International air freight movements through Australian airports to 2030

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ABSTRACT

Long-term forecasts of air freight movement are essential for government, airports and freight operators for planning and investment decision making purposes. However, such forecasts have not been previously published in Australia. In this study, long-term forecasts of air freight movements through Australian airports over the next twenty years have been developed using econometric freight demand models. The models are single equation models and are specified in a double logarithmic linear functional form in terms of population, income, prices and exchange rates. They have been widely used in many tourism and transport demand forecasting studies and were estimated using historical data from 1985-86 to 2009-10. In the models, freight volume and income variables are specified on a per capita basis to avoid the consequences of possible collinearity between population and real income variables.

The estimated demand parameters suggest that the volume of air freight is positively influenced by per capita real income and negatively influenced by own real prices.

In 2009-10, a total of 798,100 tonnes of international air freight, including 318,600 tonnes of exports and 479,500 tonnes of imports, were moved through Australian airports. With expected positive population and economic growth, the international air freight industry will continue to perform strongly over the next twenty years. The volume of international outbound and inbound air freight through Australian airports is forecast to increase by 2.7 and 6.0 per cent a year over the next twenty years to 0.5 and 1.2 million tonnes, respectively, in 2029-30.

1. Introduction

Air freight has become increasingly important for transporting goods on Australia's international routes, largely due to the fact that Australia is a large island nation which lies far from densely populated business centres such as Singapore, Hong Kong, London, Paris, New York and Los Angles and that movement of freight by sea on Australia's international routes is time consuming. Goods that are moved by air are mostly light and high value goods requiring urgent delivery.

In 2009-10, a total of 798 100 tonnes of international air freight passed through Australian airports. It included 318 600 tonnes of outbound air freight and 479 500 tonnes of inbound air freight. About seventy per cent of the outbound air freight volume was uplifted at Australia's two major airports, Sydney and Melbourne (Table 1). Sydney accounted for 40.4 per cent of the outbound freight tonnage, Melbourne 29.4 per cent, Brisbane 14.6 per cent, Perth 10.4 per cent, Adelaide 3.5 per cent and all other airports 1.7 per cent. Similarly, 80.7 per cent of the inbound air freight volume was discharged at Sydney and Melbourne airports. Sydney accounted for 56.8 per cent of the inbound freight tonnage followed by Melbourne (23.9 per cent), Brisbane (9.3 per cent), Perth (7.0 per cent), Adelaide (1.8 per cent) and all other airports (1.3 per cent).

In terms of volume, New Zealand is the largest destination for Australia's outbound air freight (Figure 1). It accounts for around 16 per cent of total outbound air freight, followed by

Singapore (14 per cent), Hong Kong (SAR of China 10 per cent), United Arab Emirates (UAE, 7 per cent), Japan (6 per cent), USA (5 per cent), Malaysia and Thailand (4 per cent each), Indonesia and Papua New Guinea (3 per cent each) and all other destinations (28 per cent in total).

Regarding Australia's international inbound freight volume, China is the largest source country (Figure 2). It accounts for 23 per cent of the total inbound air freight to Australia followed by USA (17 per cent), New Zealand (9 per cent), Germany (7 per cent), United Kingdom and Malaysia (4 per cent each), France and Japan (3 per cent each), Italy and Singapore (2 per cent each) and all other countries (26 per cent).

Table 1: Air freight volumes and airport shares by main airport, 2009-10

Airport	Export (tonnes)	Shares (%)	Import (tonnes)	Shares (%)	Total (tonnes)	Shares (%)
Sydney	128,759	40.4	272,444	56.8	401,203	50.3
Melbourne	93,594	29.4	114,419	23.9	208,013	26.1
Brisbane	46,451	14.6	44,549	9.3	91,000	11.4
Perth	33,280	10.4	33,576	7.0	66,857	8.4
Adelaide	11,042	3.5	8,503	1.8	19,545	2.4
Darwin	102	0.0	317	0.1	419	0.1
Other	5,374	1.7	5,707	1.2	11,082	1.4
Total	318,604	100.0	479,515	100.0	798,119	100.0

Note: The sum of the components may not be equal to totals due to rounding.

