

MARKET AND INFRASTRUCTURE ANALYSIS OF FUTURE AIR CARGO DEMAND IN CHINA

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ABSTRACT

This paper describes an analysis of future air cargo demand in China and its implications for system infrastructure. By extrapolating current trends and evaluating government policies, China is projected to achieve sustained economic development over the next 20 years. Based on this assumption, a forecast for future air cargo demand is made for the period through 2020 using econometric methods. The forecast projects air cargo traffic growth at 11.2% per annum, expanding more than seven fold by 2020 – resulting in an expected 27 million tonnes cargo throughput originating from Chinese airports. A baseline forecast for the cargo throughput at the major hubs and large airports in mainland China, Hong Kong and Taiwan is presented.

1. INTRODUCTION

Driven by increasing domestic demand and international trade, China's economy has soared since its economic reform starting in 1978. The nation's gross domestic product (GDP) has expanded more than eight fold from its 1978 level by 2002. This is equivalent to an average annual growth rate of 9.4%. During the same period, air cargo transportation has experienced exponential expansion.¹ Freight tonne-kilometers (FTK) have achieved an average growth rate of 18.0%. In 2002, 4,018,314-tonnes of freight throughput were recorded by the airports in mainland China, with domestic and international air cargo throughput increasing 18.1% and 19.3% respectively.¹

This paper presents a market analysis of future air cargo demand in China and its implications for system infrastructure. First, a brief review is given on economic development in China and international trade. Some unique characteristics of the Chinese market are identified. The status quo of air cargo transportation and express delivery is evaluated and the impact of economic development is analyzed. The paper then

discusses two important factors that affect air cargo transportation: surface transportation modes, and government policies and the impact of China's WTO accession. A forecast for China's air cargo demand through 2020 is developed using econometric and extrapolation methods. Given the predicted demand, the paper finally discusses its implications for system infrastructure, particularly major hubs and emerging cargo airports in mainland China, Hong Kong and Taiwan.

To accomplish the analysis and forecast, the following data sources were used: National Bureau of Statistics of China (NBS) for economic/demographic development, Ministry of Foreign Trade and Economic Cooperation of China (MOFTEC) for international trade, the General Administration of Civil Aviation of China (CAAC) for air transportation, Ministry of Railways of China for rail transportation, and Ministry of Communications of China for highway transportation. Unless explicitly stated, the data in this paper are for mainland China only. The air cargo data for mainland China and Taiwan includes both freight and mail cargo, while the data for Hong Kong and Macau does not include mail cargo.

2. ECONOMIC DEVELOPMENT REVIEW

Fast Growing Economy

China has a land area of about 9.6 million square kilometers, similar in size to the United States. It is the largest developing country in the world. As of 2002, there are 1,284 million people residing in mainland China.² Economic reform and opening up to world markets began in 1978. Since then, the Chinese economy has expanded rapidly, as indicated by GDP changes in Figure 1.³ Despite the challenges of the 1997-1998 Asian currency crisis and the 2001 worldwide economic recession, China's mainland economy has maintained an average growth rate of

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7.7% since 1997. In 2002, the GDP reached 10,240 billion in local currency (RMB), about 12% of that of the United States when evaluated at the 2002 exchange rate (8.2773 RMB/1 USD).² The GDP per capita has increased from 379 RMB (223 USD, 1.7 RMB/1 USD) in 1978 to 7972 RMB (963.1 USD) in 2002.^{2,3}

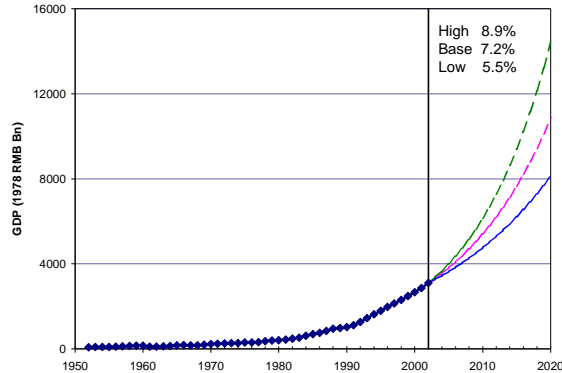


Figure 1: China's GDP growth
Source: NBS data

As one major stimulus to the nation's economy, international trade has grown even more rapidly since 1978, with an average growth rate of 15.2% (Figure 2).⁴ In 2002, the total value of import and export reached 621 billion USD, of which, export was 326 billion USD and import was 295 billion USD.² Machinery products accounted for 50% of the total value, and high-tech products including IT/biochemical products and precision instruments contributed 24%.² However, the growth is geographically imbalanced within China.

