The costs of waterfront unreliability

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Abstract:

Costs of waterfront unreliability to ship-owners were estimated from information provided by operators of liner ships and by bulk shippers. These costs totalled \$200 - \$250 million in 1988. Costs to imports and exports were estimated from data derived from a survey. Total costs of waterfront unreliability to national welfare were estimated to have been in the range \$900 - \$1020 million in 1988. Some of this reflects the costs of delays originating outside the waterfront. It is improbable that these costs could be reduced to zero, and no attempt is made to estimate to what amount they could be reduced or the costs of reducing them.

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Introduction

It was clear from the Inter-State Commission's inquiry into the waterfront that users of the Australian waterfront were concerned about delays and unreliability to at least the same extent as they were about the direct costs of the waterfront. The Commission commented that "... reliability was the main point stressed, with shippers claiming that, even on the basis of realistic expectations and even recognising the inevitability of some delay in the absence of costly over-provisioning of waterfront infrastructure and services, there is substantial scope for improvement" (ISC 1989, 15). This paper presents the results of research by the Bureau of Transport and Communications Economics (BTCE) into the costs of waterfront unreliability (BTCE 1990). The analysis is based on data supplied by shipping companies and on responses to a survey of importers and exporters.

The costs presented in the paper are the total costs of waterfront unreliability. Reform of the waterfront will not be able to reduce these costs to zero for two reasons. First, it is either not feasible or prohibitively expensive to develop a perfectly reliable system. Secondly, some of the more serious disruptions of the waterfront have been a result of events beyond the control of providers of waterfront services. The truck blockades of the Sydney waterfront are notable examples. No attempt is made to estimate the extent to which the costs of unreliability can be reduced in practice nor of the costs of the measures required to reduce them.

How unreliability affects costs

Delays to ships and cargo can be measured by the mean and variance of the delay distribution. A uniform delay (zero variance) would lead to a predictable performance which could be built into shipping schedules and ordering lead times. There would be some costs associated with uniform delays due to lower ship productivity and higher financing costs for importers and exporters. A large variance reflects poor predictability of waterfront and shipping performance and it is this poor predictability that leads to high costs. When unreliability is mentioned it is usually poor predictability, or large variance in cargo delivery times and ship arrival and departure times that are the major concern.

Ship operators incur costs through the disruption to schedules caused by unreliability of the waterfront. Planned schedules cannot be maintained when unpredicted delays occur. Shipowners adopt a range of measures to make up lost time. These measures, which all add to costs, range from fast steaming for moderate delays to the dropping of ports from their schedule and the chartering of additional ships for the more serious delays.

Unreliability of delivery time affects the price overseas consumers are willing to pay for our exports. Lancastrian demand theory views goods as a bundle of characteristics for which consumers have preferences. Customers will generally prefer a good delivered on time to a physically identical good whose delivery is unpredictable (Tirole 1988). Poor delivery performance is likely to be reflected in lower prices customers are willing to pay. If delivery is too haphazard the potential buyer may not be willing to take the risk at all. There are many examples of lost export opportunities due to Australia's poor reputation as a supplier (Australian Trade Commission 1989, AMC 1989).

Unreliability means that importers must hold larger inventories than they would in a more reliable environment and must adopt longer lead times when ordering stock. Long lead times are common for seasonal goods such as fashion wear or Christmas and Easter goods. Despite larger inventories and longer lead times some importers must still use air transport at freight rates four to ten times higher than sea freight rates when disruptions to shipping schedules become particularly severe.

Importers and exporters of small volumes face increased costs through the poor performance of container depots. Analysis by the Bureau suggested that during 1988 some containers took up to 35 days to unpack. This can be especially costly if depot delays mean that the season for which the goods were imported is missed.

Costs to ship operators

The Bureau's analysis of the costs to liner ship operators of waterfront unreliability was based on information supplied by four liner shipping groups. Data for liner ship delays were obtained for the second and fourth quarters in both 1987 and 1988. Altogether, 190 voyages incorporating 613 scheduled Australian port calls were studied. These represented almost 28 per cent of port calls by cellular container and roll-on roll-off (ro-ro) ships in the four quarters studied.

