Quinn's (2006) research as is the focus of Gabe, Lynch, and McConnon (2006). Bull (1996) undertakes a microeconomic analysis of the cruise market, exploring issues such as operating costs, market structure, and the sourcing of factor inputs. Hobson (1993) charts the growth of the U.S. cruise industry from the 1970s until the early 1990s and looks at factors behind the growth and changes within the industry.

Economic impact studies of the cruise industry have been undertaken previously. Mescon and Vozikis (1985) use a regional input–output analysis to estimate the economic impact of the cruise industry in Miami in the early 1980s. Direct economic impacts are taken from a survey of both cruise ship passengers and the cruise line industry. Multipliers were then implemented to estimate the indirect, induced, and hence total economic impact of the cruise industry on the economy of South Florida. Dwyer and Forsyth (1996) identify the types of economic impacts resulting from cruise tourism. They then provide estimates of expenditures injected into the Australian economy from two types of cruises: a coastal cruise in Australian waters with two visits to stopover ports and one to a home port, and an 11-day cruise in international waters originating in Sydney with stopovers in Vanuatu and Fiji. Dwyer and Forsyth (1998) build on their previous work on this subject, outlining a framework for assessing the economic impacts of cruise tourism for a nation and its regions, calling for greater use of CGE models. Mak (2008) examines the implications of a head tax on cruise ship passengers in Alaska.

Annually, the Cruise Lines International Association (CLIA) produces an economic impact study of the contribution of the North American cruise industry to the U.S. economy. This study is undertaken using input–output analysis. The total contribution of the cruise industry to the U.S. economy is composed of direct and indirect economic impacts. Direct impacts consist of three types of expenditures: cruise passenger spending, crew spending, and expenditure by the cruise lines. The direct effects, explained above, lead to a series of successive or indirect impacts on the producing sectors. The 2005 report (CLIA, 2006) estimates that in 2005, the cruise industry generated US$32.4 billion in total expenditures, an increase of 7.9% over the previous 12 months. Of that total, direct expenditures accounted for US$16.2 billion. Employment generated by this expenditure is estimated to be 330,346 workers and total wages for U.S. employees is estimated to be US$13.5 billion.

However, as noted above, input–output analysis can seriously overstate estimated economic impacts. As such, there appears to be a clear need to undertake an economic impact study of the cruise industry using a CGE modeling methodology. This research undertakes this task.

Research Context

The cruise industry in Hawaii has experienced significant change in the past few years. From the 1970s, cruise ships periodically visited the Hawaiian Islands. This continued up until 1985, when two U.S.-flagged ships, the SS *Independence* and the SS *Constitution,* owned by American Hawaii Cruises sailed around the Hawaiian Islands year-round on 7-day cruises. In the aftermath of September 11, 2001, and the resulting decrease in tourism, American Hawaii Cruises ceased operation (DBEDT, 2004). Seeing a marketing opportunity, Norwegian Cruise Lines (NCL) entered the market. The NCL vessels home-ported in Hawaii from 2001 were foreign flagged meaning they were subject to the 1886 U.S. Passenger Services Act. This Act essentially says that no foreign-flagged vessels can transport passengers directly between U.S. ports. The penalty for doing so will result in a penalty of US$300 for each passenger transported and landed. The Passenger Services Act, however, does not prohibit foreign-flagged ships departing from and returning to the same U.S. port. Nor does it prohibit foreign-flagged ships departing from a U.S. port, visiting a foreign port, and then continuing to a second U.S. port. It is this latter route that NCL used when it entered the Hawaii market. To circumvent the legislation, NCL cruises left Hawaiian waters and traveled down to Fanning Island, Kiribati, an international stop, and then returned to a second Hawaiian port of call. In July 2004, NCL introduced a home-ported U.S.-flagged ship to Hawaii with two more U.S.-flagged ships being put into operation in 2005 and 2006, one in each year. Being U.S.-flagged means that taxes are to be paid in Hawaii and U.S. crews will be hired. This represents a significant structural change in the Hawaiian cruise industry.

Like the worldwide market, the Hawaiian cruise industry has undergone strong growth in the past few years, coinciding with additional supply (see Figure 1). Total cruise passenger arrivals rose from 92,250 in 1996 to 316,546 in 2005, at an average annual growth rate of 16.5%. At the same time, cruise passengers as a share of total visitors to Hawaii has also been increasing, from 1.4% of total Hawaii visitors in 1996 to 4.2% of total visitors in 2005.

Methodology

This multiregion CGE model follows the interactions and relationships of the Hawaiian economy. The model solves for a set of prices, including production prices, factor prices, and exchange rate and levels of production that clear all markets. The result is that, following the neoclassical assumption, producers maximize profits, which are the difference between revenue earned and the cost of factors and intermediate inputs. This static model recreates an Arrow-Debreu general economic equilibrium model. The model contains a representative consumer in each region. Each consumer has an initial endowment of the 26 commodities and a set of preferences resulting in demand functions for each commodity. Market demands are the sum of all consumers' demands. Commodity market demands depend on all prices and satisfy Walras's law. That is, the total value of consumer expenditures equals consumer incomes, at any set of prices. The zero homogeneity of demand functions and the linear homogeneity of profits in prices (i.e., doubling all prices double money profits) imply that only relative prices are of any significance in such a model. The absolute price level has no impact on the equilibrium outcome (Rutherford & Paltsev, 1999).

