

工學碩士 請求 論文

DEA

가

**An Empirical Study on the Efficiency of Container Ports and
Terminals using DEA Model**

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韓國海洋大學校 大學院

物流 工學科

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An Empirical Study on the Efficiency of Container Ports and Terminals using DEA Model

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Abstract

The main purpose of this study is to implement a empirical research about the efficiency of container ports and terminals, and to suggest a effective strategy which can operate container ports and terminals more well.

In this study, we evaluate a relative efficiency with Data Envelopment Analysis(DEA) about 33 ports including pusan port and 68 container terminals including 3 container terminal in pusan.

As a results, we suggest several ideas that can improve the efficiency of ports and container terminals. There are as follows.

Firstly, we suggest information about efficient and inefficient container ports and terminals and then we present a method that can move to efficiency container port and terminal.

Secondly, we evaluate the efficiency of container ports and terminals in pusan, and grasp the position at the present time, suggest a advanced direction in future.

Finally, on the basis of our results, we suggest a method which port and terminal to be operated effectively not reducing input factor and increasing output factor to improve operating system.

1

1.1.

6 TEU가

가

가

가

가

가

가

(, , ,)

Panamax(가) Post Pananax(

가) 2

Super

Super Post Pananax

()

(,) 가

가

Post Pananax

가

1 2 가
2 3 (,
AGV : Auto Guarded Vehicle)

2 3 ,
50 1

가

DEA

3

, 2

DEA

가

1.2.

1

, 2

DEA

()

DEA
3 DMU , 4
가 , 5
가

2

2.1.

2.1.1.

()

DEA Charnes and Cooper(1985)

- DMU(Decision Making Unit : DMU)

가

가

- DMU

가

inefficiency)

(output inefficiency)

(input

2.1.2

1)

가 가

가

가

가 DEA 가 , , 가 .

, () , .
가

2)

○

가
가가 . ,

○

가 가

가

가 가 .

2.1.3.

1)

가

가
() , ‘ ,
,
(1999) ,
,
가 ,
,
가 가
가 가
, 가 가
가 , ,
가
, 가 가 ,
, 가 ,
(1999)

170 , 225 , 265
 가 , ,
 ,
 2 4 ,
 , , 50% , ,
 ,
 60% .
 가 ,
 가가 .
 (1999) , 가
 , ,
 , 6 (, , ,
 , ,) 가 , 6
 가 , ,
 가 .
 (1999) ,

Risk

3

가

(1999)

LCL

(1999)

가

, CFS,

DEA (DMU) 가 .
DMU ()
(frontier) 가 .
DEA 가 가 , , ,
, 가 DMU 가
, 가 가
가 (Linear Programming Technique) .
DMU DMU , 가
DMU .
DEA 가 가
() 가 가 .
DEA 가 가
, 가 가
. 가 .
DMU 가
가(Schaffnit, Rosen, & Paradi, 1997), R&D 가(Oral, Ossama & Lang,
1991), (Shang & Sueyoshi, 1995), 가
(Parkan, Lam & Hang, 1997) 가 .

2.2.2. DEA

$$\text{(Efficiency)} = \frac{\text{(Output)}}{\text{(Input)}}$$

$$\text{(Efficiency)} = \frac{\text{Weighted Sum of Outputs}}{\text{Weighted Sum of Inputs}}$$

, 가

$$\text{가 } j = \frac{u_1 y_{1j} + u_2 y_{2j} + \dots}{v_1 x_{1j} + v_2 x_{2j} + \dots}$$

$$u_r = \text{가 } r$$

$$y_{rj} = \text{가 } j \text{ } r$$

$$v_i = \text{가 } i$$

$$x_{ij} = \text{가 } j \text{ } i$$

가 가 가 가

가 가 가

가

가 가

Charnes, Cooper, and Rhodes(1978)

DMU가

가 가

(2-1)

CCR

. (2-1)

(Linear Programming)

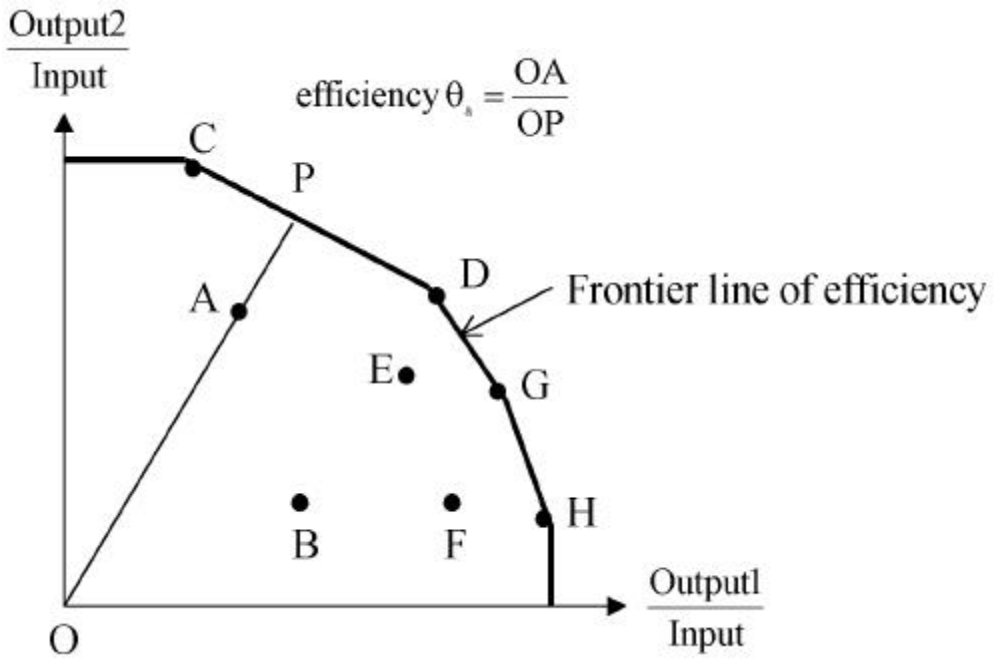
(2-2)

$$\left. \begin{aligned}
 \text{Max } h_o &= \frac{\sum_{r=1}^t u_r y_{rj_o}}{\sum_{i=1}^m v_i x_{ij_o}} \\
 \text{subject to} \\
 \frac{\sum_{r=1}^t u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} &\leq 1, \quad j=1, \dots, n, \\
 u_r, v_i &\geq \epsilon, \quad \forall r \text{ and } i,
 \end{aligned} \right\} (1)$$

$$\left. \begin{aligned}
 \text{Max } h_o &= \frac{\sum_{r=1}^t u_r y_{rj_o}}{\sum_{i=1}^m v_i x_{ij_o}} \\
 \text{subject to} \\
 \sum_{i=1}^m v_i x_{ij_o} &= 1 \\
 \sum_{r=1}^t u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} &\leq 0, \quad j=1, \dots, n, \\
 -u_r &\leq -\epsilon, \quad r=1, \dots, t, \\
 -v_i &\leq -\epsilon, \quad i=1, \dots, m.
 \end{aligned} \right\} (2)$$

DEA < 2-1> 1 , 2
 DEA , DMU
 (C,D,G,H) Frontier Line , DMU
 (A,B,E,F) . , A
 DMU가 가 가 C,D ()
) P .

CCR DMU 가 , 가



< 2-1 > 1 , 2 DEA

Banker, Charnes and Cooper(1984)

BCC . BCC 가 ,

DMU . (3) BCC

CCR (2)

u_0 . BCC (3) u_0
 $u_0^* > 0$
 $u_0^* = 0$, $u_0^* < 0$

$$\begin{aligned}
 \text{Max } h_o &= \sum_{r=1}^t u_r y_{rj_o} - u_0 \\
 \text{subject to} \\
 \sum_{i=1}^m v_i x_{ij_o} &= 1 \\
 \sum_{r=1}^t u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} &\leq 0, \quad j=1, \dots, n, \\
 -u_r &\leq -\varepsilon, \quad r=1, \dots, t, \\
 -v_i &\leq -\varepsilon, \quad i=1, \dots, m, \\
 u_0 &\text{urs(free) variable}
 \end{aligned}
 \tag{3}$$

DEA
CCR, BCC 가

2.2.3. DEA

DEA CCR, BCC 가

가

DEA

, DEA 가

, DMU 가 DMU가

Kamakura, Lenartowicz and Ratchford(1996) 188

DMU (clustering)

DMU DEA

, DEA DATA가 Numerical Value 가

Morey(1986) DEA, Banker, Kamakura(1988)가 Data Data, Cooper, Park, and Yu(1999) IDEA (Imprecise Data Envelopment Analysis) 가 DEA 가, 가 DMU 가 가, < 2-2> Thompson, Dharmapala, Rothenberg, and Thrall(1996) 14 가 / Assurance Region DEA/AR, DEA, 1, Färe and Grosskopf(1996) (Intermediate Products) Network Model, Löthgren and Tanbour(1996)

< 2-2> 가

(ranking)		$\{ u_r = u_{r+1} \}$ for some r	Golany(1988)
		$\{ u_r - u_{r+1} \geq \eta \}$ for some r ($\eta \equiv a$ positive number)	Ali, Cook, and Seiford(1991)
(Bounds)		$\{ \alpha_r^- \leq u_r \leq \alpha_r^+ \}$ for some r ($\alpha_r^-, \alpha_r^+ \equiv constants$)	Roll, Cook, and Golany(1991) Dyson, Thanassoulis(1988)
		$\{ \beta_r^- \leq u_r / u_{r+1} \leq \beta_r^+ \}$ for some r ($\beta_r^-, \beta_r^+ \equiv constants$)	Thompson et al.(1990)

2.2.4. DEA

DEA Charnes, Cooper, and Rhodes(1978)가 Farrell

.

