PORT LEVEL FORECASTS OF CONTAINER AND SHIP MOVEMENTS IN AUSTRALIA: 2004-05 TO 2024-25

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1 Introduction

Shipping has remained the main mode of transporting exports and imports in Australia. In 2003-04, Australia's total international trade in commodities was 623.1 million tonnes (worth $248.5 billion) including 558.6 million tonnes of exports and 64.5 million tonnes of imports. Sea trade accounted for 99.9 per cent of the total trade.

Following the September 11 terrorist attacks in the USA, the Bali bombings, the Madrid bombing and more recently, the London bombings, there are security concerns in relation to the movement of containers and ships through Australian ports. Information on the movement of containers and ships is vital for the planning and implementation of security measures at Australian ports. Hence, this study presents the port level forecasts of container and ship movements through Australian ports over the next twenty years. The forecasts are developed for Australia's five main city ports (Brisbane, Sydney, Melbourne, Adelaide and Fremantle) and, in aggregation, 'other ports' (that is, all Australian ports excluding the five main city ports).

2 Forecasting models

In this paper, forecasts of container and ship movements have been developed using single equation econometric models. The models are relatively better than time trend or univariate time-series models in the sense that they 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 tourism and transport demand forecasting studies, such as Loeb (1982), Hamal (1997a, 1997b and 2004) and BTRE (2002a and 2002b).

The forecasts of container and ship movements for the five main city ports are derived using a two-step forecasting procedure. In the first step, the econometric models are estimated and used to forecast the export and import of full and empty containers measured in Twenty-Foot Equivalent Units (teus). In the second step, the export and import forecasts of full and empty containers are added to develop forecasts of total container trade which is then divided by the average teus exchanged per container ship visit to derive forecasts of container ship visits.

Econometric models could not be estimated in the case of other ports in the absence of long time-series data on full and empty container exports and imports for other ports. Forecasts of container and ship movements for other ports are derived using the average growth rate forecasts of the five main city ports. This approach has been used following the fact that the five main city ports dominate Australia's container trade, accounting for 89.9 per cent of the total container trade, and the approach allows maintaining consistency in port level and national level forecasts.

The econometric models of full and empty container exports and imports are empirically estimated using historical data from 1993-94 to 2003-04 and are discussed in detail in the

following sections.

2.1 Full container export model

As shown in equation (1), a full container export model is specified in terms of population, real income, exchange rates and the number of empty import containers.

$$\ln PFUX_{it} = \alpha_{i0} + \alpha_{i1} \ln PGDP_{jt} + \alpha_{i2} \ln EXUSAU_{t} + \alpha_{i3} \ln IEC_{it} + u_{it} \quad (1)$$

Where $PFUX_i$ = Per capita full container exports from the ith port of Australia in teus; $PGDP_j$ = Per capita real Gross Domestic Product (GDP) in the jth export destination country in billion US dollars; EXUSAU = Exchange rate of the US dollar per Australian dollar; IEC_i = Import of empty containers to the ith port measured in teus; u = Error term; α's = Regression coefficients; i = ith Australian port; j = jth export destination country; and t = Time subscript.

In the model, population is included on a per capita basis to avoid the consequences of a possible collinearity between population and other exogenous variables such as real income and the import of empty containers. Also, the exchange rate variable is substituted by the Trade Weighted Index (TWI) in the model for Adelaide and Fremantle ports, mainly to increase the predictive power of the model.

Since most container exports from Brisbane and Fremantle are destined for Japan, the Japanese population and real income are used as proxy for the population and real income of all export markets of Brisbane and Fremantle ports. Similarly, the population and real income of the OECD countries are used as proxy for the population and real income of the export markets of Sydney, Melbourne and Adelaide ports. This is because the OECD countries currently account for 59.2 per cent of Australia's total merchandise export value.

Although the OECD and non-OECD countries account for a more or less equal share in Sydney's total container exports, the population and real income of the OECD countries are used in the container export model of Sydney Ports. This is because the OECD countries are relatively matured export markets compared with the non-OECD countries. In other words, the export demand elasticities that are estimated using data from the OECD countries are relatively stable and likely to reflect long-run elasticities. Nonetheless, the influence of high economic growth in the emerging markets, such as China and other Asian countries, on Sydney's container exports is included by adjusting the model based forecasts qualitatively based on the magnitude of the growth and the market share of emerging markets.