Waterfront unreliability is especially a problem for liner ship operators because they offer a service based on frequency and reliability. The costs to liner ship operators can be conveniently considered in two categories. The first is the cost of departure from planned schedules. Liner ship operators are often prepared to spend significant amounts of money to regain lost time so that schedules can be regained. The second is the cost of normal delays that are allowed for when schedules are planned. Ship operators generally comment that they do not allow for delays when planning schedules, but they do consider the productivity that can be anticipated at the ports called at on the voyage. The productivity at these ports will be affected by minor delays such as stop work meetings of short duration, equipment failures and other unpredictable events. These will generally be allowed for in an implicit way so that a realistic schedule can be planned.

Table 1 Statistics of days lost on the Australian coast

	1987		1988	
Statistic	2nd qtr	4th qtr	2nd qtr	4th qtr
Number of voyages	48	48	48	46
Average delay (days)	3.1	4.5	3.4	4.5
Standard deviation (days)	2.5	3.9	2.6	3.3
Upper quartile (days)	4.3	7.0	5.0	6.1
Upper decile (days)	6.6	8.8	6.6	9.2

Source: BTCE estimates based on data supplied by shipping companies.

Delays to liner ship schedules

Companies supplying data were asked to compare arrival and departure dates with scheduled dates current when the ship left the last foreign port before coming to Australia. This was done so that the effects of delays on the Australian coast would not be confused with delays occurring at foreign ports. The majority of ships in the sample arrived late in Australian ports. Importers faced delays of from one to seven days in ship arrivals and exporters faced even longer delays from three to eight days. Table 1 provides some indicative statistics of days lost on the Australian coast as reported in the sample.

The statistics in Table 1 include delays from all sources including delays for reasons beyond the control of providers of waterfront services such as weather and ship breakdowns. These non-waterfront delays were subtracted from the total delays to give net waterfront caused delays which are shown in Table 2.

Ideally ship delay cost estimates would be based on the costs of the measures actually adopted by ship operators to make up lost time and to reduce the severity of the delay. The data to do this were not available. Instead the method adopted by Stubbs (n.d.) of applying a multiplier to the undelayed operating cost of a ship was used. The multiplier is designed to take account of all the additional costs of the measures taken by ship operators when ship delays occur. Stubbs (n.d.) used a multiplier of 1.3. In this analysis we took account of the distribution of delays because it seems clear that cost per delay depends on the length of the delay. It was assumed that the multiplier increases linearly with delay length to a maximum value of 1.76. The data were not available to determine the time over which the multiplier reached the maximum value so two alternative values (four and six days) were chosen for this parameter. The maximum value of 1.76 was derived from data contained in the Australia to Europe Shipping Conference (AESC) submission to the Prices Surveillance Authority (PSA) inquiry into the proposed congestion surcharge for Sydney (AESC 1989). The costs of delays in Sydney are shown in Table 3. The

Table 2 Net average days lost in Australian ports per ship call

	1987		1988	
Port	2nd qtr	4th qtr	2nd qtr	4th qtr
Sydney	1.48	2.54	1.50	2.72
Melbourne	0.84	0.57	0.71	0.73
Brisbane	0.57	1.45	1.19	1.32
Fremantle	0.02	0.40	0.56	0.43
Adelaide	0.20	0.28	-	0.29
Average	0.84	1.24	0.89	1.37

Source: BTCE estimates based on data supplied by shipping companies

daily operating costs of a 1880 TEU ship which was the average size container ship in the AESC fleet were estimated to be US$23 550 per day which is equivalent to US$74.62 for each laden container carried during the period covered by the AESC (1989) submission. The ratio of the total delay costs per day derived from Table 3 to the daily operating costs is 1.76.

The total delay costs for container and ro-ro ships can now be estimated from the distribution of delay times derived from the data provided by the shipping companies, the distribution of delay cost multipliers as discussed above, the average daily operating cost for a typical liner ship, and the number of ship calls at the mainland capital city ports. It was assumed that a 1300 TEU ship would be representative of container ships visiting Australian ports and, based on information supplied by shipping companies, it was estimated that this representative ship would have a daily

Table 3 Total costs of ship delays reported by AESC
(US$ per laden TEU)

Cost component	Cost
Cost of chartered ships[a]	73.40
Additional port costs	5.07
Additional land-side costs	11.24
Fast steaming costs	16.24
Container leasing costs	16.57
Additional shifts	9.00
Total	131.52

a Includes bunker costs
Source: AESC (1989)

Table 4 Estimated costs of delays to container and ro-ro ships (1987 and 1988)

($ Million)