Banker, Charnes, Cooper, and Schinner(1982)

가 Charnes, Cooper, Seiford, and

Slutz(1982) DEA Multiplicative , Charnes, Cooper,

Golany, Seiford, and Slutz(1985) Additive .

Banker, Charnes, Cooper(1984) , Banker(1984) DEA

가

가 가 , Sherman and

Gold(1985)

. Rangan et Al(1990) , , 가

, , , ,

.

Ferrier and lovell(1990) translog DEA

. Grabowski, Rangan and

Rezvanian(1993) . Miller and

Noulas(1996) 1984 1990 10 201

.

(1991) 가

, , 3가 ,

, , 3가 , 가 DEA

. (1993) .

27 . (1996)

Cummins

and Weiss(1993) 가 , DEA
(1998)
DEA(Delta Envelopment Analysis)
(2000) DEA/AHP 가
DEA/AHP
DMU 가

3

3.1.

3.1.1. 가

가
가
가
가
< 3-1>

< 3-1> 가

Rank 1998	Country /region	1998 TEU	1997 TEU	Rank 1997	Rank 1998	Country /region	1998 TEU	1997 TEU	Rank 1997
1	China	24,729,085	19,929,241	2	31	New Zealand	950,888	950,366	29
2	USA	21,953,084	21,766,354	1	32	Hawaiian	935,403	875,136	13
3	Singapore	15,100,000	14,135,300	3	33	Venezuela	830,109	606,036	40
4	UAE	10,998,029	10,224,940	5	34	Ireland	827,092	759,311	36
5	Japan	10,227,914	10,847,201	4	35	Argentina	806,674	720,247	37
6	UK	6,520,240	6,111,364	6	36	Egypt	802,071	993,554	28
7	South Korea	6,331,416	5,636,876	9	37	Sweden	779,788	796,736	34
8	Netherlands	6,061,577	5,637,532	8	38	Chile	774,343	711,112	38
9	Germany	5,985,772	5,916,277	7	39	Finland	737,737	766,983	35
10	Italy	5,287,558	4,689,719	10	40	Mexico	665,721	832,475	33
11	Spain	4,552,354	4,102,091	11	41	Portugal	596,064	521,561	41
12	Belgium	4,059,828	3,615,953	12	42	Jamaica	573,114	496,682	42
13	Philippines	3,166,716	2,491,990	15	43	Denmark	513,916	411,874	43
14	Malaysia	3,014,564	2,843,248	13	44	Honduras	446,613	365,864	48
15	Thailand	2,638,906	2,123,671	18	45	Ecuador	407,434	375,894	46
16	France	2,386,265	2,168,158	17	46	Peru	378,013	321,568	49
17	Indonesia	2,233,394	2,478,674	16	47	Bangladesh	345,327	300,476	51
18	Puerto Rico	2,071,385	1,971,904	19	48	Ilan	325,904	260,095	53
19	Australia	2,040,251	2,667,956	14	49	Russia	291,702	292,180	52
20	Panama	1,997,372	1,580,933	22	50	Lebanon	289,562	309,719	50
21	India	1,828,836	1,738,406	20	51	Norway	276,831	260,017	54
22	Sri Lanka	1,714,077	1,687,184	21	52	Trinidad & Tobago	270,204	239,952	55
23	South Africa	1,560,272	1,467,153	23	53	Morocco	245,382	210,688	58
24	Canada	1,421,978	1,330,680	25	54	Iceland	228,339	212,512	57
25	Saudi Arabia	1,380,804	1,286,806	26	55	Poland	214,382	192,845	59
26	Brazil	1,345,395	1,376,537	24	56	Cyprus	214,030	402,700	44
27	Israel	1,217,607	1,089,970	27	57	Turkey	201,471	368,505	47
28	Greece	1,120,198	845,071	31		Other countries	2,483,015	3,856,979	-
29	Malta	1,118,741	704,427	39		World total record	171,528,276	160,720,794	-
30	Canary Is	1,053,529	843,112	32					

: Containerisation International Yearbook 2000, p 8

1) 10 가 가
 10 가 < 3-2> .
 10 가 가가 4 40%
 . 20 가 40% 30 가
 33% 가
 가 .
 10 가 1998 113,194,675
 10% 가 66%
 . , 1998 가
 56,388,415 33%

가

< 3-2> 10 가 가

가	가	98	97
1	China	24,729,085	19,929,241
2	USA	21,953,084	21,766,354
3	Singapore	15,100,000	14,135,300
4	UAE	10,998,029	10,224,940
5	Japan	10,227,914	10,847,201
6	UK	6,520,240	6,111,364
7	South Korea	6,331,416	5,636,876
8	Netherlands	6,061,577	5,637,532
9	Germany	5,985,772	5,916,277
10	Italy	5,287,558	4,689,719
10 가		113,194,675	104,894,804
가		171,528,276	160,720,794
10 가	가	65.99%	65.27%
1	China	24,729,085	19,929,241
3	Singapore	15,100,000	14,135,300
5	Japan	10,227,914	10,847,201
7	South Korea	6,331,416	5,636,876
가		56,388,415	50,548,618
10 가		113,194,675	104,894,804
가		171,528,276	160,720,794
10 가		49.82%	48.19%
가		32.87%	31.45%

: Containerisation International Yearbook 2000, p 8

2) 20 가 가
 1998 20 가
 < 3-3> 141,355,710
 가 82% . 1998
 가 67,441,995 20
 가 48% 가 39%

< 3-3> 20 가 가

가	가	98	97
1	China	24,729,085	19,929,241
2	USA	21,953,084	21,766,354
3	Singapore	15,100,000	14,135,300
4	UAE	10,998,029	10,224,940
5	Japan	10,227,914	10,847,201
6	UK	6,520,240	6,111,364
7	South Korea	6,331,416	5,636,876
8	Netherlands	6,061,577	5,637,532
9	Germany	5,985,772	5,916,277
10	Italy	5,287,558	4,689,719
11	Spain	4,552,354	4,102,091
12	Belgium	4,059,828	3,615,953
13	Philippines	3,166,716	2,491,990
14	Malaysia	3,014,564	2,843,248
15	Thailand	2,638,906	2,123,671
16	France	2,386,265	2,168,158
17	Indonesia	2,233,394	2,478,674
18	Puerto Rico	2,071,385	1,971,904
19	Australia	2,040,251	2,667,956
20	Panama	1,997,372	1,580,933
20 가		141,355,710	130,939,382
가		171,528,276	160,720,794
20 가	가	82.41%	81.47%
1	China	24,729,085	19,929,241
3	Singapore	15,100,000	14,135,300
5	Japan	10,227,914	10,847,201
7	South Korea	6,331,416	5,636,876
13	Philippines	3,166,716	2,491,990
14	Malaysia	3,014,564	2,843,248
15	Thailand	2,638,906	2,123,671
17	Indonesia	2,233,394	2,478,674
가		67,441,995	60,486,201
20 가		141,355,710	130,939,382
가		171,528,276	160,720,794
20 가		47.71%	46.19%
가		39.32%	37.63%

: Containerisation International Yearbook 2000, p 8

1997 60,486,201
 20 가 46%, 38%
 . 20 · 80
 100 가 20% 가가
 82% (30% 가 90%) . 10
 , 20 , 30 가 2.2% 4%

3) 30 가 가
 < 3-4> 30 가 가
 1998 30 가 155,117,147
 가 90% . 1998 가
 70,984,908 30 가 46%, 가
 41% .

