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Paper title: **Forecasting container and freight ship movements on international routes to and from Australia**

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Abstract (200 words):
International shipping has remained the main mode of transporting exports and imports from and to Australia. However, following the September 11 terrorist act in the USA and the Iraq war, there are security concerns in relation to the movement of containers and ships on international routes to and from Australia. Information on the movement of containers and ships is vital for the planning and implementation of security measurements at the Australian ports. Hence, this paper presents forecasts of container and ship movements on international routes to and from Australia over the next ten years and the likely impact of large containers and ships upon container and ship movements.

Econometric models have been used to forecast the number of container and ship movements. The models are specified with exports and imports as the dependent variables and population, real income, exchange rates and export and import prices as explanatory variables. The empirical results suggest that the number of containers and ships on international routes to and from Australia will increase significantly over the next ten years, largely driven by positive economic outlook for Australia and its major trading partners.

Introduction

International shipping has remained the main mode of transporting exports and imports in Australia. This is because Australia is an island nation and its exports and imports are dominated by heavy and low-value bulk commodities which can not be transported by air at the current level of technology. In 2002-03, Australia's total trade in commodities was 603 million tonnes and sea freight accounted 99.9 per cent of the total trade.

Heavy and low-value commodities are exported and imported in bulk vessels, whereas lighter and high-value commodities are exported and imported in container ships (Figures 1 and 2). Presently, bulk vessels account for 94 per cent of outbound sea freight volume and 74 per cent of inbound sea freight volume. However, the shares markedly decline when exports and imports are measured in value terms. Bulk vessels account only for 53 per cent of outbound sea freight value and 22 per cent of inbound sea freight value.

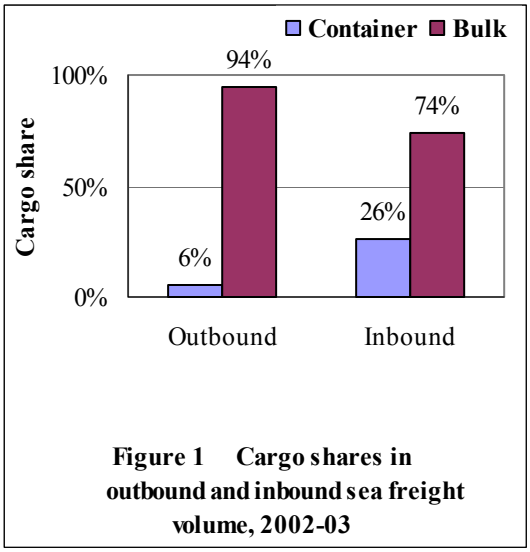

Figure 1 Cargo shares in outbound and inbound sea freight volume, 2002-03

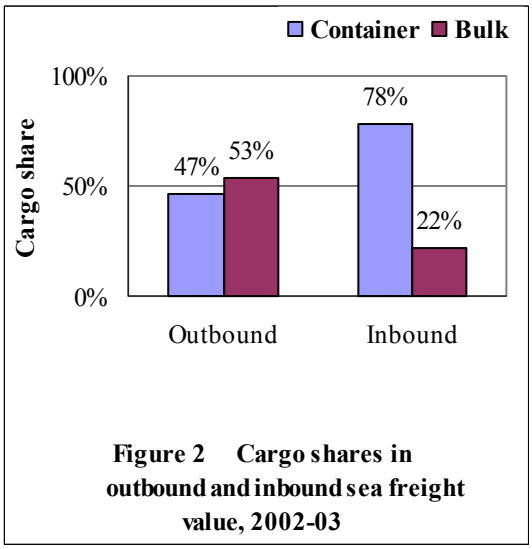

Figure 2 Cargo shares in outbound and inbound sea freight value, 2002-03

Following the September 11 terrorist act in the USA and the Iraq war, there are security concerns in relation to the movement of containers and ships on international routes to and from Australia. Information on the movement of containers and ships is vital for the planning and implementation of security measurements at the Australian ports. Hence, this paper attempts to forecast container and freight ship movements on Australia's international shipping routes over the next ten years.

Forecasting models

In this study, econometric models have been used to forecast container and ship movements. The models are relatively better than time trend or univariate time series models, because the models can accommodate several explanatory variables to analyse their influence on container and ship movements. Since the models are specified in a double logarithmic linear functional form, they are easy to estimate, provide superior fit and the estimated parameters can be directly interpreted as elasticities. The models have been widely used in many previous tourism and transport demand forecasting studies, such

as Loeb (1982), Witt and Witt (1992), Hamal (1997a and 1997b) and BTRE (2002a, 2002b and 2004a).

Since the export and import of loaded and empty containers are linked, a system of simultaneous equations underlying the demand and supply structure of container movements is likely to present a better set of container forecasts. However, such a system simultaneous equations is found to be a bit complex to estimate, especially when long time-series data on supply side variables are not readily available and the length of time series data is not the same for all demand side model variables. Therefore, the single equation modelling technique is used to forecast container numbers in this study.

Ships carrying Australia's exports and imports are grouped into three categories for modelling purposes. These are container ships, bulk ships and other freight ships. A container ship is defined as a ship designed to carry containers only. The group of bulk ships includes tankers and ships carrying bulk dry, bulk oil, gas and general commodities. Other freight ships are defined as those ships which do not fall under the container ship and bulk ship categories.

Forecasts of container, bulk and other freight ship movements are separately developed using the forecasting frameworks presented in Figures 3 and 4. Forecasts of outbound and inbound container and ship movements are separately developed to account for the fact that major factors influencing outbound and inbound container and ship movements are different.

Since the volume of exports and imports directly influences the number of container and freight ship movements, econometric models of export and import volumes are specified to forecast the number of container and ship movements. The models include export and import volumes as dependent variables and income, prices, exchange rates and population as explanatory variables.

The forecasts of container and container ship movements are derived using a three-step forecasting procedure as shown in Figure 3.

In the first step, econometric models were estimated and used to forecast the growth rates of containerised export and import volumes measured in tonnes. Then these growth rates are used to derive forecasts of containerised export and import volumes measured in Twenty-Foot Equivalent Units (TEUs). This procedure of converting tonnes into TEUs is justified on the basis that a high degree of correlation exists between tonnes and TEUs. The coefficient of correlation between tonnes and TUEs, which was estimated using the last ten years data, is observed to be 0.95 for exports and 0.98 for imports.

In the second step, the export and import volumes measured in TEUs are further converted into loaded container numbers on the basis of a conversion equation which was previously estimated and used in BTRE (2002b). The equation is presented in next section.