Figure 1: Main export destinations in terms of tonnages, 2009-10
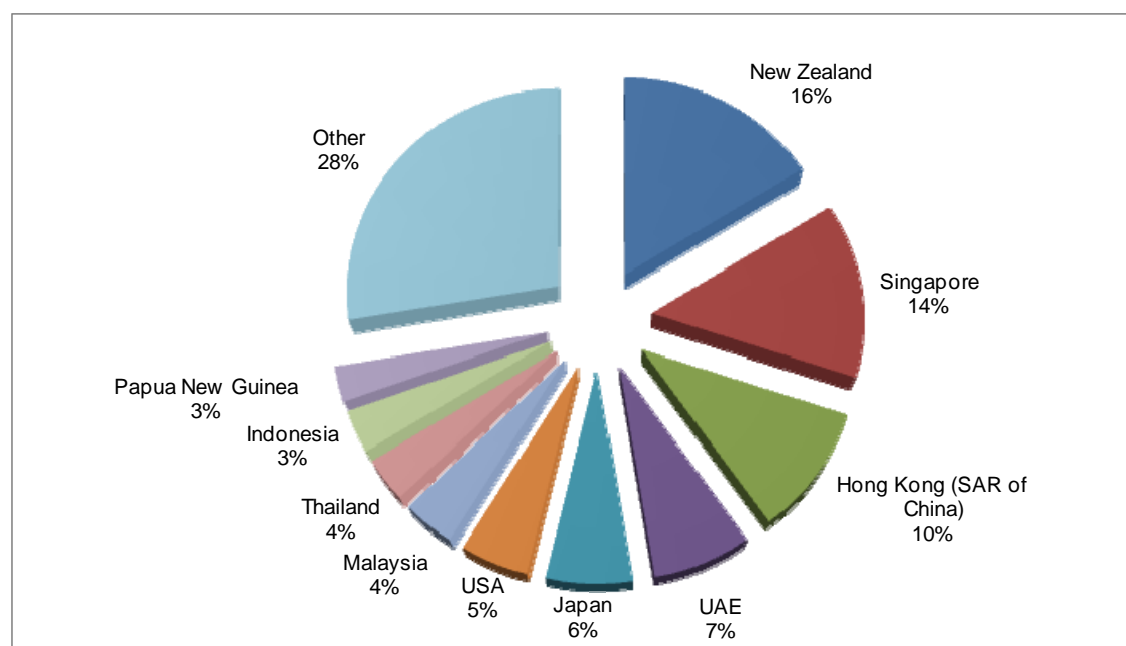
As shown in Table 2, Australia's major outbound air feight products by weight are meat and meat preparations (18.1 per cent); vegetables and fruit (16.8 per cent), fish, crustaceans, molluscs and preparations (8.8 per cent) and miscellaneous manufactured articles (5.3 per cent), whereas its major outbound air feight products by value are non-monetary gold (37.4

per cent), commodities and transactions which are not included in merchandise trade (18.1 per cent), medicinal and pharmaceutical products (8.9 per cent) miscellaneous manufactured articles (3.8 per cent) and professional, scientific and controlling instruments (3.8 per cent). While outbound air freight encompasses an extremely diverse range of products, a large percentage of these exports in terms of weight are perishable primary products (45.7 per cent) which originate in regional Australia. These products are often moved long distances along sensitive supply chains to reach international airports just in time for loading onto aircraft.