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

The model is estimated for each main city port using historical data. The estimated regression statistics, which are presented in Table 1, suggest that the estimated models are a good fit with an adjusted R-square value ranging from 0.93 to 0.96. In other words, the models have a high predictive power, and hence, they are expected to provide reliable forecasts of full container exports. Moreover, all of the estimated elasticities, except for the exchange rate elasticity in the Adelaide Port model, are found to be statistically significant and have the expected signs. They indicate that full container exports are positively influenced by per capita real income in Australia's export markets and the import of empty

containers, and negatively by the exchange rate. The import of empty containers was not found to be a driver of full container exports in Brisbane and Sydney.

Table 1 Estimated regression statistics: Full container export model

Variable by port	Estimated coefficient	t-ratio	Significance level	Other statistics
Brisbane				
PGDPJP	5.573	7.867	0.01	Adjusted-R^2 = 0.93
EXUSAU	-0.939	-5.501	0.01	N = 11 DW = 2.11
Intercept	-47.430	-6.920	0.01	
Sydney				
PGDPOE	1.734	7.275	0.01	Adjusted-R^2 = 0.94
EXUSAU	-0.232	-3.038	0.02	N = 9 DW = 1.96
Intercept	2.757	4.532	0.01	
Melbourne				
PGDPOE	1.736	2.229	0.06	Adjusted-R^2 = 0.96
EXUSAU	-0.136	-1.325	0.23	N = 11 DW = 1.38
IEC	0.228	1.324	0.23	
Intercept	1.439	0.429	0.68	
Adelaide				
PGDPOE	3.583	5.778	0.01	Adjusted-R^2 = 0.96
TWIAU	-0.096	-0.376	0.71	N = 11 DW = 1.74
IEC	0.284	2.267	0.02	
Intercept	4.521	1.876	0.06	
Fremantle				
PGDPJP	4.816	3.944	0.01	Adjusted-R^2 = 0.94
TWIAU	-1.456	-4.375	0.01	N = 11 DW = 1.61
IEC	0.514	3.688	0.01	
Intercept	-37.731	-3.474	0.01	

Per capita real income is observed to be the main factor influencing full container exports. The elasticity of per capita real income varies from 1.7 to 5.6, and it implies that a one per cent increase (decrease) in per capita real income in Australia's main export markets will result in an increase (decrease) in per capita full container exports by 5.6 per cent in Brisbane, 1.7 per cent in Sydney and Melbourne, 3.6 per cent in Adelaide and 4.8 per cent in Fremantle.

The low income elasticity in Sydney and Melbourne suggests that the Sydney and Melbourne ports are relatively matured ports in comparison to the other city ports. However, Brisbane, Adelaide and Fremantle ports are assumed to gradually mature by the middle of the forecast period. In other words, the value of income elasticity in Brisbane, Adelaide and Fremantle will gradually decline to the level of Sydney and Melbourne by 2013-14.

The estimated exchange rate elasticity suggests that a decrease (increase) in the value of the Australian dollar will increase (decrease) per capita full container exports.

Similarly, an increase (decrease) in the import of empty containers will increase (decrease) per capita full container exports in Melbourne, Adelaide and Fremantle ports.

2.2 Empty container export model

The export of empty containers largely depends on the degree of substitution between export and import containers and the import of full containers. 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 (higher cargo volume related to weight) and therefore they mostly arrive in 40-foot containers. In such a situation, the number of empty containers will increase with an increase in the import of full containers. Moreover, a higher percentage of full container imports has a destination close to port. In the case of Sydney, 85 per cent of full container trade has an origin/destination within 40 kilometres of Port Botany. As a result, empty containers remain close to port and are exported when container ships are available.

An empty container export model is specified in terms of full container imports and presented in equation (2).

$$\ln EMX_{it} = \gamma_{i0} + \gamma_{i1} \ln FCM_{it} + \gamma_{i2} D_{it} + v_{it} \qquad (2)$$

Where EMX_i = Empty container exports from the ith port in teus; FCM_i = Full container imports to the ith port in teus; D_i = Dummy variable to capture a large variation in empty container exports from the ith port; v = Error term; γ's = Regression parameters; and i and t have the same meaning as mentioned in equation (1).

The regression results of the model estimation are presented in Table 2. They show that the estimated models are a good fit with an adjusted R-square value ranging from 0.87 to 0.98. The estimated coefficients are highly significant and suggest that a one per cent increase (decrease) in the import of full containers will make the export of empty containers increase (decrease) by 1.5 per cent in Brisbane, 2.6 per cent in Sydney, 1.4 per cent in Melbourne, 1.9 per cent in Adelaide and all ports and 0.7 per cent in Fremantle.