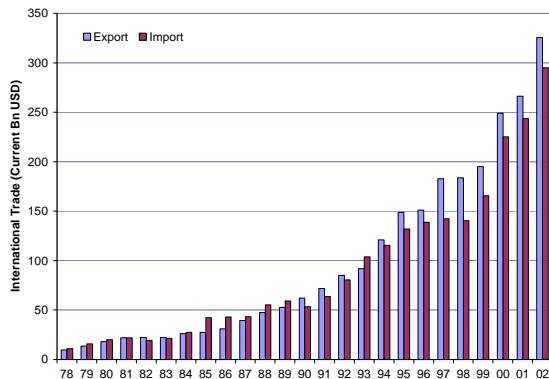


Figure 2: International trade development
Source: MOFTEC data

Imbalanced Development by Region

Figure 3 depicts distribution of cities and towns with the three government defined economic regions (West, Middle, East) indicated.⁵ The majority of the population resides in the middle and eastern regions. As of 2002, over 70% of the total mainland population

resides in the Middle and East regions, which account for only 28.5% of the land area.

Although all parts of the country have seen rapid growth, the real economic boom is on a narrow band along the coast – in the East region. Fast growing cities in this region are clustered around Beijing, Shanghai, and Guangzhou, forming three commonly identified economic centers. They are Bohai Bay area, Changjiang Delta and the Pearl Delta respectively.

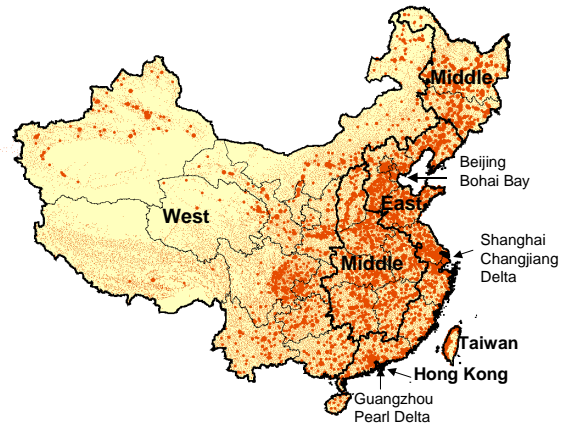


Figure 3: Distribution of cities and towns
Source: National Bureau of Survey and Mapping of China

The economic and trade contributions for each region are shown in Table 1. The geographical imbalance of international trade and economic development is striking with the East region dominating all economic metrics.

Table 1: Percentage comparison of economic development and international trade in regions

	West	Middle	East
Land Area	71.5%	17.4%	11.1%
Population	28.5%	33.2%	37.3%
GDP	17.0%	25.2%	57.8%
Import/Export	3.3%	4.2%	92.5%

Source: based on NBS data

Accompanying the rapid economic development in the East region was rapid urbanization. As of 2002, the mainland urban population had tripled from 1978 level to 502 million. The share of urban population had increased from 19.4% in 1978 to 39.1% in 2002.^{2,3} The urbanization is partially attributed to the migration of labor force from the inland countryside to the large cities. It is also promoted by government policies supporting the formation of new cities through local economic development and government investment on local infrastructure. Income difference between urban and rural populations has increased in recent years. In

2002, the average disposable income per urban capita was 7,703 RMB, while the number per rural capita was only 2,476 RMB.²

3. AIR CARGO TRANSPORTATION

Airports

As of 2002, there are about 150 commercial airports operational in mainland China. There are also about a dozen or so military airports that offer access for commercial aircraft. Some of these military airports may be transferred into fully commercial airports as civil traffic grows. The location of mainland airports, as well as those in Hong Kong, Macau, and Taiwan are shown in Figure 4. Note that only major airports are labeled while the secondary airports are indicated by smaller blocks.



Figure 4: Location of major and secondary airports

According to CAAC plans, the total number of commercial airports will reach 237 by 2010.⁶ However, the new airports will be small serving regional markets and the general layout of the airport distribution is not likely to change significantly. The major efforts in airport development in China will be to improve operational conditions and increase capacity at the major hub airports. Beijing Capital is the largest airport in the Bohai Bay area. It has recently been united with Tianjin airport. Shanghai has two large airports, Hongqiao and Pudong, serving domestic and international routes respectively. In the Pearl Delta, there are three mainland airports, Guangzhou, Shenzhen, and Zhuhai. This is in addition to the Hong Kong airport and Macau airport in the same area.

Air cargo throughput at mainland airports has tripled over the past ten years (Figure 5), with an average annual growth rate of 14.1%. In 2002, 141 mainland airports provided commercial service to 132 cities.¹ The total cargo throughput in 2002 was approximately 4 million tonnes, of which, 73% was for domestic routes and 27% for international routes.¹ It is estimated (based on data from [1]) that for international cargo, 39% was carried by mainland Chinese airlines, while 61% by foreign airlines including airlines based in Hong Kong and Macau (Figure 6). The cargo throughputs at major mainland airports in 2002 and their average growth rate over the period are provided in Table 2. The cargo throughputs of large mainland airports centered at Beijing (Beijing, Tianjin), Shanghai (Hongqiao, Pudong), and Guangzhou (Guangzhou, Shenzhen) accounted for 16.7%, 26.8% and 19.6% of mainland total respectively. From hereafter, these airports are identified as three major airport groups for the sake of simplicity.