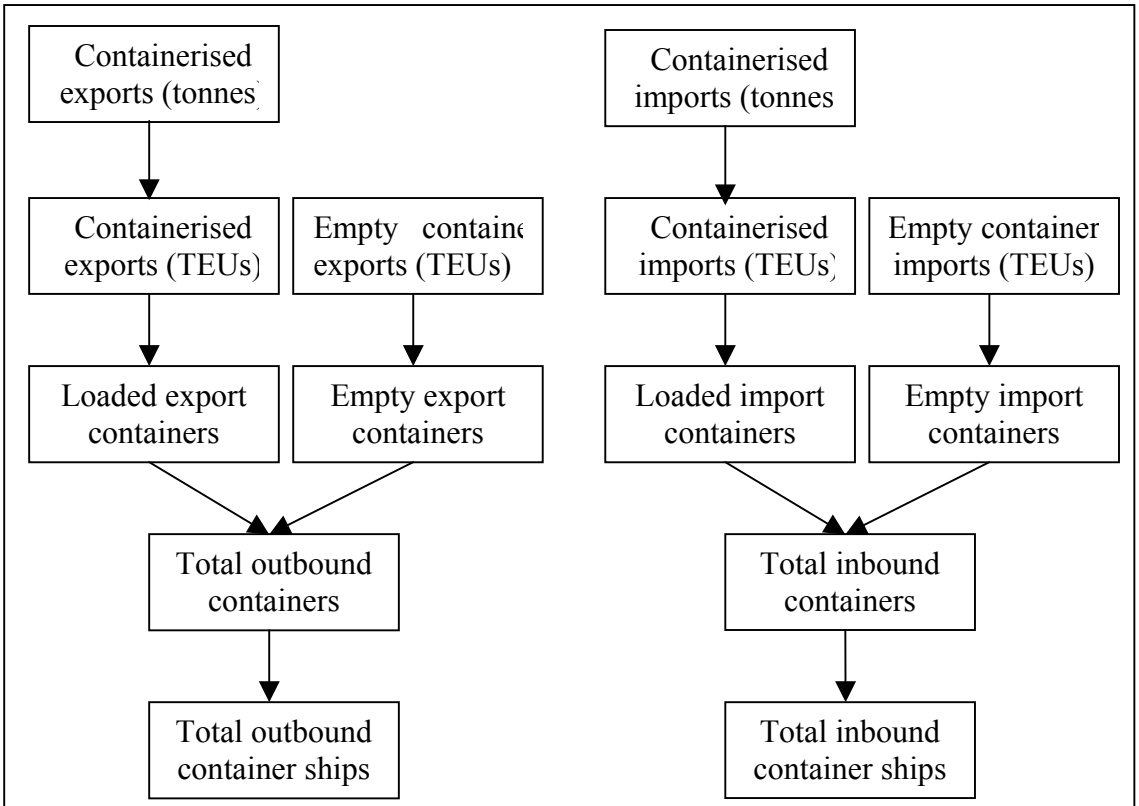

Figure 3 Container and container ship forecasting framework

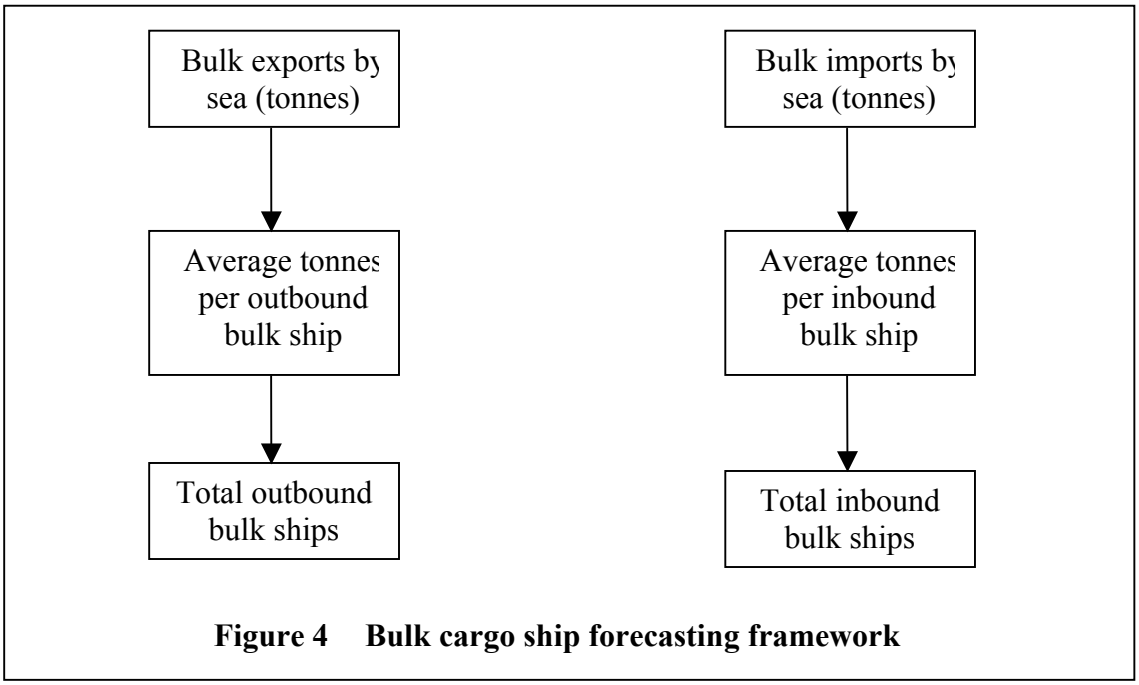

Figure 4 Bulk cargo ship forecasting framework

In the third step, forecasts of loaded container numbers are converted into the number of container ship movements using the average number of outbound and inbound container exchange in Australia. In 2002-03, an outbound container ship exchanged an average of 772 containers, whereas an inbound container ship exchanged an average of 918 containers. The average number of container exchanged per ship increased by 6.3 per cent a year in the last five years, largely due to an increase in ship size. However, this historical growth is not expected to continue in the next ten years due to the Australian ports' capacity to handle large ships and the expected growth in trade volume. In this study, the average number of container exchange per ship is assumed to increase by 3.2 per cent a year to 2 300 (including 1050 outbound container exchange and 1256 inbound container exchange) in 2012-13.