2.3 Full container import model

A full container import model is specified in terms of population, real GNE and exchange rates, and it is presented in equation (3).

$$\ln FUM_{it} = \beta_{i0} + \beta_{i1} \ln PGNEAU_t + \beta_{i2} \ln EXUSAU_t + e_{it} \qquad (3)$$

Where FUM_i = Per capita full container imports to the ith port in teus; PGNEAU = Per capita real Gross National Expenditure (GNE) of Australia in million dollars; e = Error term; β's = Regression parameters; and EXUSAU, i and t have the same meaning as in earlier equations. The exchange rate variable is substituted by the TWI variable in the case of Sydney Ports.

Since each city port has its own catchment area of consumers, it is more meaningful to include the income of people residing in the catchment area. However, historical and forecast data on real income by catchment area are not readily available. Hence, GNE at the national level is used to reflect the real income level of consumers residing in the catchment area of the five main city ports.

Table 2 Estimated regression statistics: Empty container export model

Variable by port	Estimated coefficient	t-ratio	Significance level	Other statistics
Brisbane				
FCM	1.531	12.262	0.01	Adjusted-R^2 = 0.98
D0203	0.532	4.055	0.01	N = 11 DW = 2.08
D0304	0.547	3.925	0.01	
Intercept	-0.987	-1.102	0.31	
Sydney				
FCM	2.617	8.165	0.01	Adjusted-R^2 = 0.87
Intercept	-10.066	-3.750	0.01	N = 11 DW = 1.52
Melbourne				
FCM	1.416	8.939	0.01	Adjusted-R2 = 0.94
D0203	0.161	1.729	0.12	N = 11 DW = 1.72
Intercept	-0.179	-0.135	0.90	
Adelaide				
FCM_{t-1}	1.903	19.560	0.01	Adjusted-R2 = 0.98
D2001	0.265	2.862	0.02	N = 10 DW = 2.88
Intercept	-2.564	-4.421	0.01	
Fremantle				
EMX_{t-1}	0.599	3.223	0.02	Adjusted-R2 = 0.92
FCM	0.674	1.730	0.13	N = 10 DW = 1.90
D2001	0.456	2.587	0.04	
Intercept	-0.470	-0.355	0.74	

The regression statistics of the model estimation which are shown in Table 3 indicate that the estimated models are a good fit with the adjusted R-square value ranging from 0.90 to 0.99. The estimated coefficients of the per capita real GNE are highly significant and have expected signs.

According to the estimated elasticities, the per capita real GNE appears to be the main factor influencing full container imports. A one per cent increase (decrease) in per capita real GNE leads per capita full container imports to increase (decrease) by 3.8 per cent in Brisbane, 2.1 per cent in Sydney, 2.2 per cent in Melbourne, 2.7 per cent in Adelaide and 2.9 per cent in Fremantle.

Although the coefficient of the exchange rate variable is not found statistically significant in the full container import model, the variable is included in the model of Sydney and Melbourne ports, simply because the predictive power of the model increases significantly with its inclusion and the estimated elasticity of the exchange rate shows an expected positive sign. This implies that the import of full containers increases (decreases) with the appreciation (depreciation) of the Australian dollar against the US dollar. However, the magnitude of such increase (decrease) appears to be relatively small.

Table 3 Estimated regression statistics: Full container import model

Variable by port	Estimated coefficient	t-ratio	Significance level	Other statistics
Brisbane				
PGNEAU	3.780	22.951	0.01	Adjusted-R^2 = 0.98
Intercept	16.277	29.424	0.01	N = 11 DW = 1.63
Sydney				
PGNEAU	2.055	16.398	0.01	Adjusted-R^2 = 0.97
TWIAU	0.047	0.317	0.76	N = 9 DW = 2.43
Intercept	10.934	14.983	0.01	
Melbourne				
PGNEAU	2.157	22.122	0.01	Adjusted-R^2 = 0.99
EXUSAU	0.026	0.371	0.72	N = 11 DW = 1.71
Intercept	11.941	34.683	0.01	
Adelaide				
PGNEAU	2.744	5.967	0.01	Adjusted-R^2 = 0.90
Intercept	12.225	7.914	0.01	N = 11 DW = 1.47
Fremantle				
PGNEAU	2.883	17.474	0.01	Adjusted-R^2 = 0.97
Intercept	13.820	24.936	0.01	N = 11 DW = 1.99

