Proceedings of the First European Academic Research Conference on Global Business, Economics, Finance and Social Sciences (EAR15Italy Conference) ISBN: 978-1-63415-028-6
Milan-Italy, June 30-July 1-2, 2015, Paper ID: I544

Exploring Macau and its air transportation development, a potential strategic gateway connecting Europe, Portuguese speaking countries and the Greater China Region

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Abstract

Air transportation plays a vital role in facilitating tourism, business travel and global supply chains. Macau, due to its unique location and strong ties with Europe and Portuguese speaking countries, has set a clear goal to position itself as "a world tourism and leisure center". Macau attracted over 29 million visitors in 2013 which made it one of the top travel destinations in the world. Its air transportation sector recorded 2,161 business jets movements, 5.02 million passenger traffic and 48,000 aircraft movements in 2013. This study, through qualitative and quantitative approaches, evaluates the current market situation and forecasts the future growth of Macau, positioning as a regional aviation gateway, based on a broad series of internal and external factors, especially its interaction with international airlines in Europe, Portuguese speaking countries and the Greater China Region. The results of this study provide a long-term plan with development strategies to the policy makers for right decisions on the future of Macau's air transportation industry to link the important markets mentioned above.

Key words: *Air Transportation, Regional Aviation Gateway, International Travel, Macau and Portuguese Speaking Countries*
JEL Classification: *F63, L93, O18, R41*

1. Introduction

1.1 Aviation Background

Nowadays, air transportation plays an important role in connecting people and businesses in the world. The aviation industry needs to be improved, not just in safety and security, but in the planning and services too, so that operations can be more efficient and profitable. Passengers are demanding airlines to operate on the most direct routes, with more comfortable aircrafts and inexpensive tickets. The airlines should follow these trends and try to enhance passenger's experience and accomplish high level of passenger satisfaction.

Commercial aviation has grown significantly over the last few decades (Abdelghany 2009). According the statistics of International Civil Aviation Organization or ICAO (2013), in terms of Revenue Passenger Kilometer (RPK) and Gross Domestic Product (GDP), the world's GDP grew at 2.8 percent per year since 1995, while the world's RPK increased at an average annual growth rate of 5.0 percent.

Over past many years, economies from the Asia-Pacific region have posted rapid economic growth. Progressive trade agreements among the region's countries has further helped maintain its economic growth. Boeing (2014) anticipates that, over the next twenty years, Asia-Pacific's economy to grow by 4.5% annually, surpassing 3.5% annual growth expected in the world economy. Accordingly, airline passenger traffic in Asia-Pacific is expected to grow by 6.3% annually over this time period, compared to annual growth of 5% expected in global airline passenger traffic.

This faster growth in passenger traffic from Asia-Pacific will force airlines from the region to increase their flying capacities significantly by adding new airplanes to their fleets. Boeing (2014) estimates that driven by this addition of new airplanes, Asia-Pacific's fleet size will nearly triple to 14,750 airplanes in 2032, from 5,090 airplanes currently. In comparison, airplane deliveries to developed regions including North America and Europe will mostly go towards replacement of aging airplanes rather than expanding fleet sizes.

Additionally, liberalization in the airline sector of many Asia-Pacific countries has also helped expand the air travel market in the region. It has enabled airlines to expand beyond national boundaries and grow the region's passenger traffic. Separately, like in developed markets, expansion of low cost carriers in the Asia-Pacific region has also expanded its air travel market through lower fares.

In all, these trends have driven strong growth in the Asia-Pacific aviation market over the last couple of decades and will likely continue to drive growth in this market for many years to come. As a result, the region will receive the largest portion of global commercial airplane deliveries in the coming years.

The rapid growth of air transportation in Asia Pacific region has attracted considerable attention of researchers and academics. Increasing volumes of traffic make the demand analysis plays an important role in determining the fleet and routes planning decision in airlines. However, the research for Macau aviation passenger demand and forecasting remain uninvestigated.