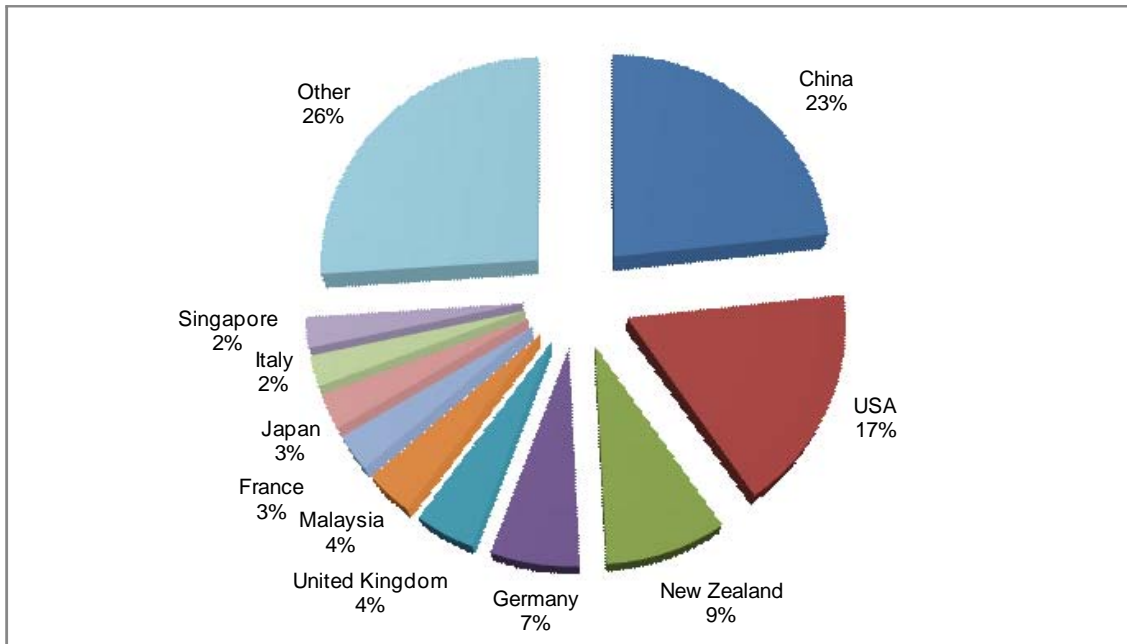**Figure 2: Main import source countries in terms of tonnages, 2009-10**

Table 2: Top five outbound air freight products by weight and value and their shares, 2009-10

Commodity	Share (%)
By weight	
Meat and meat preparations	18.1
Vegetables and fruit	16.8
Fish, crustaceans, molluscs and preparations	8.8
Special transactions and commodities not classified	5.8
Miscellaneous manufactured articles	5.3
Other	12.3
Total	100.0
By value	
Gold, non-monetary (excl. gold ores and concentrates)	37.4
Commodities & transactions not in merchandise trade	18.1
Medicinal and pharmaceutical products	8.9
Miscellaneous manufactured articles	3.8
Professional, scientific and controlling instruments	3.8
Other	4.5
Total	100.0

Note: The sum of the components may not be equal to totals due to rounding.

Australia's major inbound air feight products by weight are Office machines and automatic data processing machines (9.5 per cent), miscellaneous manufactured articles (8.9 per cent), articles of apparel and clothing accessories (8.8 per cent), electrical machinery, apparatus and appliances (7.3 per cent), general industrial machinery and equipment, (7.2 per cent) and telecommunications and sound recording equipment (6.6 per cent) (Table 3); whereas its top five inbound air feight products by value are gold, non-monetary (excl. gold ores and concentrates) (13.6 per cent), medicinal and pharmaceutical products (12.7 per cent), telecommunications and sound recording equipment (12.0 per cent), commodities & transactions not in merchandise trade (11.0 per cent), and Office machines and ADP machines (10.7 per cent).

Table 3: Top five inbound air freight products by weight and value and their shares, 2009-10

Commodity	Share (%)
By weight	
Office machines and ADP machines	9.5
Miscellaneous manufactured articles	8.9
Articles of apparel and clothing accessories	8.8
Electrical machinery, apparatus and appliances	7.3
General industrial machinery and equipment	7.2
Other	14.4
Total	100.0
By value	
Gold, non-monetary (excl. gold ores and concentrates)	13.6
Medicinal and pharmaceutical products	12.7
Telecommunications and sound recording equipment	12.0
Commodities & transactions not in Merchandise Trade	11.0
Office machines and ADP machines	10.7
Other	3.8
Total	100.0

Note: The sum of the components may not be equal to totals due to rounding.

The international air freight industry in Australia has been growing annually by 9.9 per cent a year since 1961-62, from 8 500 tonnes in 1961-62 to 798 100 tonnes in 2009-10 (Figure 3). It experienced unprecedented turbulence from 1998-99 onwards, mainly triggered by the 9/11 terrorism incident in the USA, the Asian Financial Crisis and the Global Financial Crisis. The volume of international air freight declined by 1.9 per cent a year between 2000-01 and 2003-04 resulting from a decline of 6.7 per cent a year in international outbound air freight during the period.

Long-term forecasts of air freight movements are essential for government, airports and freight operators for planning and investment decision making purposes. This study presents the national level forecasts of air freight movements through Australian airports over the next twenty years.