CGE models need to have the functional forms of utility and production functions specified. While CGE models need to be specific about the nature of production technology, it is important that the most appropriate functional forms are chosen.

Firms

Firms in each region (r) are assumed to be price takers who choose variable inputs and its level of investment in order to maximize profits. Each industry is modeled using the constant elasticity of substitution (CES) family of functions, which includes Leontief, Cobb-Douglas, and constant elasticity of transformation (CET) functions. Each production sector $Y_{i,r}$ produces two types of commodities: domestic goods ($D_{i,r}$) and goods for export ($E_{i,r}$). These goods are assumed to be imper-

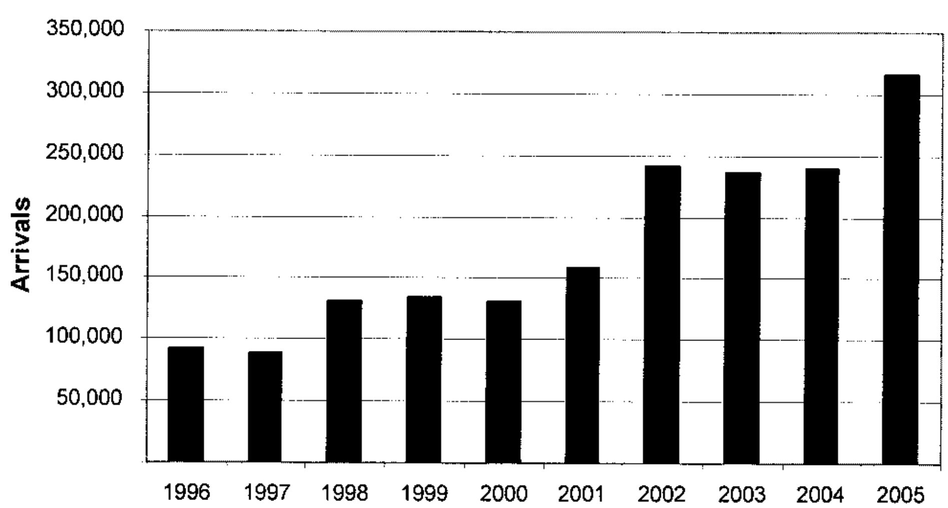

Figure 1. Cruise passenger arrivals.

fect substitutes, and they have a constant elasticity of transformation. For production, each sector uses capital, labor, and intermediate goods. As such, the sector's *i* production function is

$$Y_{i,r} = g(D_{i,r},E_{i,r}) = f(K_{i,r},L_{i,r},A_{i,r,j,rr})$$

where *g* is output transformation function, and *f* is input transformation function. Output transformation is assumed to be the constant elasticity of transformation (CET):

$$Y_{i,r} = \Phi(\delta_i^e D_{i,r}^{\eta-1/\eta} = (1 - \delta_i^e)E_{i,r}^{\eta-1/\eta})^{\eta-1/\eta}$$

where

$Y_{i,r}$ = output
$E_{i,r}$ = exports
$D_{i,r}$ = domestic production
η = the elasticity of transformation in total supply
δ_i^e = the calibrated share of exports
Φ = the calibrated shift parameter in the transformation function

The factors of production are combined via a Leontief aggregation. Capital and labor enters as a Cobb-Douglas value-added aggregate. Intermediate inputs from different sectors enter as a Leontief aggregate into a sector *i*'s production function:

$$f(K_{i,r},L_{i,r},A_{i,r,j,rr}) = \min\left\{B_i L_i^{\alpha_i} K_i^{(1-\alpha_i)}, \min\left\{\frac{A_{i,r,1,rr}}{a_{i,r,1,rr}}, \frac{A_{i,r,2,rr}}{a_{i,r,2,rr}}, \ldots, \frac{A_{i,r,j,rr}}{a_{i,r,j,rr}}\right\}\right\}$$

An intermediate input to a sector *i* from a sector *j* is an Armington aggregate of domestic output and imports. Users regard these goods as imperfect substitutes, and these goods are assumed to have a constant elasticity of substitution (CES) between them.

The Armington aggregate is used for private consumption, government consumption, investment, and as an intermediate input for production. The Armington specification treats imports and domestic goods produced in the same industry as distinct goods with a specified elasticity of substitution in demand. By differentiating exports, imports, and domestically produced goods sold on the domestic market, the CGE model increases the scope of the nontradable sector. The effect of product differentiation allows domestic prices to be partially insulated from changes in the world prices of exports and imports and from changes in the exchange rate. The elasticity of substitution has been set to 4 between domestic and imported goods. The production of goods follows from a nested Leontief–Cobb Douglas production function. Output is allocated to the domestic and export markets according to a constant-elasticity-of-transformation function. Intermediate inputs are Leontief, while labor and capital enter as a Cobb-Douglas value-added aggregate.