< 3-4>

30 가

가

가	가	98	97
1	China	24,729,085	19,929,241
2	USA	21,953,084	21,766,354
3	Singapore	15,100,000	14,135,300
4	UAE	10,998,029	10,224,940
5	Japan	10,227,914	10,847,201
6	UK	6,520,240	6,111,364
7	South Korea	6,331,416	5,636,876
8	Netherlands	6,061,577	5,637,532
9	Germany	5,985,772	5,916,277
10	Italy	5,287,558	4,689,719
11	Spain	4,552,354	4,102,091
12	Belgium	4,059,828	3,615,953
13	Philippines	3,166,716	2,491,990
14	Malaysia	3,014,564	2,843,248
15	Thailand	2,638,906	2,123,671
16	France	2,386,265	2,168,158
17	Indonesia	2,233,394	2,478,674
18	Puerto Rico	2,071,385	1,971,904
19	Australia	2,040,251	2,667,956
20	Panama	1,997,372	1,580,933
21	India	1,828,836	1,738,406
22	Sri Lanka	1,714,077	1,687,184
23	South Africa	1,560,272	1,467,153
24	Canada	1,421,978	1,330,680
25	Saudi Arabia	1,380,804	1,286,806
26	Brazil	1,345,395	1,376,537
27	Israel	1,217,607	1,089,970
28	Greece	1,120,198	845,071
29	Malta	1,118,741	704,427
30	Canary Is	1,053,529	843,112
30	가	155,117,147	143,308,728
	가	171,528,276	160,720,794
30	가 가	90.43%	89.17%

1	China	24,729,085	19,929,241
3	Singapore	15,100,000	14,135,300
5	Japan	10,227,914	10,847,201
7	South Korea	6,331,416	5,636,876
13	Philippines	3,166,716	2,491,990
14	Malaysia	3,014,564	2,843,248
15	Thailand	2,638,906	2,123,671
17	Indonesia	2,233,394	2,478,674
21	India	1,828,836	1,738,406
22	Sri Lanka	1,714,077	1,687,184
	가	70,984,908	63,911,791
30	가	155,117,147	143,308,728
	가	171,528,276	160,720,794
30	가	45.76%	44.60%
	가	41.38%	39.77%

: Containerisation International Yearbook 2000, p 8

< 3-6>

()	×	×	×	×	×	
()			×			
()		×		×		,
()		×				, 가 ,

: (1996),

2 3
 , , , , ,

< 3-7>

< 3-7>

(: TEU)

	1995	1996	1997	2001	2006
	16,109	17,631	19,508	28,700	47,203
	8,415	9,083	9,927	14,168	22,174
	3,760	4,271	4,852	8,081	15,351
	2,182	2,329	2,487	3,231	4,480
	859	941	1,105	1,375	1,813
	553	618	691	1,079	1,884
	340	389	446	766	1,501

: , “ ”, ‘98. 4

< 3-7> < 3-8>

< 3-8> . < 3-8> 97

가 70.30%, 33.46%, 43.68%, 21.11%,

29.66%,

21.24%

가

70%

< 3-8 >

가

				가 (%)	가 (%)
	99	1	16,100,000	9.9	18.6(3))3 = 6.2
	98	2	14,650,000	1.0	
	97	1	14,500,000	7.7	
	96	1	13,460,343	-	
가	99	2	15,900,000	5.3	21.3(3))3 = 7.1
	98	1	15,100,000	6.9	
	97	2	14,120,000	9.1	
	96	2	12,943,900	-	
	99	3	6,958,361	11.0	33.5(3))3 = 11.27
	98	3	6,271,053	10.1	
	97	3	5,693,339	12.4	
	96	3	5,063,048	-	
	99	4	6,439,589	11.9	32.6(3))3 = 10.9
	98	5	5,752,955	9.9	
	97	5	5,233,880	10.8	
	96	5	4,725,206	-	
	99	19	2,200,000	0.0	-7.5(3))3 = -2.5
	98	15	2,200,000	-5.6	
	97	13	2,330,000	-1.9	
	96	10	2,374,912	-	
	99	18	2,200,000	5.4	-1.0(3))3 = -0.3
	98	17	2,087,000	-0.6	
	97	17	2,100,000	-5.8	
	96	15	2,229,320	-	

:

(<http://www.kca.or.kr/KOR/menu3/statistics.htm>)

3.2.

3.2.1. DEA

DEA 가 , 가 ,
 가 DMU 가
 . 50
 (97 96) 50
 . ,
 가 .

< 3-9> DEA

Category	Variable -	
Input data	V1 : Berth Length(m)	
	V2 : Total Area(m ²)	
	V3 : C- Gantries	: Container Gantries
	V4 : 1	: Yard Gantries, Quay Cranes, Floating Cranes, Mobile Cranes
	V5 : 2	: Straddle Carriers, Forklifts, Reachstackers, Top lifter
	V6 : Y- Tractors	: Yard Tractors
	V7 : Y- Chassis/Trailers	: Yard Chassis/Trailers
	V8 : CFS Area(m ²)	Container Freight Stations Area(m ²)
Output data	U1 : Full TEU(L)	
	U2 : Empty TEU(L)	
	U3 : Full TEU(S)	
	U4 : Empty TEU(S)	

50 98 , 가
 33 , 97 35 , 50
 98 , 97 가 68
 .
 , DMU <
 3- 10>, < 3- 11>, < 3- 12>, < 3- 13> .

(Input), (Output)

< 3-9> V4, V5

가

가 8 ,

4 가

< 3-10> DEA - DMU(1998)

DMU	Port Name
DMU3	Kaohsiung
DMU4	Rotterdam
DMU5	Pusan
DMU7	Hamburg
DMU8	Yokohama
DMU9	Los Angeles
DMU10	Antwerp
DMU12	New York/New Jersey
DMU13	Dubai
DMU14	Keelung
DMU17	Manila
DMU18	San Juan
DMU19	Oakland
DMU21	Nagoya
DMU23	Port Klang
DMU24	Colombo
DMU25	Bangkok
DMU27	Hampton Roads
DMU28	Charleston
DMU32	Durban
DMU33	Melbourne
DMU34	La Spezia
DMU36	Genoa
DMU38	Laem Chabang
DMU39	Qingdao
DMU40	Southampton
DMU41	Houston
DMU42	Santos
DMU43	Barcelona
DMU44	Jeddah
DMU45	Sydney (Harbour)
DMU46	Khor Fakkan
DMU47	Valencia

DMU	Port Name
DMU1	HongKong
DMU2	Singapore
DMU3	Kaohsiung
DMU4	Rotterdam
DMU5	Pusan
DMU7	Hamburg
DMU8	Yokohama
DMU9	Los Angeles
DMU10	Antwerp
DMU12	New York/New Jersey
DMU13	Dubai
DMU14	Keelung
DMU17	Manila
DMU18	San Juan
DMU19	Oakland
DMU20	Seattle
DMU22	Tanjung Priok
DMU23	Port Klang
DMU24	Colombo
DMU25	Bangkok
DMU26	Osaka
DMU27	Hampton Roads
DMU28	Charleston
DMU33	Melbourne
DMU34	La Spezia
DMU36	Genoa
DMU38	Laem Chabang
DMU39	Qingdao
DMU40	Southampton
DMU42	Santos
DMU43	Barcelona
DMU44	Jeddah
DMU45	Sydney (Harbour)
DMU46	Khor Fakkan
DMU47	Valencia

가

	(Port)	(Terminal-Term)
DMU1	Hong Kong	Term 3
DMU2	Hong Kong	Term 8(East)
DMU3	Hong Kong	Term 1/2/5/8(West)
DMU4	Hong Kong	Term 4/6/7
DMU14	Rotterdam	brittannie Term
DMU19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)
DMU20	Rotterdam	Home Term
DMU25	Rotterdam	Waalhaven Pier 7
DMU30	Pusan	Jasungdae Con-Term
DMU31	Pusan	Shinsundae Con-Term
DMU32	Pusan	Uam Con-Term
DMU40	Hamburg	Burchardkai Term
DMU42	Hamburg	Eurogate Con-Term
DMU44	Hamburg	TCT Tollerort Term
DMU45	Hamburg	Unikai Con-Term
DMU48	Yokohama	Term C3
DMU60	Los Angeles	Yang Ming Line Term
DMU70	Tokyo	Berth 2-OC
DMU90	Keelung	Keelung Harbor Bureau
DMU101	Manila	Manila International Con-Term
DMU102	Manila	Manila Slipway
DMU103	Manila	Pier 10
DMU104	Manila	Pier 12
DMU105	Manila	Pier 14
DMU106	Manila	Pier 16
DMU107	Manila	Pier 2
DMU108	Manila	Pier 4
DMU109	Manila	Pier 6
DMU111	Manila	South Harbor
DMU115	Oakland	Ben E Nutter Con-Term
DMU130	Nagoya	Kinjo Pier
DMU131	Nagoya	NCB Term
DMU132	Nagoya	Tobishima North Pier
DMU133	Nagoya	Tobishima South Pier
DMU135	Port Klang	Klang Con-Term
DMU136	Port Klang	Klang Multi Term
DMU137	Port Klang	Klang Port Con-Term
DMU138	Port Klang	WestPort Term
DMU139	Colombo	Jaye Con-Term
DMU140	Colombo	Queen Elizabeth Quay Con-Term
DMU141	Bangkok	Bangkok
DMU150	Hampton Roads	Newport News Marine Term
DMU151	Hampton Roads	Norfolk International Term
DMU152	Hampton Roads	Portsmouth Marine term
DMU169	Durban	Con-Term
DMU172	Melbourne	East Swanson Dock
DMU173	Melbourne	TT-Line Term
DMU178	Melbourne	Webb Dock Term
DMU179	Melbourne	West Swanson dock
DMU180	Melbourne	West Swanson dock
DMU181	La Spezia	La Spezia Con-Term
DMU187	Genoa	Southern European Con-Hub-Term
DMU189	Genoa	Voltri Term
DMU191	Laem Chabang	Laem Chabang
DMU192	Qingdao	Qingdao
DMU196	Santos	Tecon Term
DMU197	Barcelona	Estibadora de Ponent
DMU200	Barcelona	T CB Term
DMU202	Barcelona	Term Port-Nou
DMU203	Jeddah	Con-Term
DMU204	Sydney(Harbour)	Darling Harbour
DMU205	Sydney(Harbour)	White Bay
DMU206	Khor Fakkan	Khor Fakkan Con-Term
DMU209	Valencia	Valencia Con-Term(Terport SA)