2. Forecasting models

In this study, econometric air freight demand models have been used to forecast the volume of air freight movements through Australian airports. The models depict the underlying relationship between freight volumes and quantitative driving factors. The models are single

equation models and are specified in a double logarithmic linear functional form. Hence, they are easy to estimate and provide superior fit. The estimated parameters can be directly interpreted as elasticities. The models have been widely used in many tourism and transport demand forecasting studies, such as Loeb (1982), Witt and Witt (1992), Hamal (1997a, 1997b and 2004) and BITRE (2008).

Figure 3: International air freight movements through Australian airports
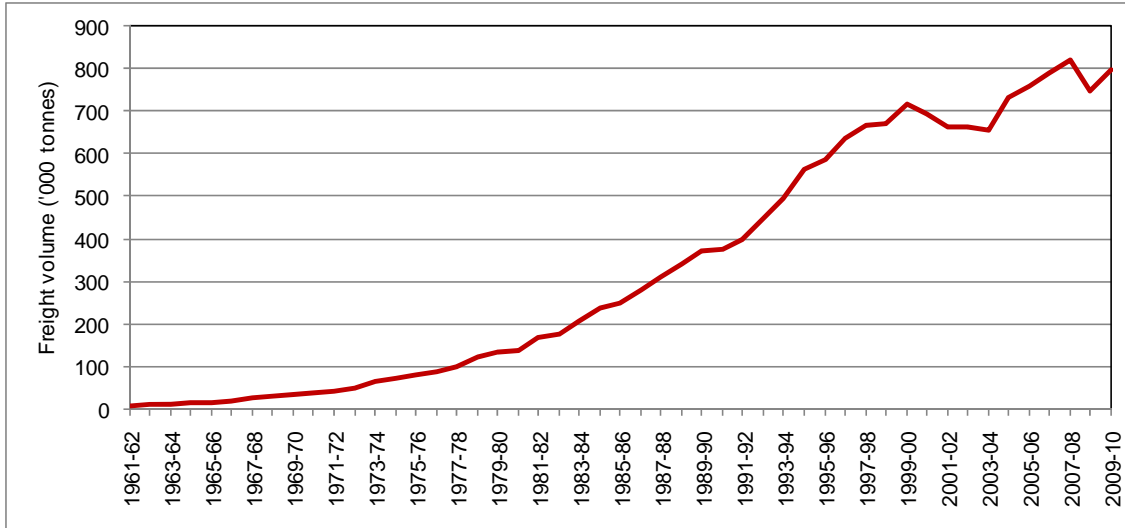
Forecasts of outbound and inbound freight movements were separately developed as they are driven by different factors. The volume of outbound freight is largely influenced by the real disposable household income level of consumers in export destination countries, whereas the volume of inbound freight is mainly driven by the real disposable household income level of Australians.

The models of outbound and inbound freight movements through Australian airports are specified in equations 1 and 2 respectively.

$$\ln X_t = \alpha_0 + \alpha_1 \ln Y_{1,t} + \alpha_2 \ln P_t + \alpha_3 AFC_t + u_t \qquad (1)$$

$$\ln M_t = \beta_0 + \beta_1 \ln Y_{2,t} + \beta_2 \ln Q_t + \beta_3 GFC_t + \varepsilon_t \qquad (2)$$

Where:

X = Per capita international outbound freight air freight movements through Australian airports in thousand tonnes;

Y_1 = Per capita real income in export destination countries in billion US dollars;

P = Real export price index;

AFC = Dummy variable to capture a large variation in freight movements due to the Asian Financial Crisis in 1998-99;

M = Per capita international inbound air freight movements through Australian airports in thousand tonnes;

Y_2 = Per capita real income in Australia in billion dollars;

Q = Real import price index;

GFC = Dummy variable to capture a large variation in freight movements due to the Global Financial Crisis in 2008-09;

u and ε = Error terms;

α's and β's = Regression coefficients; and

t = Time subscript.

In the above models, freight volume and income variables are specified on a per capita basis to avoid the consequences of possible collinearity between population and real income variables. Real GDP is used as proxy for real income. Since OECD countries account for 56.2 per cent of Australia's total outbound freight, the population and real income of the OECD countries are used as proxies for the population and real income of Australia's export destination countries. Real average export and import prices have been derived by deflating nominal aggregate export and import prices by aggregate exchange rates.

