

REGIONAL TRAVEL DEMAND MODELS FOR TOURISM IN
QUEENSLAND

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ABSTRACT

Trip production and trip attraction models of tourist travel demand are developed for the study which includes six regions namely Gold Coast, Brisbane, Sunshine Coast, Mackay, Townsville and Cairns. This area has been experiencing rapid growth in tourism and the development of these models is seen as the first step towards the process of transportation infrastructure planning to cope with and positively contribute to the growing tourist industry. Trip attraction models are based on an analysis of visitor volumes and a number of determinants like population, bed spaces, tourist expenditure, occupancy rates, visitor nights, and completed tourist projects. The attractiveness of a region and its perceived image as a tourist destination as well as the quality and quantity of transportation system supply are also considered. Sixty five multiple linear and non-linear regression models are developed using grouped and ungrouped data and are examined for their statistical significance and logic. Trip production models for estimating visitor trips made by Queenslanders showed trip productions to be an invariant and constant proportion of a region's population. A model for trips produced by population outside Queensland has also been developed.

INTRODUCTION

In recent years, Queensland has experienced a rapid growth in tourism. Unlike many other tourist regions in the world, Queensland has a decentralised tourist activity spread almost entirely along the 2000 km. east coast with three international airports at Brisbane, Townsville and Cairns. The current growth of tourism and travel within Queensland far exceeds the national average and this trend is anticipated to continue in the future. However, the development of infrastructure to cope with the increased tourist activity is occurring on an ad-hoc basis. No rational or comprehensive study has been undertaken to date to predict the transportation requirements of growing tourism in Queensland in time and space. Intercity and regional travel demand models need to be developed to guide the process of transportation infrastructure development to cope with and positively contribute to the growing tourist industry.

As a part of the sequential modelling approach to travel demand forecasting, this paper deals with the development of trip attraction and trip production models for various tourist destinations in Queensland. The significant components of the work presented in this paper include the identification of factors purported to influence visitor numbers to a destination, acquisition and analysis of relevant data, defining regional attractiveness and developing models of trip attraction and trip production for various destinations. As is common with this type of modelling, trip production models use the socio-economic factors including population of the zone of origin while trip attraction models are related to the land use variables at the destination zone. Multiple regression technique is used for model development.

SETTING THE SCENE

The Study Area

The study area comprises of six regions along the eastern corridor of Queensland. These are Gold Coast, Brisbane, Sunshine Coast, Mackay, Townsville and Cairns (Figure 1). The regions are referred to by the name of the main city contained within the defined region except for the Gold and Sunshine Coasts. Local area boundaries were chosen to