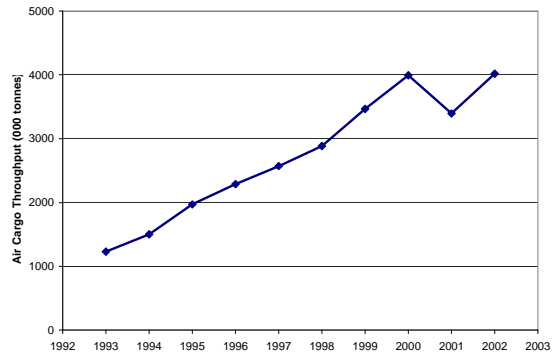


Figure 5: Air cargo throughputs of mainland China (1993-2002)

Source: CAAC data

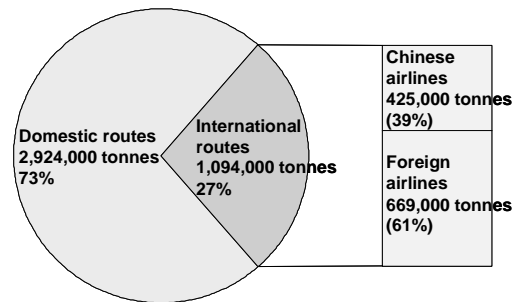


Figure 6: Share distribution of airport cargo throughputs (Domestic routes include routes to Hong Kong and Macau)

Source: based on CAAC data

Table 2 also includes data for airports in Hong Kong, Macau and Taiwan. The throughput at the Hong Kong airport was equivalent to the sum of the three major mainland airport groups. It is worth noting that Hong

Kong still serves as the most important international trade port for mainland. This is attributed to its extensive international network and its role as the dominant transit port between mainland and Taiwan since direct trade is still restricted by political barriers.

Table 2: Air cargo throughput at major airports in mainland China, Hong Kong, Macau and Taiwan in 2002 (growth rates averaged over 1993/1994-2002 to 1996-2002 depending on data availability)

City/Airport	Throughput (000 tonnes)	Average Growth Rate
Mainland Total	4,018	14.1%
Shanghai Pudong	635	18.8%
Shanghai Hongqiao	440	
Guangzhou	497	13.7%
Shenzhen	289	
Beijing	629	11.7%
Tianjin	42	
Shenyang	57	9.6%
Xi'an	65	8.9%
Chengdu	162	10.5%
Kunming	122	16.8%
Wuhan	52	3.8%
Urumqi	43	7.2%
Dalian	73	11.0%
Chongqing	71	8.2%
Qingdao	46	9.6%
Hangzhou	87	14.1%
Nanjing	52	9.4%
Fuzhou	48	7.5%
Xiamen	110	8.5%
Zhuhai	8	-3.0%
Haikou	54	5.2%
Lhasa	9	3.2%
Hong Kong	2,481	9.0%
Macau	111	-
Taiwan Total	1,514	6.6%
Taipei Airport	1,381	7.1%
Kaohsiung Airport	96	4.6%

Source: CAAC, Hong Kong Airport Authority, Macau Airport, Taipei Airport, Kaohsiung Airport

Air Cargo Performed by Domestic Chinese Airlines

Since the 1978 economic reform, air cargo has experienced exponential growth in China. Air cargo freight tonne-kilometers carried by domestic Chinese airlines strongly increased in the periods of 1978-1988 and 1990-2000 (Figure 7), with average growth rates of 22.4% and 19.9% respectively. Including the brief down turns in 1989 and that in 2001, the overall average annual growth rate during the 1978-2002 period was still 18.0%.

Figure 7 compares the air cargo traffic and passenger traffic normalized to 1978 levels. Air cargo and passenger traffic were observed to track very closely until 1996. Starting in 1997, the passenger traffic lags the cargo traffic growth. This is thought to be due to the Asian currency crisis which resulted in serious deflation of currencies in Southeast Asia and slowed economic development and passenger growth between Southeast Asia and China.

Accompanying the rapid growth of cargo traffic, the fleet of large freighters expanded from 6 aircraft (2 B747F, 1 MD11F, and 3 Y-8F) in 1997 to 17 (7 B747F, 3 MD11F, 2 B737QC, 5 Y-8F) by 2002. The fleet expansion generally focused on adding large long-haul freighters for international cargo market.

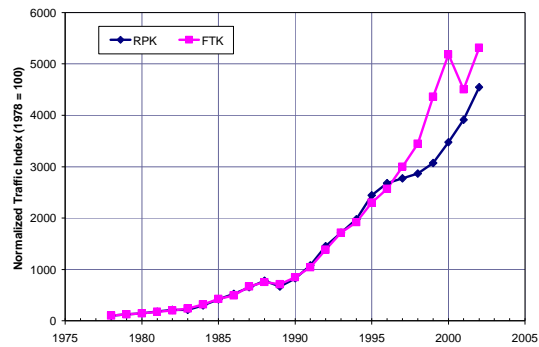


Figure 7: Comparison of passenger traffic and cargo traffic performed by domestic Chinese airlines
Source: based on CAAC data

It is observed that the average air cargo trip distance has been gradually increasing. The average trip distance was obtained by dividing FTK by the total cargo and mail carried. As of 2002, the average cargo trip distance for domestic routes reached 1,457 km. This is roughly the route distance between Shanghai and Hong Kong.