2.4 Empty container import model

Since empty containers are imported to ship export commodities, the import of empty containers depends on the export of full containers. Therefore, an empty container import model is specified in terms of the export of full containers. The model is shown in equation (4) and the results of the model estimation are presented in Table 4.

$$\ln EMM_{it} = \lambda_{i0} + \lambda_{i1} \ln FCX_{it} + \lambda_{i2} \ln D_{it} + w_{it} \qquad (4)$$

where EMM_i = Empty container imports to the ith port in teus; FCX_i = Full container exports from the ith port in teus; D_i = Dummy variable to capture a large variation in empty container imports to the ith port; w = Error term; λ's = Regression parameters; and i and t have the same meaning as in earlier equations.

The estimated models are observed to be a good fit with adjusted R-square value ranging from 0.51 to 0.96. The estimated coefficients are highly significant and show that the export of full containers positively influences the import of empty containers.

3 Data sources

Historical data on the export and import of full and empty containers, GNE, GDP, exchange rates, the trade weighted index and population were gathered from the Port of Brisbane Corporation (PBC 2004 and 2005), Sydney Ports Corporation (SPC 2004 and 2005), Port of Melbourne Corporation (PMC 2004 and 2005), Flinders Ports Pty Ltd (FPPL 2004 and 2005), Fremantle Ports (FP 2004 and 2005), the Association of Australian Ports and Marine Authorities (AAPMA 2006), BTRE's international cargo statistics database,

BTRE's Waterline (BTRE 2005 and earlier issues), the Australian Bureau of Statistics (ABS 2004a and 2004b), Access Economics (2006) and OECD (2003).

Table 4 Estimated regression statistics: Empty container import model

Variable by port	Estimated coefficient	t-ratio	Significance level	Other statistics
Brisbane				
FCX	0.357	6.828	0.01	Adjusted-R2 = 0.96
D9495	-0.273	-10.274	0.01	N = 11 DW = 1.70
D2001	0.164	6.360	0.01	
Intercept	8.157	20.200	0.01	
Sydney				
FCX_{t+1}	0.510	3.040	0.02	Adjusted-R^2 = 0.51
D0304	-0.494	-2.373	0.05	N = 11 DW = 1.80
Intercept	5.748	4.375	0.01	
Melbourne				
FCX	0.617	8.110	0.01	Adjusted-R2 = 0.87
Intercept	6.020	9.233	0.01	N = 11 DW = 1.81
Adelaide				
FCX_{t-1}	0.618	9.123	0.01	Adjusted-R2 = 0.92
D0102	0.307	2.969	0.02	N = 10 DW = 2.39
Intercept	5.567	12.108	0.01	
Fremantle				
FCX	0.804	8.066	0.01	Adjusted-R2 = 0.90
D2001	0.613	5.278	0.01	N = 11 DW = 1.57
Intercept	4.312	5.920	0.01	

4 Macroeconomic and population assumptions

In this paper, long-run assumptions on macroeconomic variables and population which are used to develop the forecasts of container and ship movements are obtained from the ABS (2004b), Access Economics (2006) and the US Census Bureau (USCB 2004). The assumptions are summarised in Table 5. Since these assumptions are available for the next ten years only, the assumptions for the rest of the forecast period are considered to be the same as those in year 2014-15.

Australia's real GNE grew annually by 4.2 per cent in the last five years. However, such high growth is not expected to continue over the next twenty years. It is forecast to increase by 2.7 per cent a year over the forecast period. The slowing of economic growth in Australia will make Australia's full container imports grow at a rate lower than the rate observed during the last five years.

The strength of the Australian dollar against the US dollar is expected to weaken over the forecast period, from US$0.74 per Australian dollar in 2004-05 to US$0.59 per Australian dollar in 2024-25. This will have a positive impact on full container exports and a negative impact on full container imports.

Population growth will remain relatively low but positive in Australia and its major trading

partner countries over the next twenty years. Queensland is expected to have a relatively higher population growth than any other State in Australia. The expected positive population growth will influence Australia's container imports and exports.

Table 5 Macroeconomic and population assumptions

	1999-00 to 2004-05	**2004-05 to 2024-25**
Annual average economic growth rates (%)		
Real GNE		
- Australia	4.2	**2.7**
Real GDP		
- USA	2.9	**2.8**
- Japan	1.7	**1.6**
- OECD	2.6	**2.8**
Trade Weighted Index (TWI)	55.4	**53.3**
Exchange rate (US$/AU$)	0.62	**0.61**
Annual average population growth rates (%)		
Australia	1.2	**0.9**
- Queensland	2.1	**1.6**
- New South Wales	1.0	**0.7**
- Victoria	1.2	**0.7**
- South Australia	0.5	**0.2**
- Western Australia	1.4	**1.2**
USA	1.1	**0.9**
Japan	0.2	**0.1**
OECD	0.9	**0.8**

*Numbers in bold are forecasts.