Similarly, forecasts of the export and import of empty container numbers are derived using econometric models of the export and import of empty containers measured in TEUs. These TEU forecasts are then converted into empty container numbers using a conversion equation which is also given in BTRE (2002b) and presented in the next section.

The forecasts of loaded and empty container numbers are added together to derive the forecasts of total container numbers.

Econometric models of bulk export and import volumes measured in tonnes are estimated and used to forecast bulk export and import volumes. These volumes are then converted into the number of bulk ships using the average volume of cargo carried by outbound and inbound bulk ships (Figure 4).

In 2002-03, a bulk ship carried an average of 77 000 tonnes of export cargo and 7 000 tonnes of import cargo. The average volume of cargo carried by outbound and inbound bulk ships increased annually by 9 and 4.3 per cent in the last five years due to an increase in ship size. As discussed earlier, this historical growth rate is less likely to continue in future, mainly due to the Australian ports' capacity to handle large ships and the expected growth in trade volume. In this study, the average volume of cargo carried by bulk ships is forecast to increase annually by 4.5 per cent to 119 600 tonnes in 2012-13 on Australia's outbound routes and by 2.2 per cent to 8 500 tonnes on inbound routes.

The econometric models that are used to forecast the volumes of containerised and bulk exports and imports, the numbers of loaded and empty containers and the number of other freight ship movements are discussed in the following sections.

Containerised export volume

An econometric model of containerised exports is specified in terms of population and real income, exchange rates and the number of empty import containers. The model is presented in equation (1).

$$\ln PXAU_t = \alpha_0 + \alpha_1 \ln PGDPOE_t + \alpha_2 \ln EX_t + \alpha_3 \ln IC_t + u_t \quad (1)$$

where PXAU is per capita containerised exports from Australia in thousand mass tonnes; PGDPOE is per capita real GDP in the OECD countries in billion US dollars; EX is exchange rate in the US dollar per Australian dollar; IC is the number of empty import

containers proxy by containerised imports in thousand mass tonnes; u is an error term; α's are regression coefficients; and t is a time subscript.

In the model, the population and real income of the OECD countries are used as proxy for population and real income of all Australia's export markets. This is because the OECD countries currently account for $68.4 billion or 59.2 per cent of Australia's total merchandise export value.

In Australia, shippers do use to some extent empty import containers (i.e. containers emptied after unloading imported cargo) to load their export cargo. In 2001, the volume of containerised exports was adversely affected by a shortage of import containers to be used for loading export cargo (Daily Commercial News 2001). Therefore, the number of empty import containers is included as one of the explanatory variables in the model.

In the model, population is included on a per capita basis to avoid the consequences of a possible collinearity between two exogenous variables such as real income and the import of containers.

The model is empirically estimated using historical data from 1983-84 to 2002-03. The estimated regression results that are presented in Table 1 suggest that the estimated model is a good fit with an adjusted R^2 value of 0.95. In other words, the model has a high predictive power, and hence it is expected to provide reliable forecasts of containerised exports.

Table 1 Estimated regression statistics – per capita containerised exports

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
Intercept	-10.371	-4.405	0.01	N = 20
PGDPOE	1.383	3.650	0.01	Adjusted-R^2 = 0.95
EX	-0.352	-1.614	0.11	DW =1.94
IC	1.016	5.993	0.01	

All of the estimated coefficients are found to be statistically significant and have expected signs. They indicate that containerised export volumes are positively influenced by the per capita real income in Australia's export markets and the number of empty import containers, and negatively by the exchange rate.

The per capita real income is observed to be the main factor influencing containerised exports. The elasticity of per capita real income is estimated to be 1.4 which implies that a one per cent increase (decrease) in per capita real income in Australia's export markets will result in a 1.4 per cent increase (decrease) in per capita containerised exports.

The estimated exchange rate elasticity suggests that the volume of containerised exports increases (decreases) with a depreciation (appreciation) of the Australian dollar against the US dollar.

Similarly, an increase (decrease) in the number of empty import containers will increase (decrease) the volume of containerised exports.

Containerised import volume

A containerised import model presented in equation (2) is specified in terms of population, real gross national expenditure (GNE), the trade weighted index of exchange rate (TWI) and a dummy variable.

$$(2) \qquad \ln PMAU_t = \beta_0 + \beta_1 \ln PGNEAU_t + \beta_2 \ln TWIAU_t + \beta_3 D8889_t + e_t$$

where PMAU is per capita containerised imports to Australia in thousand mass tonnes; PGNEAU is the per capita real gross national expenditure of Australia in million dollars; TWIAU is the trade weighted index of exchange rate; D8889 is a dummy variable to capture an unexplained spike in containerised imports in 1988-89; e is an error term; β's are regression parameters; and t is a time subscript.

The model is estimated using historical data from 1983-84 to 2002-03. The estimated regression statistics of the model are shown in Table 2. The model is a good fit with the adjusted R-square value of 0.84.

Table 2 Estimated regression statistics – per capita containerised imports

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
Intercept	3.418	4.364	0.01	
PGNEAU	1.483	6.511	0.01	N = 20
TWIAU	0.292	1.664	0.10	Adjusted-R^2 = 0.84
D8889	0.112	2.003	0.05	DW = 1.76

All the estimated coefficients of the model are highly significant and have expected signs. The magnitude of the estimated income and price elasticities appears to be reasonable.

Real GNE appears to be the main factor influencing the containerised imports. A one per cent increase (decrease) in per capita real GNE leads per capita containerised imports to increase (decrease) by 1.5 per cent.

The estimated elasticity of the exchange rate is positive implying that the volume of containerised imports increases (decreases) with the appreciation (depreciation) of the Australian dollar against the US dollar. If the Australian dollar appreciates by one per cent then the volume of per capita containerised imports will rise by 0.3 per cent, and vice versa.

Conversion from TEUs to loaded container numbers

The forecasts of export and import volumes in TEUs are converted into loaded container numbers using equation (3) which is given in details in BTRE (2002b).

(3) $$Loaded\ container\ numbers = 40059 + 0.706TEU$$

Export of empty containers

The export of empty containers largely depends up on the volume of containerised imports, the degree of substitution between export and import containers and the system of distributing import commodities within Australia. At current technology, export and import containers are not perfect substitutes. Export commodities are generally heavy, and hence they are mostly shipped in twenty-foot containers. On the other hand, most import commodities are relatively light and therefore they are mostly shipped in 40-foot containers.