1.2 Macau Economy

Fast growing economy in Macau with stabilized economic development in China promote continuously another period of rapid infrastructure development of the city. The investments (multi-billion dollar) made by gaming operators to solidify the city as a destination market and the city will attract more and more visitors as well. Booming Market in China with its premium customers had been a main driver to push a continuous growth of air transportation market in past years as well as in future with increasing more China Mainland cities under the individual visit scheme (IVS) which allows their residents to visit Macau on an individual basis.

Moreover, Macau as a “World Centre of Tourism and Leisure” positioned by China Central Government has started to diversify and broaden the base to attract visitors beyond hard-core players such as shows, foods, shopping, exhibition and conferences, traditional festivals and other activities in order to enrich Macau’s image as a cultural tourism destination and one of Asia’s exciting MICE destinations. All these will create a lot of opportunity and sustain the Macau aviation market in future.

1.3 Connection with Europe, China, Southeast Asia and other Portuguese speaking countries (PSCs)

Linkage with Europe, China, Southeast Asia and other PSCs:

Apart from the benefits gained from gaming and tourism industry, Macau has long played a unique role as a trade and economic co-operation service platform between China, Europe and other PSCs. Due to historical ties, Macau has been closely connected in trade and economy with PSCs of a population of 260 million. In recent years, trade and economic co-operation between China and PSCs have been growing rapidly. Bilateral trade in 2002 was USD5.6 billion, while that in 2012 stood at about USD130 billion, showing an annual growth of around 37%.

Macau uses Portuguese as one of its official languages and has a legal system similar to those of PSCs, along with the long-established ties providing easier access for PSCs wishing to tap into Macau’s markets. As a result, Macau can serve as a stepping stone for PSCs’ products and services (particularly those from SMEs in PSCs) to enter into Mainland China market, enabling PSC enterprises to be better prepared for marketing and product design operations, or explore the Mainland China market in co-operation with Pan-PRD enterprises through franchising.

Linkage with the Pearl River Delta:

Guangzhou-Zhuhai Railway (GZ Railway) along the southern coast of the Pearl River, has been operating since the end of 2012, cutting the journey time from Guangzhou to Zhuhai to just 46 minutes. Also, a 38.5-km extension from Zhuhai to MIA is under construction. The whole railway route means that visitors from all over China can board the train in Guangzhou South station and reach MIA in less than two hours.

Hong Kong-Zhu Hai-Macau Bridge (HZMB):

Upon completion of the HZMB, the entire PRD will fall within a 3-hour-commuting radius from Macau. There will be substantial reduction in both transportation cost and time, whilst both air passenger and air cargoes flow that used via Hong Kong International Airport (HKIA) will be able to utilize the facilities of MIA. The HZMB will help to facilitate the economic integrations between Macau and the PRD region, and eventually, MIA can, performing as a hub, provide economy and air linkage for Mainland China and PSCs

2. Thesis Objective

The aim of this thesis is to develop air passengers forecasting model for airlines to plan direct flights from Macau to Europe, China, Southeast Asia and other Portuguese speaking countries. Also, the thesis will describe the possibilities of collecting historical and existing data, analysis methodology, which can help to identify the main factors that influence the passenger demand.

This model should help airlines operating at Macau International Airport to plan direct long-haul flights to Europe, China, Southeast Asia and other PSCs. Moreover, the result should be general enough for planning routes in similar environment with similar conditions (e.g. from Macau International Airport to major airports in Europe and South America).

3. Literature Review

3.1 Decision levels in air transportation / airline management

Airline management consists of three layers of decision, strategic, planning and operation. All these decisions are interrelated. For example, strong demand forecasting might call for a change in a strategic and also in planning decision regarding expansion or increase and decrease in fleet size, change in number of flights, or change in origin/destination (Abdelghany 2009). In this chapter, all three layers of decision process will be reviewed and explained.

3.1.1 Strategic Decision: Network Structure

Most of the systems of airline´s flights are based on one of the two systems, linear network and hub network, or their combination.

Most of the commercial airlines are scheduled airlines with predefined flight schedule including (i) the specification of the airports they flies to; (ii) departure times; (iii) capacity (number of seats) of each flight in the schedule and (iv) predefined network structure. Very few airlines are charter airlines that are typically operated on demand basis (Abdelghany 2009). This thesis focuses on airline planning and route development of scheduled airlines operating in MIA.

