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Forecasting Australia's international container trade

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Abstract

A substantial part of Australia's trade is currently carried in containers. The proportion of goods traded internationally in containers is expected to increase, as traditional bulk cargoes such as coal, grain and salt are increasingly being shipped in containers. Container trade is thus of vital importance to liner shipping and waterfront activities. The quantity of containers discharged and loaded at a port drives port infrastructure investment, as port authorities seek to improve efficiency by means of faster vessel turnaround times. This paper provides forecasts of future numbers of containers traded by using two different methods: dynamic econometric modelling and multivariate autoregressive modelling. The two methods are applied to two sets of data obtained from different sources. Most empirical studies focus on trade volumes in mass tonnes. Where these studies focus on actual containers, they often include double-handled containers. This paper, however, focuses on actual container quantities, and in so doing is able to model the impact of the increasing use of 40-foot containers. Although trade volumes may be rising, the increasing use of larger containers could actually cause a decline in the total number of containers used. This issue is of importance to port planners, as it may mean they need to make different kinds of investments.

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GO BACK TO START SCREEN **GO BACK TO INDEX**

Introduction

The purpose of this paper is to provide a broad overview of container trade in Australia and to identify future trends in the trade. The analysis is broad in the sense that it is carried out at the national level rather than by port. The paper provides aggregate forecasts of future levels of container quantities by using two different methods: dynamic econometric modelling and multivariate autoregressive modelling. It also considers the likely impact of rapid growth in the use of 40-foot containers.

This paper focuses on actual container quantities (boxes) rather than mass tonnes or twenty-foot equivalent units (TEUs). It uses data that exclude double handling, as figures that include double handling or trans-shipment may invalidate growth forecasts. This approach allows for the separate modelling of the impact of the increasing use of 40-foot containers. Although trade volumes may be rising, the increasing use of larger containers could actually cause a decline in the total number of containers used. This issue is of importance to port planners, as it may mean they need to make different kinds of investments.

Container trade is of vital importance to liner shipping and container port development. It drives over fifty per cent by value (see table 3) of Australia’s seaborne trade and therefore is a key player in the national economy. The proportion of goods traded internationally in containers is expected to increase, as traditional bulk cargoes such as coal, grain and salt are increasingly being shipped in containers.

History of Container Trade in Australia

The first domestic container operation in Australia commenced in 1964, and was followed by overseas container shipping in 1969. Two consortia operated the overseas services: Overseas Containers (Australia) Ltd (OCAL) and Associated Containers Transportation’s (ACT) Australian subsidiary, Trans-Ocean Containers Ltd (TOC). In late 1969, the Australian National Line also introduced container services to Japan and Britain (BTE 1982). During 1976–77, after a decade of containerisation in Australian ports it was estimated that 654 000 TEUs were handled at the five major ports (see table 1). Of these, about 60 000 TEUs (about 9 per cent) were trans-shipped (in other words, they were handled more than once through the ports).

Table 2 shows that container throughput at these five major ports increased to 3.3 million TEUs in 2000–01, an increase of nearly 400 per cent since 1976–77. Adelaide, Fremantle and Brisbane have experienced the greatest growth, with Adelaide averaging 70 per cent per year over this period. In contrast, container trade in Melbourne and Sydney in 1976–77 was more mature than in the other ports at that time. The annual growth rates of container trade in Melbourne and Sydney since then have been 13 and 12 per cent respectively. On average, between 89 and 95 per cent of all container trade in Australia goes through the five major ports.

Table 1 1976–77 International Container Throughput (TEUs)

Port	Full import	Empty import	All import	Full Export	Empty Export	All Export	Total
Melbourne	144 243	5 699	149 942	126 519	27 425	153 944	303 886
Sydney	138 493	2 519	141 012	66 267	45 127	111 394	252 406
Brisbane	18 582	2 791	21 373	27 939	63 22	34 261	55 634
Adelaide	3 312	29	3 341	36 48	174	3 822	71 63
Fremantle	11 650	1 246	12 896	16 484	5 250	21 734	34 630
Five Ports	316 280	12 284	328 564	240 857	84 298	325 155	653 719

Source BTE (1982)

The levels of growth in container trade experienced by these five ports have been in double digits and are unlikely to be repeated in the next decade as shown by the forecast contained in this paper, even though the volume of trade is expected to grow rather than plateau.