The outbound and inbound freight movement models were estimated using historical data from 1984-85 to 2009-10. The estimated regression statistics are presented in Table 4. High adjusted R-square values suggest that the estimated models have a high predictive power, and hence, they are expected to provide reliable forecasts of international air freight movements through Australian airports. Moreover, the estimated parameters of income and price variables are found to be highly significant and have the expected signs. They indicate that the volume of outbound and inbound air freight is positively influenced by the per capita real income and negatively by own prices.

The estimated income elasticity of outbound air freight demand suggests that a one per cent increase (decrease) in the per capita real income level of consumers in Australia's export destination countries will result in an increase (decrease) in the volume of outbound air freight by 2.2 per cent. Similarly, a one per cent decrease (increase) in the real average export prices will increase (decrease) the volume of outbound air freight by 0.4 per cent. The estimated parameters also suggest that the Asian Financial Crisis had a slight negative impact on the volume of Australia's outbound air freight although the estimate is not statistically significant at 10 per cent level.

Table 4: Estimated regression statistics of outbound and inbound air freight movements through Australian airports

Variable	Estimated coefficient	Significance level	Other statistics
Outbound freight			
Income*	2.217	0.01	Adjusted-R^2 = 0.94
Export price**	-0.388	0.04	N = 25
AFC	-0.056	0.18	
Intercept	11.699	0.01	
Inbound freight			
Income*	2.150	0.01	Adjusted-R^2 = 0.97
Import price**	-0.305	0.01	N = 25
GFC	-0.069	0.10	
Intercept	10.704	0.01	

*Per capita real income. ** In real terms

According to the estimated income elasticity of inbound air freight demand, a one per cent increase (decrease) in the per capita real income level in Australia will result in an increase (decrease) in the volume of inbound air freight by 2.2 per cent. Similarly, a one per cent decrease (increase) in the real average import prices will increase (decrease) the volume of

inbound air freight by 0.3 per cent. The estimated parameter of the GFC dummy variable which is marginally significant at the 10 per cent level suggests that the volume of inbound freight was negatively influenced by the Global Financial Crisis.

3. Historical data and future assumptions

Historical data on outbound and inbound international air freight, population, GDP and exchange rates used to estimate air freight movements were obtained from Access Economics (2010) and BITRE (2011). The estimated air freight demand models and long-run assumptions on population and macroeconomic variables were used to develop the long-run forecasts of air freight movements through Australian airports. The long-run population and macroeconomic assumptions are obtained from Access Economics (2010). Since these assumptions are available for the next ten years only, the assumptions for the rest of the forecast period are assumed to remain the same as those in year 2020-21. The assumptions are summarised in Table 5.

Table 5: Macroeconomic and population assumptions

Variable	1989-90 to 2009-10	**2009-10 to 2029-30**
Annual average growth rates (%)		
Real GDP		
Australia	3.2	**3.3**
OECD	2.0	**2.1**
Export price	1.9	**2.9**
Import price	0.0	**3.9**
Population		
Australia	1.4	**1.3**
OECD	0.7	**0.7**
Exchange rate (US$/A$)	0.72	**0.79**

*Numbers in bold are forecasts.

Real GDP of Australia and the OECD countries, which grew annually by 3.2 and 2.0 per cent respectively over the last twenty years, are forecast to increase by 3.3 and 2.1 per cent a year respectively over the next twenty years. The higher expected economic growth in Australia and the OECD countries will have a positive influence on Australia's inbound and outbound air freight movements.

Average export prices, which increased by 1.9 per cent a year over the last twenty years, are forecast to increase by 2.9 per cent a year over the forecast period. Similarly, average import prices, which remained flat over the last twenty years, are expected to increase by 3.9 per cent a year over the forecast period.

The population of Australia and the OECD countries grew by 1.4 and 0.7 per cent per annum respectively in the last twenty years, and are expected to increase at about the same rate over the next twenty years.

The average annual exchange rate for the last twenty years is observed to be US 72 cents per Australian dollar, and it is expected to be US 79 cents per Australian dollar over the next twenty years. In other words, the strength of the Australian dollar against the currencies of Australia's trading partners is expected to be slightly stronger over the forecast period. This will have a negative impact on the volume of outbound air freight and a positive impact on the volume of inbound air freight.

4. Forecasts

As mentioned earlier, the estimated freight movement models and the long-run assumptions on population and macroeconomic variables have been used to forecast outbound and inbound air freight movements through Australian airports over the next twenty years.