The average trip distance of international air cargo has been increasing as more long-haul freighters were added into the fleet. The ratio between domestic and international air cargo has remained relatively stable over the past 13 years with international cargo accounting for 23% of total traffic by weight and 55% by FTK.

Current Cargo Operating Practices

In mainland China, domestic air cargo is primarily carried in the belly space of passenger aircraft. This has two implications. First, the cargo capacity for a specific route is therefore determined by the type of passenger aircraft and the frequency of flights. Second,

since the passenger fares are regulated, belly cargo space can be sold at marginal cost, making it difficult for all-cargo carriers to compete in these markets. As of 2002, there was no dedicated domestic air cargo carrier. The overall assessment indicates that the domestic air cargo demand is still at a relatively low level. The commodities transported domestically by air include perishable goods (seafood, fruits, flowers, etc.), livestock, clothing, electronics, instruments, and medical products.

International air cargo transportation is quite different. National flagship carriers have been expanding their long-haul freighter fleets to capture the demand over the past few years. The problems facing mainland airports and carriers are the limited network connections to the world, cargo handling efficiency, and the ground accessibility to major international hubs for shippers.

Since the 1990s, the trade between mainland and Taiwan has increased dramatically, as well as the mainland's transit trade through Taiwan. At present, air cargo across the Taiwan Strait has to be shipped via a separate transit point such as Hong Kong or Macau. Moreover, transportation services between mainland and Taiwan can only be provided by third party carriers, unless the freight is to be handed over to the carrier of the other side at the transit airport. This mode of operation is clearly inefficient and is likely to change over the next decade or so.

Express Delivery

Express delivery is an emerging market in mainland China. In 2001, China Post Airlines has set up the only air express delivery network in China. The network utilizes Shanghai Hongqiao airport as its hub. At present, it has 5 Y-8F, 1 Y-7F, and 2 Saab 340 aircraft flying this network. The airline also uses the belly space of other airline passenger aircraft to provide services to cities not covered by its own network. Because of this, package sorting is performed at local airports (spoke cities) before aircraft departs for the hub. Aircraft arrive at the hub between 6:10-6:50 AM, and then depart after reconsolidation for the spoke cities between 7:20-9:00 AM. With this network and the extended coverage of express truck routes, China Post has been able to extend its overnight delivery to 20 major cities and over 100 surrounding smaller cities.

International express delivery integrators such as FedEx, UPS, DHL and TNT have been in the mainland China market for years, providing international express delivery services. Normally each carrier has its own

domestic partner to provide ground service. As such, network coverage is limited to large port cities.

As a new development in air express delivery sector, Hainan Airlines launched an all cargo carrier Yangtze River Express in January 2003. It's aiming to become a domestic integrator. At present, Yangtze River Express is flying two B737QCs to provide domestic connection flights for the US integrator UPS and to offer air cargo services on high-density routes between coastal cities. It is also responsible for selling the belly space of passenger aircraft operated by Hainan Airlines.

4. FACTORS AFFECTING AIR CARGO DEVELOPMENT

For mainland China, surface transportation infrastructure and government policies are significant in determining the likely future development of air cargo.

Rail

The principle alternative mode of freight transportation in China is rail. There is an extensive and expanding state-owned rail transport system. In 2002, there were 71,500 kilometers (44,438 miles) of railways in operation with 1,548 billion FTK (1,060 billion ton-miles) and 497 billion revenue passenger-kilometers (309 billion RPM) carried.³ The railroad network is shown in Figure 8. In comparison, the US Class I railroads have 99,250 miles of track and carried 1,466 billion freight ton-miles in 2000.⁷ The largest current construction project is the Qinghai-Tibet line, which will offer rail access to Tibet upon its completion in 2007. At that point, the railroad network will connect all the provinces and major cities in mainland China.



Figure 8: China's railroad network

To compete with highway and air transportation, the rail administration has launched a series of system upgrades to raise the operating speed in addition to the network expansion. Upgraded rail has reached 15,000 km, covering most large cities and regions. Express passenger trains now have a maximum speed of 120 km/h. The trip speed between Beijing and Guangzhou has reached 100 km/h, giving a travel time of 23 hours. The trip speed between Beijing and Shanghai is 104 km/h, giving a travel time of 14 hours. Although these are not attractive travel times for passengers by US standards, it is attractive for much freight. For many long routes such as Beijing to Guangzhou, freight could arrive at the destination the second day. For trip distances in the 500-1200 km range, the rail system can offer same day or overnight passenger service.

China Railway Express (CRE) offers express freight service utilizing the “belly” space on the higher speed passenger trains. CRE’s commitment is to deliver goods within three days for city pairs that have direct passenger train services (most major city pairs do). There are more than 190 cities under CRE’s network coverage. In recent years, the company has expanded its truck fleet to complement the rail capacity on medium range routes and to provide flexible service on short range routes.