The most common network structures are hub-and-spoke network that usually consists of one or more airports in the network as a hub (Abdelghany 2009). Big airlines such as United Airlines, Air France, British Airways and Delta use the hub-and-spoke network structure. Other types of networks can be point-to-point that is defined as network with non-stop flights between all airports (Grosche 2009), or combination of both of the networks. Network structure is one of the major strategic decisions of the airline (Abdelghany 2009).

For example, the research of Hansen & Wei (2006) shows that airlines operating with hub-and-spoke networks are the most influenced by density of the network. This research also proved that if airlines would focus on increasing frequency of flights, rather than increasing size of aircrafts in hub-and-spoke networks, they could interest more customers.

3.1.2 Planning Decision: Airline Schedule Planning

According to Abdelghany (2009), planning starts by recording and anticipated demand and supply and taking into consideration the available airline sources. Next, route development and schedule development is followed, including schedule planning, fleet assignment, aircraft routing, crew scheduling, airport staff scheduling, pricing and seat inventory control, sales and marketing initiatives.

Airline scheduling is a difficult problem that cannot be represented simultaneously and solved as a single problem but has to be divided into sub-problems and be solved in steps, because many decisions in airline schedule planning process have traditionally been classified and optimized in a sequential manner (Grosche 2009; Lohatepanont & Barnhart 2004). The scheduling methodology also depends on airline size and network structure. Big airlines companies usually use special software systems for schedule planning. The airline schedule planning is decomposed into two main procedures: route development and schedule development. Detailed review will be conducted in the thesis.

3.1.3 Operation Decision: Revenue Management

"Revenue management is defined as selling the right seat to the right customer at the right price and at the right time" (Abdelghany 2009). Likewise, "Revenue management is the subsequent process of determining how many seats to make available at each fare level" (Belobaba et al. 2009).

The revenue management focuses on business passengers and makes sure that there are always enough seats for them, because they bring profit to the airlines. Business passengers usually require flexible tickets and are able to pay more than the leisure passengers. Leisure passengers are more sensitive to the price of the tickets and they have lower budgets for tickets.

Revenue management involves the three main modules (Abdelghany 2009):

- pricing (set up the optimal price including competitors pricing in each specific market)
- demand forecasting
- seat inventory control (assigned seats of each flight to the concrete demand to maximize total revenue)

Revenue management is calculated by mathematical formula that maximizes total revenue considering fare-class, demand, seat capacity, and so on (Abdelghany 2009). There are some pricing and inventory decision support tools that helps airlines to more accurately forecast future demand and set up ticket prices. One of them is Sabre® AirVision™ Revenue Manager (Sabre 2014).

3.2 Demand Forecasting

Poore (1993) has developed a study to test the hypothesis that forecasts of the future demand for air transportation offered by aircraft manufacturers and aviation regulators are reasonable and representative of the trends implicit in actual experience. He compared forecasts issued by Boeing, Airbus Industry and the International Civil Aviation Organization (ICAO) which have actual experience and the results of a baseline model for revenue passenger kilometers (RPKs) demand.

Inzerilli and Sergioc (1994) have developed an analytical model to analyze optimal price capacity adjustments in air transportation. From this study, they used numerical examples to analyze the behavior of the policy variables (and the resulting load factor) under different degrees of uncertainty.

Matthews (1995) has done measurement and forecasting of peak passenger flow at several airports in the United Kingdom. According to his research, annual passenger traffic demand can be seen as the fundamental starting point, driven by economic factors and forecasting. While forecasts of hourly flows are needed for long-term planning related with infrastructure requirements. Hourly forecasts are almost always based on forecasts of annual flows.

Bafail, Abed, and Jasimuddin (2000) have developed a model for forecasting the long-term demand for domestic air travel in Saudi Arabia. They utilized several explanatory variables such as total expenditures and population to generate model formulation. Another study for air travel demand forecasting has done by Grosche, Rothlauf, and Heinzl (2007). According to their research, there are some variables that can affect the air travel demand, including population, GDP and buying power index. He considered GDP as a representative variable for the level of economic activity.