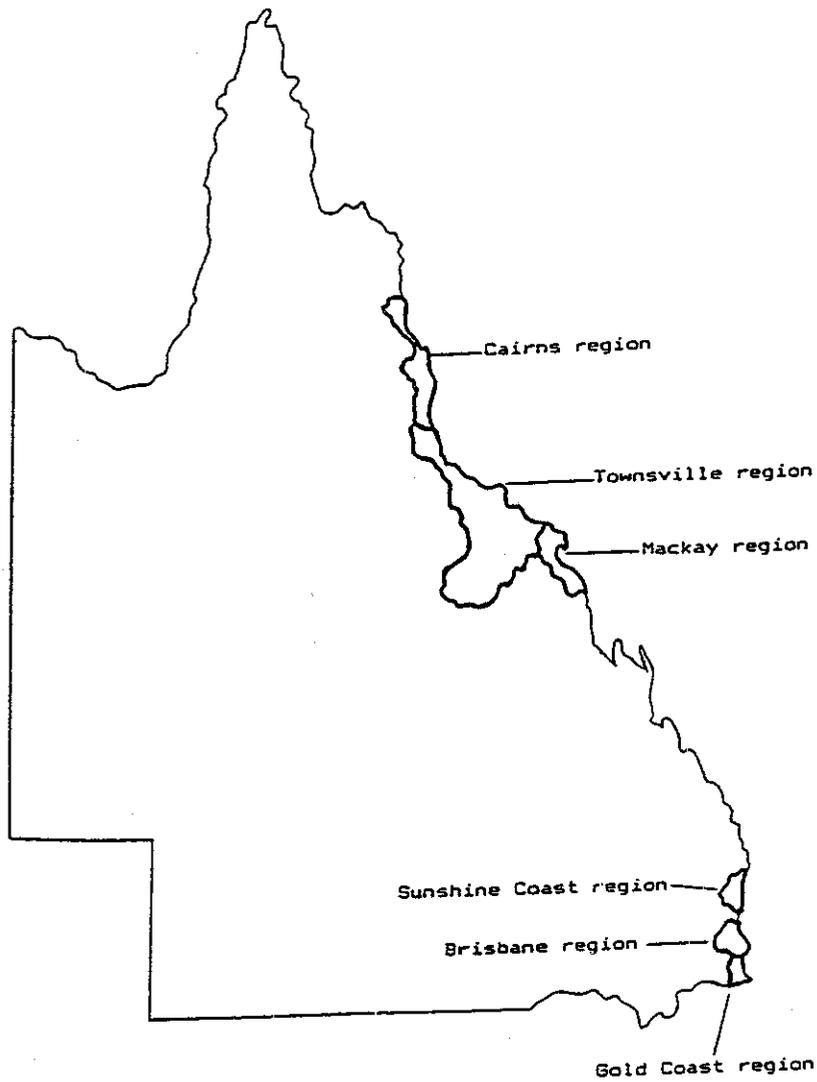


Figure 1. The Study Area

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define each region since most data are collected on this basis. These regions together make up the majority of the tourist areas within Queensland.

Gold Coast occupies 32 km of ocean frontage. As Australia's best known holiday resort, it has a well established tourist industry. The region abounds in theme parks like Sea World, Dream World, Land of Legend, Santaland etc. Jupiter Casino is also located in Gold Coast.

As capital of Queensland, Brisbane is a major industrial, manufacturing and administration centre and a popular destination for tourists. It offers the attraction of being close enough for day trips to the Gold Coast, Sunshine Coast and Darling Downs. This region has a number of parks and wildlife reserves, a planetarium, sporting complexes, historical buildings and museums.

The Sunshine Coast has experienced a steady development in recent years. It offers a number of high quality resorts and excellent beaches. Other tourist attractions include Bribie island, big pineapple and glasshouse mountains.

Mackay is a rural agricultural centre producing over one third of national sugar output. The majority of tourist activity in the region is at Arlie Beach and Shute Harbour on the coast along with the Whitsunday and Cumberland group of islands. This region is experiencing unprecedented growth in tourism.

Townsville is the centre for manufacturing, transport, communication, administration, education and defense of the north. Its major attractions include Reef Wonderland, Casino, Floating Hotel, gold fields near Charters Towers and Magnetic, Orpheus and Palm islands.

The expanding international airport at Cairns has made it one of the fastest growing tourist centres in Queensland. Easy access to the Great Barrier Reef through Green island and the Low Isles, the Port Douglas Mirage resort, beautiful northern beaches and the adjacent rainforest and wilderness areas have provided the necessary impetus for tourism growth.

Table 1 gives some further data about the study area.

Table 1: The Study Area

Region	Population	Area (km ²)	Major Cities/Towns
Gold Coast	193,000	659	Southport, Surfers Paradise, Coolangatta
Brisbane	1,196,000	3,080	Brisbane, Ipswich, Logan
Sunshine Coast	120,000	3,130	Noosa, Maroochydore, Nambour
Mackay	69,000	5,442	Mackay, Proserpine, Airlie Beach
Townsville	155,000	33,203	Townsville, Bowen, Ingham, Ayr, Thuringowa
Cairns	125,000	10,475	Cairns, Mareeba, Innisfail, Port Douglas

Transportation Systems in the Study Area

All regions in the study area are linked by road by the Bruce Highway between Cairns and Brisbane and then onto Pacific Highway to Gold Coast. All regions lie on the national highway except the beach areas of the Mackay and Sunshine Coast regions.

All tourist destinations in the study area are served by major roads. A number of regular coach services run along the Queensland Coast and include Greyhound, Ansett Pioneer, VIP coaches, McCafferty's Coaches, Deluxe Coachlines, and Sunline Express. There are a large number of Bus and Charter Service operators at each of the six study zones.

The railway line runs between Cairns and Brisbane and once again excludes the beach areas of Mackay and Sunshine Coast. Furthermore Gold Coast is not linked by rail. Regular train services run between Cairns and Brisbane with stops at all major tourist destinations.