In Addition CRE has launched dedicated express cargo trains between large cities such as Beijing and Guangzhou which competes with air cargo. For freight from Beijing to Shanghai, CRE charges a regular door-to-door fee of 3.3 RMB/kg. For the same route, air cargo charges a regular airport-to-airport fee of 4.7 RMB/kg plus a 30 RMB base fee. Because of its efficiency and low cost, even China Post Airlines subcontracted mail services to CRE on some routes.

During the current (tenth) five-year plan (2001-2005), two more speed-raises are planned on 28 rail routes. By then, the maximum speed of passenger train on these routes will reach 200 km/h. For this range, air cargo will only have a marginal advantage on high-density domestic routes. In short rail cargo would be a strong competitor to air cargo on short/ medium-range routes where direct rail service is available.

Highway

As of 2002, the total length of roads in mainland China reached 1,765,000 km, of which, 1,601,800 km are paved and 249,700 km are of high-grade (grade 1, 2, and super highway).³ Completed super highways reached 25,130 km by 2002.³ The road network is shown in Figure 9.⁸ At present, the Ministry of Communications (MOC) is committed to complete and

upgrade the national highway network. The national highway network is the strategic road network that connects the provincial highways.

Based on the national highway network, MOC launched a program to build a 35,000 km backbone network. The backbone network consists of five north-south highways and seven east-west highways.⁸ The purpose is to connect all the major cities (i.e. population of one million and above), and 93% of all the large cities (population of half million and above) with high-grade arteries.⁸

Upon expected completion in 2010, the average travel speed should be doubled from that of today’s national highway network, providing express surface channels for intercity passenger and cargo transportation. MOC expects the backbone network will promote the process of industrialization and urbanization. In addition to the national highway network and backbone network, numerous high-grade road construction projects are conducted and planned by the provincial and local government.



Figure 9: National highway network (solid black lines depict national highways, bold red lines depict north-south backbone highways, and bold blue lines for east-west backbone highways)

The investment in road system has two effects regarding air cargo. First, it will significantly improve the investment environment, enabling sustained economic growth. For the inland regions, it is a key element in assuring the realization of the government’s long-term economic development plan. Second, the fast surface connection will improve airport access. Since the intercity air cargo in China is not meant for short range, limited competition is seen from the increased highway transportation infrastructure.

China's WTO Entry

China's entry into the WTO accession in December 2001 initiated a new era of China's reform and opening up to the world. The limited, segmented and regional opening up to markets and investment is expanding to much broader levels. The systematic opening of markets and China's commitment to its WTO obligations is boosting investors' confidence. As a result, international trade is expected to continue to grow. The government has set the international trade target at 2,000 billion USD by 2020, which implies an average annual growth rate of 7.2%.⁹

Revised Regulations of Foreign Investment in Aviation Industry

Revised regulations on foreign investment in aviation industry took effect on August 1, 2002. These revisions widened foreign investors' access to the air transport market. The regulation relaxed the share-holding limitation in domestic airlines and airports from 35% to 49%.¹⁰ No limitations are set for air cargo ground services and warehousing. Foreign investments together with modern operation techniques and management are expected to improve the operation efficiency and stimulate the domestic market.

West Region Development Strategy

As mentioned earlier, the economic development in the vast West region is slower than the east of China. The West Region Development strategy, established in November 1999, has the goal of accelerating the economic development. The government's investment focuses on infrastructure construction as well as ecological protection and restoration. The west has abundant natural resources and low labor costs. These factors, coupled with infrastructure improvements, are expected to provide new investment opportunities. The large distance between the western and eastern cities coupled with the weak surface transportation infrastructure in the west implies an important role for air transportation and air cargo in this region.

5. MARKET FORECAST

Methodology

A forecast of future air cargo demand in mainland China and specific forecasts of cargo throughput at some major airports including Hong Kong and Taipei is presented below.

Since economic growth has been the prime driver for air cargo demand,^{11,12} the aggregate forecast of future air cargo in China is projected based on the relationship between air cargo demand and economic development. Econometric methodology is used to determine the GDP/air cargo relationship. GDP projections are obtained by trend analysis and the projections from Chinese government and recognized institutions.

The relationship between air cargo traffic and economic development is shown in Figure 10, where, the year-by-year air cargo carried by mainland Chinese airlines is plotted with respect to GDP. Based on the historical trends the relationship between air cargo and GDP is

$$\text{Cargo} = 0.0096(\text{GDP})^{1.536} \quad (1)$$

where, *Cargo* is evaluated in thousand tonnes and GDP in constant 1978 billion RMB. The correlation coefficient of above is 0.985.

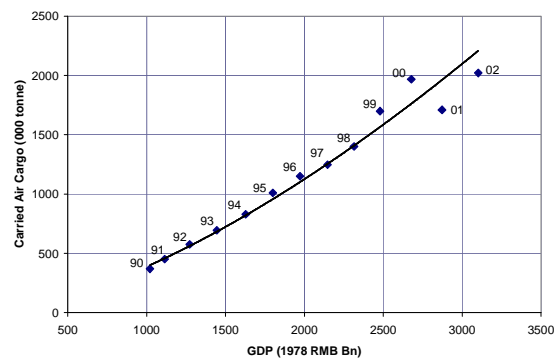


Figure 10: Relationship between carried air cargo (performed by domestic China airlines) and GDP
Source: based on CAAC and NBS data

GDP Projection

Three GDP projections, high, low and baseline, are provided to take into account the uncertainty of economic development. A trend analysis indicates that GDP grew at average 8.9% over the past decade. As the total volume increases, the growth rate is likely to slow. The observed growth rate is therefore likely optimistic for the long-term, and hence is used as the high projection.