	Delay costs	
Quarter	Lower[a]	Upper[b]
1987 - Second quarter	15.8	17.0
1987 - Fourth quarter	26.4	27.5
1988 - Second quarter	18.9	20.2
1988 - Fourth quarter	29.1	31.1

a. Multiplier reaches maximum of 1.76 after 6 days
b. Multiplier reaches maximum of 1.76 after 4 days
Source: BTCE estimates based on data supplied by shipping companies and AESC (1989).

operating cost of $25 000 per day. Table 4 summarises the costs for the four quarters analysed. The estimates for the four quarters were grossed up to annual estimates in proportion to the value of Australian trade carried by liner shipping (ABS 1989). The annual estimates derived in this way were $84 million to $89 million in 1987 and $96 million to $102 million in 1988.

The second element of the costs to ship operators, the cost of normal delays, was estimated on the basis of the time a container ship could expect to spend in an Australian port if it performed at the average level of European and Mediterranean ports. Three indicators were adopted to establish the "standard" port times. These were time waiting for a berth, ratio of net working time to berth time, and net production rate (containers per net working hour). The average values for the first two indicators were three hours for berth waiting time and 0.69 for the ratio of net working time to berth time. Two Australian ports (Melbourne and Adelaide) averaged better than the standard value for this latter indicator so the actual value achieved in practice was used in the calculations for these ports. A value of 25 containers per net working hour, which was the typical contract rate that the ANZECS consortium uses for European ports, was chosen for the standard net production rate. A higher rate of 30 containers was chosen for Sydney because the data in the AESC submission suggested that this should be achievable. The excess port time estimated by this method was equivalent to an annual cost of about $50 million.

Delay costs were also estimated for other ship types, but the data supporting these estimates were more speculative. Essentially it was assumed that freight rates for grain exports were higher than they would be in a more reliable environment to the extent that they incorporated an average expectation of two days delay in Australian ports. Information provided by a coal exporter suggested that ship delay costs in New South Wales were equivalent to an extra 90 cents per tonne compared

Table 5 Summary of delay costs to ship operators (1988)
($ Million)

Ship type	Cost imports	Cost exports
Container and ro-ro		
departure from schedule	96 - 102	0
normal delays	45 - 55	0
Total	141 - 157	0
Bulk	0	40 - 60
Other	10 - 15	10 - 15
Total	151 - 172	50 - 75

Source: BTCE estimates based on data supplied by shipping companies and bulk exporters.

to freight rates from Queensland where delays are relatively minor. Delay costs for the remaining ships were based on an average delay due to industrial disputes of three hours per port call. The total estimated delay costs for 1988 are shown in Table 5.

Table 5 also shows the split up of the costs between exports and imports. This allocation of costs is based on the assumptions that all bulk ship delay costs are incurred by exports and all liner shipping delay costs are incurred by imports. This latter assumption was made because the Australian liner trades are imbalanced with imports exceeding exports and under these circumstances imports could be expected to bear the delay costs. Delay costs for other ship types were allocated equally to exports and imports.

Australian imports and exports are carried predominantly by foreign owned ships, but while the delay costs are initially borne by foreigners, it can be expected that these costs would be passed forward to cargo owners as higher freight rates. The final incidence of the delay costs depends upon the elasticities of supply of and demand for Australian imports and exports. This issue is taken up in more detail later in the paper.

Costs of waterfront unreliability to exporters

The survey of exporters indicated that exporters generally experienced an estimated additional seven days in transit times for their exports as result of waterfront delays.

This added an additional $150 million in financing costs for exporters. The survey included questions about severe delays experienced during the period January 1988 to March 1989. About 60 per cent of respondents reported delays of more than five days during this period and about two thirds of these incurred additional costs as a result. The longest delays reported during this period ranged from an average of 14 days during the June Quarter 1988 to 21 days during the September quarter 1988. About three-quarters of these exporters anticipated at least some adverse effects. The cost burden fell most heavily on small exporters. Further details of the survey of exporters can be found in BTCE (1990).

As mentioned in the introduction waterfront unreliability can affect the price foreign consumers are willing to pay for Australian exports. The Bureau in its survey of exporters explored this issue to some extent. Respondents were asked by how much they anticipated that their exports could be increased if waterfront and shipping delays were negligible. They were not asked to comment on the effect reduced costs or increased demand might have on prices. The analysis of the survey responses therefore included an examination of the possible interpretations that respondents may have given to this question.