Swan (2002) has analyzed airline demand distributions model. The model explains when the Gamma shape will dominate and when the Normal will determine the shape. From his study, he found that Gamma shapes are probably better for revenue management and Normal for spill modeling. Fernandes and Pacheco (2002) have analyzed the efficient use of airport capacity. According to their research, on the basis of passenger demand forecast, it was possible to determine the period when capacity expansion would become necessary to maintain services at standards currently perceived by passengers.

Hsu and Chao (2005) have examined the relationships among commercial revenue, passenger service level and space allocation in international passenger terminals. They developed a model for maximizing concession revenues while maintaining service level, to optimize the space allocation for various types of stores.

Svrcek (1994) has analyzed three fundamental measures of capacity, including static capacity that is used to describe the storage capability of a holding facility or area, dynamic capacity which refers to the maximum processing rate or flow rate of pedestrians and sustained capacity that is used to describe the overall capacity of a subsystem to accommodate traffic demand over a sustained period.

3.2.1 Gravity Model

Above mentioned researches use the methods express the statistical relationship between air travel demand and selected economic or supply variables that stimulate travel. Causal models are better in describing passenger's behavior. Typically, the most used mathematical model is regression model. One of its alternatives is gravity model (Grosche 2009; Wensveen 2007). For model development the variables have to be selected. It usually depends on the resources available and judgment of the researcher.

In this thesis, gravity model will be chosen as modeling of demand. Gravity model calculates the number of passengers between two airports in relation to the productivity and attractiveness of these airport-pairs. The purpose of the gravity modeling is to predict the passenger of selected flights between MIA and selected airports in Europe, China, Southeast Asia and other PSCs.

4. Forecasting Techniques

Forecasting methods exists from very simple to very sophisticated. Forecasting techniques can be divided into two main groups: qualitative and quantitative. The choice of forecasting techniques should be based on several factors, i.e.: what the forecast is going to be used to for, availability of data and its quality and accuracy, possible data processing techniques (Wensveen 2007).

The biggest airport and airlines do not always use the most sophisticated methods.

Moreover, complex methods do not always result in better forecasts (TRB 2007). For forecasting, one may use causal models that are based on a statistical relationship between the dependent (forecasted) variable and independent (explanatory) variables, or judgmental methods that are based on assessment of experts (Wensveen 2007).

Gravity Model is the most common casual model in air transportation forecasting. Based on the study of (Chang 2011), the general form of the gravity model for analyzing passenger demand can be expressed, for example, as:

$$T_{ij} = \frac{CP_i A_j}{f(d_{ij})}$$

where T_{ij} represents the number of trips produced in country i (origin) and attracted to country j (destination), C is a constant, P_i is the production factors of country i, A_j is the attracting factors of country j, and d_{ij} is the distance between country i and country j. For example, the study of Chang (2011) showed that GDP and import values have a positive impact on passenger flow including national per capita income for the origin country in regression analysis. In contrast, the unemployment rate has negative influence. In this study, gravity model will be adopted for the modeling of demand in Matlab. The target is to forecast passenger demand from MIA to selected PSC airports. Also, based on the forecasts, flight frequencies and operating aircraft will be recommended.

4.1 Data collection

In general, the demand for air passenger can be affected by two factors, those are external and internal factors. Some internal factors that affect the air passenger demand are airfare impact and level of service impact. While the external factors we consider economic conditions such as Gross Domestic Product (GDP) and demographic factor, e.g. population. In this case, two types of data will be collected: internal data and external data.

4.1.1 Internal data

Internal data signifies complete information of number of passengers based on the manifested airline schedules. One of the passenger demand sources is MIDT (Grosche 2009). According the Grosche (2009), the absolute passenger demand is estimated using gravity model.

4.1.2 External data

External data describes the demographic and economic activities of the city that serves the selected airports, which contains: urban population, bedding capacity, travel distance and GDP related data.