Production can be depicted as in Figure 2. Each firm's production technology is represented by a constant elasticity of substitution (CES) function.

$$VA_{i,r} = A_i^o((1 - \delta_i^o)(K_{i,r})^{1/\sigma_i^o} + \delta_i^o)(L_{i,r})^{\sigma_i^o-1/\sigma_i^o})^{\sigma_i^o/\sigma_i^o-1}$$

where

$VA_{i,r}$ = the gross value added of sector *i*
A_i^o = the level of technology in the production function
$K_{i,r}$ and $L_{i,r}$ = the amounts of capital and labor used in sector *i* in each region
σ_i^o = the share parameter of labor in production
σ_i^o = the elasticity of substitution and the subscript indicates that the parameters apply to "output"

This is a constant returns to scale production function.

Consumption

A representative agent in each region is endowed with primary factors of production: capital and labor. They demand investment, private and government goods, and collect all applicable taxes. The investment and the government sectors' output are exogenous, while private demand is determined by utility maximizing behavior. Consumer utility consists of a Cobb-Douglas utility index defined over Armington aggregation of domestic and imported commodities

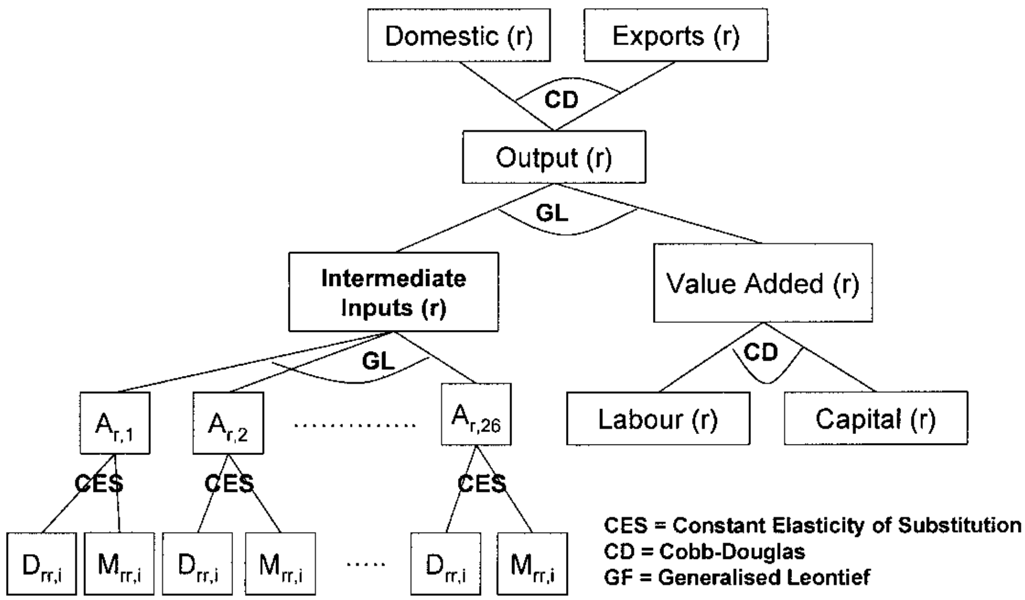

Figure 2. Production functions.

$$C_r = \prod_{i=1}^{n} c_{i,r}^{\alpha_{i,r}}$$

where

$$c_{i,r} = X(\delta_i^m CD_{i,r}^{\gamma-1/\gamma} + (1 - \delta_i^m) CM_{i,r}^{\gamma-1/\gamma})^{\gamma-1/\gamma}$$

where

$c_{i,r}$ = output
$CM_{i,r}$ = imported production of consumption good
$CD_{i,r}$ = domestic production of consumption good
γ = the elasticity of substitution between domestic goods and services and imported goods and services
δ_i^m = the calibrated share of imports
X = the calibrated shift parameter in the substitution function

Government

In this model, there are two types of government: the federal government and the state and local government. The federal government agent is assumed to be exogenous in the model. The state and local government in each region collects tax revenues to maximize social welfare functions, which represent the state's preferences. The role of taxes is to redistribute income, to finance state and local government expenditures, to alter behavior of the other economic agents, and to stabilize an economy. The state and local government can use taxes to maximize social welfare. The aim of the optimal taxation is to balance efficiency losses from taxes with equity gains. The tax revenue that the state and local government receives is wholly expended on public consumption and transfers to the representative household. Like Blake (2000), this model is characterized by fiscal neutrality so that public consumption remains constant. Any changes in tax revenues or changes in the prices paid by the government for public consumption goods result in changes in the level of transfers. This is done so that welfare calculations are based solely on private utility. State and local government consumption is fixed in real terms. State and local government savings is a flexible residual.

Tourism

Tourism is modeled in the following way: A representative tourism household demands aggregated tourism in the state of Hawaii at an aggregated tourism price level. The statewide tourism is an aggregation of a composite tourism product at a regional level. The regional tourism products are a certain quantity of a composite good and service, both domestic and imports. A constant elasticity of demand function is used, whereby demand varies according to the price of the appropriate bundle of tourism goods and services. The elasticity of demand has been set at 0.5. Tourists are endowed with foreign exchange. The nesting of the tourism product can be seen in Figure 3.