All regions contain domestic airports which have regular flights either directly between themselves or are linked directly to southern capital cities. Australian Airlines, Ansett and East-West Airlines regularly serve these airports. A large number of charter airlines also operate in the study area. Brisbane, Townsville and Cairns have also international airports which receive flights from Singapore, Japan, Indonesia, Thailand and Phillipines in Asia with convenient connections to flights from Europe. Direct flights to and from North America, the Pacific, and New Zealand are also available.

Regular boat hire and charter services to the tropical islands on the Great Barrier Reef and for fishing are available in most of the study zones.

TOURIST TRAVEL DEMAND CHARACTERISTICS

Destination Choice

The decision of choosing a destination can only first be initiated through the knowledge that a particular destination exists. This is achieved through word of mouth (other peoples' experiences) and promotion and advertising of a destination in books, magazines, television, posters etc. An image of a destination is created by the intending traveller through these media, who then decides if the destination holds sufficient value for him/her to travel to.

A desirable destination must have five major requirements: attraction, access, accommodation, amenities and activities. Attraction of a destination is probably the most important single feature. Attractions can be categorised into natural and manmade. Natural attractions include forests, mountains, lakes, beaches, islands, waterfalls, rivers etc. These natural features lure travellers to enjoy the beauty, recreation and weather that these destinations provide. Manmade attractions include historical and archeological sites, theatres, museums, theme parks, zoos, sporting complexes, nightclubs, restaurants, casinos, shops, resorts, festivals, exhibitions etc.

Access is also important for a successful tourist destination. Access can include the availability of permits and visas and the ease of getting to the destination. Therefore, efficient transit and air terminals and safe and direct travel routes to handle the traffic is very important.

Insufficient and inadequate accommodation at a tourist destination can have detrimental effect on visitor volumes especially the future growth of tourist activity in the region. The provision of tourist amenities and availability of various activities in which tourists can participate has a positive influence on visitor volume.

Transportation Modes for Tourism

Both the transportation and tourism industries have prospered with rapid growth and development since 1945.

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The technological advancements in air and ground transportation have significantly benefitted the travel and tourism industries. Increase in transportation capacity and decrease in travel cost and travel time have led to its common availability.

The four main modes of tourist travel are car, coach, rail and air. The car is, by far, the most popular form of transport with about 80% of all tourist trips made in Australia. The popularity of the car for holiday travel was a very logical development. Travel by family car has appeal because it is convenient, cheap, and comfortable. Since majority of families are able to afford a car, short vacations and holidays have come within the financial range of majority of families.

The coach offers comfortable travel for groups or those who do not wish to drive or are unable to do so. Such comforts as individual control panels for air conditioning, lights and sound, washrooms and even videos in some coaches have improved the level of comfort in coach travel.

In addition to the features of coach travel, air offers inflight entertainment, meals and beverages. Although relatively more expensive than coach, car or rail travel, air has a distinct popularity for longer hauls. The inconvenience of long travel periods for other modes and significant time savings by air travel makes it a very attractive mode for longer distances.

REVIEW OF TOURIST TRAVEL DATA

Data Sources

Data on visitor numbers and the assumed determinants were collected from a number of sources including the Australian Bureau of Statistics (ABS, 1982-88), the Queensland Tourist and Travel Corporation (QTTC), Main Roads Department, Queensland, domestic airlines, as well as the coach and railway time tables. Data on population, bedspaces and hotels/motels, domestic and international air passengers as well as aircraft movements were obtained from ABS publications. The QTTC provided information relating to visitors such as visitor nights, visitor numbers, takings by motels/hotels, tourism projects, investment and expenditure for each region.

Key Model Variables

Based on a review of tourist behaviour and travel motivation, the following factors are purported to affect visitor numbers to a region.

Population
Image
Accessibility
Local attractions
Accommodation
Investment

It is believed that larger populations have a greater potential for attracting visitors in cities or regions. The image of a region as a desirable destination is assumed to be related to the amount spent on advertising and promotion. The degree of accessibility is also an important factor and is represented by the available modes, level of service, frequency, cost, travel time etc. Accommodation available in a region determines the total number of visitors able to stay in the region at a particular time. It is a reflection of the local anticipated potential for visitors. Although not explicitly included in this study, the class of accommodation available is also very important. Investment relating to tourism projects reflects the confidence that developers have in the growth of tourism in a region. Some results of data analysis for the study area are summarised below:

VISITORS Gold Coast (71%) and Cairns (51%) experienced very high growth in the number of visitors in the past five years. Brisbane had a steady growth whereas the other regions showed irregular changes.