5 Forecasts of containers and container ship visits

5.1 Forecasts of containers

Following a positive economic outlook for Australia and its trading partners, Australia's total container trade will continue to grow strongly over the next twenty years. It is forecast to increase by 5.4 per cent a year in the next twenty years, from 5.2 million teus in 2004-05 to 14.9 million teus in 2024-25 (Figure 1 and Table 6). It is projected to increase annually by 7.4 per cent in Brisbane, 5.0 per cent in Sydney, 4.9 per cent in Melbourne, 5.3 per cent in Adelaide, 5.4 per cent in Fremantle and 5.3 per cent in all other ports.

The annual average growth rate forecast for the total container trade is relatively lower than those observed in the last ten years, mainly because of the maturing of Australia's container trade and the expected slowing of economic and population growth in Australia and its major trading partners. The annual average growth rate was observed to be 12.0 per cent during 1994-95 to 1999-2000 and 8.0 per cent during 1999-2000 to 2004-05.

Full container exports account for 63.6 per cent of the total container exports and are forecast to increase by 5.3 per cent a year over the next twenty years to 4.6 million teus in 2024-25 (Table 7). They will increase annually by 6.9 per cent in Brisbane, 4.5 per cent in Sydney, 5.0 per cent in Melbourne, 5.7 per cent in Adelaide, 5.6 per cent in Fremantle and 5.3 per cent in all other ports.

FIGURE 1 CONTAINER TRADE, 1993-94 TO 2024-25: ALL PORTS

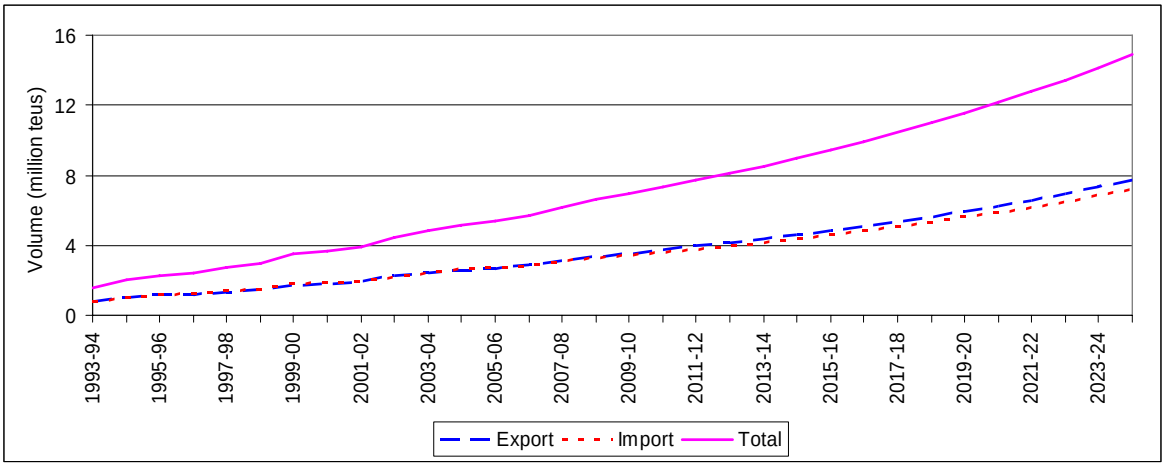

Table 6 Total container trades by port ('000 teus)