	(Port)	(Terminal-Term)
DMU1	Hong Kong	Term 3
DMU2	Hong Kong	Term 8(East)
DMU3	Hong Kong	Term 1/2/5/8(West)
DMU4	Hong Kong	Term 4/6/7
DMU14	Rotterdam	brittannie Term
DMU16	Rotterdam	Delta Term(Europahaven)
DMU19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)
DMU20	Rotterdam	Home Term
DMU25	Rotterdam	Waalhaven Pier 7
DMU30	Pusan	Jasungdae Con-Term
DMU31	Pusan	Shinsundae Con-Term
DMU35	Long Beach	ITS Term
DMU36	Long Beach	Longbeach Con-Term
DMU40	Hamburg	Burchardkai Term
DMU42	Hamburg	Eurogate Con-Term
DMU44	Hamburg	TCT Tollerort Term
DMU45	Hamburg	Unikai Con-Term
DMU48	Yokohama	Term C3
DMU60	Los Angeles	Yang Ming Line Term
DMU63	Antwerp	Europe Term
DMU68	Antwerp	Seaport Term
DMU69	Antwerp	Westerlind
DMU70	Tokyo	Berth 2-OC
DMU71	Tokyo	Berth 6-OG
DMU76	Tokyo	Berth 4-OE/5-OF
DMU90	Keelung	Keelung Harbor Bureau
DMU101	Manila	Manila International Con-Term
DMU102	Manila	Manila Slipway
DMU103	Manila	Pier 10
DMU104	Manila	Pier 12
DMU108	Manila	Pier 4
DMU111	Manila	South Harbor
DMU115	Oakland	Ben E Nutter Con-Term
DMU134	Tanjung Priok	Tanjung Priok Con-Term
DMU135	Port Klang	Klang Con-Term
DMU136	Port Klang	Klang Multi Term
DMU137	Port Klang	Klang Port Con-Term
DMU138	Port Klang	WestPort Term
DMU139	Colombo	Jaye Con-Term
DMU140	Colombo	Queen Elizabeth Quay Con-Term
DMU141	Bangkok	Bangkok
DMU150	Hampton Roads	Newport News Marine Term
DMU151	Hampton Roads	Norfolk International Term
DMU152	Hampton Roads	Portsmouth Marine term
DMU153	Charleston	Columbus Street Term
DMU154	Charleston	North Charleston Term
DMU155	Charleston	Wando Welch term
DMU169	Durban	Con-Term
DMU170	Melbourne	Berth1
DMU174	Melbourne	Webb Dock Term
DMU176	Melbourne	Webb Dock Term
DMU181	La Spezia	La Spezia Con-Term
DMU182	La Spezia	Term Del Golfo
DMU184	Montreal	Cast Term
DMU186	Montreal	Racine Term
DMU187	Genoa	Southern European Con-Hub-Term
DMU190	Tianjin	Con-Term
DMU191	Laem Chabang	Laem Chabang
DMU195	Santos	Right Bank
DMU197	Barcelona	Estibadora de Ponent
DMU198	Barcelona	Muelle Principe de Espana
DMU199	Barcelona	Saport Term
DMU200	Barcelona	TCB Term
DMU201	Barcelona	Term Catalunya
DMU202	Barcelona	Term Port-Nou
DMU204	Sydney (Harbour)	Darling Harbour

< 3- 14>, < 3- 15>, < 3- 16>, < 3- 17>

< 3- 14> (1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	68	197232.69	260025.43	2833.00	1830431.00
U2	68	70548.60	103774.04	784.00	496629.00
U3	68	236923.69	329312.47	5567.00	2245854.00
U4	68	43222.37	58897.66	0	288924.00
V1	68	973.50	774.37	160.00	3292.00
V2	68	429609.72	422734.48	15500.00	2472500.00
V3	68	6.87	5.16	1.00	32.00
V4	68	13.87	20.11	1.00	129.00
V5	68	31.79	31.33	1.00	189.00
V6	68	30.16	26.95	2.00	146.00
V7	68	54.47	51.30	0	230.00
V8	68	53279.57	84435.27	2500.00	479723.00

< 3- 15> (1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	67	195908.26	263858.16	2833.00	1830431.00
U2	67	69084.80	104987.85	784.00	496629.00
U3	67	235199.53	334181.05	5567.00	2245854.00
U4	67	41475.26	58644.10	0	288924.00
V1	67	964.21	783.35	160.00	3292.00
V2	67	415355.47	407567.90	15500.00	2472500.00
V3	67	6.83	5.23	1.00	32.00
V4	67	13.79	20.38	1.00	129.00
V5	67	32.42	31.59	1.00	183.00
V6	67	29.42	26.64	2.00	146.00
V7	67	53.56	51.43	0	230.00
V8	67	54666.83	85334.91	2500.00	479723.00

가

< 3- 16>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	33	722808.42	618824.96	42665.00	2530000.00
U2	33	229807.03	245044.54	3657.00	1249198.00
U3	33	767459.58	714746.96	37586.00	2910398.00
U4	33	193027.24	196958.71	4204.00	777491.00
V1	33	3739.76	3231.48	181.00	15585.00
V2	33	1590319.94	1548253.66	105000.00	7156000.00
V3	33	19.58	12.84	2.00	48.00
V4	33	30.09	23.33	1.00	96.00
V5	33	95.24	95.61	2.00	444.00
V6	33	89.21	99.18	2.00	431.00
V7	33	122.91	119.96	13.00	590.00
V8	33	176226.21	286649.35	5000.00	1535000.00

< 3- 18>

가

가

< 3- 17>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	35	321773.74	386894.85	11002.00	2083734.00
U2	35	68381.86	90553.41	800.00	409255.00
U3	35	342672.43	461106.95	16236.00	2439713.00
U4	35	50295.77	56444.97	1064.00	219585.00
V1	35	1332.83	1073.04	217.00	4500.00
V2	35	554457.17	546787.02	17845.00	2685000.00
V3	35	9.60	6.94	1.00	32.00
V4	35	17.63	24.58	1.00	129.00
V5	35	29.80	29.77	3.00	107.00
V6	35	30.86	23.16	2.00	84.00
V7	35	70.17	63.87	1.00	255.00
V8	35	61937.91	94193.61	2700.00	479723.00

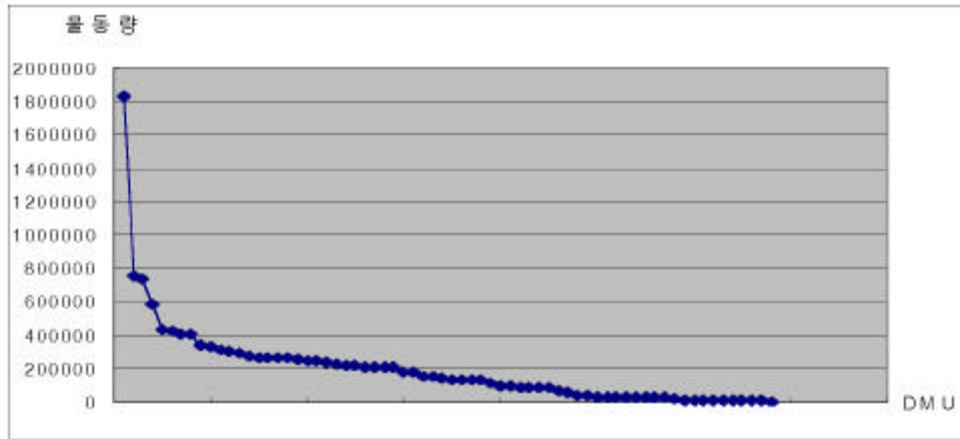
< 3- 18>

	U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8	V9
U1	1.00	0.65 ^a	0.93 ^a	0.65 ^a	0.35 ^b	0.65 ^a	0.40 ^a	0.83 ^a	0.80 ^a	0.31 ^b	0.11	0.30 ^b	0.18
U2	0.65 ^a	1.00	0.86 ^a	0.28 ^b	0.28 ^b	0.54 ^a	0.23	0.68 ^a	0.64 ^a	0.06	0.05	0.22	0.18
U3	0.93 ^a	0.86 ^a	1.00	0.47 ^a	0.33 ^b	0.63 ^a	0.32 ^b	0.85 ^a	0.82 ^a	0.19	0.04	0.28 ^b	0.20
U4	0.65 ^a	0.28 ^b	0.47 ^a	1.00	0.27 ^b	0.40 ^a	0.35 ^b	0.38 ^b	0.43 ^a	0.38 ^b	0.32 ^b	0.22	0.16
V1	0.35 ^b	0.28 ^b	0.33 ^b	0.27 ^b	1.00	0.76 ^a	0.18	0.45 ^a	0.29 ^b	- .01	0.08	0.21	0.15
V2	0.65 ^a	0.54 ^a	0.63 ^a	0.40 ^a	0.76 ^a	1.00	0.45 ^a	0.76 ^a	0.48 ^a	0.06	0.13	0.34 ^b	0.16
V3	0.40 ^a	0.23	0.32 ^b	0.35 ^b	0.18	0.45 ^a	1.00	0.34 ^b	0.24 ^b	0.25	0.13	0.30 ^b	0.10
V4	0.83 ^a	0.68 ^a	0.85 ^a	0.38 ^b	0.45 ^a	0.76 ^a	0.34 ^b	1.00	0.68 ^a	0.17 ^b	0.13	0.33 ^b	0.06
V5	0.80 ^a	0.64 ^a	0.82 ^a	0.43 ^a	0.29 ^b	0.48 ^a	0.24 ^b	0.68 ^a	1.00	.012	0.16	0.30 ^b	0.04
V6	0.31 ^b	0.06	0.19 ^b	0.38 ^b	- .01	0.06	0.25 ^b	0.17	0.12	1.00	0.10	0.01	0.23
V7	0.11	0.05	0.04	0.32 ^b	0.08	0.13	0.13	0.13	0.16	0.10	1.00	0.58 ^a	0.09
V8	0.30 ^b	0.22	0.28 ^b	0.21	0.21	0.34 ^b	0.30 ^b	0.33 ^b	0.30 ^b	0.01	0.58 ^a	1.00	0.33 ^b
V9	0.18	0.18	0.20	0.16	0.15	0.16	0.10	0.06	0.42	0.23	0.09	0.33 ^b	1.00