Factor Markets

The characteristics of the factor markets, labor and capital, can have a large impact on the results of the simulations. An increase in the demand for the factors of production will increase the rate of return of these factors, the wage rate, and the interest rate, and therefore increase the wage rate and interst rates that firms need to pay for factor services. Assumptions about the way factor markets operate can be used to hypothesize about short- and long-run impacts. This article follows Blake, Sinclair, and Sugiyarto (2003), who assume in the short run, factors of production are sector specific but in the long run labor and capital are free to move between sectors. Blake et al. consider the short-run assumptions to cover the economic adjustment period of between 1 and 2 years and the long-run adjustment to cover the economic adjustment period of between 3 and 5 years.

Model Closure

The CGE model includes three closures:

1. Government closure
2. External closure (the current account of the balance of payments, which includes the trade balance)
3. Savings-investment closure

While the choice of closure makes no difference to the calibrated base model, the closures do affect the results of the counterfactual simulations.

The closure for production in this model follows neoclassical characteristics, where the quantity supplied of each factor is fixed at the original level. Holding quantities constant means prices change to bring about equilibrium. So in the labor market, for example, an economywide wage can vary to ensure that total demand for labor equals total supply of labor. In this type of closure, industry-specific wages are fixed.

The closure for the government sector allows the current fiscal stance (the difference between current government revenues and current government expenditures) to be a flexible residual, while all tax rates are fixed (discussed above).

For the external closure in this model, the default balance requires the real exchange rate to vary while keeping foreign savings (the current ac-

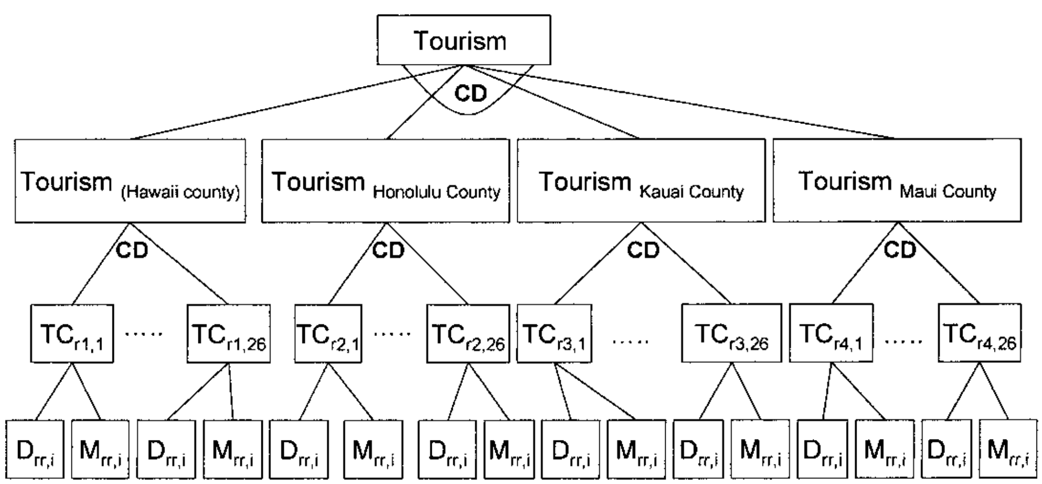

Figure 3. Nesting of the tourism product.

count deficit) fixed. Foreign savings is the difference between foreign currency spending and receipts. The trade balance is also fixed, since all other items in the external balance, such as transfer between the rest of the world and domestic institutions, are fixed.

Regarding the savings-investment balance, the closure is termed *investment-driven* savings. For closure that is investment driven, real investment quantities are fixed. In order for savings to balance, the savings rates of nongovernment institutions are altered by the same number of percentage points, the implicit assumption being that government is able to put into action policies that generate the necessary private savings to finance the fixed real investment quantities.

In this model, the consumer price index for Honolulu County was chosen as the numeraire. The model has been programmed using the GAMS software package. GAMS, the general algebraic modeling system, is a modeling language that was developed for linear, nonlinear, and integer programming. A GAMS subsystem, MPSGE, developed by Rutherford (1999), is a language for the concise representation of Arrow-Debreu economic equilibrium models. MPSGE provides a shorthand representation for complicated systems of nonlinear inequalities that underlie general equilibrium models.

Data

The data used in this research come from two sources. The first source is the 2002 Hawaii intercounty input–output table (DBEDT, 2007) produced by the state of Hawaii Department of Business, Economic Development, and Tourism (DBEDT). The input–output table depicts a comprehensive and detailed set of accounts of sales and purchases of goods and services among the producing industries, final consumers (residents, visitors, exports, and government), and resource owners (labor and capital) during a particular time period (in this case, 2002) for the state of Hawaii. The benefit of an interregional input–output table is that the table shows the value of goods and services flowing among the various sectors within each county as well as the relationship between sectors across counties. This is useful for analyzing different geographical distribution effects as a result of CGE simulations.