The export of empty containers is also influenced by the system of distributing import commodities within Australia. For example, Sydney port is presently being used as a major gateway for South Australian imports. Mostly, import containers are offloaded in Sydney, cleared customs, opened and the contents distributed around the country including Adelaide. This system results in an increase in the number of empty containers in Sydney while these containers could be used to export commodities in Adelaide. Since the cost to reposition these empty containers to Adelaide where the demand for import containers is high will not be borne by shipping line and exporters, the empty containers are likely to remain in Sydney and be exported as empty containers.

Assuming the degree of substitution between export and import containers remains at its current level and no change in the present system of distributing import commodities within Australia, the export of empty containers is largely influenced by the volume of containerised imports. Hence, the model of empty container exports is specified in terms of containerised import volumes. The model is presented in equation (4).

(4) $$\ln XEC_t = \gamma_0 + \gamma_1 \ln MAU_t + v_t$$

Where XEC is the export of empty containers in TEUs; MAU is containerised imports in thousand tonnes; v is an error term; γ's are regression parameters; and t is time subscript.

In the absence of a long time series data on model variables, the model is estimated using only 10 years data, from 1993-94 to 2002-03. The estimated regression results of the empty container export model show that the model is a good fit with adjusted R-square value of 0.93 (Table 3). The estimated coefficients are highly significant and suggest that a one per cent increase (decrease) in the volume of containerised imports will result in a 1.8 per cent increase (decrease) in the export of empty containers measured in TEUs.

Table 3 Estimated regression statistics – export of empty containers

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
				N = 10
Intercept	-3.951	-2.580	0.03	Adjusted-R^2 = 0.93
MAU	1.771	10.820	0.01	DW = 1.85

Import of empty containers

Since empty containers are imported to ship export commodities, the number of imported empty containers depends on the expected volume of containerised exports. Therefore, the model of empty container imports is specified in terms of the volume of containerised exports. The model is shown in equation (5).

(5) $$\ln MEC_t = \lambda_0 + \lambda_1 \ln XAU_{t+1} + w_t$$

Where MEC is the import of empty containers in TEUs; XAU is containerised exports in thousand tonnes; w is an error term; λ's are regression parameters; and t is a time subscript.

The model is estimated using only 10 years data, from 1993-94 to 2002-03. Regression results of the model are shown in Table 4.

Table 4 Estimated regression statistics – import of empty containers

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
				N = 10
Intercept	5.872	5.084	0.01	Adjusted-R^2 = 0.87
XAU_{t+1}	0.639	5.454	0.01	DW = 1.79

The estimated model is observed to be a good fit with adjusted R-square value of 0.87. The estimated coefficients are highly significant and show that the import of empty containers is positively influenced by the expected containerised exports in one period ahead. A one percent increase (decrease) in the expected volume of containerised exports will result in a 0.6 per cent increase (decrease) in the import of empty containers measured in TEUs.

Conversion from TEUs to empty container numbers

The forecasts of empty export and import containers measured in TEU are converted into the number of empty containers using equation (6) given in details in BTRE (2002b).

(6) $$Empty\ container\ number = -524 + 0.226\,TEU$$

BULK EXPORT VOLUME

An econometric model of Australia's bulk exports is specified in terms of real income of importing countries, aggregate export prices, exchange rates and population. The model is presented in equation (7).

$$(7) \qquad \ln PBX_t = \delta_0 + \delta_1 \ln PGDPOE_t + \delta_2 \ln XPR_t + \delta_3 EX_t + m_t$$

where PBX is per capita bulk exports in million tonnes; PGDPOE is the per capita real income of importing countries billion US dollars; XPR is the aggregate export price index; EX is exchange rate in the US dollar per Australian dollar; m is an error term; δ's are regression parameters; and t is a time subscript.

Although Australia's trade patterns have been changing towards non-OECD countries, the OECD countries remain the major bulk export markets. In 2002-03, Australia exported 343 million tonnes of bulk commodities (or 67 per cent of Australia's total bulk exports) to the OECD countries. In other words, the economy of the OECD has a significant influence on Australia's bulk exports. Hence, the real GDP of the OECD countries is used as proxy for the income variable in the model.

The model is estimated using 20 years historical data, from 1983-84 to 2002-03. The estimated regression results presented in Table 5 indicate that the model is a good fit with the adjusted-R^2 value of 0.97. The income variable is observed to be highly significant and it is the main driver of bulk exports. The aggregate export price and exchange rate variables are not statistically significant. However, they are included in the model as they have expected signs and their inclusion improves the predictive power of the model.

Table 5 Estimated regression statistics – bulk exports

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
Intercept	-2.199	-1.448	-0.15	N = 20
PGDPOE	2.229	5.303	0.01	Adjusted-R^2 = 0.97
XPR	-0.038	-0.362	0.72	DW = 1.80
EX	-0.035	-0.336	0.74	

The estimated income elasticity implies that a one per cent increase (decrease) in per capita real income will result in a 2.2 per cent increase (decrease) in the volume of bulk exports. Similarly, a decrease in export price and/or a depreciation of Australian dollar will have a positive impact on bulk exports.

Bulk import volume

An econometric model of bulk imports is specified in terms of real GNE, the aggregate import price index, exchange rates and population. The model is given in equation (8).

(8) $$\ln PBM_t = \theta_0 + \theta_1 \ln PGNEAU_t + \theta_2 \ln MPR_t + \theta_3 EX_t + n_t$$

where PBM is per capita bulk imports in million tonnes; PGNEAU is per capita real gross national expenditure in Australia in million dollars; MPR is the aggregate import price index; EX is exchange rate in the US dollar per Australian dollar; n is an error term; θ's are regression parameters; and t is a time subscript.

The initial estimation of the model suggested that the import price is neither statistically significant nor it has an expected sign. One possible reason could be that the aggregate price index may have been dominated by the prices of high value containerised commodities and thus it may have failed to reflect the true price of bulk commodities. Hence, the import price variable is dropped from the model in its final run.

Like the bulk export model, the bulk import model is also estimated using 20 years historical data, from 1983-84 to 2002-03. The estimated model is observed to be a good fit with adjusted R-square value of 0.92 (Table 6). The income variable is found to be the main driver of bulk imports. The exchange rate variable is not found statistically significant. However, the variable is included in the model for two reasons. The estimated coefficient of the variable has an expected sign and the predictive power of the model improves with the inclusion of the variable.

The estimated income elasticity of bulk imports imply that a one per cent increase (decrease) in per capita real income (measured by real GNE) will increase (decrease) the per capita volume of bulk imports by 1.5 per cent.