Table 2 2000–01 Container Throughput (TEUs)

Port	Full import	Empty import	All Import	Full Export	Empty Export	All Export	Total	% ch 76-77	% ch annual
Melbourne	571 177	98 394	669 571	523 519	123 575	647 094	1 316 665	333	13
Sydney	491 689	19 905	511 594	306 099	171 274	477 373	988 967	292	12
Brisbane	153 486	74 575	228 061	194 173	30 805	224 978	453 039	714	29
Adelaide	38 008	21 059	59 067	63 294	10 875	74 169	133 236	1 760	70
Fremantle	136 494	47 582	184 076	125 574	44 494	170 068	354 144	923	37
Five Ports	1 390 854	261 515	1 652 369	1 212 659	381 023	1 593 682	3 246 051	397	16

Source BTRE estimates

In future, growth in container trade is expected to be driven largely by the containerisation of traditionally non-containerised bulk cargo, such as grain and coal. If trade liberalisation impacted on the current centralised grain marketing arrangements, many small and niche markets could be better supplied by the use of containers.

Melbourne, Sydney and Brisbane have consistently had greater shares of container trade than other ports. Melbourne exchanged the largest number of TEUs (1 316 665 or 41 per cent) in 2000–01, followed by Sydney (988 967 or 30 per cent). Their relative shares are set to increase even further, given the upward trend in vessel sizes. Larger vessels cannot call at all ports. Many ports have limited infrastructure and physical constraints, such as insufficient depth, which preclude them from servicing larger vessels. The scale of the investment required to enable them to do so would in most cases be prohibitive. Containers that are presently discharged at ports by relatively small ships will, in future, be discharged at ports that can handle them. Crisp (2000) reported that the largest vessel deployed in the Australian trade had a capacity of 3 450 TEU. This is set to increase to 4 200 TEU, as P&O Nedlloyd and its partner Contship Containers have placed orders for vessels of this size to be deployed in 2002, (the first of such vessel was deployed in July 2002). It is thus clear that in the medium to long term, as more large vessels are deployed in Australian trade, more port calls will be dropped. However, the penetration of larger vessels into the Australian trade is expected to be slow because the market is so thin.

There are container ships presently in use around the world with a capacity of 7 060 TEUs. Haralamdides *et al* (2000) outlined some of the characteristics that ports need to possess in order to receive such vessels. These include: sufficient channel depth, better proximity to markets, established processing facilities with sufficient storage and processing, modern cargo handling equipment, large breakwaters, reinforced piers and enough space for future expansion. Baker (1996) believes that the Australian trade does not warrant ships of this size because trade is too thin, at least in the short to medium term. According to Baker, if 6 000 TEU or larger ships entered the Australian trade, there would have to be offsetting changes to balance capacity and ensure cost-efficient slot utilisation, such as lower frequency port calls, which would not be beneficial to Australian trade.

Developments in vessel sizes highlight the need for trade analysis that focuses on actual imports and export volumes excluding trans-shipment, because these figures truly represent the size of the trade task, even though trans-shipment is important for efficient port management.

Another development that is set to enhance container trade is the increasing adoption of electronic-commerce technology. It is clear that greater efficiencies can be achieved by the adoption of e-commerce on a wider scale. Communication and administrative costs could be reduced significantly, particularly if the technology provides the customer with access, information and schedules to manage booking, financial transactions, and container tracking. In the case of container tracking, this may include the ability to divert containers in transit. These technological advances, if adopted, could translate into potential cost and price reductions. Trade that until now has been expensive to containerise could then become attractive because of lower prices.

Container trade is thus expected to continue to be an important part of Australian export and import trade. Table 3 shows the relative importance of containerised trade in comparison with bulk commodities.