) a : P < 0.001, b : P < 0.05

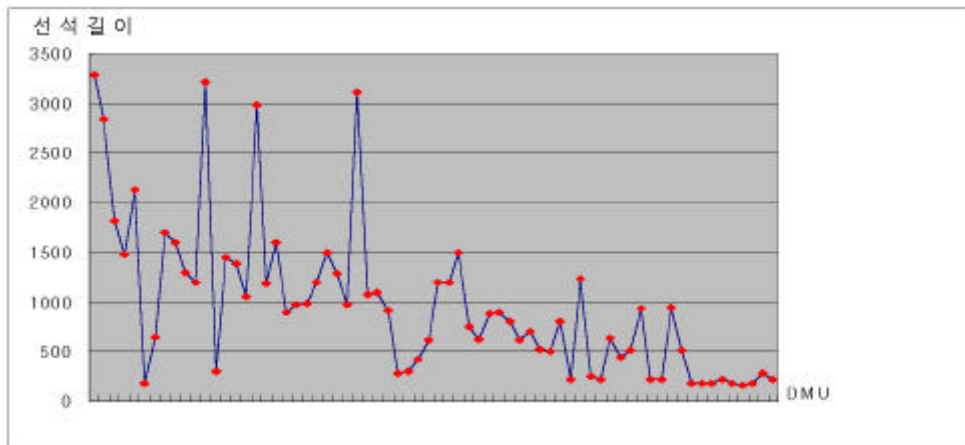
3.2.2. DEA

98, DMU
 < 3-1>, < 3-2>, <
 3-3>, < 3-4>, 가 DMU4(
 가 DMU109() .

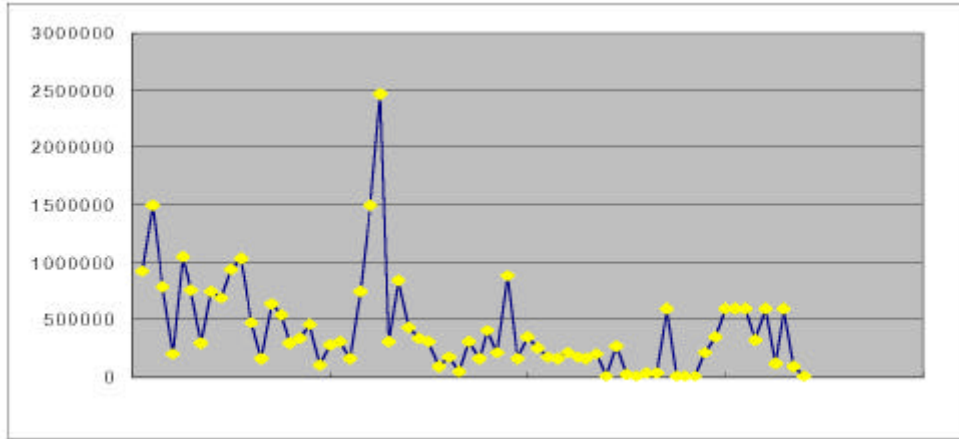


< 3-1> DMU

DMU4(HongKong, Term4/ 6/7)
 가 가 , DMU202(Barcelona, Term Port - Nou)가 가

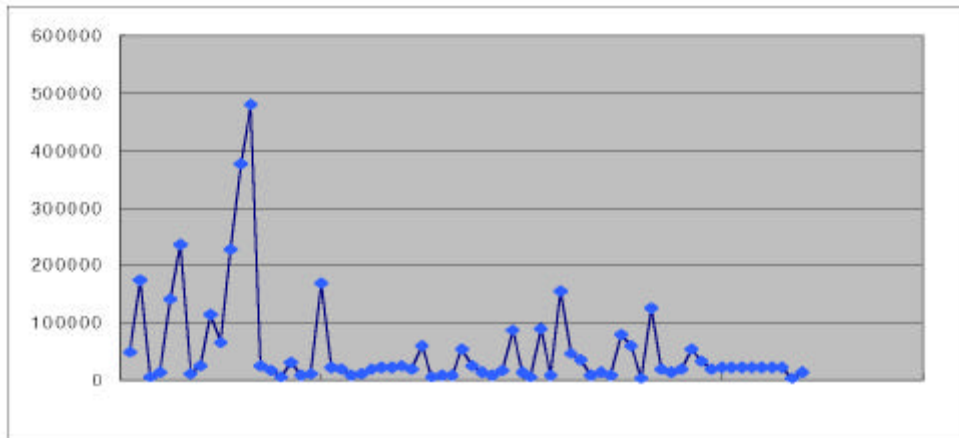


< 3-2> DMU



DMU151(Hampton Port, Norfolk International Term)가 , DMU205(Sydney, White Bay)가

< 3-3> DMU



< 3-4> CFS DMU

CFS DMU1(HongKong, Terminal3)가 , DMU 197(Barcelona, Estibadora de Ponent)가

Input DMU , , , CFS DMU < 3-19>, <

3-20>, < 3-21>, < 3-22>

< 3-19> DMU

DMUs	U1()	V1()	V2()	V8(CFS)
DMU4	1830431	3292	930714	50000
DMU40	754000	2850	1500000	175000
DMU3	736957	1822	792000	5249
DMU139	586220	1474	207000	14917
DMU169	437310	2128	1055000	142300
DMU203	425103	181	768000	235000
DMU2	401677	640	300000	12000
DMU20	401650	1700	750000	25000
DMU42	338718	1600	700000	113000
DMU101	333426	1300	940000	66309
DMU31	311776	1200	1038534	229200
DMU141	300290	3217	480000	377000
DMU1	289559	305	165000	479723
DMU30	270593	1447	647566	25119
DMU200	260849	1390	550000	15000
DMU206	260644	1060	300000	5000
DMU90	260153	2992	339000	29000
DMU192	260000	1189	470000	7260
DMU191	254421	1600	105000	12000
DMU131	241355	900	289000	168000
DMU180	240567	980	320000	22365
DMU181	233000	987	170000	19000
DMU189	222910	1200	750000	8000
DMU209	221234	1500	1500000	10000
DMU151	219025	1290	2472500	19000
DMU179	209779	980	320000	21450
DMU111	206354	3114	850000	22000
DMU135	205548	1079	440000	23592
DMU137	205548	1100	340000	20000
DMU44	183314	920	320000	60000
DMU70	181834	285	100000	6000
DMU48	155424	305	175000	7559
DMU140	153256	425	55000	7430
DMU60	142111	610	320000	55000
DMU136	133875	1200	160000	23566
DMU138	133875	1200	410000	13682
DMU19	130000	1500	220000	8000
DMU152	127992	759	886200	15000
DMU132	113418	620	170000	87500
DMU172	95726	885	350000	14230
DMU115	92330	898	255474	5707
DMU130	88505	800	176000	88900
DMU45	87000	613	165000	9200
DMU133	81280	700	225000	154200
DMU187	80555	520	173000	47000
DMU32	69521	500	159258	35450
DMU25	55488	800	200000	7500
DMU108	40184	217	18000	13376
DMU14	40000	1240	272000	9000
DMU106	31392	250	25452	77500
DMU104	30241	221	17845	60000
DMU197	26500	630	45000	2500
DMU107	25918	444	39680	124200
DMU150	25432	512	596100	19000
DMU205	25194	934	15500	14357
DMU103	25163	220	17845	20000
DMU105	25163	222	17856	55400
DMU204	15033	949	220000	33100
DMU196	13687	510	350000	20000
DMU174	9042	183	600453	23000
DMU175	8754	183	600453	23000
DMU176	8257	183	600453	23000
DMU173	7765	220	330000	22450
DMU177	7423	183	600453	23000
DMU202	7400	160	120000	22500
DMU178	6645	183	600453	23000
DMU102	5196	280	98672	2700
DMU109	2833	217	18000	14520