4.2 Data Analysis

Based on the above discussion, it is important to realize that Macau, due to its unique linkage to the Portuguese Speaking Countries and geographic location, can play a vital role in aviation transportation between the Greater China region to Portuguese Speaking Countries.

To demonstrate such potential, popular destinations are chosen to determine the traffic volume. DDS Ticket Comprehensive Report by CADDS150 is used for our data analysis.
The number of passengers traveling from four departure airports, Guangzhou (CAN), Hong Kong (HKG), Beijing (PEK) & Shanghai Pudong (PVG) and two destination airports Lisbon (LIS) and Brasília (BSB) from January 2012 to December 2014 (by month) is drawn from DDS Ticket Comprehensive Report by CADDS150, as shown in Figure 1 and 2 below.

Figure 1: Monthly passenger volume between major airports in China and Lisbon, Portugal (LIS) from January 2012 to December 2014, DDS Ticket Comprehensive Report by CADDS150

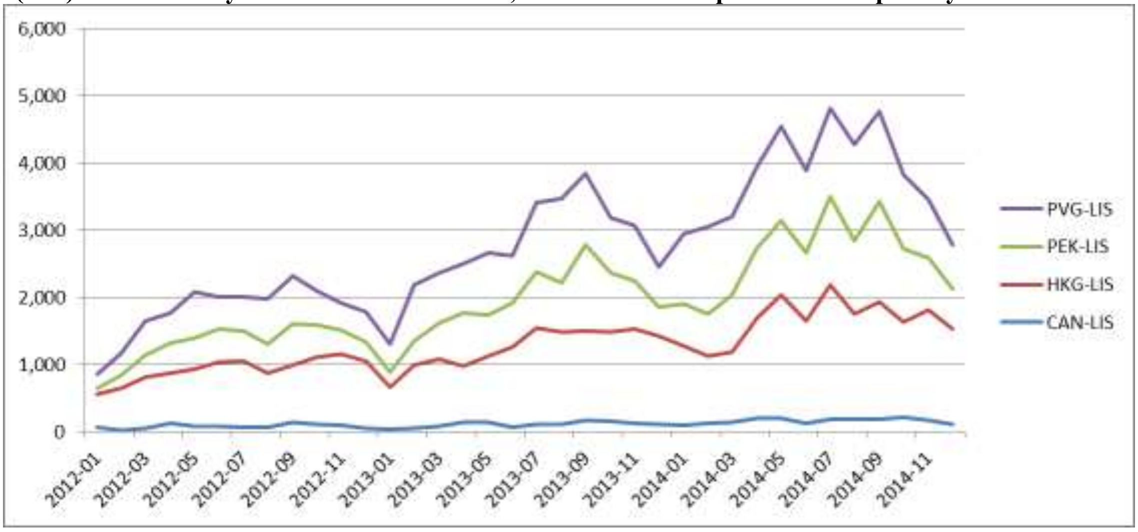
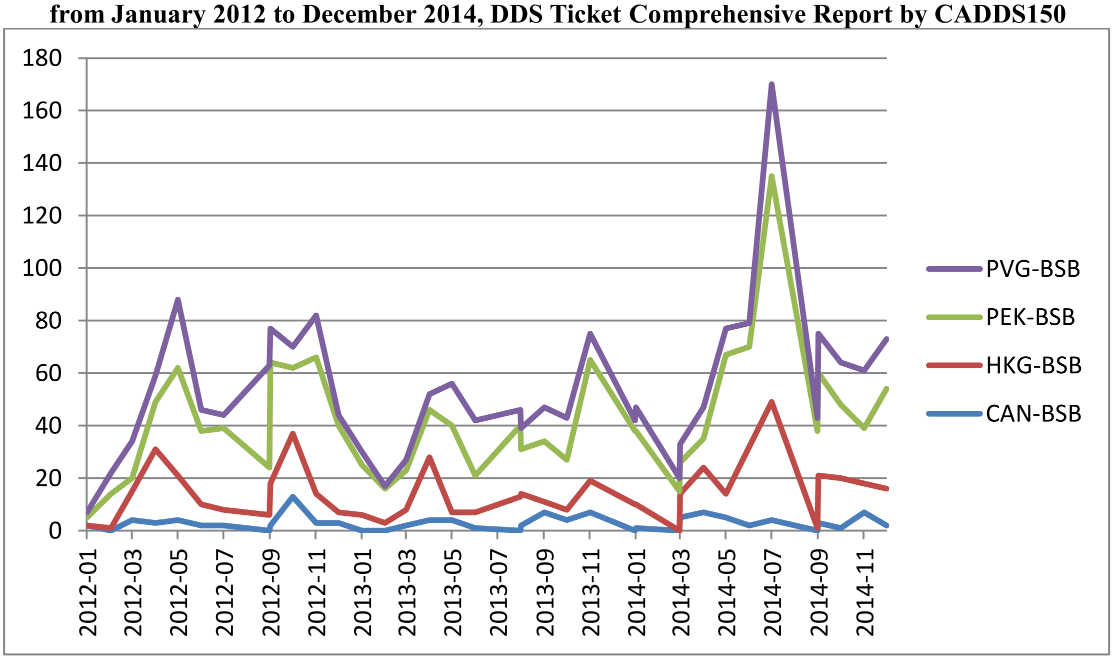