Table 3 1999–2001 Relative Shares Of Liner And Bulk Trade

	Liner		Non Liner		ALL		% Liner by	
Year	Kilotonnes	$ billion	Kilotonnes	$ billion	Kilotonnes	$ billion	Value	Volume
1999	34 001	86	462 098	55	496 100	141	61	7
2000	32 125	93	508 775	79	540 900	172	54	6
2001	38 144	111	515 500	75	553 644	185	59	7

Source BTRE estimates

Empty containers

Australia's trade is affected by the movement of empty containers. A relatively high proportion of Australia's exports require shipping in refrigerated containers largely for meat and dairy products. Imports are largely manufactured products. As a result, it is necessary to import large numbers of empty refrigerated containers into Australia, as many of Australia's imports cannot be carried in refrigerated containers. Empty dry containers are carried from Australia for subsequent use in other trades (Productivity Commission 1999). The cost of moving empty containers has been reduced by improvements in the logistics of empty container movements, and further reductions are likely to be achieved with the introduction of collapsible twenty-foot shipping containers. The collapsible containers will allow shipping lines to fit three collapsible twenty-foot containers into each standard container slot (Flower 2001).

Data

International Cargo Statistics is a detailed unpublished database presented in quarters on Australian imports and exports collected by the Australian Bureau of Statistics (ABS) and provided to the Bureau of Transport and Regional Economics (BTRE). It includes information on liner cargo imports and exports. The data in the series prior to September 1994 were not used, as the series was re-based at that time and the data before and after the re-basing are not comparable**.** The format of the data enabled imports and exports to be analysed separately. However, the database does not contain information on the quantity of containers involved in cargo movement. Figures given in mass tonnes were therefore converted into numbers of containers. The International Cargo Statistics database was selected for econometric analysis despite these limitations because it offered a large sample size.

Ideally, one would wish to analyse historical data on actual container movements. The Bureau of Transport and Regional Economics has accumulated data on container movements for its publication *Waterline*. However, these data have some limitations. The database only covers the five major ports and only uses data from the three major stevedoring companies. It does not distinguish trans-shipment from actual imports and exports. However, it provides a good indication of the proportions of twenty and forty-foot containers handled. This information is useful to determine the growth in forty-foot container movement. The database was used to convert mass tonnes carried to TEUs and TEUs to numbers of containers and to estimate the ratios of loaded containers to empty containers.

The Department of Transport and Regional Services (DOTARS) is currently developing a more comprehensive database. This unpublished database contains monthly data, but at present covers only a two-year period. Some of the economic data used for modelling were only available as quarterly or annual data. This meant that the monthly data had to be aggregated into quarters before they could be used. This step reduced the sample size for analytical purposes (as twenty-four monthly data points equates to only eight quarters). The monthly data were considered to be adequate for use in multivariate time series analysis and forecasting — an approach gaining popularity among researchers (Veenstra 2001)

Economic data

Both economic theory and empirical work (for example, Stopford , Benetatos et al 199, BTCE 1991 and BTE 1988) postulates links between certain economic variables and international cargo flows. In general, these links suggest that in times of world and national economic growth and prosperity, trade flows (imports and exports) flourish. This is perhaps not surprising, given that trade is at the heart of economic activity. This means that economic indicators can be used to explain and predict imports and exports. These economic variables include gross domestic product (GDP), currency exchange rates, household disposable income, GDP per capita, freight rates and commodity prices.

GDP and foreign exchange rates were sourced from the ABS and Access Economics. They include aggregate GDP, GDP per capita and household disposable income for Australia, G7 countries, OECD countries, Japan, EU15 countries, the US and UK. The data are presented in quarters. Although quarterly estimates are generally less detailed and less reliable than annual estimates, they have a very important role in economic analysis. First, they are more up-to-date than annual accounts, so they provide a more timely indicator of the direction in which an economy is heading. Second, they enable a more detailed analysis to be made of the behaviour of economies around turning points in the business cycle. Annual accounts tend to hide the pattern of growth around turning points to some extent because peaks or troughs in economic activity generally cut across years.

The foreign exchange rates include the Australian trade weighted index and the Australian dollar versus the US dollar, the Euro, the Yen and the UK pound. Freight rates and commodity prices can also affect the volume of trade flows. For example, if freight rates are very high, margins on low value products are reduced. Similarly, low commodity prices may reduce exporters' margins and thereby discourage exports. Other qualitative factors such as economic policy, trade policy (for example, tariffs and quotas as opposed to trade liberalisation), political strategy and technological change also have a bearing on container trade flows. Some of these effects may impact in the short to medium term, while others have long term effects. For example, technological changes, such as the proposed collapsible container, would generally have medium to long term effects. To a large extent, these impacts are captured in economic indicators, and reflected in forecasts of these indicators.