The modified input–output table is disaggregated into 4 counties (Honolulu, Maui, Kauai, and Hawaii) and 26 sectors. The data for Honolulu county are disaggregated into 67 sectors. The other counties, known collectively as the neighbor islands, contain less sectoral detail due to data limitations. The 67-sector Honolulu county data was aggregated into the 26 sectors in Table 1 with the transportation sector disaggregated into 7 smaller sectors based on their NAICS codes (Sectors 5 to 11 in Table 1). Sectors in the other counties were aggregated to match this sectoral detail with the exception of the transportation sector. The neighbor island data did not have sectoral detail for this sector, containing only an aggregated transportation sector. However, as the area of interest for this research is the cruise industry and there is no specific industry classification code available for the cruise industry, it is important to assess the impact on disaggregated transportation rather than a general transportation sector. Hence, for the neighbor islands, the aggregated transportation sector was apportioned in the same fixed coefficient ratios as was the Honolulu county data. This means the total transportation sector remains the same (and the input–output table balances) but the disaggregated sectors are populated with data.

According to the 2002 Hawaii intercounty input–output table, total output (final demand + intermediate demand) is US$70.618 billion, with gross state product (GSP) for Hawaii in 2002 being $33.088 billion. In terms of regional distribution, Honolulu county accounted for 75% of total output, Maui county contributed 11%, Hawaii county 9%, and Kauai county 4%.

Not surprisingly, each industry's share of county output differs. Across all sectors, Honolulu county contributes the most in absolute value to the state's output in that sector, but proportions differ across counties. Honolulu county's transit and ground transportation and air transportation have a state share of 94% and 91%, respectively, (due in part to the fact that the large majority of domestic U.S. flights and nearly all international flights fly into Honolulu International Airport) down to 42% for both accommodation and agriculture. On the neighbor islands, agriculture and

Table 1
Industry Sectors

Sector	Abbreviation	Sector	Abbreviation
Agriculture	AGR	Wholesale trade	WHO
Construction	CON	Retail trade	RET
Food processing	FOD	Finance and insurance	FIN
Manufacturing	MAN	Real estate and rentals	REA
Air transportation	ATR	Professional services	PRO
Water transportation	WTR	Business services	BUS
Truck & rail transportation	TTR	Educational services	EDU
Transit & ground transportation	GTR	Health services	HEA
Scenic and support activities	STR	Arts, entertainment, & recreation	ART
Couriers & messengers	COR	Accommodation	ACC
Warehousing & storage	WRH	Eating and drinking places	EAT
Information	INF	Other services	OTH
Utilities	UTL	Government	GOV

tourism are relatively more important than in Honolulu county. Hawaii county's share of agriculture is 30% and its share of accommodation is 18%. Kauai county's share of the state's accommodation sector is 11% and Maui county's share of the state's agriculture sector is 21%, just below this county's share of accommodation (29%) and arts, entertainment, and recreation (24%).

Like many island economies, tourism is an important sector of the Hawaiian economy. Visitor expenditures accounted for 17.3% of total final de- [Q1] mand, reaching US$9.0 billion. Differences in the composition of final demand differ by county. As a share of Federal government expenditures, Honolulu county has a share of 97% whereas the share of visitor expenditures is relatively larger in Maui, Kauai, and Hawaii counties. Intercounty trade, that is, exports to other Hawaiian counties, comprises a larger share on the neighbor islands than for Honolulu county (7.3%–8.2% vs. 2.7%).

The second source of data that was used in this research comes from the state of Hawaii DBEDT's "2002 and 2003 Hawaii Cruise Industry Impact Study" (DBEDT, 2004). DBEDT estimated the direct impact of the cruise industry in Hawaii in 2002 for four segments: cruise passengers, cruise crew, the cruise lines, and shipping agents. The data were collected using self-administered surveys. Table 2 shows the total direct spending in the Hawaiian cruise industry in 2002. It is estimated that the cruise industry in Hawaii generates US$260.96 million. This represents 0.37% of Hawaii's GSP. Table 2 shows that cruise passengers who are Hawaii residents spend US$1.51 million in total, with US$1.31 million remaining in the local economy. Out-of-state passengers spend US$163.08 million and crew members spend an extra US$38.82 million. The expenditure for cruise lines is US$57.54 million, with approximately half of this amount leaking from the Hawaiian economy through imports. For Hawaii residents, crew members, and out-of-state cruise passengers, approximately 13% of their expenditures are spent directly on imports.

Table 3 shows the direct effect of the cruise industry by sector for each segment. These data were used in the simulations in the CGE model.

Results

The data in Table 3 show the direct impacts of the cruise industry for four different segments: Hawaiian residents who take cruises to and around the Hawaiian Islands; out-of-state cruise passengers; expenditures by the cruise crew while on cruises around Hawaii; and expenditures by the cruise lines. In 2002, Hawaiian residents cruising in Hawaii were estimated to spend an additional US$1.31 million. Out-of-state cruise passengers were estimated to be the largest segment of the four, spending an additional US$141.25 million. Cruise crew members were estimated to spend slightly more than cruise lines in 2002: US$33.89 million compared to US$28.66 million. A weighted sum of all these direct impacts is also included as a further scenario. This figure totalled US$205.11

Table 2
Total Spending in the Cruise Industry in Hawaii in 2002

2002 (US$ millions)	Hawaii Residents	Out-of-State Cruise Passengers	Crew Members	Cruise Lines	Final Demand
Total spending	1.51	163.08	38.82	57.54	260.96
Spending in Hawaiian economy	1.31	141.25	33.89	28.66	205.11
Imports	0.20	21.83	4.93	28.88	55.85

Note. Adapted from DBEDT, 2004.

million. Further, the direct impacts were estimated on a state-wide basis. As the CGE model is a multiregional model, these impacts need to be apportioned by region. This was done based on percentages based on the cruise ship visitors' total length of stay in each county. The additional demand by sectors are used for the simulation in this CGE model.