< 3-19> DMU DMU4(HongKong, Term-4/6/7) 가 DMU109(Manila, Pier6) 가

< 3-20>

DMU

DMUs	U1()	V1()	V2()	V8(CFS)
DMU4	1830431	3292	930714	50000
DMU141	300290	3217	480000	377000
DMU111	206354	3114	850000	22000
DMU90	260153	2992	339000	29000
DMU40	754000	2850	1500000	175000
DMU169	437310	2128	1055000	142300
DMU3	736957	1822	792000	5249
DMU20	401650	1700	750000	25000
DMU191	254421	1600	105000	12000
DMU42	338718	1600	700000	113000
DMU19	130000	1500	220000	8000
DMU209	221234	1500	1500000	10000
DMU139	586220	1474	207000	14917
DMU30	270593	1447	647566	25119
DMU200	260849	1390	550000	15000
DMU101	333426	1300	940000	66309
DMU151	219025	1290	2472500	19000
DMU14	40000	1240	272000	9000
DMU31	311776	1200	1038534	229200
DMU136	133875	1200	160000	23566
DMU138	133875	1200	410000	13682
DMU189	222910	1200	750000	8000
DMU192	260000	1189	470000	7260
DMU137	205548	1100	340000	20000
DMU135	205548	1079	440000	23592
DMU206	260644	1060	300000	5000
DMU181	233000	987	170000	19000
DMU179	209779	980	320000	21450
DMU180	240567	980	320000	22365
DMU204	15033	949	220000	33100
DMU205	25194	934	15500	14357
DMU44	183314	920	320000	60000
DMU131	241355	900	289000	168000
DMU115	92330	898	255474	5707
DMU172	95726	885	350000	14230
DMU25	55488	800	200000	7500
DMU130	88505	800	176000	88900
DMU152	127992	759	886200	15000
DMU133	81280	700	225000	154200
DMU2	401677	640	300000	12000
DMU197	26500	630	45000	2500
DMU132	113418	620	170000	87500
DMU45	87000	613	165000	9200
DMU60	142111	610	320000	55000
DMU187	80555	520	173000	47000
DMU150	25432	512	596100	19000
DMU196	13687	510	350000	20000
DMU32	69521	500	159258	35450
DMU107	25918	444	39680	124200
DMU140	153256	425	55000	7430
DMU48	155424	305	175000	7559
DMU1	289559	305	165000	479723
DMU70	181834	285	100000	6000
DMU102	5196	280	98672	2700
DMU106	31392	250	25452	77500
DMU105	25163	222	17856	55400
DMU104	30241	221	17845	60000
DMU173	7765	220	330000	22450
DMU103	25163	220	17845	20000
DMU109	2833	217	18000	14520
DMU108	40184	217	18000	13376
DMU176	8257	183	600453	23000
DMU175	8754	183	600453	23000
DMU174	9042	183	600453	23000
DMU177	7423	183	600453	23000
DMU178	6645	183	600453	23000
DMU203	425103	181	768000	235000
DMU202	7400	160	120000	22500

< 3-20>

DMU4(Ho-

ng Kong, Term 4/6/7) 가

DMU202(Barcelona, Term Port-Nou)가 가

< 3-21>

DMU

DMUs	U1()	V1()	V2()	V8(CFS)
DMU 151	219025	1290	2472500	19000
DMU 209	221234	1500	1500000	10000
DMU 40	754000	2850	1500000	175000
DMU 169	437310	2128	1055000	142300
DMU 31	311776	1200	1038534	229200
DMU 101	333426	1300	940000	66309
DMU 4	1830431	3292	930714	50000
DMU 152	127992	759	886200	15000
DMU 111	206354	3114	850000	22000
DMU 3	736957	1822	792000	5249
DMU 203	425103	181	768000	235000
DMU 20	401650	1700	750000	25000
DMU 189	222910	1200	750000	8000
DMU 42	338718	1600	700000	113000
DMU 30	270593	1447	647566	25119
DMU 177	7423	183	600453	23000
DMU 174	9042	183	600453	23000
DMU 178	6645	183	600453	23000
DMU 176	8257	183	600453	23000
DMU 175	8754	183	600453	23000
DMU 150	25432	512	596100	19000
DMU 200	260849	1390	550000	15000
DMU 141	300290	3217	480000	377000
DMU 192	260000	1189	470000	7260
DMU 135	205548	1079	440000	23592
DMU 138	133875	1200	410000	13682
DMU 172	95726	885	350000	14230
DMU 196	13687	510	350000	20000
DMU 137	205548	1100	340000	20000
DMU 90	260153	2992	339000	29000
DMU 173	7765	220	330000	22450
DMU 180	240567	980	320000	22365
DMU 179	209779	980	320000	21450
DMU 60	142111	610	320000	55000
DMU 44	183314	920	320000	60000
DMU 2	401677	640	300000	12000
DMU 206	260644	1060	300000	5000
DMU 131	241355	900	289000	168000
DMU 14	40000	1240	272000	9000
DMU 115	92330	898	255474	5707
DMU 133	81280	700	225000	154200
DMU 204	15033	949	220000	33100
DMU 19	130000	1500	220000	8000
DMU 139	586220	1474	207000	14917
DMU 25	55488	800	200000	7500
DMU 130	88505	800	176000	88900
DMU 48	155424	305	175000	7559
DMU 187	80555	520	173000	47000
DMU 132	113418	620	170000	87500
DMU 181	233000	987	170000	19000
DMU 1	289559	305	165000	479723
DMU 45	87000	613	165000	9200
DMU 136	133875	1200	160000	23566
DMU 32	69521	500	159258	35450
DMU 202	7400	160	120000	22500
DMU 191	254421	1600	105000	12000
DMU 70	181834	285	100000	6000
DMU 102	5196	280	98672	2700
DMU 140	153256	425	55000	7430
DMU 197	26500	630	45000	2500
DMU 107	25918	444	39680	124200
DMU 106	31392	250	25452	77500
DMU 108	40184	217	18000	13376
DMU 109	2833	217	18000	14520
DMU 105	25163	222	17856	55400
DMU 103	25163	220	17845	20000
DMU 104	30241	221	17845	60000
DMU 205	25194	934	15500	14357

< 3-21>

DMU 151

(Hampton, Norfolk International Term) 가
가 가

DMU 205(Sydney White Bay)

< 3-22> CFS DMU

DMUs	U1()	V1()	V2()	V8(CFS)
DMU1	289559	305	165000	479723
DMU141	300290	3217	480000	377000
DMU203	425103	181	768000	235000
DMU31	311776	1200	1038534	229200
DMU40	754000	2850	1500000	175000
DMU131	241355	900	289000	168000
DMU133	81280	700	225000	154200
DMU169	437310	2128	1055000	142300
DMU107	25918	444	39680	124200
DMU42	338718	1600	700000	113000
DMU130	88505	800	176000	88900
DMU132	113418	620	170000	87500
DMU106	31392	250	25452	77500
DMU101	333426	1300	940000	66309
DMU44	183314	920	320000	60000
DMU104	30241	221	17845	60000
DMU105	25163	222	17856	55400
DMU60	142111	610	320000	55000
DMU4	1830431	3292	930714	50000
DMU187	80555	520	173000	47000
DMU32	69521	500	159258	35450
DMU204	15033	949	220000	33100
DMU90	260153	2992	339000	29000
DMU30	270593	1447	647566	25119
DMU20	401650	1700	750000	25000
DMU135	205548	1079	440000	23592
DMU136	133875	1200	160000	23566
DMU176	8257	183	600453	23000
DMU174	9042	183	600453	23000
DMU175	8754	183	600453	23000
DMU178	6645	183	600453	23000
DMU177	7423	183	600453	23000
DMU202	7400	160	120000	22500
DMU173	7765	220	330000	22450
DMU180	240567	980	320000	22365
DMU111	206354	3114	850000	22000
DMU179	209779	980	320000	21450
DMU103	25163	220	17845	20000
DMU196	13687	510	350000	20000
DMU137	205548	1100	340000	20000
DMU181	233000	987	170000	19000
DMU150	25432	512	596100	19000
DMU151	219025	1290	2472500	19000
DMU152	127992	759	886200	15000
DMU200	260849	1390	550000	15000
DMU139	586220	1474	207000	14917
DMU109	2833	217	18000	14520
DMU205	25194	934	15500	14357
DMU172	95726	885	350000	14230
DMU138	133875	1200	410000	13682
DMU108	40184	217	18000	13376
DMU2	401677	640	300000	12000
DMU191	254421	1600	105000	12000
DMU209	221234	1500	1500000	10000
DMU45	87000	613	165000	9200
DMU14	40000	1240	272000	9000
DMU189	222910	1200	750000	8000
DMU19	130000	1500	220000	8000
DMU48	155424	305	175000	7559
DMU25	55488	800	200000	7500
DMU140	153256	425	55000	7430
DMU192	260000	1189	470000	7260
DMU70	181834	285	100000	6000
DMU115	92330	898	255474	5707
DMU3	736957	1822	792000	5249
DMU206	260644	1060	300000	5000
DMU102	5196	280	98672	2700
DMU197	26500	630	45000	2500

< 3-22> CFS DMU1
 (HongKong, Term3) 가 DMU197(Barcelona, Estibadora de Ponent)가
 가 .