Econometric methodology

Econometric modelling can be used to predict trends in container flows by considering which factors are likely to influence cargo movements and how they are likely to impact on growth. Container movements are essentially a direct result of cargo flows, which depend on the economic activities occurring within the areas of origin and destination of the cargoes. The key measure of economic activity is GDP. Until the 1990s, the US, Japan and Germany used gross national income (GNI) as their main measure of economic activity. However, all of the major industrialised countries now use GDP as their main measure of economic activity. The implication is that the volumes of exports and imports have some form of relationship with Australia's GDP and those of its trading partners. Similarly, the exchange rate of the Australian dollar to the currencies of its trading partners could be expected to have a bearing on the volume and timing of imports and exports. The model developed explores these dynamic relationships.

A dynamic econometric model, the Polynomial Distributed Lag (PDL)[1] model, has been adopted for this analysis. For details of this technique see Gujarati (1995). This technique incorporates both short and long run components of the data set. This means that the impact on imports and exports of the economic (explanatory) variables felt in both the short and the long term are measured and reflected in the structural part of the model. To illustrate, if the value of the Australian dollar declines relative to the US dollar, the impact of the low Australian dollar on import and export volumes will be felt shortly after the low dollar value occurs (that is, in the short term) as well as in subsequent periods (the long term). This makes economic sense because trade contracts are usually entered into long before delivery occurs. Dynamic models capture such delayed (lagged) effects in addition to the short-term effects, whereas standard static econometric models do not capture such lagged effects.

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1 For example, $Y_t = a + b_0 X_t + b_1 X_{t-1} + ... b_k X_{t-k} + m_t$

Autoregressive integrated moving average (ARIMA) model

A multivariate ARIMA model was applied to the monthly actual container data to produce an alternative forecast of container movements. The primary intention for doing this was to establish a growth rate range for container movements rather than to determine which model was a better predictor. Apart from the use of the monthly actual container data from DOTARS instead of the quarterly International Cargo Statistics liner cargo imports and exports data, the source data used were the same.

The ARIMA approach was first popularised by Box and Jenkins, and ARIMA models are often referred to as Box-Jenkins models. The general transfer function model employed by the ARIMA procedure was discussed by Box and Tiao (1975). When an ARIMA model includes other time series as input variables, the model is sometimes referred to as an ARIMAX model. Pankratz (1991) refers to the ARIMAX model as dynamic regression (see for instance SAS). In this paper it is referred to as multivariate ARIMA and has been used to forecast the econometric model's explanatory variables as well as an alternative container forecast. The ARIMA modelling as discussed in SAS is described below

$$W_t = \mu + \frac{\theta(B)}{\phi(B)} a_t$$

Mathematically the pure ARIMA model is written as

where t indexes time,
W_t is the response series Y_t or a difference of the response series,
μ is the mean term,

B is the backshift operator (that is, $BX_t = X_{t-1}$),
$\phi(B)$ is the autoregressive operator, represented as a polynomial in the back shift operator:

$$\phi(B) = 1 - \phi_1 B - \ldots - \phi_p B^p$$

$\theta(B)$ is the moving-average operator, represented as a polynomial in the back shift operator:

$$\theta(B) = 1 - \theta_1 B - \ldots - \theta_q B^q$$

and
a_t is the independent disturbance, also called the random error.

As well as the dynamic structure of the model, careful attention was given to the univariate and multivariate stochastic properties of the data set under consideration. Time series data presents some special problems for econometricians. Most empirical work based on time series data assumes that the underlining time series are stationary. Time series data are said to be stationary if their mean value and variance do not vary systematically over time.

If the time series data are non-stationary, a very high correlation may be obtained even though there may be no meaningful relationship between the variables being regressed. If the time series variables exhibit strong trends (sustained upward or downward movements), the high correlation observed would be due to the presence of the trend, not the true relationship between the variables. In econometric terms, the apparent relationship would be described as spurious. The usual remedy in such a situation is to simply estimate the model using first differences. This practice, however, results in model misspecification, since first differences essentially nullify the information concerning the long-term relationship between variables. Cointegration analysis addresses this problem. Should the relationship be cointegrated, the short and long run relationships discussed above are retained. In this analysis, both the univariate and multivariate properties have been examined using augmented Dickey-Fuller (1984) and Phillips-Perron (1988, 1990) tests.