POPULATION Sunshine Coast recorded the largest population increase of about 19% over the past five years followed by Gold Coast (14%) and Cairns (9%). Brisbane, Townsville and Mackay showed a moderate increase of just 5% over the same period.

BEDSPACES Although accommodation for visitors in terms of bedspaces increased in all regions since 1982-83, the increase was most significant in Gold Coast, Cairns and Brisbane. Occupancy rates also rose dramatically for Cairns from a low of 32.5% to a high of 61.8%.

EXPENDITURE All cash outlays on accommodation and out of pocket expenses on local transportation increased in all regions of the study area. However, expenditure in Gold Coast far exceeded all other regions.

VISITOR NIGHTS Although the pattern for visitor nights is similar to the expenditure trends, it is obvious from the data that expenditure per visitor night is higher on the Gold Coast than other destinations.

INVESTMENT The data on expenditure on new tourist projects in each region is incomplete and not truly representative of actual activity. The available data shows significant expenditure on tourist projects in all regions especially Brisbane, Cairns, Townsville and Gold Coast. The effect of these projects in attracting tourists is likely to be lagged and long-term.

Origin

There is a general decrease in the percentage of visitors with origin in Queensland over the past five years. Due to the location of international airports at Brisbane, Cairns and Townsville, the proportion of overseas visitors to these three destinations has increased. Cairns has shown the highest increase in the proportion of overseas visitors. Gold Coast showed an increase in the share of inter-state visitors whereas the trend in other regions is either for a reduced share or show irregular pattern.

Modal Shares

Although the data shows a general increase in air mode, it is important to realise an important change in the survey questionnaire in 1986/87. Previously a visitor who flew to Brisbane and then drove to Gold Coast would have been recorded as having arrived by car. The new survey questionnaire emphasises main mode of travel, which now would be recorded as air. Therefore, real increases in the share of air mode are not easy to isolate. There has been a general increase in the number of domestic air passengers in all regions except for Mackay.

Car mode shows a generally decreasing trend. The proportion of visitors using car is highest for Sunshine Coast and least for Brisbane. This is to be expected. Sunshine Coast has a low volume airport and does not lie along rail line or major highway for coaches whereas Brisbane has a large modern airport and major facilities for rail and buses. No clear trends are exhibited for coach and other modes.

TRIP ATTRACTION MODELS

Correlation of Data

Plot of visitor numbers with its various determinants were prepared and correlation matrices were determined. The objective was to identify factors which showed high correlation with visitor numbers and to identify collinearity among the factors examined. All six regions were first analysed separately and then data for all regions were pooled. Townsville, Mackay and Sunshine Coast data did not display any statistical significant correlation either individually or when pooled. For all six regions, bedspaces were found to have a high correlation with visitor volumes. This was also true for Gold Coast, Brisbane and Cairns. Significant correlation was also found between population and bedspaces specially for Brisbane, Townsville and Cairns. Similarly while there was positive correlation between population and visitors for some regions, it was not exhibited generally.

Model Types

Although a wide diversity of models of different forms was attempted, it was to be expected from the correlation analysis that visitor volumes regressed against bedspaces and attractiveness were, in general, likely to be more significant. Furthermore, models for Gold Coast and Cairns were likely to be statistically more acceptable.

A number of trip attraction models were attempted using visitor volumes as dependent variable and bedspaces, population and attractiveness index as independent variables. The models were developed for the six zones of the study area individually as well as pooled. Simple and multiple regression models and simple mathematical functions were tried using statistical packages Cricket Graph and Statworks. In one set of models, time was the only independent variable used to see if time alone was able to explain the growth in tourism. The procedure used for developing the regression models from the data was similar to the stepwise approach given by Hutchinson (1974)

Model Development

Models were obtained using the following linear, polynomial, logarithmic and exponential forms:

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$$\begin{aligned} \text{VIS} &= c_0 + c_1 * \text{POP} + c_2 * \text{BEDS} \\ \text{VIS} &= c_0 + c_1 * \text{POP} \\ \text{VIS} &= c_0 + c_1 * \text{BEDS} \\ \text{VIS} &= c_0 + c_1 * \text{POP} + c_2 * \text{BEDS} + c_3 * \text{ATT} \\ \text{VIS} &= c_0 + c_1 * \text{BEDS} + c_2 * \text{ATT} \\ \text{VIS} &= c_0 + c_1 * (\text{YEAR} - 1981) \\ \text{VIS} &= c_0 + c_1 * \text{BEDS} + c_2 * \text{BEDS}^2 \\ \text{VIS} &= c_0 + c_1 * \text{BEDS} + c_2 * \text{BEDS}^2 + c_3 * \text{BEDS}^3 \\ \text{VIS} &= c_0 * \text{BEDS}^{c_1} \\ \text{VIS} &= c_0 * 10^{(c_1 * \text{BEDS})} \end{aligned}$$

VIS = visitors; POP = population; BEDS = bedspaces; ATT = attractiveness index; YEAR = year; and $c_0, c_1, c_2,$ and c_3 are model parameters.

Of the sixty five models attempted, the following were judged acceptable based on the criteria of coefficient of determination, standard error, the constant term, and signs of coefficients (Table 2). For details, see Sacilotto (1988)

Table 2: Some Trip Attraction Models

Region	Model No.	Model	R ²	Error
Gold Coast	1	-897.95 + 93.32 * BEDS + 4.45 * POP	0.997	0.3%
	2	-171.51 + 100.17 * BEDS	0.993	0.7%
	26	-121.62 + 94.75 * BEDS + 5.86 * ATT	0.994	0.6%
	34	-192.64 + 102.77 * BEDS - 0.077 * BEDS ²	1.000	N/A
	47	63.98 * BEDS ^{1.12}	0.990	N/A
	54	476.10 * 10 ^{0.029} * BEDS	0.990	N/A
	60	807.30 + 205.30 (YEAR - 1981)	0.900	11%
Brisbane	5	485.75 + 13.6 * BEDS	0.819	22%
	27	471.34 + 13.48 * BEDS + 1.97 * ATT	0.851	17%
	36	183.11 + 67.90 * BEDS - 2.38 * BEDS ²	0.920	N/A
	48	356.51 * BEDS ^{0.242}	0.910	N/A
	55	502.21 * 10 ^{0.009} * BEDS	0.910	N/A
Sunshine Coast	28	572.06 + 5.02 * BEDS + 48.44 * ATT	0.961	4%
Cairns	17	15.41 + 57.90 * BEDS	0.856	17%
	52	64.79 * BEDS ^{0.961}	0.900	N/A
	59	193.10 * 10 ^{0.049} * BEDS	0.910	N/A

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Although any of the above models could be considered suitable, it is advisable to use the simplest model without compromising the accuracy.

No suitable models could be formulated for Townsville or Mackay either individually or by grouping with other regions. Figures 2 to 5 show some suitable trip attraction models for Gold Coast, Brisbane, Cairns and Sunshine Coast with the actual data and model values plotted for comparison.

TRIP PRODUCTION MODELS

Urban home-based trip production for any purpose is usually assumed to be a function of the population of specific age groups. Other factors that may be used include incomes, car ownership etc. A linear multiple regression model is commonly developed for trip productions.

In developing tourist trip production models for Queensland, the following procedure was adopted: The visitor volumes to a region were multiplied by the proportion of visitor nights with origin in Queensland. This was summed across all six regions giving the trips produced by Queensland population. The underlying assumption is that the proportion of visitors with origin Queensland is the same as the proportion of visitor nights spent by visitors from Queensland. The data on visitor nights and not on visitors by origin was available. The component of visitor trips produced by Queenslanders was related to the population of Queensland by the following equation:

$$O_q = K_1 * POP_q$$

where K_1 represents visitor trips produced per capita; POP_q is Queensland population and O_q is the visitor trips produced by Queenslanders.

The value of K_1 was found to be fairly consistent for the five years from 1982 to 1987.