DMU , CFS()
가 ,
Output Input 가
DMU 가 ,
Output Input
Output 가 Input

< 3-23> DMU ()

U1 ()	DMU factor	Mean	Std Dev	Min	Max
	Large(19)	458619.8	365938.3	254421	1830431
	Middle(27)	157605	57164.66	69521	241355
	Small(22)	20123.18	13965.97	2833	55488

< 3-24> DMU ()

V2 ()	DMU factor	Mean	Std Dev	Min	Max
	Large(18)	1970	750	1240	3292
	Middle(17)	1039	122	885	1200
	Little- small(17)	570	151	305	800
	Small(16)	212	36	160	285

< 3-25> DMU ()

V3 (Total Area)	DMU factor	Mean	Std Dev	Min	Max
	Large(15)	455831.93	420928.41	127992	1830431
	Middle(22)	170333.68	133041.25	15033	586220
	Little- small(17)	117194.59	113583.22	6645	300290
	Small(14)	59621.071	77655.669	2833	254421

4

1970, 1039, 570, 212

DMU DMU4가 , DMU220 가

가 .

< 3-26> CFS DMU ()

V9 (CFS Area)	DMU factor	Mean	Std Dev	Min	Max
	Large(10)	219762.3	119320.6	113000	479723
	Middle(12)	59679.92	18034.71	33100	88900
	Little-small(21)	22335.33	2400.435	19000	29000
	Small(25)	9607.48	4021.241	2500	15000

< 3-27> DMU

	V2	v3	v9
U1()	0.6536091	0.396775	0.181222
U2()	0.539057231	0.228655	0.178917
U3()	0.633910481	0.324918	0.203634
U4()	0.404119073	0.351692	0.163175

Input Output
 Output 0.001 가
 (V9) Output 가
 가
 가
 가

< 3-28> DMU

	V2	V3	V9
large	0.481469708	0.387447	-0.11502
middle	0.388214388	0.395261	-0.11373
small	0.509391515	-0.41624	0.114023

4 DEA

4.1. CCR

DEA al(1991) DEA, Boussofiane et al(1984) (DMU) , Banker et al(1984)

가
가
, DMU 32((8) X (4) = 32) 36(((8)+ (4))X3 = 36) 98 68 (97 66) 가 33(35) , 가 Data

CCR 가 . CCR
가 < 4-1>, < 4-2>
DMU 98 68 46 , 97
66 47 ,
DMU DMU 가 가
. ,
가 .
< 4-1> < 4-2>
DMU DMU
(Reference Set) . DEA ,
DMU , < 4-3>,
< 4-4> .

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	1.000	Effi.	-
DMU14	0.631	INEffi.	70, 151, 192, 203
DMU19	1.000	Effi.	-
DMU20	1.000	Effi.	-
DMU25	0.586	INEffi.	1, 4, 19, 60, 151, 191, 192, 200, 206
DMU30	1.000	Effi.	-
DMU31	1.000	Effi.	-
DMU32	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	1.000	Effi.	-
DMU48	1.000	Effi.	-
DMU60	1.000	Effi.	-
DMU70	1.000	Effi.	-
DMU90	1.000	Effi.	-
DMU101	1.000	Effi.	-
DMU102	0.065	INEffi.	3, 4, 70, 105, 107
DMU103	0.918	INEffi.	1, 40, 70, 105, 107
DMU104	1.000	Effi.	-
DMU105	1.000	Effi.	-
DMU106	1.000	Effi.	-
DMU107	1.000	Effi.	-
DMU108	1.000	Effi.	-
DMU109	0.071	INEffi.	139, 140, 191, 197
DMU111	1.000	Effi.	-
DMU115	0.786	INEffi.	152, 172, 191, 200, 206
DMU130	0.844	INEffi.	1, 40, 60, 70, 107, 111, 172, 203
DMU131	1.000	Effi.	-
DMU132	1.000	Effi.	-
DMU133	1.000	Effi.	-
DMU135	0.926	INEffi.	4, 20, 50, 131, 152, 181, 191, 200
DMU136	0.826	INEffi.	1, 60, 70, 139, 181, 192
DMU137	0.839	INEffi.	1, 139, 191, 192
DMU138	0.338	INEffi.	2, 4, 48, 70, 181, 192, 203
DMU139	1.000	Effi.	-
DMU140	1.000	Effi.	-
DMU141	1.000	Effi.	-
DMU150	0.228	INEffi.	1, 40, 70, 151, 152, 174, 191, 203
DMU151	1.000	Effi.	-
DMU152	1.000	Effi.	-
DMU169	1.000	Effi.	-
DMU172	1.000	Effi.	-
DMU173	0.111	INEffi.	1, 2, 40, 152, 174, 191, 203
DMU174	1.000	Effi.	-
DMU175	0.976	INEffi.	174
DMU176	0.913	INEffi.	174
DMU177	0.821	INEffi.	174
DMU178	0.735	INEffi.	174
DMU179	1.000	Effi.	-
DMU180	1.000	Effi.	-
DMU181	1.000	Effi.	-
DMU187	0.509	INEffi.	1, 4, 40, 70, 151, 152, 181, 191
DMU189	1.000	Effi.	-
DMU191	1.000	Effi.	-
DMU192	1.000	Effi.	-
DMU196	0.214	INEffi.	1, 2, 151, 174, 191, 192
DMU197	1.000	Effi.	-
DMU200	1.000	Effi.	-
DMU202	0.226	INEffi.	1, 172, 178, 191, 192
DMU203	1.000	Effi.	-
DMU204	0.109	INEffi.	1, 44, 70, 200
DMU205	0.796	INEffi.	1, 4, 139, 191
DMU206	1.000	Effi.	-
DMU209	1.000	Effi.	-

) Effi. : DMU, INEffi. : DMU

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	1.000	Effi.	-
DMU14	1.000	Effi.	-
DMU16	1.000	Effi.	-
DMU19	1.000	Effi.	-
DMU20	0.619	INEffi.	2, 16, 134, 152, 182, 186, 187, 195
DMU25	0.400	INEffi.	1, 4, 90, 151, 186, 187, 190, 195
DMU30	1.000	Effi.	-
DMU31	1.000	Effi.	-
DMU35	0.806	INEffi.	36, 70, 71, 134, 151
DMU36	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	1.000	Effi.	-
DMU48	0.680	INEffi.	1, 2, 4, 70, 139, 151
DMU60	1.000	Effi.	-
DMU63	1.000	Effi.	-
DMU68	1.000	Effi.	-
DMU69	1.000	Effi.	-
DMU70	1.000	Effi.	-
DMU71	0.562	INEffi.	1, 2, 4, 16, 70
DMU76	0.697	INEffi.	1, 2, 4, 16, 70, 151, 190
DMU90	1.000	Effi.	-
DMU101	1.000	Effi.	-
DMU102	0.210	INEffi.	70, 140, 187, 190, 201
DMU103	1.000	Effi.	-
DMU104	1.000	Effi.	-
DMU108	0.596	INEffi.	1, 186, 190
DMU111	1.000	Effi.	-
DMU115	0.972	INEffi.	151, 152, 186, 201
DMU134	1.000	Effi.	-
DMU135	0.470	INEffi.	2, 4, 16, 70, 134, 152, 186, 195
DMU136	0.518	INEffi.	1, 2, 36, 71, 182, 187
DMU137	1.000	Effi.	-
DMU138	0.262	INEffi.	1, 19, 70, 139, 151
DMU139	1.000	Effi.	-
DMU140	1.000	Effi.	-
DMU141	0.482	INEffi.	1, 4, 16, 70, 186, 187
DMU150	0.205	INEffi.	2, 16, 70, 152, 174, 198
DMU151	1.000	Effi.	-
DMU152	1.000	Effi.	-
DMU153	1.000	Effi.	-
DMU154	1.000	Effi.	-
DMU155	1.000	Effi.	-
DMU169	1.000	Effi.	-
DMU170	0.308	INEffi.	1, 2, 70, 190, 198
DMU174	1.000	Effi.	-
DMU176	1.000	Effi.	-
DMU181	1.000	Effi.	-
DMU182	1.000	Effi.	-
DMU184	1.000	Effi.	-
DMU186	1.000	Effi.	-
DMU187	1.000	Effi.	-
DMU190	1.000	Effi.	-
DMU191	0.238	INEffi.	1, 151, 186, 187
DMU195	1.000	Effi.	-
DMU197	0.281	INEffi.	1, 151, 174, 187, 198
DMU198	1.000	Effi.	-
DMU199	0.187	INEffi.	40, 44, 68, 69, 190, 195
DMU200	0.609	INEffi.	1, 4, 186, 190
DMU201	1.000	Effi.	-
DMU202	1.000	Effi.	-
DMU204	1.000	Effi.	-