In Australia, the volume of outbound international air freight increased by 2.8 per cent a year over the last twenty years, from 184 400 tonnes in 1989-90 to 318 600 tonnes in 2009-10 (Figure 4 and Table 6). Outbound air freight is forecast to increase at the same rate over the next twenty years to 549 500 tonnes in 2029-30, mainly due to the expected positive growth rates of real income and population. Similarly, the volume of international inbound air freight which increased by 4.9 per cent a year over the last twenty years, from 185 500 tonnes in 1989-90 to 479 500 tonnes in 2009-10, is forecast to increase by 4.7 per cent a year over the forecast period to 1.2 million tonnes in 2029-30 (Figure 5 and Table 6), largely due to the expected high economic growth in the OECD countries as well as the expected appreciation of the Australian dollar against the US dollar over the forecast period.

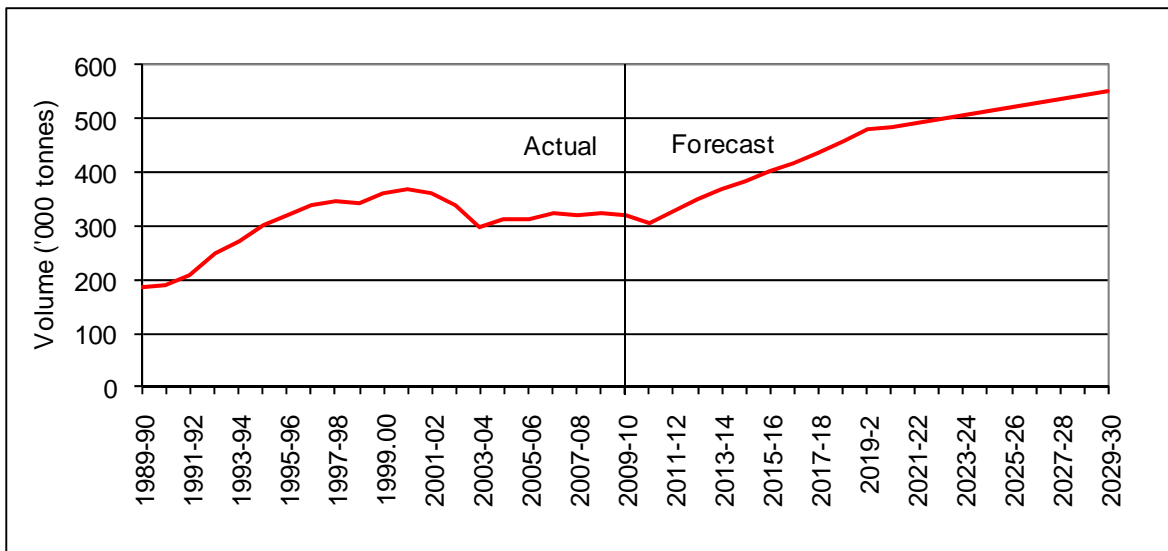**Figure 4: Outbound international air freight through Australian airports**

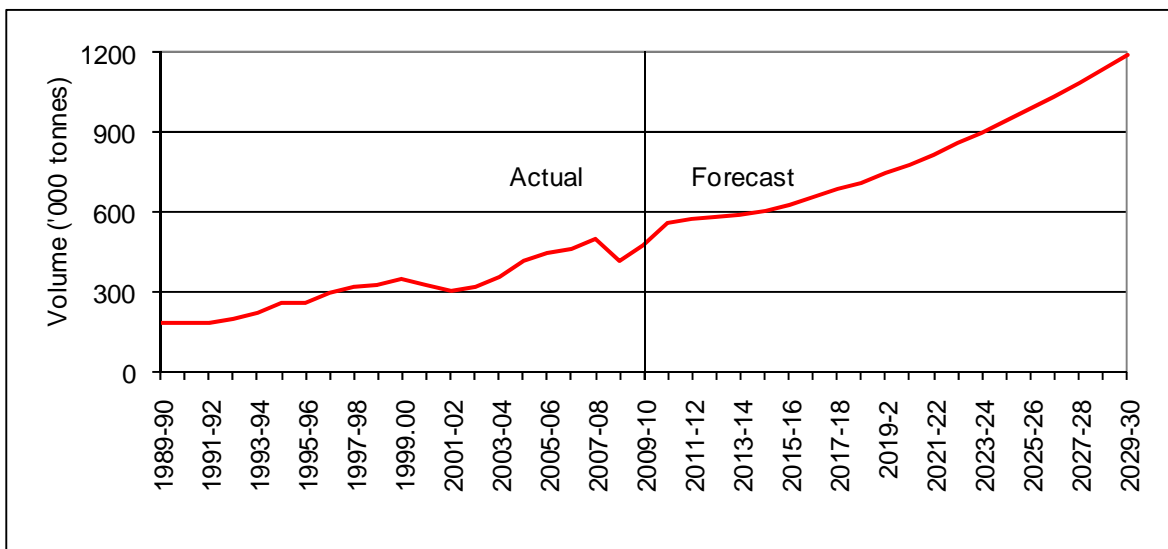**Figure 5: Inbound international air freight through Australian airports**