Table 6 Estimated regression statistics – per capita bulk imports

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
Intercept	-1.212	-0.730	0.47	N = 20
PGNEAU	1.480	3.148	0.01	Adjusted-R^2 = 0.92
EX	0.132	0.638	0.52	DW = 1.44

Other freight ship movements

Since the movement of other freight ships is found to be largely influenced by non-economic factors, an econometric model of other freight ship movements could not be specified and estimated for forecasting purposes. Instead, time trend models are used to forecast the outbound and inbound movements of other freight ships. The models are presented in equations (9) and (10).

(9) $$\ln OOFS_t = \pi_0 + \pi_1 T_t + p_t$$

(10) $$\ln IOFS_t = \mu_0 + \mu_1 T_t + q_t$$

where OOFS is the number of outbound other freight ships; IOFS is the number of inbound other freight ships; T is time trend variable; p and q are error terms; π's and μ's are regression parameters; and t is a time subscript.

In the absence of a long time series data on the movements of other freight ships, the models are estimated using only 6 years historical data, from 1997-98 to 2002-03. The estimated regression statistics shown in Table 7 suggest that the models are not a good fit. However, they do provide trend lines of outbound and inbound movements of other freight ships based on historical data, and there are no other credible forecasting techniques available at this point of time. Hence the model is accepted with caution for forecasting purposes.

Table 7 Estimated regression statistics – other freight ship movements

Variable	Estimated coefficient	T-ratio	Significance level	Other statistics
Outbound ships				N = 6
Intercept	6.461	77.673	0.01	R^2 = 0.36
TIME	-0.032	-1.503	0.21	DW = 1.54
Inbound ships				N = 6
Intercept	6.421	78.787	0.01	R^2 = 0.17
TIME	-0.019	-0.901	0.42	DW = 1.72

Data and assumptions

Historical data on containerised exports and imports, empty containers, GNE, GDP, exchange rates, trade weighted index of exchange rates, export price index, import price index and population which were used to estimate the above econometric and time trend models were gathered from BTRE's international cargo statistics database, BTRE's Waterline (2004b and earlier issues), ABS (2004), Access Economics (2004) and OECD (2003). The population and macroeconomic assumptions, which are used to forecast the movements of container and bulk ships, are obtained respectively from ABS (2004) and Access Economics (2004). The assumptions are shown in Table 10 in Appendix A. The macroeconomic assumptions are slightly adjusted to account for changes in the conditions of domestic and overseas economies, and for smoothing purposes.

In this study, liner exports and imports are used to represent containerised exports and imports. Presently 96 per cent of the liner cargo measured in mass tonnes is being transported in containers.

Forecasts of container and ship movements

Container movements

In recent times, shippers are using more and more 40-foot containers to import and export commodities. The proportion of 40-foot containers has increased by 6.3 per cent a year in the last five years, from 28 per cent in 1998-99 to 36 per cent in 2002-03. However, it is difficult to predict the proportion over the forecast period especially in the absence of long quality time-series data on factors influencing the proportion, such as freight cost, port capacity, safety, durability and transferability. In this study, forecasts of container numbers have been derived using the current level of split between 20-foot and 40-foot containers. That is, the proportion of 40-foot containers is assumed to remain at 36 per cent over the forecast period.

The total number of container movements is forecast to increase by 4.5 per cent a year in the next ten years, from 2.5 millions in 2002-03 to 3.9 millions in 2012-13 (Table 8). This

Table 8 Container movements on Australia's international routes ('000)

	Outbound			Inbound			All
Year	Loaded	Empty	Total	Loaded	Empty	Total	containers
1998-99							
1999-00	*920*	*93*	*1013*	*1129*	*52*	*1181*	2194
2000-01	*949*	*91*	*1040*	*1083*	*62*	*1145*	2184
2001-02	*978*	*95*	*1073*	*1131*	*65*	*1197*	2269
2002-03	*973*	*150*	*1123*	*1303*	*57*	*1360*	2483
2003-04	**929**	**153**	**1083**	**1388**	**56**	**1444**	**2527**
2004-05	**954**	**149**	**1103**	**1395**	**58**	**1453**	**2556**
2005-06	**998**	**153**	**1151**	**1428**	**60**	**1488**	**2638**
2006-07	**1052**	**162**	**1215**	**1487**	**64**	**1551**	**2766**
2007-08	**1137**	**174**	**1311**	**1590**	**68**	**1658**	**2969**
2008-09	**1221**	**182**	**1403**	**1654**	**71**	**1725**	**3128**
2009-10	**1280**	**188**	**1468**	**1711**	**74**	**1785**	**3253**
2010-11	**1357**	**197**	**1554**	**1792**	**78**	**1869**	**3423**
2011-12	**1457**	**212**	**1669**	**1900**	**82**	**1981**	**3650**
2012-13	**1550**	**224**	**1774**	**1996**	**85**	**2082**	**3855**
Average annual growth rate (%)							
1998-99							
1999-00							
2000-01	3.1	-2.3	2.6	-4.1	19.2	-3.1	-0.4
2001-02	3.0	4.7	3.2	4.5	5.2	4.5	3.9
2002-03	-0.5	58.4	4.7	15.2	-13.3	13.6	9.4
2003-04	**-4.4**	**2.1**	**-3.6**	**6.6**	**-1.3**	**6.2**	**1.8**
2004-05	**2.7**	**-2.6**	**1.9**	**0.5**	**3.1**	**0.6**	**1.1**
2005-06	**4.6**	**2.5**	**4.3**	**2.3**	**4.3**	**2.4**	**3.2**
2006-07	**5.5**	**6.0**	**5.5**	**4.2**	**6.6**	**4.3**	**4.8**
2007-08	**8.1**	**7.1**	**7.9**	**6.9**	**6.1**	**6.9**	**7.4**
2008-09	**7.4**	**4.6**	**7.0**	**4.0**	**3.8**	**4.0**	**5.3**
2009-10	**4.8**	**3.5**	**4.6**	**3.4**	**4.6**	**3.5**	**4.0**
2010-11	**6.0**	**4.9**	**5.8**	**4.7**	**5.5**	**4.7**	**5.2**
2011-12	**7.4**	**7.4**	**7.4**	**6.0**	**4.8**	**6.0**	**6.6**
2012-13	**6.4**	**5.6**	**6.3**	**5.1**	**4.7**	**5.1**	**5.6**
Annual average growth rate (%): 2003-04 to 2012-13							
	4.8	**4.1**	**4.7**	**4.4**	**4.2**	**4.4**	**4.5**

*Numbers in Italic and bold are respectively estimates and forecasts.

increase in container numbers is largely driven by the expected positive economic growth in Australia and its major export markets. Australia's gross national expenditure is forecast to grow by an annual average growth rate of 2.9 per cent over the forecast period. This will lead the volume of containerised imports and thereby the number of inbound loaded containers to rise by 4.4 per cent a year to 2 millions in year 2012-13.