Year	Brisbane	Sydney	Melbourne	Adelaide	Fremantle	Other	Total
2000-01	453	990	1 324	133	354	379	3 635
2001-02	482	1 009	1 424	145	382	486	3 928
2002-03	570	1 161	1 597	150	431	547	4 456
2003-04	640	1 270	1 721	170	457	601	4 859
2004-05	726	1 376	1 910	171	467	521	5 171
2005-06	**768**	**1 423**	**1 979**	**181**	**487**	**543**	**5 380**
2006-07	**845**	**1 481**	**2 066**	**191**	**512**	**573**	**5 669**
2007-08	**939**	**1 618**	**2 246**	**207**	**555**	**623**	**6 188**
2008-09	**1 015**	**1 731**	**2 406**	**226**	**595**	**667**	**6 640**
2009-10	**1 074**	**1 786**	**2 501**	**240**	**621**	**696**	**6 917**
2010-11	**1 153**	**1 874**	**2 636**	**254**	**657**	**735**	**7 309**
2011-12	**1 242**	**1 982**	**2 781**	**269**	**690**	**776**	**7 740**
2012-13	**1 322**	**2 062**	**2 896**	**281**	**723**	**811**	**8 096**
2013-14	**1 425**	**2 155**	**3 029**	**294**	**768**	**853**	**8 523**
2014-15	**1 525**	**2 258**	**3 171**	**307**	**808**	**896**	**8 965**
2015-16	**1 632**	**2 367**	**3 317**	**321**	**849**	**940**	**9 426**
2016-17	**1 747**	**2 482**	**3 469**	**335**	**893**	**986**	**9 913**
2017-18	**1 871**	**2 602**	**3 628**	**350**	**940**	**1 035**	**10 426**
2018-19	**2 005**	**2 727**	**3 795**	**366**	**988**	**1 086**	**10 967**
2019-20	**2 148**	**2 860**	**3 970**	**382**	**1 039**	**1 140**	**11 539**
2020-21	**2 302**	**2 998**	**4 152**	**399**	**1 093**	**1 197**	**12 142**
2021-22	**2 469**	**3 144**	**4 343**	**417**	**1 150**	**1 257**	**12 780**
2022-23	**2 647**	**3 296**	**4 543**	**435**	**1 210**	**1 321**	**13 453**
2023-24	**2 840**	**3 456**	**4 752**	**455**	**1 272**	**1 388**	**14 163**
2024-25	**3 047**	**3 625**	**4 971**	**475**	**1 338**	**1 458**	**14 915**
Annual average growth rate (%):2004-05 to 2024-25							
	7.4	**5.0**	**4.9**	**5.3**	**5.4**	**5.3**	**5.4**

*Numbers in bold are forecasts.

Table 7 Full container exports by port ('000 teus)

Year	Brisbane	Sydney	Melbourne	Adelaide	Fremantle	Other	Total
2000-01	194	306	525	63	126	88	1,302
2001-02	199	307	555	70	142	252	1,526
2002-03	193	294	569	72	153	273	1,554
2003-04	205	303	592	86	160	285	1,633
2004-05	227	320	653	80	161	184	1,625
2005-06	**242**	**336**	**685**	**85**	**172**	**194**	**1,714**
2006-07	**283**	**361**	**728**	**91**	**185**	**211**	**1,859**
2007-08	**304**	**383**	**781**	**100**	**196**	**225**	**1,988**
2008-09	**328**	**408**	**838**	**110**	**210**	**242**	**2,136**
2009-10	**355**	**432**	**886**	**119**	**224**	**258**	**2,273**
2010-11	**379**	**454**	**935**	**127**	**239**	**273**	**2,407**
2011-12	**400**	**474**	**983**	**134**	**249**	**286**	**2,526**
2012-13	**428**	**494**	**1,028**	**141**	**263**	**301**	**2,656**
2013-14	**463**	**515**	**1,075**	**147**	**283**	**318**	**2,802**
2014-15	**489**	**535**	**1,123**	**154**	**297**	**332**	**2,931**
2015-16	**517**	**555**	**1,172**	**161**	**312**	**347**	**3,065**
2016-17	**547**	**576**	**1,223**	**168**	**328**	**363**	**3,205**
2017-18	**579**	**597**	**1,276**	**176**	**344**	**380**	**3,352**
2018-19	**612**	**620**	**1,332**	**184**	**361**	**397**	**3,506**
2019-20	**647**	**643**	**1,390**	**193**	**379**	**416**	**3,667**
2020-21	**684**	**667**	**1,451**	**201**	**397**	**435**	**3,836**
2021-22	**724**	**693**	**1,514**	**211**	**417**	**455**	**4,013**
2022-23	**765**	**719**	**1,580**	**220**	**438**	**476**	**4,198**
2023-24	**809**	**746**	**1,649**	**230**	**460**	**498**	**4,391**
2024-25	**856**	**774**	**1,720**	**241**	**482**	**521**	**4,594**
Annual average growth rate (%):2004-05 to 2024-25							
	6.9	**4.5**	**5.0**	**5.7**	**5.6**	**5.3**	**5.3**

*Numbers in bold are forecasts.