Figure 2: Monthly passenger volume between major airports in China and Brasília, Brazil (BSB) from January 2012 to December 2014, DDS Ticket Comprehensive Report by CADDS150



There is a clear pattern of high volume travel in summer between July and September with steady year to year growth between China and Portugal demonstrated in Figure 5.1. The peak monthly volume was close to 5,000 and annual volume reached 45,456 in 2014, which provides enough market potential for Macau to introduce such route in the near future.

On the other side, travel volume between China and Brazil, another important Portuguese Speaking Country in South America, is at a relatively low level. Figure 5.2 shows that seasonality is not as obvious as the first sample. The peak month volume was 170 and annual volume was 790 in 2014, which doesn't support a dedicate route between Macau and Brazil at this point.

5. Conclusion

Air transportation plays a vital role in facilitating tourism, business travel and global supply chains. Macau, due to its unique location and strong ties with Europe and Portuguese speaking countries, has set a clear goal to position itself as "a world tourism and leisure center". Macau attracted over 29 million visitors in 2013 which made it one of the top travel destinations in the world. Its air transportation sector recorded 2,161 business jets movements, 5.02 million passenger traffic and 48,000 aircraft movements in 2013. This study, through qualitative and quantitative approaches, evaluates the current market situation and forecasts the future growth of Macau, positioning as a regional aviation gateway, based on a broad series of internal and external factors, especially its interaction with international airlines in Europe, Portuguese speaking countries and the Greater China Region. The results of this study show a clear potential for Macau to develop itself as a gateway between the Greater China Region and Portugal. However, there is not enough demand at this point to explore other Portuguese speaking countries such as Brazil.

5.1 Limitation

Due to the time constraint, the quantitative analysis of this research is mainly focus on the existing passenger numbers between key airports in the important target markets. A more accurate forecast based on Gravity Model is yet to be completed.

Besides, other important Portuguese speaking countries located in Africa are not included in this study, which could be a missing piece of the whole picture.

Finally, inbound travel may play a significant role in air transportation, which should be added to the research if such data is available.

5.2 Future Research

Based on the existing and growing cultural and economic tie between the Portuguese speaking countries and China, it is important for Macau to position itself as a gateway in such strong connection. The distance between these destinations determines that air transportation is only way of travel, which provides Macau a huge potential to serve as an international aviation hub in the region.

To further explore such potential, an accurate forecast taking both internal and external factors into consideration can be conducted with a more sophisticated model such as Gravity Model. Both inbound and outbound travel should be included in the future research with possibility test of other key Portuguese speaking markets in Africa besides Portugal and South America.