Similarly, the economy of the OECD countries is forecast to grow by an annual average rate of 2.7 per cent in the next decade. As a result, the volume of containerised exports and thereby the number of outbound loaded containers will increase by 4.8 per cent a year during the next ten years, from 1 million in 2002-03 to 1.6 millions in 2012-13. An expected devaluation of the Australian dollar against the US dollar towards the second half of the forecast period is one of the reasons to make the number of outbound containers to rise more rapidly than the number of inbound containers.

The number of outbound and inbound empty containers is expected to increase respectively by 4.1 and 4.2 per cent a year during the forecast period. In 2012-13, 224 000 empty containers will be exported and 85 000 empty containers will be imported.

The number of outbound loaded containers is expected to rise at a rate relatively higher than the rate of increase in the number of outbound empty containers. This is because the number of outbound loaded and empty containers depends respectively on the volume of containerised exports and imports, and the volume of containerised exports is forecast to increase rapidly than the volume of containerised imports during the forecast period (Table 11 Appendix B).

Ship movements

The total number of ship movements on Australia's international shipping routes is forecast to increase by 0.7 per cent a year in the next ten years, from 17 200 in 2002-03 to 18 500 in 2012-13. As the volume of exports is expected to rise largely due to a positive economic outlook for the OECD countries and the likely depreciation of Australian dollar against the US dollar, the total number of outbound freight ship movements will rise by 0.5 per cent a year over the forecast period. Around 9 000 ships will depart from Australia in 2012-13 (Figure 5 and Table 9).

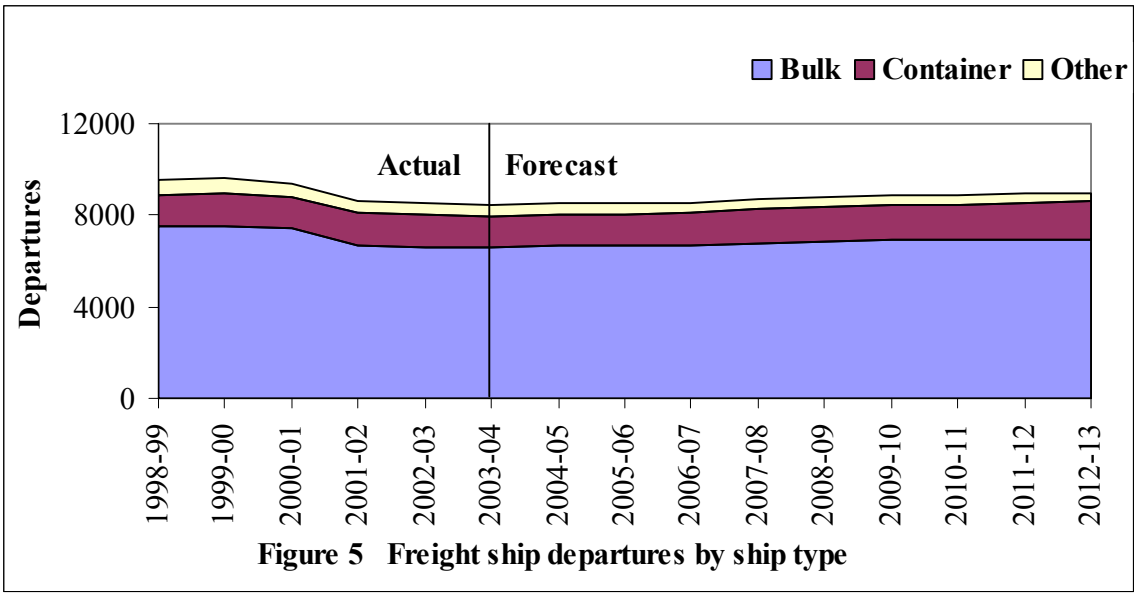

Figure 5 Freight ship departures by ship type

A positive economic outlook for Australia will see the number of inbound freight ship movements increasing by 0.9 per cent a year over the next decade, from 8 700 in 2002-03 to 9 500 in 2012-13 (Figure 6).

Conclusions

This paper shows that the forecasts of inbound and outbound ship movements on Australia's international shipping routes can be developed using econometric models. The main advantage of using econometric models is that the magnitude and direction of the likely impact of economic variables on ship movements can be easily estimated and used for policy analysis purposes.