Full container imports dominate the total container imports in Australia, accounting for 87.3 per cent of the total container imports. Full container imports are expected to increase by 5.4 per cent a year over the forecast period to 6.5 million teus in 2024-25, including 7.7 per cent in Brisbane, 4.9 per cent in Sydney, 4.6 per cent in Melbourne, 5.1 per cent in Adelaide, 5.7 per cent in Fremantle and 5.5 per cent in all other ports (Table 8).

5.2 Forecasts of container ship visits

Container vessels operating through Australian ports are of different size, ranging from 5 000 to 60 000 Gross Tonnes (GT). At the present time, 81.8 per cent of port visits are made by ships with sizes ranging from 15,000 GT to 45,000 GT.

In 2004-05, a container ship exchanged an average of 832 teus in Brisbane, 1 303 teus in Sydney, 1 742 teus in Melbourne, 738 teus in Adelaide and 1,001 teus in Fremantle and 334 teus in other ports. This average teus exchanged is not expected to increase significantly in the next twenty years because of a time lag in increasing the Australian

ports' capacity to handle large ships, the flattening of the expected growth in trade volume and a long time lag in the construction of new ships with larger container carrying capacity. Although old container ships are being replaced by large (wider and deeper) new generation ships on the major international shipping routes, Australia is less likely to get the new generation ships. This is because the volume of Australia's international container trade is relatively small and Australia does not fall on the world's main international shipping routes. In this paper, the average teus exchanged per container ship is assumed to increase by 1.0 per cent a year over the forecast period.

Table 8 Full container imports by port ('000 teus)

Year	Brisbane	Sydney	Melbourne	Adelaide	Fremantle	Other	Total
2000-01	153	493	575	38	136	125	1,520
2001-02	174	507	606	41	154	138	1,620
2002-03	223	586	698	41	186	155	1,889
2003-04	262	643	777	42	204	179	2,107
2004-05	292	687	854	40	210	201	2,284
2005-06	**308**	**707**	**877**	**41**	**216**	**207**	**2,356**
2006-07	**329**	**733**	**906**	**43**	**225**	**216**	**2,452**
2007-08	**377**	**800**	**988**	**47**	**252**	**238**	**2,701**
2008-09	**413**	**852**	**1,049**	**50**	**272**	**254**	**2,889**
2009-10	**432**	**876**	**1,074**	**51**	**279**	**262**	**2,974**
2010-11	**466**	**920**	**1,124**	**54**	**296**	**276**	**3,135**
2011-12	**506**	**971**	**1,184**	**57**	**315**	**293**	**3,327**
2012-13	**537**	**1,012**	**1,229**	**60**	**330**	**306**	**3,472**
2013-14	**578**	**1,061**	**1,285**	**63**	**349**	**322**	**3,657**
2014-15	**621**	**1,113**	**1,345**	**66**	**368**	**339**	**3,853**
2015-16	**668**	**1,168**	**1,407**	**69**	**389**	**357**	**4,059**
2016-17	**718**	**1,226**	**1,472**	**73**	**411**	**376**	**4,277**
2017-18	**772**	**1,286**	**1,540**	**77**	**435**	**397**	**4,506**
2018-19	**830**	**1,350**	**1,611**	**81**	**459**	**418**	**4,749**
2019-20	**893**	**1,416**	**1,685**	**85**	**486**	**441**	**5,005**
2020-21	**960**	**1,486**	**1,763**	**89**	**513**	**464**	**5,276**
2021-22	**1,032**	**1,559**	**1,844**	**94**	**542**	**489**	**5,561**
2022-23	**1,109**	**1,636**	**1,929**	**99**	**573**	**516**	**5,863**
2023-24	**1,193**	**1,717**	**2,019**	**104**	**606**	**544**	**6,182**
2024-25	**1,283**	**1,802**	**2,112**	**109**	**640**	**574**	**6,519**
Annual average growth rate (%):2004-05 to 2024-25							
	7.7	**4.9**	**4.6**	**5.1**	**5.7**	**5.4**	**5.4**

*Numbers in bold are forecasts.

Following strong growth in container trade and relatively small growth in ship size, the number of container ship visits is expected to increase by 4.6 per cent a year over the next twenty years, from 5 300 visits in 2004-05 to 13 100 in 2024-25, including 3 000 visits in Brisbane, 2 300 visits in Sydney and Melbourne, 500 in Adelaide, 1 100 in Fremantle and 3 800 in other remaining ports in Australia (Table 9).