Exports modelling and forecasting

Economic theory posits that if the economies of Australia's trading partners are growing (measured by GDP) and the value of the Australian dollar is relatively low, Australian exports should increase. Conversely, if the economies of Australia's trading partners are in decline and the Australian dollar is relatively strong, Australia's export would be expected to decrease.

The trading partner's GDP is represented by the G7[2] aggregate GDP and the trade-weighted index (TWI)—an index of the exchange rate of Australia's major trading partners—which represents the relative strength or weakness of the Australian dollar in the model. Examination of the plot of economic data covering the period of the analysis reveals that the G7's real GDP has been growing steadily, while the Australian exchange rate has been declining. Imports were used as a proxy for 'imported containers' and introduced in the model as an explanatory variable.' Australian exports in containers are to some extent influenced by the number of empty containers available. For example, the *Daily Commercial News* of September 9, 2001, when commenting on the slump in exports, attributed part of the problem to a shortage of incoming containers for loading export cargo.

The model is of the form

$$\ln y_t = a + \sum_{i=0}^{4} b_i \ln x_{t-i} + \sum_{i=0}^{3} g_i \ln z_{t-i} + m_t$$

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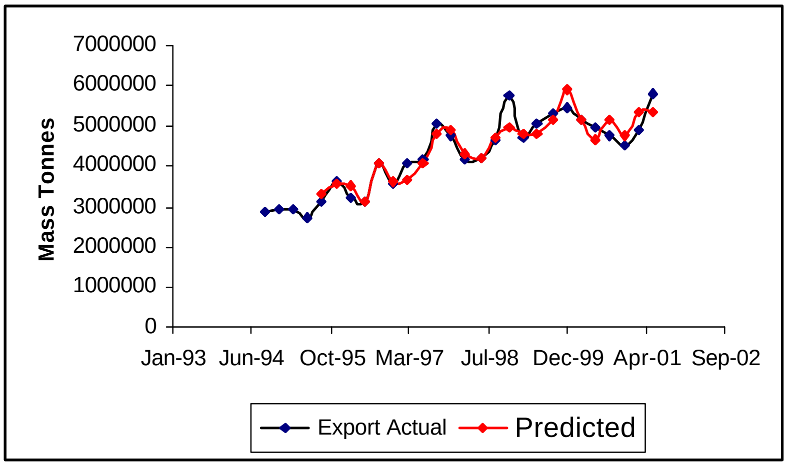
[2] The Group of seven countries comprises Canada, France, Germany, Italy, Japan, UK and USA.

where y_t is the predicted total exports in time *t*; the a, *b*s and ?s are regression coefficients; x_t is the predictor variable GDP of G7 countries; z_t is the predictor variable import containers; and m is an error term.

The best-fit dynamic export model (loglog) based on the adjusted coefficient of determination (Adjusted R^2) was with G7's real GDP and 'import containers'. Real TWI was statistically not significant and had the wrong sign. The model's Adjusted R^2 was 0.89. Figure 1 shows the plot of the actual values and values predicted by the model.

Figure 1 Exports, Actual and Econometric Model Predictions (Tonnes)



Source ABS International Cargo Statistics and BTRE estimates

Import modelling and forecasting

If both the Australian economy as measured by real GDP and the dollar are strong, imports can be expected to rise; that is, demand for goods will increase. If the Australian dollar is strong relative to the currencies of Australia's trading partners, imports could be expected to be less expensive. The regression coefficients for both GDP and the trade-weighted index in such a situation would thus be expected to have positive signs. The model was constructed in loglog form and is of the form

$$\ln y_t = a + \sum_{i=0}^{1} b_i \ln x_{t-i} + \sum_{i=0}^{3} g_i \ln z_{t-i} + m_t$$