Table 9 Freight ship movements on Australia's international routes

	Outbound				Inbound			
Year	Bulk	Container	Other	Total	Bulk	Container	Other	Total
1998-99	7541	1363	604	9508	7560	1314	581	9455
1999-00	7545	1391	661	9597	7572	1372	665	9609
2000-01	7434	1360	586	9380	7477	1339	592	9408
2001-02	6702	1448	504	8654	6727	1445	518	8690
2002-03	6619	1411	519	8549	6715	1436	542	8693
2003-04	**6593**	**1361**	**511**	**8464**	**6587**	**1525**	**538**	**8650**
2004-05	**6673**	**1344**	**495**	**8512**	**6475**	**1486**	**528**	**8490**
2005-06	**6700**	**1360**	**479**	**8538**	**6497**	**1475**	**519**	**8491**
2006-07	**6714**	**1392**	**464**	**8569**	**6678**	**1491**	**509**	**8677**
2007-08	**6800**	**1456**	**449**	**8706**	**6876**	**1544**	**499**	**8920**
2008-09	**6871**	**1511**	**435**	**8818**	**6867**	**1556**	**490**	**8913**
2009-10	**6896**	**1533**	**421**	**8850**	**6929**	**1561**	**481**	**8971**
2010-11	**6905**	**1574**	**408**	**8887**	**7068**	**1584**	**472**	**9125**
2011-12	**6914**	**1639**	**395**	**8948**	**7269**	**1628**	**463**	**9359**
2012-13	**6923**	**1689**	**383**	**8995**	**7419**	**1657**	**454**	**9530**
Average annual growth rate (%)								
1998-99								
1999-00	0.1	2.1	9.4	0.9	0.2	4.4	14.5	1.6
2000-01	-1.5	-2.2	-11.3	-2.3	-1.3	-2.4	-11.0	-2.1
2001-02	-9.8	6.5	-14.0	-7.7	-10.0	7.9	-12.5	-7.6
2002-03	-1.2	-2.6	3.0	-1.2	-0.2	-0.6	4.6	0.0
2003-04	**-0.4**	**-3.6**	**-1.6**	**-1.0**	**-1.9**	**6.2**	**-0.6**	**-0.5**
2004-05	**1.2**	**-1.2**	**-3.2**	**0.6**	**-1.7**	**-2.5**	**-1.9**	**-1.8**
2005-06	**0.4**	**1.1**	**-3.2**	**0.3**	**0.3**	**-0.8**	**-1.9**	**0.0**
2006-07	**0.2**	**2.3**	**-3.2**	**0.4**	**2.8**	**1.1**	**-1.9**	**2.2**
2007-08	**1.3**	**4.7**	**-3.2**	**1.6**	**3.0**	**3.6**	**-1.9**	**2.8**
2008-09	**1.0**	**3.8**	**-3.2**	**1.3**	**-0.1**	**0.8**	**-1.9**	**-0.1**
2009-10	**0.4**	**1.5**	**-3.2**	**0.4**	**0.9**	**0.3**	**-1.9**	**0.6**
2010-11	**0.1**	**2.6**	**-3.2**	**0.4**	**2.0**	**1.5**	**-1.9**	**1.7**
2011-12	**0.1**	**4.1**	**-3.2**	**0.7**	**2.8**	**2.7**	**-1.9**	**2.6**
2012-13	**0.1**	**3.1**	**-3.2**	**0.5**	**2.1**	**1.8**	**-1.9**	**1.8**
Annual average growth rate (%): 2002-03 to 2012-13								
	0.5	**1.8**	**-3.0**	**0.5**	**1.0**	**1.4**	**-1.7**	**0.9**

*Numbers in bold are forecasts.

The model parameters estimated in this paper suggest that the volume of exports which determines the number of outbound freight ship movements is observed to be largely driven by the economic growth in Australia's major export markets and exchange rates; whereas the number of inbound freight ship movements are mainly influenced by the performance of the Australian economy and exchange rates.

In this study, a variable describing shippers' substitutability behaviour between air and sea transport was not incorporated in the econometric models of freight ship movements, because the volume of sea freight is dominated by heavy and low value bulk commodities. It is not economically efficient to transport these commodities by air.

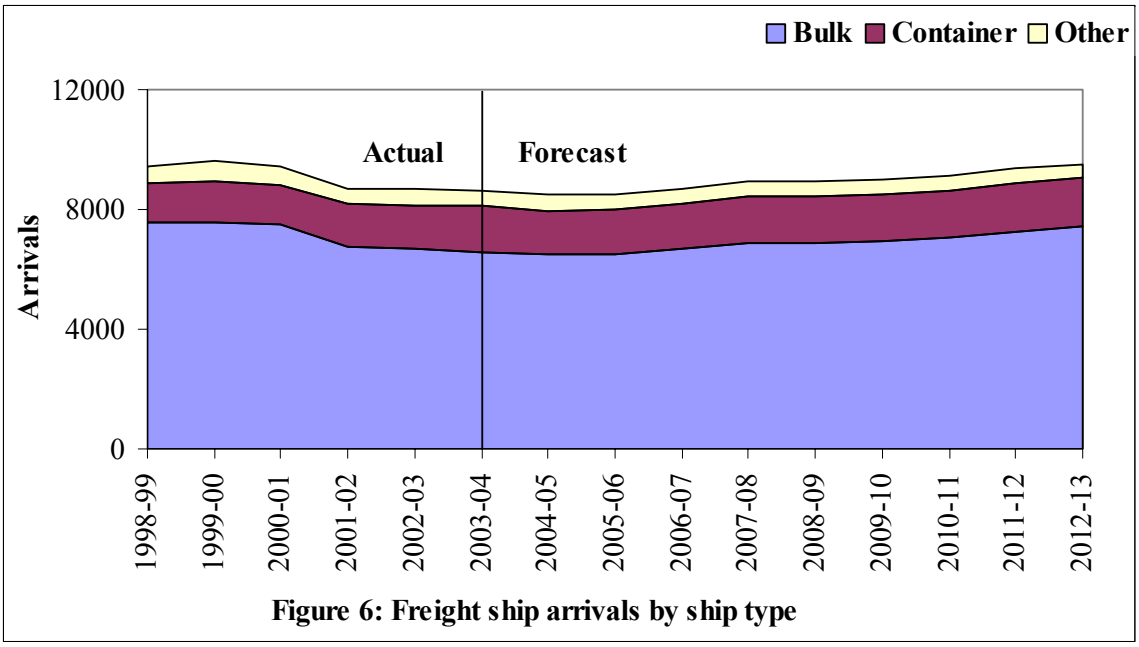

Figure 6: Freight ship arrivals by ship type

In sum, the forecasts developed in this paper clearly indicate that the sea transport sector will remain strong in the next 10 years and that bulk vessels will continue to be the main mode of sea freight on Australia's international shipping routes.

Appendix A

Table 10 Population and macroeconomic assumptions

Year	Real GNE Australia (% change)	Real GDP OECD (% change)	Population Australia (% change)	Population OECD (% change)
1998-99	5.9	2.6	1.1	0.5
1999-00	4.7	3.9	1.2	0.7
2000-01	0.0	2.5	1.3	1.4
2001-02	4.5	0.1	1.3	0.7
2002-03	5.9	3.4	1.3	0.8
2003-04	**3.8**	**2.6**	**1.2**	**0.8**
2004-05	**0.8**	**3.0**	**1.1**	**0.8**
2005-06	**2.0**	**2.6**	**1.0**	**0.8**
2006-07	**3.7**	**2.5**	**1.0**	**0.8**
2007-08	**3.8**	**3.0**	**1.0**	**0.8**
2008-09	**2.3**	**2.8**	**1.0**	**0.8**
2009-10	**2.4**	**2.6**	**0.9**	**0.8**
2010-11	**3.1**	**2.5**	**0.9**	**0.8**
2011-12	**3.7**	**2.5**	**0.9**	**0.8**
2012-13	**3.1**	**2.5**	**0.9**	**0.8**
Annual average over forecast period				
	2.9	**2.7**	**1.0**	**0.8**