Figure 1 illustrates the effect of an improvement in waterfront reliability. Export volumes and prices are initially at OQ1 and OP1 respectively. The improvement in reliability reduces the costs faced by exporters so that the supply curve moves down from S1 to S2. Simultaneously the demand for the exported good increases and the demand curve moves to the right from D1 to D2. The final equilibrium is at A with price OP3 and quantity OQ3. In Figure 1 the price OP3 is shown as larger than the initial price, but in practice it could be lower.

The rectangle P1EFP2 represents the unreliability costs faced by Australian exports and these are estimated to have been $239 million in 1988 comprising $146 million financing costs, $63 million in increments to sea freight rates due to ship delays, $20 million truck queuing costs and $10 million for additional use of air transport to avoid waterfront delays. Details of these costs and how they were estimated may be found in BTCE (1990).

Although these costs are paid in the first instance by Australian exporters, they are ultimately shared between Australian exporters and their foreign customers. Cassidy (1980) showed that the final share of these costs accruing to the exporting country can be measured by the ratio of the absolute value of the elasticity of export demand to the sum of the elasticity of export supply and the absolute value of the elasticity of export demand. Using this approach and the elasticities shown in Table 6 the share of the direct costs incurred by Australian residents was estimated to have been 58 per cent or $138 million of the total direct costs of $239 million in 1988.

Knowing the level of these costs allows the price difference P1-P2 to be estimated as a proportion of OP1. The potential increase in export volume, Q2-Q1, as a result of the supply curve shift and with no change in the price can be derived from the export supply elasticity.

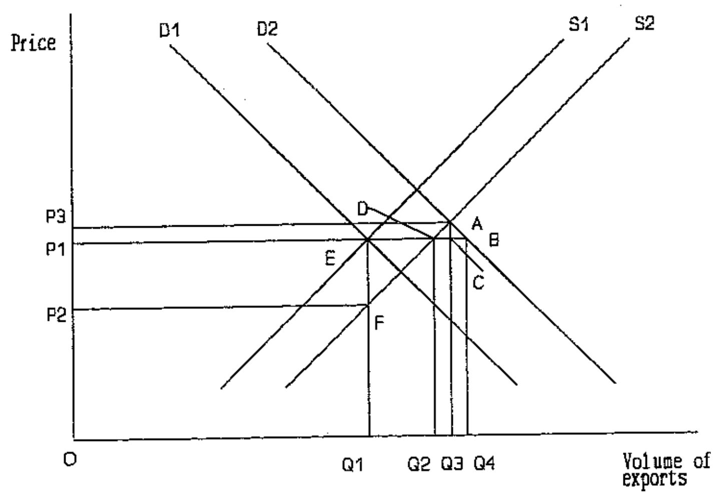

Figure 1 The effect of improved waterfront reliability on export prices and volumes

The proportional increase, (Q2-Q1)/OQ1, can be compared with the increase reported by respondents to the survey If it is less than the reported increase, the price OP3 must be greater than the initial price OP1 and vice versa. At this point it is necessary to consider the interpretation respondents may have given to the question asking them to estimate the increase in export value they anticipated if waterfront and shipping delays were negligible.

One possibility was that respondents to the survey may have formulated their expectations of increased export sales assuming that prices would not change. If so, their estimate of export sales increase in the absence of waterfront and shipping delays would overstate or understate the increase they may be able to achieve depending on whether the equilibrium price increased or decreased The evidence from the survey suggested that they may not have considered potential price changes.

Two approaches were taken so that the likely range in the impact on national welfare could be estimated. The first was to assume no respondent took account of any price effect, and the second was to assume all respondents took account of possible price changes.

The actual increase in value, in addition to that already estimated as a consequence of the supply curve shift is given (Q3-Q2)OP1+(P3-P1)OQ3. The increase reported by respondents assuming no price change is (Q4-Q2)OP1. The actual increase is the proportion $(E_s+1+\alpha)/(E_s-E_d)$ of the reported increase where α is the proportion (Q3-Q2)/OQ2 and E_s and E_d are the export supply and demand elasticities respectively.

The total increase in producers' surplus that would result from the elimination of waterfront and shipping delays is the area P2FAP3 in Figure 1. The increase in value of export sales reported by respondents has two components. One component is due to an increase in export volumes and the other is due to a change in the price. Both components must be considered in estimating the producers' surplus.