The government plans to quadruple GDP by 2020 from 2000 level, implies an average annual growth rate of 7.2%.⁹ Other recognized organizations and institutes have made projections. Morgan Stanley projected a growth rate of 7.5% and 7.8% for 2003 and 2004 respectively after evaluating SARS impact. The World Bank Group predicted China's GDP to grow 7%

annually through 2020 in its *Global Economic Prospects* report.¹³ London based Consensus Economics Inc. projected that China economy to expand at 7.2-7.5% per annum through 2013.¹⁴ Therefore, the government's projection of 7.2% GDP growth rate is used as the baseline projection.

The high projection 8.9% differs from the baseline value 7.2% by 1.7%. Applying the same variance, the low GDP projection is obtained as 5.5%. The GDP projections are shown in Figure 2.

Aggregate Forecast

Given the GDP projections, forecasts of air cargo carried by domestic Chinese airlines can be obtained from equation (1). The average growth rates of air cargo carried with respect to low, baseline and high predictions are 8.6%, 11.2% and 14.0% respectively. The baseline prediction is higher than Boeing's prediction of 10.5%.¹²

As mentioned before, the average trip distances of both international and domestic cargo flown by mainland Chinese airlines have been increasing over the years. In the future, for the domestic market, more cargo is expected to flow between the western and the eastern cities implying that the average trip distance will continue to increase. For conservative purpose, current average trip distance is assumed for the forecasting period, implying that baseline FTK is expected to grow at 11.2% as well. This projection is lower than the 13% growth rate planned by CAAC and the prediction of 11.8% by Aviation Industry Development Research Center of China.¹⁵

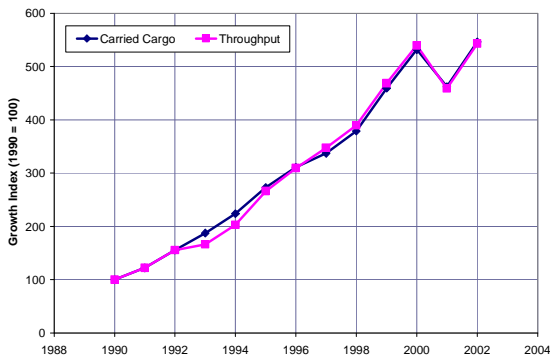


Figure 11: Comparison of mainland airport throughput and air cargo carried by domestic China airlines (normalized to 1990 level)

Source: based on CAAC data

The total throughput at mainland airports is closely related to the air cargo carried. Figure 11 compares the normalized carried air cargo with the normalized

mainland airport throughput (1990 as 100). The figure indicates that airport throughput has been growing at the same pace as air cargo traffic. Therefore, the total throughput at mainland airports is expected to grow at the same 11.2% per annum baseline projection.

The projections of China's GDP, air cargo traffic (tonnage and FTK) performed by mainland Chinese airlines are shown in Figure 12. The projections of cargo throughput at mainland airports are provided in Figure 13. For the baseline projection, the forecasts project that the air cargo traffic performed by domestic Chinese airlines will expand more than seven fold from its 2002 level by 2020. The air cargo traffic performed by domestic Chinese airlines is expected to grow to 15 million tonnes and 34.8 billion freight-tonne kilometers by 2020. The total cargo throughput in mainland airports is expected to reach 27 million tonnes.

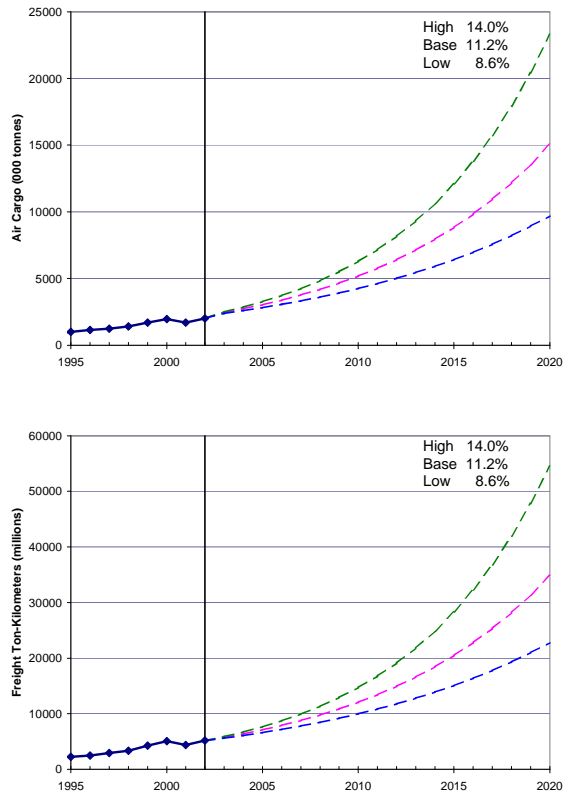


Figure 12: Aggregate projections of air cargo traffic performed by domestic Chinese airlines (tonnage and FTK)