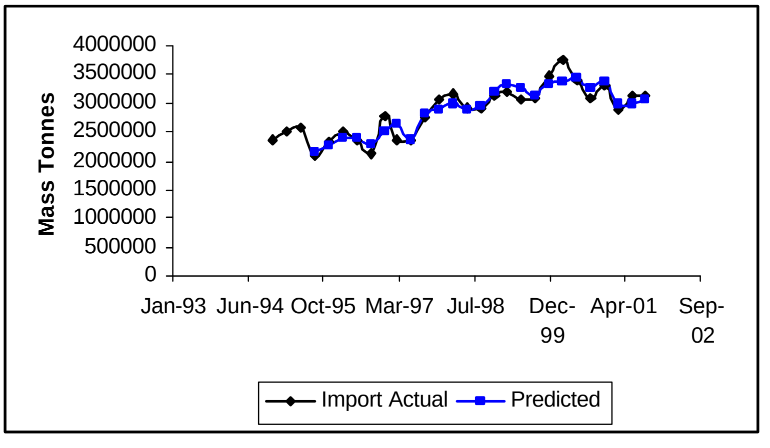
where y_t is the predicted total imports in time *t*; the a, *b*s and ?s are regression coefficients; x_t is the predictor variable Trade Weighted Index (TWI); z_t is the predictor variable Australia's GDP; and m is an error term.

The best-fit dynamic imports model based on Adjusted R^2 was with Australia's real GDP and real TWI. The model's Adjusted R^2 was 0.88. Figure 2 shows the plot of the actual values and values predicted by the model.

The ARIMA model is shown in Figure 3 with the plot of the actual values and values predicted by the model. The best model was determined on the basis of its mean absolute percent error (MAPE). In this case MAPE was 1.35 and R^2 was 0.93.

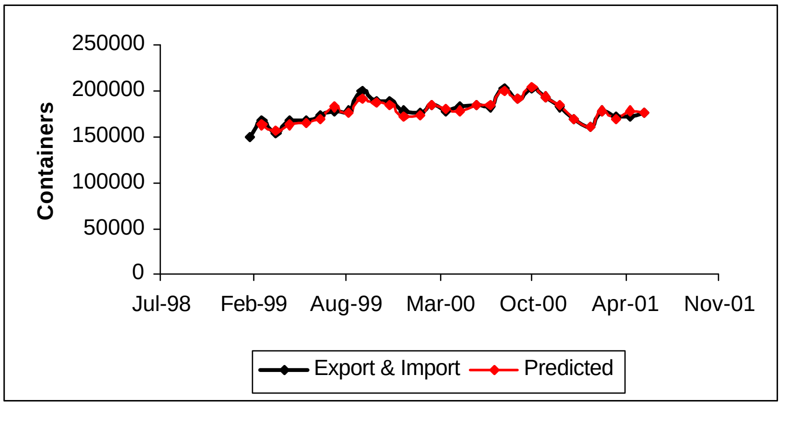
Both models were run using the SAS program. The model's statistical properties are shown in appendix B, including short and long run coefficients and the univariate test for stationarity and multivariate test for cointegration. For presentational purposes, monthly (ARIMA) and quarterly (econometric) forecasts have been aggregated to show annual figures.

Figure 2 Imports, Actual and Econometric Model Predictions (Tonnes)



Source ABS International Cargo Statistics and BTRE estimates

Figure 3 Export and Import of Containers, Actual and ARIMA Model Predictions



Source DOTARS unpublished statistics and BTRE estimates

Derivation of container quantities

As raised elsewhere in this paper, the econometric modelling generated cargo forecasts in mass tonnes. However, the focus of this paper is not so much on cargo throughput *per se,* but rather on the number of containers, and separating double-handled containers from actual imports and exports. The number of containers handled and ship sizes are the prime determinants of port infrastructure investment. The econometric modelling forecasts in mass tonnes have been converted to numbers of containers, both fully loaded and empty, to assist ports to assess their future needs. Limitations on the length of this paper prevent a full discussion of the methods used for the conversion. Readers may refer to a forthcoming BTRE Working Paper 50 on container forecasting.

Some may question the need to separate trans-shipment containers from the total number of containers, since what drives investments in ports is the volume of containers passing through them. While generally this is the case, it is also important to determine the future volume of actual expected container imports and exports, that is, excluding double handling and local traffic. For example, the federal government's stevedoring levy scheme applies levies to import and export containers excluding trans-shipment containers. With the expected increase in the use of larger ships, it is inevitable that the proportion of trans-shipment containers will increase. At the extreme, forecasts that do not separate out trans-shipment containers could indicate high growth rates when all that is being measured is increased double handling. This may not be the most important issue for individual ports, but double handling is an important policy issue. It is also necessary to project the growth in the use of forty-foot containers. Increasing mass tonne imports and exports may not necessarily translate into increasing number of containers, particularly if larger containers are used. If the increasing use of larger containers does affect volumes substantially, then it may also affect the direction of port infrastructure investment, and those policy instruments that are based on containers.