Year	Export price (% change)	Import price (% change)	Exchange rate TWI	Exchange rate US$/AU$
1998-99	1.7	7.3	55.4	0.61
1999-00	-4.6	0.6	56.2	0.64
2000-01	-4.4	10.0	50.5	0.55
2001-02	5.0	4.3	49.8	0.51
2002-03	-0.6	-3.5	52.4	0.57
2003-04	**-9.3**	**-10.5**	**61.7**	**0.71**
2004-05	**2.8**	**3.7**	**57.4**	**0.70**
2005-06	**1.0**	**4.4**	**55.3**	**0.70**
2006-07	**1.2**	**4.7**	**52.3**	**0.70**
2007-08	**2.9**	**-1.3**	**53.9**	**0.70**
2008-09	**0.1**	**0.2**	**54.0**	**0.65**
2009-10	**3.0**	**2.8**	**53.1**	**0.65**
2010-11	**3.5**	**2.8**	**52.4**	**0.65**
2011-12	**1.4**	**0.8**	**52.6**	**0.65**
2012-13	**1.6**	**1.3**	**52.5**	**0.65**
Annual average over forecast period				
	1.0	**0.8**	**54.5**	**0.68**

Appendix B

Table 11 Containerised and bulk sea cargo (million tonnes)

	Containerised cargo		Bulk cargo	
Year	Exports	Imports	Exports	Imports
1998-99	20.3	12.5	411.8	43.8
1999-00	20.9	13.7	441.5	42.6
2000-01	20.2	12.4	475.5	42.0
2001-02	27.6	14.0	479.0	44.0
2002-03	29.9	16.2	510.0	46.0
2003-04	**29.4**	**17.8**	**530.8**	**46.1**
2004-05	**30.2**	**17.9**	**561.5**	**46.3**
2005-06	**31.7**	**18.4**	**589.0**	**47.5**
2006-07	**33.5**	**19.1**	**616.8**	**49.8**
2007-08	**36.3**	**20.5**	**652.8**	**52.4**
2008-09	**39.1**	**21.3**	**689.3**	**53.5**
2009-10	**41.0**	**22.1**	**722.8**	**55.1**
2010-11	**43.6**	**23.2**	**756.3**	**57.4**
2011-12	**46.9**	**24.6**	**791.4**	**60.3**
2012-13	**50.0**	**25.9**	**828.1**	**62.9**
Average annual growth rate (%)				
1998-99				
1999-00	3.2	9.7	7.2	-2.6
2000-01	-3.4	-9.5	7.7	-1.5
2001-02	36.7	12.9	0.7	4.8
2002-03	8.1	15.4	6.5	4.6
2003-04	**-1.5**	**10.2**	**4.1**	**0.2**
2004-05	**2.8**	**0.5**	**5.8**	**0.4**
2005-06	**4.8**	**2.4**	**4.9**	**2.5**
2006-07	**5.7**	**4.3**	**4.7**	**5.0**
2007-08	**8.4**	**7.1**	**5.8**	**5.2**
2008-09	**7.7**	**4.1**	**5.6**	**2.0**
2009-10	**5.0**	**3.5**	**4.9**	**3.1**
2010-11	**6.2**	**4.8**	**4.6**	**4.2**
2011-12	**7.6**	**6.2**	**4.6**	**5.0**
2012-13	**6.6**	**5.2**	**4.6**	**4.3**
Annual average growth rate: 2002-03 to 2012-13 (%)				
	5.3	**4.8**	**5.0**	**3.2**

a. Includes five major ports: Brisbane, Sydney, Melbourne, Adelaide and Fremantle.
*Numbers in bold are forecasts.

Table 12 Containerised sea cargo[a] ('000 TEUs)

	Containerised exports			Containerised Imports		
Year	Loaded	Empty	Total	Full	Empty	Total
1998-99	1004	338	1342	1216	195	1411
1999-00	1133	377	1510	1403	213	1615
2000-01	1213	381	1594	1391	262	1653
2001-02	1273	405	1678	1481	280	1761
2002-03	1279	647	1926	1733	245	1978
2003-04	**1260**	**681**	**1941**	**1910**	**250**	**2159**
2004-05	**1294**	**663**	**1958**	**1919**	**257**	**2177**
2005-06	**1357**	**680**	**2036**	**1965**	**268**	**2233**
2006-07	**1434**	**720**	**2154**	**2050**	**286**	**2335**
2007-08	**1554**	**771**	**2325**	**2196**	**303**	**2499**
2008-09	**1673**	**806**	**2480**	**2286**	**314**	**2601**
2009-10	**1756**	**835**	**2591**	**2367**	**329**	**2695**
2010-11	**1865**	**875**	**2740**	**2481**	**346**	**2827**
2011-12	**2007**	**940**	**2947**	**2634**	**363**	**2997**
2012-13	**2139**	**992**	**3131**	**2771**	**380**	**3151**
Average annual growth rate (%)						
1998-99						
1999-00	12.9	11.5	12.5	15.4	8.8	14.4
2000-01	7.0	1.0	5.5	-0.8	23.1	2.3
2001-02	4.9	6.4	5.3	6.5	6.9	6.6
2002-03	0.5	59.7	14.8	17.0	-12.3	12.3
2003-04	**-1.5**	**5.3**	**0.8**	**10.2**	**1.8**	**9.2**
2004-05	**2.8**	**-2.6**	**0.9**	**0.5**	**3.0**	**0.8**
2005-06	**4.8**	**2.5**	**4.0**	**2.4**	**4.2**	**2.6**
2006-07	**5.7**	**5.9**	**5.8**	**4.3**	**6.5**	**4.6**
2007-08	**8.4**	**7.1**	**8.0**	**7.1**	**6.1**	**7.0**
2008-09	**7.7**	**4.6**	**6.7**	**4.1**	**3.8**	**4.1**
2009-10	**5.0**	**3.5**	**4.5**	**3.5**	**4.5**	**3.6**
2010-11	**6.2**	**4.9**	**5.8**	**4.8**	**5.4**	**4.9**
2011-12	**7.6**	**7.4**	**7.5**	**6.2**	**4.8**	**6.0**
2012-13	**6.6**	**5.5**	**6.2**	**5.2**	**4.7**	**5.1**
Annual average growth rate (%): 2003-04 to 2012-13						
	5.3	**4.4**	**5.0**	**4.8**	**4.5**	**4.8**

a. Includes five major ports: Brisbane, Sydney, Melbourne, Adelaide and Fremantle.
*Numbers bold are forecasts.

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