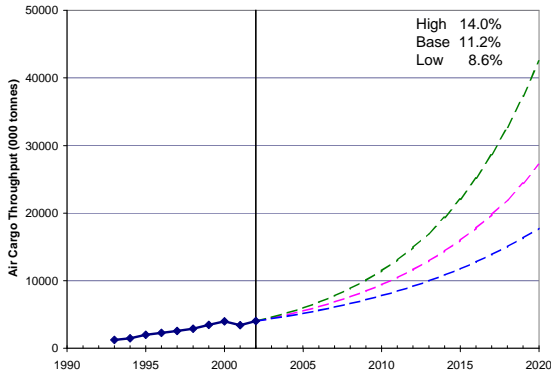


Figure 13: Aggregate projections of airport cargo throughput in mainland China

Airport Specific Forecast

Over twenty large mainland airport groups and airports plus Hong Kong and Taipei were identified and cargo throughput histories were examined. Figure 14 illustrates the different growth patterns and cargo throughputs of these airports. The Shanghai airport group demonstrates the fastest growth of annual 18.8% while Wuhan has the slowest increase of annual 3.8%.

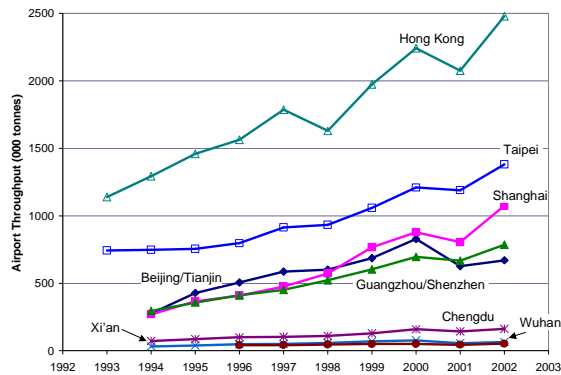


Figure 14: Cargo throughput at three major airport groups and large airports in mainland China, Hong Kong and Taipei

Source: CAAC data, Hong Kong Airport Authority

By extrapolating historical trends into the future, a set of projections for throughputs of these specific airports can be obtained. The results are provided in Table 3. The extrapolated projections of three mainland airport groups, Hong Kong and Taipei are shown in Figure 15.

It should be noted that projections for specific airports are estimated based on their historical trends. For those airports that experienced rapid growth in the past, the results might be optimistic. As shown in Table 3, the Shanghai airport group is projected a throughput of 24 million tonnes by 2020. This is believed to be optimistic, since there are many constraints limiting the

throughput in Shanghai, such as cargo demand, airport capacity, cargo facility and ground transportation. The projections of Hangzhou and Kunming seem optimistic as well. Each of the two airports serves a local market. As the market matures, the growth rate is likely to slow down. In contrast, the throughput at Wuhan is likely underestimated. Wuhan is situated at the center of the triangle formed by Beijing, Shanghai and Guangzhou. It is also at the intersection of rail, highway and the Changjiang waterway. Its geographical advantage makes it a good candidate for the domestic sorting hub of express delivery.

Table 3: Extrapolated projections of cargo throughputs at three airport groups and large airports in mainland China, Hong Kong and Taipei

Unit: 000 tonnes

City/Airport	2002	2,005	2,010	2,020
Shanghai Pudong/Hongqiao	1,075	1,804	4,276	24,019
Guangzhou/Shenzhen	786	1,134	2,089	7,093
Beijing/Tianjin	671	935	1,625	4,911
Shenyang	57	75	118	295
Xi'an	65	84	130	305
Chengdu	162	219	362	985
Kunming	122	195	424	2,001
Wuhan	52	58	70	102
Urumqi	43	53	75	150
Dalian	73	99	167	474
Chongqing	71	91	135	297
Qingdao	46	61	97	243
Hangzhou	87	129	249	927
Nanjing	52	68	107	262
Fuzhou	48	60	86	178
Xiamen	110	140	211	476
Zhuhai	8	7	6	5
Haikou	54	63	81	134
Lhasa	9	10	12	16
Hong Kong	2,479	3,212	4,948	11,739
Taipei	1,381	1,698	2,396	4,772

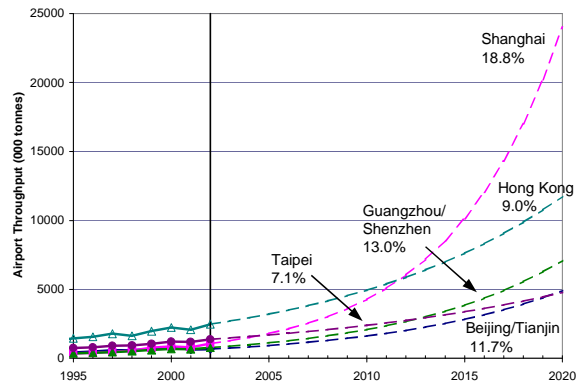


Figure 15: Extrapolated projections of cargo throughput of three mainland airport groups, Hong Kong and Taipei

6. IMPLICATIONS FOR INFRASTRUCTURE

According to the forecast above, the air cargo traffic and airport throughput in China will expand more than seven fold by 2020. This will create opportunities and impose challenges for system infrastructure.