Table 6: International air freight movements through Australian airports ('000 tonnes)

Year	Outbound	Inbound	Total
1989.90	184.4	185.5	369.9
1990.91	190.2	184.1	374.3
1991-92	208.1	189.1	397.1
1992-93	248.6	201.4	450.0
1993-94	272.8	222.2	495.0
1994-95	300.2	261.5	561.7
1995-96	320.2	264.4	584.6
1996-97	338.9	297.5	636.4
1997-98	346.6	321.0	667.6
1998-99	343.2	326.6	669.7
1999-00	360.4	354.5	714.9
2000-01	367.7	327.2	694.8
2001-02	360.4	303.1	663.5
2002-03	338.5	324.1	662.6
2003-04	298.4	357.1	655.4
2004-05	312.6	419.1	731.8
2005-06	312.9	444.9	757.9
2006-07	322.7	465.2	787.9
2007-08	320.0	499.9	819.9
2008-09	323.9	422.1	746.0
2009-10	318.6	479.5	798.1
2010-11	**304.4**	**558.1**	**862.5**
2011-12	**328.7**	**574.3**	**903.0**
2012-13	**350.5**	**581.6**	**932.2**
2013-14	**369.3**	**588.4**	**957.7**
2014-15	**383.5**	**608.0**	**991.5**
2015-16	**400.6**	**631.0**	**1031.6**
2016-17	**417.3**	**658.7**	**1076.0**
2017-18	**436.3**	**688.5**	**1124.8**
2018-19	**458.4**	**711.7**	**1170.1**
2019-20	**479.5**	**746.8**	**1226.3**
2020-21	**486.0**	**782.5**	**1268.5**
2021-22	**492.7**	**819.9**	**1312.6**
2022-23	**499.5**	**859.0**	**1358.5**
2023-24	**506.3**	**900.1**	**1406.4**
2024-25	**513.3**	**943.1**	**1456.4**
2025-26	**520.3**	**988.2**	**1508.5**
2026-27	**527.5**	**1035.4**	**1562.9**
2027-28	**534.7**	**1084.8**	**1619.6**
2028-29	**542.1**	**1136.7**	**1678.7**
2029-30	**549.5**	**1191.0**	**1740.5**
Annual average growth rate (%):			
1989-90 to 2009-10	2.8	4.9	3.9
2009-10 to 2029-30	**2.8**	**4.7**	**4.0**

* Numbers in bold are forecasts.

5. Sensitivity analysis

The forecasts presented above are base case forecasts which represent the best possible scenario given the current information on economic and population assumptions for the next twenty years. However, it is possible that the assumptions on income, population and export and import prices could significantly change due to unexpected factors. As a result, the base case forecasts will change accordingly. Hence, a sensitivity analysis has been carried out by considering the following two scenarios which reflect optimistic and pessimistic assumptions on income, population and export and import prices:

Scenario 1:

- Annual real GDP growth rates in Australia and overseas are 0.5 percentage points above the base case level,

- Annual population growth rates in Australia and overseas are 0.2 percentage points above the base case level,

- Average export and import prices are 5 per cent below the base case level.

Scenario 2:

- Annual real GDP growth rates in Australia and overseas are 0.5 percentage points below the base case level,

- Annual population growth rates in Australia and overseas are 0.2 percentage points below the base case level,

- Average export and import prices are 5 per cent above the base case level.

In this paper, the base case is defined as a medium scenario, one that reflects the economic and political conditions as at early 2011. Forecasts of air freight movements presented in Section 4 are the base case forecasts.