Supply and demand elasticities

The issue of the appropriate value of trade elasticities is the subject of considerable disagreement among economists. For the purposes of this analysis, values which were considered plausible were chosen from the range of values available in the literature

The long run elasticity of demand for Australian exports is especially subject to debate. Values of aggregate demand elasticities for Australian exports range from empirically derived results which are almost always less than one in magnitude

Table 6 Estimated gain in producers' surplus if waterfront and shipping delays were negligible

($ Million)

ATFCC Class	Elasticity[a] of supply	Elasticity[a] of demand	1988 exports	Estimated change in exports	Estimated change in producers' surplus
Food & related products (0,1,4)	2	-4	7 964	330	138
Crude materials (2)	2	-4	14 081	132	53
Mineral fuels (3)	5	-4	6 060	296	63
Elaborately transformed manufactures (5,7,8)	10	-10	2 566	304	33
Processed materials[b] and other[c] (6,9)	2	-4	5 342	143	57
Total			36 013	1205	344

Notes: Figures may not add to totals due to rounding.
Figures in brackets refer to ATFCC groups
Estimates are based on the assumption that survey respondents took no account of price changes

a Long run elasticities.

b. Manufactured goods classified chiefly by material.

c Includes confidential items.

Source: BTCE estimates based on survey responses and ABS (1989)

(Gordon 1986) to values of -20 used for most primary products in the ORANI model (Cronin 1985, Dixon, Parmenter & Rimmer 1982). The empirically derived results are implausibly low. Jonson, McKibbin and Trevor (1980), based on some earlier comments by Harberger suggested that -2 was a lower bound to the magnitude of the long run demand elasticity. Stoeckel (1978), based on an assessment of Australia's share in world trade and export supply elasticities, concluded that -4 was a more plausible value for mining and agricultural exports. Similarly, Cronin (1982) considered -4 as being plausible for agriculture and minerals. On the basis of these assessments values of -4 were chosen for all commodity groups except for elaborately transformed manufactures (ETMs) for which a value of -10 was chosen.

A range of opinions have also been expressed about price elasticities of supply. The commodities subjected to the most attention are rural products and minerals. Results of empirical analysis suggest that the long run production supply elasticity in agriculture is around 1 (Lloyd 1982), but this elasticity is less than the export supply elasticity[1]. When allowance was made for Australian consumption a value of 2 was thought to be more plausible. A value of 2 was also found to be plausible for simply transformed manufactures and minerals except coal for which a value of 5 was used (Freebairn 1989). A value of 10 was chosen for ETMs to reflect the ease with which production of these goods can be expanded.

Table 6 shows the elasticities used and the anticipated increase in export sales after adjustment for the price effect. The national totals shown in Table 6 are derived from the survey results by grossing up the survey result in each Australian Transport Freight Commodity Classification (ATFCC) single digit category by the ratio of annual exports as reported by ABS (1989) to the exports reported by survey respondents. The gain in producers' surplus based on the adjusted increase in export sales was $344 million (Table 6). With no adjustment for the price effect the total anticipated increase in producers' surplus was $447 million.

These estimates include the previously estimated share of the direct costs borne by Australian residents. The effect of forgone export sales on national welfare is the difference between these estimates and the $138 million share of the direct costs estimated earlier, or $206 million to $309 million.

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1 An increment in exports can be achieved by either increasing Australian production or by decreasing Australian consumption, or by some combination of these. Formally we should take account of both effects by defining the export supply elasticity as:

$$E_X = E_S(S/X)\phi_{SX}+E_C(C/X)\phi_{CX}$$

Where E_S is the elasticity of production supply, E_C that of consumption demand, S is Australian production supply, C is Australian consumption and X is Australian exports. The ϕs are the price transmission elasticities.

Exporters responding to the survey are, apart from the consideration of the price effect mentioned earlier, more likely to have overstated the effect of unreliability on their business than to understate it This would be offset to some extent by the fact that businesses that do not currently export, but who might under more favourable circumstances, were excluded from the survey. To have included them in the survey would have added considerably to survey costs and the responses are likely to have been very speculative.