There are two variants of the CGE model itself—a short-run model, where the factors of production are sector specific, and a long-run model, where the factors of production are mobile.

In terms of how to assess the impact of simulations on the economy, one way to do this is to measure the change in welfare from the simulated change. This is done by comparing the exisiting

Table 3
Direct Effect of Cruise Industry by Sector

2002 (US$ millions)	Hawaii Residents	Out-of-State Cruise Passengers	Crew Members	Cruise Lines	Final Demand
AGR	0.00	0.28	0.02	1.33	1.63
CON	0.00	0.00	0.00	0.18	0.18
FOD	0.00	0.42	0.33	3.40	4.15
MAN	0.01	1.16	0.91	9.40	11.48
ATR	0.09	9.59	1.08	2.78	13.53
WTR	0.02	2.22	0.25	0.64	3.14
TTR	0.01	1.25	0.14	0.36	1.76
GTR	0.01	0.63	0.07	0.18	0.89
STR	0.02	2.41	0.27	0.70	3.40
COR	0.00	0.45	0.05	0.13	0.64
WRH	0.00	0.19	0.02	0.06	0.27
INF	0.08	8.90	1.00	2.58	12.56
UTL	0.06	6.02	0.68	1.74	8.49
WHO	0.06	6.02	5.92	0.62	12.62
RET	0.12	13.39	13.19	1.38	28.08
FIN	0.02	2.19	0.31	0.01	2.53
REA	0.06	6.23	0.87	0.04	7.20
PRO	0.02	1.74	0.34	0.40	2.49
BUS	0.01	1.53	0.30	0.35	2.19
EDU	0.00	0.39	0.08	0.09	0.55
HEA	0.03	2.62	0.51	0.60	3.76
ART	0.00	0.39	0.08	0.09	0.56
ACC	0.46	49.32	2.11	0.00	51.89
EAT	0.16	17.10	4.04	0.03	21.33
OTH	0.01	1.17	0.23	0.27	1.68
GOV	0.05	5.64	1.10	1.30	8.09
Total	1.31	141.25	33.89	28.66	205.11

Note. Adapted from DBEDT, 2004.

equilibirum with the counterfactual equilibrium. The equivalent variation (EV) takes the initial equilibrium income and prices and computes the change needed to achieve new equilibrium utilities. This means that for a welfare improving change, EV is positive. EV in welfare will be used to assess the economic benefits of the simulations. Results from the five simulations are detailed in Table 4.

The total net benefit of the cruise industry to the economy of Hawaii is estimated to be US$85.9 million under the short-run scenario and US$68.1 million under the long-run scenario. With the exception of Kauai county, the short-run welfare impact is larger than the long-run impact. Copeland (1991) explained that changes in welfare depend on the extent to which prices change. With sector-specific factors of production in the short-run model, prices vary to a larger degree than in the long-run model; hence, the welfare impacts are larger in the short-run model. Honolulu County has the largest welfare impacts, with an additional US$32.7 million being directed to that county. This is not surprising, as this county has the largest economy. This change in welfare from the base case represents a 0.27% increase in welfare in the short run and 0.16% increase in welfare in the long-run scenario. The remaining counties also benefit from the cruise industry. Maui county experiences an additional US$19.2 million under the short-run scenario and US$8.5 million under the long-run scenario, or 22% and 13% of the state total, respectively. The value of the additional welfare to Kauai county remains relatively the same under the two different time dimensions, but as the other counties' welfare is larger in the short run, Kauai county's share of the total state's welfare increases from 20% to 25% in the long-run case. Hawaii county's share of the total state's weflare increase remains similar across both short-run and long-run assumptions, but the value of the welfare benefit is larger in the short run by US$4.1 million—US$17.0 million compared to US$12.9 million.

Table 4 also breaks out the welfare impacts of the different cruise industry segments used in the simulations. The additional statewide welfare increase generated by out-of-state cruise passengers is the largest among the different segments, as this segment has the largest direct impact. Out-of-state cruise passengers generated an additional US$63.5 million under the short-run assumptions and US$46.3 million under the long-run scenario. Hawaii residents cruising throughout the islands is