Impact of forty-foot containers

Forty-foot containers are cost-effective from the point of view of importers and exporters. The introduction of the waterfront levy scheme of twelve dollars per container regardless of container size may also have provided an incentive for shippers to use the larger containers. The proportion of 40-foot containers currently used in the Australian trade is around 30 per cent. The base case forecast is that this proportion would average around 35 per cent during the forecast period (2001–02 to 2010-11). A sensitivity analysis assuming that the share of forty-foot containers reaches 56 per cent, with an average of 45 per cent over the forecast period, suggests that there would be an annual 20 per cent reduction in the actual numbers of containers handled over the forecast period. This translates into a reduction of about 628 000 containers per year spread across all ports, averaged over the forecast period (see appendix A table 6). It would be of interest to analyse this reduction by port in order to determine its practical impact. Although the number of boxes to be handled is expected to decline as larger boxes are employed, their equivalent TEU will be rising.

Findings

The econometric analysis (see appendix A table 4) has shown that, over the forecast period from 2001-02 to 2010–11, the expectation is that the combined containerised trade in imports and exports will increase at an average annual rate of 5 per cent. The ARIMA model, on the other hand, predicts an average annual growth rate of 2.3 per cent. It can thus be expected that container growth over the next decade will range between 2.3 and 5 per cent. To test the reliability of the forecast the first year results were compared with the actual. The actual number of containers handled during (2001–02) became available before the completion of the paper. The actual combined import and export containers handled during 2001–02 was 2.3 million that is, 3.9 per cent growth over the previous year (2000–01). For all containers handled, the volume was 2.6 million or 4.4 per cent growth over the previous year. As indicated in appendix A table 5, for the same period (2001–02) the ARIMA model predicted combined import and export of 2.27 million that is, growth of 3.9 per cent and all containers handled 2.6 million that is, 4.4 per cent over the previous year (2000–01). Although this is base on only a year's data after the forecast, it nonetheless demonstrates the accuracy of the models. The ARIMA model indicates that the double handling of containers increases the forecast container growth by 1.5 per cent. The ARIMA model is a good predictor in the short term. However, the econometric model's long term forecasts are much more in line with other world forecasts (see for instance DTLR 2001).

The study has also shown that if the market share of forty-foot containers reached or exceeded 45 percent, there would be a significant reduction in the number of boxes expected to be handled. This scenario is achievable, but very unlikely during the forecast period, given the large investment already made in twenty-foot containers and some constraints in the transport infrastructure network.

APPENDIX A

Table 4 Econometric Model Results (Million)

	Base Case	*Lower Case*	*Upper Case*
Year	*Import & export*	*Import & export*	*Import & export*
2000/01	2.184		
2001/02	2.394	1.701	3.309
2002/03	2.650	2.049	3.404
2003/04	2.656	2.040	3.364
2004/05	2.831	2.164	3.633
2005/06	2.989	2.263	3.897
2006/07	3.147	2.357	4.170
2007/08	3.304	2.447	4.452
2008/09	3.461	2.532	4.743
2009/10	3.616	2.612	5.042
2010/11	3.770	2.687	5.351
Growth %	5		

*Note C*ontainers include empties

Table 5 ARIMA Forecast Results (million)

year	Import and Export-Total	All Containers	Local and Trans-shipment
2001–02	2.270	2.599	0.330
2002–03	2.305	2.677	0.372
2003–04	2.383	2.786	0.403
2004–05	2.424	2.869	0.445
2005–06	2.497	2.973	0.476
2006–07	2.542	3.060	0.518
2007–08	2.612	3.161	0.550
2008–09	2.660	3.250	0.590
2009–10	2.727	3.350	0.623
2010–11	2.777	3.440	0.663
Growth (per cent)	2.3	3.8	8.1

Table 6 Forty-foot Container Impact Analysis (million)