According to CAAC plans, three major airports – Beijing Capital, Shanghai Pudong, and Guangzhou new Beiyun – will develop into international hubs, and six other inland and western airports – Shenyang, Wuhan, Chengdu, Kunming, Xi'an and Urumqi – will become second-tier hubs.⁶

Beijing/Tianjin Airports

As the gateway to north China, Beijing Capital airport is the busiest airport in mainland, while the airport in its neighboring seaport city Tianjin has been under utilized in recent years. On the other hand, more than 75% of international freight handled by Beijing airport was related to the customers based in Tianjin. This is due to Tianjin's lack of international air-route connection. Regarding ground accessibility, Tianjin airport has better ground access to other coastal cities in Bohai Bay. In 2002, the two airports formed the Beijing Capital Airport Group; and the Tianjin airport will be mainly responsible for cargo transportation. However, the air-route connection to Tianjin is still not comparable with Beijing. As such, the biggest challenge will be to integrate the operation at the two airports serving the same market.

Pearl Delta & Hong Kong

There are five large airports in the Pearl Delta: Hong Kong, Macau, Guangzhou, Shenzhen and Zhuhai. Hong Kong has the best route connection to the world, followed by Guangzhou. Shenzhen is also a major player in the air cargo market. Guangzhou and Shenzhen have better domestic route connections than Hong Kong and Macau. Zhuhai is seriously under utilized because of its poor route connection.

Geographically connected, Shenzhen partially serves as the domestic airport for Hong Kong; vice versa, Hong Kong serves as the international port for Shenzhen's local market. The two airports are complementary to some extent.

The new Guangzhou airport is expected to start operation in late 2003. With added capacity and extended network coverage, Guangzhou will be more competitive in international cargo market. As a result,

Hong Kong may see some air cargo traffic shift to Guangzhou.

Shanghai Airports

Since the Pudong airport started operation in 1999, the two airports in Shanghai have seen rapid cargo growth. However, the ground accessibility of Pudong for the customers in surrounding area could hinder its growth. As the number of cars increases in the area, the traffic congestion will impose a serious problem in the future. Fog in the Pudong airspace (40 foggy days per year) is another concern; especially when four parallel runways are in operation in the future. One alternative is to restore the international air cargo operation at Hongqiao. Another alternative could be the construction of a smaller airport in Suzhou/Wuxi area where majority of customers are located to operate high-density air cargo routes. Again, the development of Shanghai hub is expected to attract some international cargo from Hong Kong.

Second-tier Airports

Among the inland second-tier airports, the growth of Chengdu and Kunming has been strong. Enough attention should be paid to cargo facilities when planning expansions. The potential of Wuhan largely depends on its potential of being a domestic sorting hub of express delivery.

Urumqi is the only major city in Xinjiang and it is the midway point on the Silk Road. In addition to serving the local market, it could also become a gateway to Eurasia in the future. At the start point of Silk Road, Xi'an is the major pathway to northwest China. The success of West Region Development strategy will make it a major inland hub.

Other Large Coastal Airports and Taiwan

Dalian, Qingdao, Hangzhou and Xiamen are four coastal cities characterized by strong local air cargo customer base. Xiamen's air cargo is primarily driven by the international firms such as Dell and Kodak. As the mainland city closest to Taiwan, Xiamen will benefit from the realization of the three direct links of trade, mail and transport services across the Taiwan Strait. However, it is unclear when this will occur. The realization of links will greatly benefit air cargo transportation in the Changjiang Delta as well, where a large number of Taiwan businesses reside. Taiwan will benefit significantly from the direct links. Products made in Taiwan could be transported to mainland cities faster, cheaper, and easier. Taipei airport would then serve as another gateway of China to the world.

7. CONCLUSIONS

An aggregate forecast of future air cargo traffic in China was projected for the period through 2020 based on the relationship between air cargo traffic and economic development. In addition to the baseline projection, high and low projections were made to take into account uncertainty of economic development. The air cargo traffic performed by mainland Chinese airlines is expected to grow at 11.2%, as well as the total throughput at mainland airports. The total throughput in mainland is expected to increase to 27 million tonnes, of which, 15 million tonnes are expected to be carried by domestic China airlines.

Airport specific forecasts were projected for major airport groups and airports in mainland China, Hong Kong and Taipei by extrapolation. Implications for system infrastructure at these airports are analyzed. Issues facing Beijing/Tianjin airports would be route planning, balance of cargo facility investment and alternative ground connection. Ground accessibility is a concern regarding Shanghai Pudong airport. As capacity and network connections are added, Hong Kong might see some diversion of international cargo to the Guangzhou and Shanghai hubs. The development of express delivery is likely to favor Wuhan airport due to its geographical location. The realization of direct links across the Taiwan Strait will benefit airports on either side.

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