Table 4
Changes in Welfare

	Hawaii Residents		Cruise Passengers		Cruise Crew		Cruise Lines		Total Impact	
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Change in Welfare (EV) (US$ millions)										
Hawaii county	0.1	0.1	12.8	8.7	2.7	2.3	1.2	1.5	17.0	12.9
Honolulu county	0.2	0.2	24.9	21.0	5.5	5.6	2.0	2.6	32.7	29.4
Kauai county	0.1	0.1	12.1	11.5	2.9	3.0	1.8	2.5	16.9	17.3
Maui county	0.1	0.0	13.6	5.1	3.2	1.5	2.2	1.4	19.2	8.5
Total	0.6	0.4	63.5	46.3	14.3	12.5	7.1	8.0	85.9	68.1
% Change in Welfare (EV) From the Base Case										
Hawaii county	0.004	0.002	0.407	0.276	0.087	0.073	0.039	0.049	0.184	0.541
Honolulu county	0.001	0.001	0.119	0.100	0.026	0.027	0.009	0.013	0.272	0.157
Kauai county	0.009	0.009	1.023	0.972	0.241	0.256	0.148	0.212	1.002	1.428
Maui county	0.004	0.001	0.431	0.161	0.102	0.048	0.068	0.043	0.184	0.608
Change in Welfare (EV) as a % of State Total										
Hawaii county	20%	18%	20%	19%	19%	19%	17%	19%	20%	19%
Honolulu county	39%	46%	39%	45%	38%	45%	28%	33%	38%	43%
Kauai county	19%	25%	19%	25%	20%	24%	25%	31%	20%	25%
Maui county	22%	10%	21%	11%	22%	12%	30%	17%	22%	13%

estimated to be US$0.6 million under the short-run assumptions and US$0.4 million under the long-run assumptions. Interestingly, the additional welfare increase generated by the cruise lines is estimated to be US$7.1 million under the short-run scenario. This increases to US$8.0 million under the long-run scenario, with increases across each county from the short-run to the long-run with the exception of Maui county. In terms of the distribution of the welfare effects across the state, the tourist segments (Hawaii residents cruise passengers, out-of-state cruise passengers, and cruise crew members) display a similar pattern, with Honolulu county covering approximately 40% of the state's total and the remaining three counties each obtaining 20% of the state's total welfare impacts. However, the simulation involving the cruise line impacts has a much more even geographical spread. In the short run, Maui county has a 30% under short-run assumptions, Honolulu county has a 28% share, Kauai county has a 25% share, and Hawaii county has a 17% share of the state's total welfare impacts. It should also be noted that the sum of the impacts of the four segments does not total the total impact simluation. This is because the total impact has larger price effects and hence welfare increases to a larger extent than summing the impacts of the four segment scenarios.

Table 5 displays the change from the benchmark case in gross value added (GVA) denoted in US$ millions by sector and by county. Unlike input–output analysis, which only returns increases in output / GDP, in this CGE model, some sectors gain and some lose. In absolute terms,

Table 5
Percentage Change in Gross Value Added

	Total Impact									
	Hawaii County		Honolulu County		Kauai County		Maui County		Total Statewide	
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
AGR	–0.7	–3.0	–0.1	–1.0	–0.1	–1.0	–0.2	–4.0	–1.1	–9.0
CON	1.0	1.0	0.6	0.4	1.0	1.0	1.0	0.7	3.5	3.1
FOD	–0.1	–0.2	–0.4	–1.0	0.0	–0.3	–0.7	–6.0	–1.2	–7.5
MAN	–0.6	–4.0	–1.0	–3.0	0.1	0.2	0.5	2.0	–0.9	–4.8
ATR	0.6	0.9	–0.5	–0.6	0.3	0.4	0.5	0.8	0.9	1.5
WTR	0.1	0.1	0.0	–0.1	0.1	0.1	0.1	0.1	0.2	0.2
TTR	0.0	0.1	0.3	0.4	0.0	0.0	0.1	0.1	0.5	0.6
GTR	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
STR	0.1	0.2	0.0	0.1	0.1	0.1	0.1	0.2	0.4	0.5
COR	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2
WRH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INF	0.9	1.0	1.0	2.0	0.5	0.6	0.7	1.0	3.0	4.6
UTL	0.9	1.0	1.0	2.0	0.7	0.8	0.8	0.8	3.3	4.6
WHO	0.9	1.0	2.0	2.0	0.3	0.4	0.9	1.0	4.0	4.4
RET	2.0	2.0	4.0	5.0	2.0	3.0	3.0	3.0	11.0	13.0
FIN	0.6	0.6	0.1	–2.0	0.4	0.4	0.4	0.4	1.5	–0.6
REA	3.0	3.0	5.0	3.0	4.0	4.0	4.0	2.0	16.0	12.0
PRO	0.0	0.1	0.3	0.1	0.1	0.0	0.2	0.3	0.6	0.5
BUS	0.2	0.2	0.5	0.4	0.5	0.5	0.2	0.1	1.3	1.3
EDU	0.1	0.1	0.5	0.5	0.0	0.0	0.0	0.0	0.7	0.6
HEA	2.0	1.0	3.0	4.0	1.0	2.0	1.0	0.9	7.0	7.9
ART	0.0	–0.1	–0.1	–0.3	0.1	0.0	0.1	–0.1	0.1	–0.4
ACC	1.0	2.0	4.0	6.0	1.0	1.0	2.0	3.0	8.0	12.0
EAT	0.9	1.0	2.0	2.0	0.7	0.8	0.9	1.0	4.5	4.8
OTH	0.2	0.2	0.8	0.7	0.4	0.4	0.5	0.3	1.9	1.6
GOV	3.0	3.0	10.0	9.0	3.0	3.0	3.0	2.0	19.0	17.0
Total	16.0	11.3	33.3	29.7	16.2	17.6	19.1	9.7	84.5	68.3