According to the results of the sensitivity analysis, the volume of international outbound air freight through Australian airports would increase annually by 3.7 per cent over the next twenty years under Scenario 1 (optimistic scenario) and 1.9 per cent under Scenario 2 (pessimistic scenario) compared with 2.8 per cent under the base case scenario (Table 7). This implies that the volume of international air freight would increase by an additional 1.0 per cent a year (in addition to the base case growth rate) under Scenario 1, and it would increase by 0.9 percentage points less than the base case level under Scenario 2. In other words, the total volume of international outbound air freight over the forecast period will increase by 12.4 million tonnes under Scenario 1 and by 9.2 million tonnes under Scenario 2.

Similarly, the volume of international inbound air freight through Australian airports would increase annually by 5.6 per cent over the next twenty years under Scenario 1 (optimistic scenario) and 3.8 per cent under Scenario 2 (pessimistic scenario) compared with 4.7 per cent under the base case scenario (Table 7). It means that the volume of international inbound air freight would increase by an additional 0.9 per cent a year (in addition to the base case growth rate) under Scenario 1, and it would increase by 0.9 percentage points less than the base case level under Scenario 2, implying that the total volume of international inbound air freight over the forecast period will increase by 12.0 million tonnes under Scenario 1 and by 9.3 million tonnes under Scenario 2.

Table 7: International air freight movements through Australian airports by scenario

	Base case	Scenario 1	Scenario 2	Difference (per cent) Scenario 1	Scenario 2
Annual average growth rate over forecast period (%)					
Outbound	2.8	3.7	1.9	1.0	-0.9
Inbound	4.7	5.6	3.8	0.9	-0.9
Total volume over forecast period (million tonnes)					
Outbound	9.1	10.2	8.3	12.4	-9.2
Inbound	16.1	18.0	14.6	12.0	-9.3

6. Conclusions

In this study, long-term forecasts of international air freight movements through Australian airports have been developed using econometric models which are specified in terms of population, real income, export and import prices and exchange rates. These long-term forecasts of air freight movements are vital for government, airport authorities and freight operators for planning and investment decision making purposes.

In 2009-10, a total of 798 100 tonnes of international air freight, including 318 600 tonnes of outbound freight and 479 500 tonnes of inbound freight, were moved through Australian airports. New Zealand, Singapore, Hong Kong (SAR of China), United Arab Emirates and Japan are the top five major destination countries of outbound air freight, whereas China, USA, New Zealand, Germany and the United Kingdom are the top five major source countries of inbound air freight.

With expected positive population and economic growth, the international air freight industry will continue to perform strongly over the next twenty years. The expected appreciation of the Australian dollar against the US dollar will provide a positive influence on Australia's international inbound air freight and a negative influence on Australia's international outbound air freight. The volume of international outbound and inbound air freight through Australian airports is forecast to increase by 2.7 and 6.0 per cent a year over the next twenty years to 0.5 and 1.2 million tonnes, respectively, in 2029-30.

The existing capacity of Australia's airport terminals may not be adequate to handle the expected freight movements in the future. Hence, expansion of airport facilities, including terminals, may be required to realise the strong growth in air freight movements over the next twenty years.

7. References

Access Economics (2010) *Business Outlook,* December issue, Canberra: Access Economics

Bureau of Infrastructure, Transport and Regional Economics (2008) *Air passenger movements through capital city airports to 2025-26* Working Paper 72 Canberra: BITRE

Bureau of Infrastructure, Transport and Regional Economics (2011) *Airline database* unpublished data Canberra: BITRE

Hamal, K. (1997a) Substitutability between domestic and outbound travel in Australia, *Pacific Tourism Review* 11, 23-33

Hamal, K. (1997b) Modelling Domestic Holiday Tourism Demand in Australia: Problems and Solutions, *Asia Pacific Journal of Tourism Research* 12, 35-46

Hamal, K. (2004) Forecasting container and freight ship movements on international routes to and from Australia, pp Hamal 1-9 of *Papers of the 27th Australian Transport Research Forum 27* Adelaide: ATRF

Loeb, P. (1982) International Travel to the United States: An Economic Evaluation, *Annals of Tourism Research* 9: 7-20

Witt, S. F., and C.A. Witt (1992) *Modelling and Forecasting Demand in Tourism.* London: Academic Press Limited