Costs of waterfront unreliability to importers

Importers believed that if waterfront and shipping delays were negligible they could reduce their ordering lead times by 17 days or by 19 per cent About 65 per cent of importers responding to the Bureaus' survey experienced delays of more than five days during the period January 1988 to March 1989 and about three-quarters of these reported additional costs as a result. One half of those reporting delays during this period lost contracts because of the delays The longest delays reported during this period ranged from an average of 24 days during the March quarter of 1988 to 30 days during the March quarter of 1989. These delays were from seven to 12 days longer than those reported by exporters. Over 80 per cent of importers reporting delays expected at least some adverse effect on their business arising from the delay. The survey responses suggested that importers suffered more from delays than exporters. Further details on the survey of importers can be found in BTCE (1990).

Survey respondents were asked to provide an estimate of the reduction in inventory levels and interest and storage costs they anticipated would be possible if waterfront and shipping delays were negligible. The answers to these questions were grossed up to national totals in a similar manner to the anticipated export sales. The estimated existing import inventory levels and the anticipated reduction in inventory are both shown in Table 7 The interest and storage cost savings when grossed up to national figures were $312 million and $42 million respectively.

Earlier an estimate of $151 million to $172 million was presented for the ship delay costs borne by importers. In addition a separate analysis was made of the costs of truck queues. Of the total estimated annual cost of truck queues of $53 million, $33 million was estimated as incurred by imports (Joint Industry Project 1990). As a result of waterfront and shipping delays some additional use of air freight occurs. A total cost of $15 million savings was assumed from this source bringing the total costs for imports to $553 million to $574 million in 1988. It seems plausible to treat all of these costs as welfare costs to Australia. The "small country" assumption is likely to hold for imports (that is, the supply curve can be treated as horizontal).

Table 7 Import inventory levels and anticipated reduction if waterfront and shipping delays were negligible

ATFCC category	1988 imports ($M)	Existing inventory ($M)	Anticipated reduction ($M)	Anticipated reduction (%)
Food & related products (0,1,4)	1 999	400	74	19
Crude materials (2)	1 507	531	111	21
Mineral fuels (3)	1 824	385	0	0
Chemicals (5)	3 921	492	50	10
Processed materials[a] and other[b]	7 102	2 644	355	13
Machinery & trans equipment (7)	13 179	4 217	446	11
Miscellaneous manufactures (8)	3 840	1 614	231	14
Total	33 372	10 282	1 267	12

Notes: Figures may not add to totals due to rounding.
Figures in brackets refer to ATFCC groups.
a Manufactured goods classified chiefly by material
b. Includes confidential items.
Source: BTCE estimates based on survey responses and ABS (1989).

Conclusion

The total estimated welfare costs of waterfront unreliability are summarised below:

- Costs to exporters — $138 million
- Impact of forgone export sales — $206 million to $309 million
- Costs to importers — $553 million to $574 million
- Total — $897 million to $1021 million

The analysis set out in this paper reflects conditions as they were in 1988. The ISC Waterfront Strategy Inquiry was in progress at that time, but no reform program had been established. The costs estimated in the study and many of the problems mentioned by respondents to the Bureau's survey have since been addressed within the reform program, although agreement has by no means been achieved on all of the issues. Media attention has focused on reform of labour conditions in the stevedoring industry, but the reform process also involves such initiatives as increasing competitive pressures through the enhanced roles of the PSA and the Trade Practices Commission, the introduction of Electronic Data Interchange (EDI) and action to reduce the incidence of truck queuing. For the reasons given in the introduction it is improbable that the costs of waterfront unreliability could be reduced to zero, so that the cost estimates presented in this paper should not be considered as an indication of the potential benefits of waterfront reform.

While an improvement in reliability will increase the attractiveness of Australian exports, the attractiveness of imports will also increase. The analysis of the survey responses suggests that importers bear the larger burden of the costs of unreliability. The possibility therefore exists that the short run effect of waterfront reform on the balance of payments could be negative. Nevertheless, the costs of unreliability are sufficiently large that a policy to reduce them has sufficient justification without considering balance of payments effects.

A large proportion of the costs are time dependent costs in the form of financing or interest costs. These costs are sensitive to the level of interest rates, so to some extent the costs presented in this paper reflect the high level of interest rates prevailing during the analysis period

The results indicate that ship delay costs represent just over 20 per cent of the costs of unreliability borne by Australian residents. Evaluations of potential port investments tend to focus on the benefits of delay reducing investments to ship owners. The results of this research suggest that the optimal level of port capacity may be higher than that suggested by a consideration of ship owner interests alone.

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