Year	All containers	40ft impact	difference
2001–02	2.394	2.074	0.320
2002–03	2.650	2.238	0.412
2003–04	2.656	2.200	0.456
2004–05	2.831	2.300	0.531
2005–06	2.989	2.409	0.580
2006–07	3.147	2.488	0.659
2007–08	3.304	2.590	0.715
2008–09	3.461	2.663	0.798
2009–10	3.616	2.755	0.861
2010–11	3.770	2.821	0.949
Average		-20%	0.628

APPENDIX B

ARIMA MODEL RESULTS

Imports model statistical properties

SSE	0.0696	*DFE*	17
MSE	0.004	*Root MSE*	0.064
SBC	-49.812	*AIC*	-59.56
Regress R-Square	0.922	*Total R-Square*	0.88
Durbin-Watson	2.208	*Pr < DW*	0.55
Pr > DW	0.45		

SSE =the error sum of squares, MSE = the mean square error, SBC = the Schwartz information criterion, AIC = the Akaike information criterion, DFE = the degrees of freedom for error

Pr < DW is the probability value for testing positive autocorrelation and Pr > DW is the probability value for testing negative autocorrelation

Estimate of parameters

Variable	*Estimate*	*Standard Error*	*t Value*	*Approx Pr > |t|*
Constant	1.10	1.5134	0.73	0.477
TWI(0) short run	-0.12	0.295	-0.41	0.687
TWI (Long run elasticity)	0.44		1.98	0.065
GDP(0) short run	8.018	2.208	3.63	0.002
GDP (Long run elasticity)	1.862		12.28	<.0001

The above model can be written as

$$import_t = 1.10 - 0.12 twi_t + 0.56 twi_{t-1} +$$
$$8.02 gdp_t + 1.02 gdp_{t-1} - 3.04 gdp_{t-2} - 4.14 gdp_{t-3}$$

Augmented Dickey Fuller Unit root test (cointegration)

Type	*Lags*	*Rho*	*Pr < Rho*	*Tau*	*Pr < Tau*	*F*	*Pr > F*
Single mean	0	-26.6783	<.0001	-5.25	0.0004	13.79	0.001
	1	-30.9441	<.0001	-3.63	0.0129	6.59	0.0206
	2	-161.573	0.0001	-3.87	0.0079	7.48	0.007
Trend	0	-26.6925	0.0011	-5.13	0.002	13.17	0.001
	1	-30.9587	<.0001	-3.52	0.0606	6.26	0.0868
	2	-150.402	0.0001	-3.72	0.0428	7.14	0.0538

Export model statistical properties

SSE	0.0861	*DFE*	14
MSE	0.00615	*Root MSE*	0.078
SBC	-35.061	*AIC*	-46.84
Regress R-Square	0.90	*Total R-Square*	0.89
Durbin-Watson	2.01	*Pr < DW*	0.34
Pr > DW	0.66		

SSE =the error sum of squares, MSE = the mean square error, SBC = the Schwartz information criterion, AIC = the Akaike information criterion, DFE = the degrees of freedom for error

Pr < DW is the probability value for testing positive autocorrelation and Pr > DW is the probability value for testing negative autocorrelation

Estimate of parameters

Variable	*Estimate*	*Standard Error*	*t Value*	*Approx Pr > |t|*
Constant	-11.256	4.3934	-2.56	0.0226
GDP-G7(0) short run	-0.759	2.2376	-0.34	0.7396
GDP-G7 (Long run elasticity)	1.862		2.09	0.055
Import container(0) short run	1.038	0.1999	5.19	0.0001
Import containers (Long run)	0.565		1.67	0.1163

Augmented Dickey Fuller Unit root test (cointegration)

Type	*Lags*	*Rho*	*Pr < Rho*	*Tau*	*Pr < Tau*	*F*	*Pr > F*
Single Mean	0	-24.4415	0.0002	-4.83	0.0008	11.79	0.001
	1	-19.963	0.0019	-2.93	0.0576	4.31	0.0909
	2	-33.87	<.0001	-2.93	0.0589	4.36	0.0888
Trend	0	-24.4778	0.0027	-4.72	0.0053	11.15	0.001
	1	-19.9859	0.0164	-2.86	0.1931	4.09	0.418
	2	-31.845	<.0001	-2.89	0.1851	4.38	0.3666

The total import and export data unit root test significance probability is 0.0004, indicating that the series is likely to be stationary. The total containers handled significance probability is 0.0002, indicating that this series is also likely to be stationary.

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