1982/83	0.62
1983/84	0.64
1984/85	0.65
1985/86	0.68
1986/87	0.61

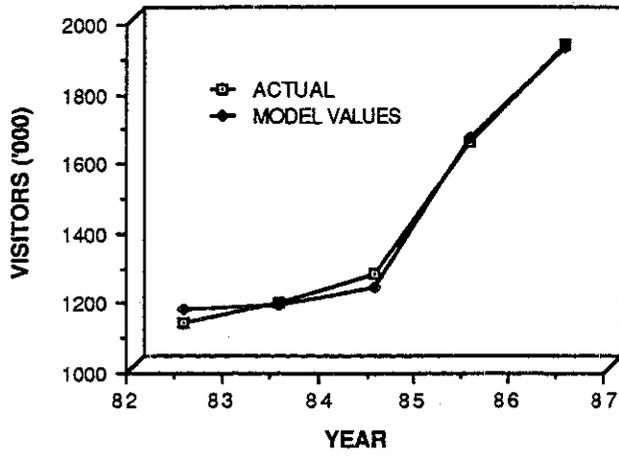


Figure 2. Trip Attraction Model for Gold Coast

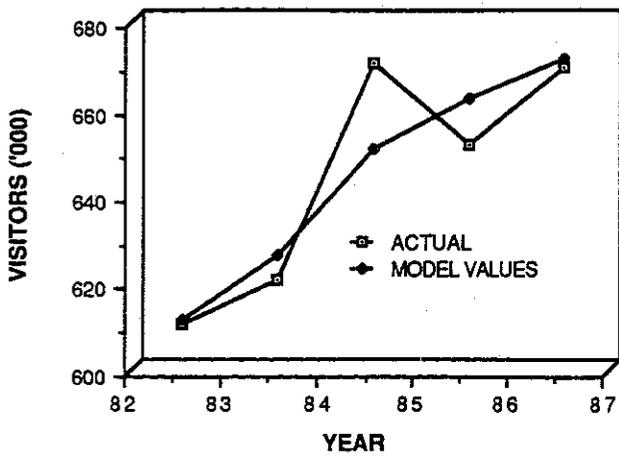


Figure 3. Trip Attraction Model for Brisbane

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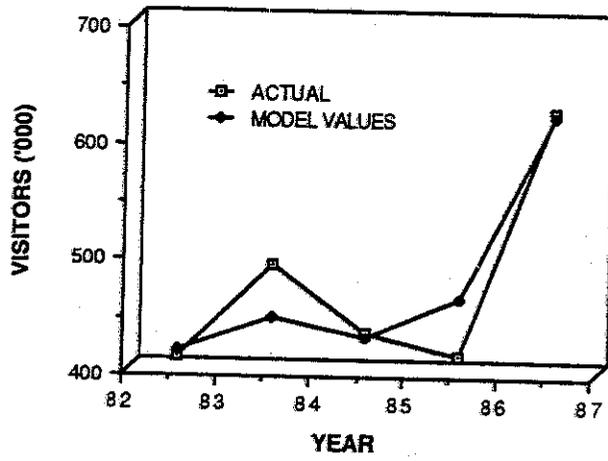


Figure 4. Trip Attraction Model for Cairns

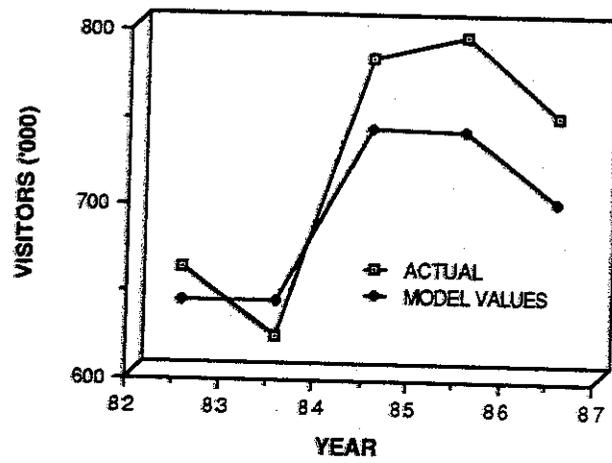


Figure 5. Trip Attraction Model for Sunshine Coast

It suggests that a model $O_q = 0.65 * POP_q$ would adequately represent the trip production behaviour. This is shown in Figure 6. This means that the number of visitor trips produced by Queenslanders per year is about 650 per 1000 persons.