change in GVA as a result of the simulation of the total impact, on a statewide basis, shows that the government, real estate, and retail trade sectors experience the largest changes in GVA under both short-run and long-run assumptions. Accommodation and health services also show relatively large impacts. The traditional exporting sectors, such as agriculture, food processing, and manufacturing, are sectors that suffer the most, with the simulations estimating negative changes in these sectors' GVA. On a statewide percentage basis, the sectors to gain the most are transit and ground transportation, air transportation, wholesale trade, information, utilities, and retail trade, while the sectors to suffer are the same sectors that suffered the largest absolute decline in GVA: manufacturing, agriculture, and food processing. One interesting thing to note is the fact that the short-run impacts are lower in absolute value than the long-run impacts. The short-run assumptions of sector-specific capital and sticky labor has limited the extent to which industries gain or lose.

Examining the regional breakdown, there are several things to note. GVA for the finance and insurance sector in Honolulu county is estimated [Q2] to decline 2%. This is because the finance and insurance sector in Honolulu county is the largest exporting sector in that county and other exporting industries have declined as a result of resources being diverted away from this sector due to the additional cruise demand. In the manufacturing sector, there are estimated losses in Hawaii and Honolulu counties but gains in Kauai and Maui counties. Unexpectedly, the arts, entertainment and recreation sector, an industry that has a strong tourism component, shows small losses in Honolulu county and losses in Hawaii and Maui counties under long-run assumptions. In the transportation sectors, particularly the ground transportation and air transportation sectors, Honolulu County is expected to experience limited if any benefit, while the other counties are expected to experience significant increases in GVA.

Comparing the statewide percentage change in GVA by sector obtained using the CGE model with the statewide percentage change in GSP by sector from the input-–ouput analysis, two points stand out. As noted above, some sectors lose and some gain using a CGE model, where in the input–output analysis, all sectors gain. The other interesting thing is that the tourism sectors (accommodation, eating and drinking places, retail trade, and air transportation) are estimated to gain the most in the input–output analysis, while the CGE model analysis shows a more diverse spread of the total economic impacts by sector.

Conclusion

The results obtained in this article corroborate the results of Zhou et al. (1997) and Polo and Valle (2008b), who found that economywide economic impacts estimated using input–output analysis grossly overstate results obtained using a CGE methodology. DBEDT (2004) estimated the cruise industry in Hawaii in 2002 to contribute an additional US$286.31 million to gross state product via direct and indirect effects, while direct, indirect, and induced impacts are estimated to contribute an additional US$381.07 million to the local economy. These estimates are more than three times as large as the total net benefit to Hawaii's economy, estimated in this article to be US$85.9 million under the short-run scenario and US$68.1 million under the long-run scenario.

This research contains several limitations. One limitation concerns the data, both the underlying input–output table and the direct-impact data. Ideally, the underlying input–output table would contain a cruise industry sector from which to estimate economic impacts. Other strong assumptions were made to the modified input–output table used in this CGE model. A detailed disaggregation of the transportation sector was not available for the smaller counties and the shares based on Honolulu county were used as basis for disaggregating the transportation sector for those counties. The disaggregated shares in Hawaii county, Kauai county, and Maui county probably do differ from Honolulu county and hence could affect the results shown. County shares were also approximated in the direct-impact data. The direct impacts estimated did not contain regional disaggregation, nor as detailed an industry breakdown as desired. Proportions were ascribed using best estimates. Future availability of this data would strengthen the results obtained in this article.

As Devarajan (1988) pointed out, in the context of CGE models in a natural resource allocation context, there is a need for more work on dynamic modeling. The CGE model implemented in this article could be termed "comparative static." The model provides projections at only one point in time, which is the solution year. The model refers implicitly to the economy at some future period to ensure the economy adjusts after the initial shock. Comparative statics are only concerned with the changes from the benchmark to the counterfactual solution. A dynamic simulation is concerned not only with this change but also the economic path taken to reach the change. An extension to this article would be to compare the static model results with a dynamic model where capital accumulation and economic agents' expectations are introduced.

Despite these limitations, this article provides the first endeavor to estimate the economic impacts of the cruise industry using a CGE methodology. Previously, all such estimates have used input–output analysis. As noted above, results obtained from input–output analysis overestimate economic impacts. Despite the fact that CGE models estimate more moderate economic impacts, results obtained in this article show that the cruise industry generates approximately US$86 million to the economy of Hawaii (0.26% of GSP) under short-run assumptions and US$68 million (0.21% of GSP) under long-run assumptions. This research is one of the few to show the regional impacts of tourism. Using a multiregional model, economic impacts are estimated for each county. It has been shown that, in the aggregate, all counties benefit but differences appear by industry and region. This study has revealed that while the economic impact of the cruise industry to the economy of Hawaii is not the boon previous input–output analyses have estimated, neither is cruise industry the economic equivalent of the *Titanic*.

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1. Please define total final demand.
2. 2% decline OK here to match Table 5 (text originally had 0.2% decline).