Table 9 Number of container ship visits

Year	Brisbane	Sydney	Melbourne	Adelaide	Fremantle	Other	Total
2000-01	721	1 129	1 046	233	563	1 256	4 948
2001-02	786	1 064	1 062	227	574	1 237	4 950
2002-03	822	1 078	1 090	226	520	1 267	5 003
2003-04	740	1 091	1 077	237	469	1 327	4 941
2004-05	873	1 056	1 097	231	467	1 557	5 281
2005-06	**914**	**1 081**	**1 125**	**242**	**482**	**1 608**	**5 453**
2006-07	**996**	**1 114**	**1 163**	**253**	**502**	**1 687**	**5 715**
2007-08	**1 096**	**1 205**	**1 252**	**272**	**538**	**1 824**	**6 187**
2008-09	**1 173**	**1 277**	**1 328**	**294**	**571**	**1 939**	**6 582**
2009-10	**1 228**	**1 304**	**1 366**	**310**	**590**	**2 006**	**6 804**
2010-11	**1 306**	**1 355**	**1 426**	**324**	**619**	**2 102**	**7 131**
2011-12	**1 393**	**1 418**	**1 489**	**339**	**643**	**2 205**	**7 489**
2012-13	**1 468**	**1 461**	**1 536**	**352**	**668**	**2 289**	**7 773**
2013-14	**1 567**	**1 512**	**1 590**	**364**	**701**	**2 392**	**8 126**
2014-15	**1 660**	**1 569**	**1 648**	**377**	**731**	**2 495**	**8 479**
2015-16	**1 759**	**1 628**	**1 707**	**390**	**761**	**2 601**	**8 845**
2016-17	**1 864**	**1 690**	**1 768**	**403**	**792**	**2 712**	**9 230**
2017-18	**1 977**	**1 754**	**1 831**	**417**	**825**	**2 829**	**9 632**
2018-19	**2 097**	**1 821**	**1 896**	**431**	**859**	**2 951**	**10 055**
2019-20	**2 224**	**1 890**	**1 963**	**446**	**895**	**3 080**	**10 498**
2020-21	**2 361**	**1 962**	**2 033**	**461**	**932**	**3 214**	**10 963**
2021-22	**2 506**	**2 037**	**2 106**	**477**	**970**	**3 356**	**11 451**
2022-23	**2 661**	**2 115**	**2 181**	**493**	**1 011**	**3 504**	**11 964**
2023-24	**2 826**	**2 195**	**2 259**	**510**	**1 052**	**3 659**	**12 502**
2024-25	**3 002**	**2 279**	**2 339**	**527**	**1 096**	**3 823**	**13 067**
Annual average growth rate (%):2004-05 to 2024-25							
	6.4	**3.9**	**3.9**	**4.2**	**4.4**	**4.6**	**4.6**

*Numbers in bold are forecasts.

7 Conclusion

In this paper, port level forecasts of container and ship movements have been developed on the basis of econometric models which are specified in terms of population, real income and exchange rates. Forecasts suggest that Australia's container trade will continue to grow strongly over the next twenty years, largely due to a positive economic outlook for Australia and its trading partners. The total container trade is forecast to increase by 5.4 per cent a year over the forecast period, from 5.2 million teus in 2004-05 to 14.9 million teus in 2024-25. It is projected to increase annually by 7.4 per cent in Brisbane, 5.0 per cent in Sydney, 4.9 per cent in Melbourne, 5.3 per cent in Adelaide, 5.4 per cent in Fremantle and 5.3 per cent in all other ports.

The growth rate forecasts for the containerised trade are relatively lower than those observed in the last ten years, mainly because of the maturing of Australia's containerised trade and the expected slowing of economic and population growth in Australia and its major trading partners.

Following an expected strong growth in container trade and a small increase in ship size, the number of container ship visits at Australian ports is forecast to increase from around from 5 300 visits in 2004-05 to 13 100 in 2024-25.

The higher expected growth in container trade will put pressure on the existing port facilities. The port authorities of Australia's main city ports and the stevedoring companies operating at these ports have been undertaking many initiatives to increase their port facilities. The main initiatives are the reclamation of 230 hectares of land in Fisherman Islands, the proposed 60-hectare Port Botany expansion plan, the proposed channel deepening project in Melbourne, Adelaide and Fremantle and the development of the North Quay rail loop and rail terminal as well as the upgrading of the Kwinana Bulk Terminal in Fremantle. Moreover, the Australian Government funding of $110 million under the AusLink program is expected to improve rail access to the port area in Melbourne.

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