For modelling inter-regional trips produced by persons with origin outside Queensland, domestic and international air passenger numbers were considered in view of the data limitations relating to modal shares and origins of tourists. Since almost all international tourists arrive by air and the use of domestic air travel is considerable among interstate visitors, the following trip production model for visitors with origin outside Queensland was proposed:

$$O_o = C_0 + C_1 \sum_i \sum_j p_{ij} * DOM_j + C_2 \sum_i \sum_j p_{ij} * INT_j$$

where C_0 , C_1 , and C_2 are coefficients determined by multiple regression analysis

p_{ij} is the propensity of a visitor who has arrived in a region i to travel to other region j

DOM_j are domestic air passenger numbers at zone j

INT_j are international air passenger numbers at zone j

When a visitor arrives at an international airport in the study area, a trip to the study area from outside Queensland has been produced. This visitor generates a propensity to produce trips to other regions in the study area. This propensity factor, p_{ij} , was assumed to be inversely proportional to the distance between i and j .

The model with the best fit to data was found to be

$$O_o = 225.478 + 1.392 \sum_i \sum_j p_{ij} * INT_j$$

with a coefficient of determination of 0.972 and standard error of 2.9%. A comparison of actual values with those given by this model is shown in Figure 7.

For details of other trip production models attempted and the model development approach, see Sacilotto (1988)

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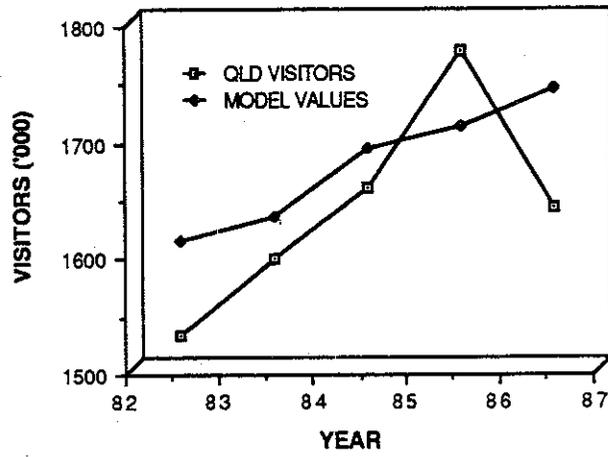


Figure 6. Trip Production Model for Queensland Visitors

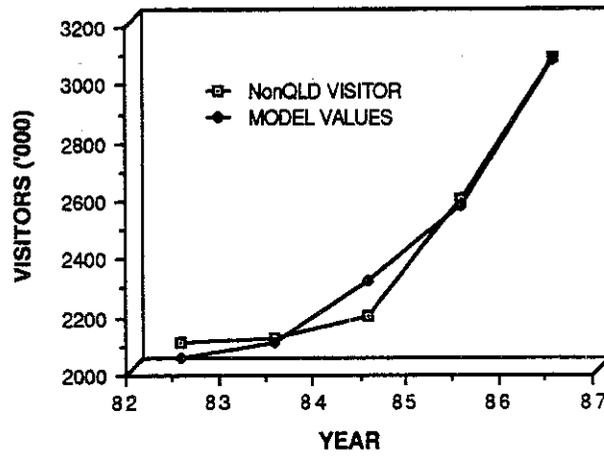


Figure 7. Trip Production Model for Non-Queensland Visitors

CONCLUSIONS

The following table gives the preferred models for trip attraction for four regions in the study area.

Region	Model No.	Model	R ²	Error
Gold Coast	2	-171.51 + 100.17 * BEDS	0.993	0.7%
Brisbane	5	485.75 + 13.6 * BEDS	0.819	22%
Sunshine Coast	28	572.06 + 5.02 * BEDS + 48.44 * ATT	0.961	4%
Cairns	17	15.41 + 57.90 * BEDS	0.856	17%

A very simple model for trip production for Queenslanders (O_q) was found to be

$$O_q = 0.65 * POP_q$$

The model with the best fit to data for trip production for visitors outside Queensland (O_o) was found to be

$$O_o = 225.478 + 1.392 \sum_i \sum_j p_{ij} * INT_j$$

The accuracy of the models can certainly be no greater than the accuracy of the data. Firstly, it is desirable to have data over a longer period of time. Fortunately relevant data are currently being collected systematically and it would be possible to validate or re-calibrate the trip generation models developed in this study. It has been identified in this study through a comprehensive analysis of data including growth rates, correlations and model estimation that the derivation of an attractiveness index based on the image of the region is essential for use with the trip attraction models. This attractiveness index should be based on advertising and promotion of the region by the tourist industry and the investment on tourist facilities including accommodation. The models should incorporate appropriate lags and the sustained impact of developments in the system. Another approach would be to assess the overall growth in tourism in the country and distribute tourist volumes to various regions based on competitiveness.

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