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Appendix 1: Monthly Passenger Number between Key Airports in China and Lisbon

Month	CAN-LIS	HKG-LIS	PEK-LIS	PVG-LIS	SHA-LIS	SZX-LIS	Total-LIS
2012-01	69	487	97	199		3	852
2012-02	13	635	198	315			1,161
2012-03	53	753	333	503		4	1,642
2012-04	126	746	443	447		4	1,762
2012-05	74	854	457	691	3	3	2,079
2012-06	79	949	503	477			2,008
2012-07	65	982	445	516			2,008
2012-08	60	807	431	673		3	1,971
2012-09	133	849	615	721	1	6	2,319
2012-10	112	997	474	517	1	4	2,101
2012-11	91	1,069	345	404	2	1	1,911
2012-12	42	1,010	273	455	2	4	1,782
2013-01	33	628	221	422			1,304
2013-02	56	928	362	838		1	2,184
2013-03	82	1,001	540	741	1	2	2,365
2013-04	136	845	788	721	0	1	2,490
2013-05	141	984	613	928		3	2,666
2013-06	63	1,196	650	706		9	2,615
2013-07	104	1,437	835	1,034			3,410
2013-08	115	1,364	738	1,255	1	3	3,473
2013-09	176	1,327	1,277	1,059			3,839
2013-10	155	1,320	894	806		3	3,175
2013-11	123	1,397	727	810		3	3,057
2013-12	110	1,310	435	595		4	2,450
2014-01	101	1,170	628	1,049		4	2,948
2014-02	119	1,003	627	1,302	1	2	3,052
2014-03	133	1,046	853	1,167	1	5	3,200
2014-04	196	1,495	1,038	1,220	1	0	3,950
2014-05	199	1,828	1,116	1,393	1	1	4,537
2014-06	119	1,534	1,011	1,223	3	2	3,890
2014-07	179	2,005	1,313	1,311		2	4,808
2014-08	182	1,569	1,087	1,430		2	4,268
2014-09	180	1,742	1,496	1,339	1	3	4,758
2014-10	213	1,423	1,078	1,107	1	1	3,822
2014-11	167	1,648	776	854		5	3,445
2014-12	107	1,415	599	657		3	2,778

Appendix 2: Monthly Passenger Number between Key Airports in China and Brasília

Month	CAN-LIS	HKG-LIS	PEK-LIS	PVG-LIS	SHA-LIS	SZX-LIS	Total-LIS
2012-01	69	487	97	199		3	852
2012-02	13	635	198	315			1,161
2012-03	53	753	333	503		4	1,642
2012-04	126	746	443	447		4	1,762
2012-05	74	854	457	691	3	3	2,079
2012-06	79	949	503	477			2,008
2012-07	65	982	445	516			2,008
2012-08	60	807	431	673		3	1,971
2012-09	133	849	615	721	1	6	2,319
2012-10	112	997	474	517	1	4	2,101
2012-11	91	1,069	345	404	2	1	1,911
2012-12	42	1,010	273	455	2	4	1,782
2013-01	33	628	221	422			1,304
2013-02	56	928	362	838		1	2,184
2013-03	82	1,001	540	741	1	2	2,365
2013-04	136	845	788	721	0	1	2,490
2013-05	141	984	613	928		3	2,666
2013-06	63	1,196	650	706		9	2,615
2013-07	104	1,437	835	1,034			3,410
2013-08	115	1,364	738	1,255	1	3	3,473
2013-09	176	1,327	1,277	1,059			3,839
2013-10	155	1,320	894	806		3	3,175
2013-11	123	1,397	727	810		3	3,057
2013-12	110	1,310	435	595		4	2,450
2014-01	101	1,170	628	1,049		4	2,948
2014-02	119	1,003	627	1,302	1	2	3,052
2014-03	133	1,046	853	1,167	1	5	3,200
2014-04	196	1,495	1,038	1,220	1	0	3,950
2014-05	199	1,828	1,116	1,393	1	1	4,537
2014-06	119	1,534	1,011	1,223	3	2	3,890
2014-07	179	2,005	1,313	1,311		2	4,808
2014-08	182	1,569	1,087	1,430		2	4,268
2014-09	180	1,742	1,496	1,339	1	3	4,758
2014-10	213	1,423	1,078	1,107	1	1	3,822
2014-11	167	1,648	776	854		5	3,445
2014-12	107	1,415	599	657		3	2,778