) Effi. : DMU, INEffi. : DMU

slack

DMU

DMU

DMU

< 4-5>, < 4-6>, < 4-7>, < 4-8>

< 4-3> Terminal DMU slack variables(1998)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU14	0.630	0.000016	-	-	-	-	-	1328	0.053	-	-	-	0.000022
DMU25	0.586	0.000013	-	-	-	-	-	-	0.074	0.087	0.038	-	-
DMU102	0.066	-	-	0.00010	-	-	-	0.207	0.074	-	-	-	0.000117
DMU103	0.918	0.000074	-	0.00037	-	-	0.000019	-	0.949	0.028	-	-	0.000020
DMU109	0.070	-	-	-	0.000033	-	0.000052	-	0.016	-	-	-	-
DMU115	0.786	-	-	-	-	-	-	-	0.190	-	-	-	0.000143
DMU130	0.844	0.000015	-	0.000013	-	-	-	-	0.157	0.017	0.002	0.0003	-
DMU135	0.926	-	-	-	0.000015	0.000256	-	-	0.064	-	-	0.00005	-
DMU136	0.826	0.000016	0.000021	0.000018	-	-	-	-	-	0.092	-	-	-
DMU137	0.839	-	-	-	-	-	-	-	-	0.080	-	-	-
DMU138	0.338	-	-	-	-	0.000502	-	-	-	-	-	-	-
DMU150	0.228	0.000014	0.000012	-	0.000010	0.002440	-	0.060	0.090	0.001	-	-	-
DMU173	0.110	0.000014	0.000015	-	-	0.003351	-	-	0.117	-	0.020	-	-
DMU175	0.976	-	-	0.000099	-	0.008152	-	-	1.322	0.001	0.394	0.693	-
DMU176	0.913	0.000111	-	0.000019	-	0.024165	-	-	0.893	-	-	0.288	0.000029
DMU177	0.820	0.000111	-	-	-	-	-	-	0.960	-	0.007	1.827	-
DMU178	0.734	0.000111	-	-	-	0.03184	0.000015	-	0.834	0.024	0.185	-	0.000037
DMU187	0.509	0.000010	-	-	0.000013	0.001313	-	0.020	0.840	-	-	-	-
DMU196	0.214	-	-	-	-	0.00244	-	-	0.005	0.002	-	-	-
DMU202	0.226	0.000078	0.000075	-	0.000069	0.011415	-	-	-	-	-	-	0.000018
DMU204	0.109	-	-	-	-	-	-	-	0.146	-	-	-	-
DMU205	0.796	0.000032	-	-	-	-	0.000062	-	-	-	0.037	-	-

< 4-4> Terminal DMU slack variables(1997)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU20	0.619	-	-	-	-	-	0.003	0.015	0.019	-	-	-	-
DMU25	0.400	-	-	-	-	-	-	-	0.094	0.074	0.048	0.008	-
DMU35	0.806	0.000013	-	-	0.000015	0.0017	-	-	-	-	-	-	0.000013
DMU48	0.680	-	-	-	-	-	-	0.142	-	0.092	-	-	-
DMU71	0.562	-	-	-	-	0.002	-	-	0.033	-	-	-	-
DMU76	0.697	-	-	-	-	0.00038	-	0.111	0.009	-	0.013	-	-
DMU102	0.210	-	0.00001	-	0.000016	0.00009	-	-	-	-	-	-	0.000043
DMU108	0.596	0.000016	-	0.000001	-	-	0.0005	-	-	-	-	-	0.000006
DMU115	0.972	-	0.00001	0.000002	0.000001	-	0.000002	-	0.147	-	-	-	0.000178
DMU135	0.470	-	-	-	-	0.00038	-	-	0.022	-	-	0.002	-
DMU136	0.518	0.000029	0.00004	0.000031	0.000021	-	-	-	-	0.131	-	-	-
DMU138	0.262	0.000014	0.00004	-	0.000026	-	-	0.037	-	0.191	-	-	-
DMU141	0.482	-	-	-	-	-	-	-	0.005	-	-	-	-
DMU150	0.205	-	-	-	-	0.00247	-	-	0.076	-	-	-	-
DMU170	0.308	0.000024	-	0.000019	-	0.00374	-	-	-	-	0.053	-	-
DMU191	0.238	-	0.00001	-	-	0.00073	-	-	0.096	-	-	-	-
DMU197	0.281	-	0.00005	0.00001	-	0.00881	-	-	-	-	0.014	-	-
DMU199	0.187	0.000044	-	0.000042	-	-	-	-	0.189	0.017	-	0.179	-
DMU200	0.609	0.000025	-	-	0.000013	-	0.000053	-	-	-	0.082	-	-

가 DMU 가 DMU
 , DMU DMU

< 4-5>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	46	265593.85	289823.65	9042.00	1830431.00
U2	46	94373.65	117975.10	1522.00	496629.00
U3	46	319900.93	370131.02	10121.00	2245854.00
U4	46	58779.85	65733.51	0	288924.00
V1	46	1144.07	850.96	181.00	3292.00
V2	46	491718.65	484331.99	17845.00	2472500.00
V3	46	7.93	5.69	2.00	32.00
V4	46	16.96	23.02	1.00	129.00
V5	46	30.43	32.65	1.00	189.00
V6	46	31.46	28.86	2.00	146.00
V7	46	60.30	56.56	0	230.00
V8	46	67900.80	98975.24	2500.00	479723.00

< 4-6>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	47	311222.87	337901.67	8754.00	2083734.00
U2	47	80305.79	83403.02	800.00	409255.00
U3	47	345235.96	398330.08	9875.00	2439713.00
U4	47	55455.85	63950.71	887.00	290205.00
V1	47	1325.28	932.03	181.00	4500.00
V2	47	633851.23	575554.10	17845.00	2685000.00
V3	47	8.68	6.39	1.00	32.00
V4	47	17.15	22.10	1.00	129.00
V5	47	31.38	35.64	3.00	189.00
V6	47	29.79	27.56	2.00	115.00
V7	47	56.51	58.67	1.00	255.00
V8	47	104098.83	188556.97	4215.00	887250.00

< 4-7>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	22	54295.73	63895.97	2833.00	205548.00
U2	22	20732.59	26280.32	784.00	86546.00
U3	22	63425.82	76255.17	5567.00	252757.00
U4	22	10693.09	13029.88	67.00	34300.00
V1	22	616.86	405.57	160.00	1240.00
V2	22	299745.59	203392.89	15500.00	600453.00
V3	22	4.64	2.80	1.00	12.00
V4	22	7.41	9.54	1.00	31.00
V5	22	34.64	28.90	4.00	102.00
V6	22	27.46	22.82	2.00	77.00
V7	22	42.27	36.21	0	154.00
V8	22	22707.91	17517.33	2700.00	88900.00

< 4-8>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	19	107434.00	118643.48	6875.00	459645.00
U2	19	21783.26	27510.96	1883.00	96155.00
U3	19	106779.21	131666.56	15129.00	528000.00
U4	19	15847.37	17276.95	1305.00	70000.00
V1	19	828.53	714.937	160.00	3217.00
V2	19	267249.79	202516.40	15500.00	750000.00
V3	19	6.63	3.30	2.00	12.00
V4	19	12.21	11.02	2.00	40.00
V5	19	21.21	22.96	3.00	102.00
V6	19	33.11	22.50	2.00	66.00
V7	19	66.00	55.68	5.00	203.00
V8	19	40605.74	82689.95	2700.00	377000.00

Scale

Infeasible

(4)

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1

$$Vi' = \frac{Vi}{\max(Vi)} \text{ for each } i, \quad Ui' = \frac{Uj}{\max(Uj)} \text{ for each } j ; \quad (4)$$

DEA

< 4-9>, < 4-10>, < 4-11>, < 4-12>

< 4-9> CCR Model (1998)

DMU	Efficiency		Reference Set
DMU3	1.000	Effi.	-
DMU4	0.957	INEffi.	3,18,44
DMU5	1.000	Effi.	-
DMU7	0.692	INEffi.	3,12,40
DMU8	0.794	INEffi.	3,18,39,40
DMU9	1.000	Effi.	-
DMU10	0.983	INEffi.	3,9,39
DMU12	1.000	Effi.	-
DMU13	0.732	INEffi.	3,5,18,42
DMU14	0.829	INEffi.	1,38,39
DMU17	0.248	INEffi.	3,18,40
DMU18	1.000	Effi.	-
DMU19	0.543	INEffi.	3,18,38,39,40
DMU21	0.458	INEffi.	3,18,40
DMU23	0.353	INEffi.	3,5,18,24,38
DMU24	1.000	Effi.	-
DMU25	0.566	INEffi.	3,38
DMU27	0.432	INEffi.	3,5,38
DMU28	1.000	Effi.	-
DMU32	0.490	INEffi.	3,12,18,40
DMU33	0.364	INEffi.	3,18,38
DMU34	0.618	INEffi.	3,18,38
DMU36	0.636	INEffi.	3,5,39
DMU38	1.000	Effi.	-
DMU39	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU41	0.703	INEffi.	3,38
DMU42	1.000	Effi.	-
DMU43	0.347	INEffi.	3,24,38,39
DMU44	1.000	Effi.	-
DMU45	0.110	INEffi.	3,18,24,38
DMU46	1.000	Effi.	-
DMU47	0.425	INEffi.	3,38,39,46

) Effi. : DMU, INEffi. : DMU

< 4- 10>

CCR Model

(1997)

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	0.901	INEffi.	1, 3, 18
DMU5	1.000	Effi.	-
DMU7	0.764	INEffi.	3, 18, 33
DMU8	0.828	INEffi.	3, 9, 18, 40
DMU9	1.000	Effi.	-
DMU10	1.000	Effi.	-
DMU12	1.000	Effi.	-
DMU13	0.661	INEffi.	1, 3, 18
DMU14	1.000	Effi.	-
DMU17	0.401	INEffi.	1, 3, 8
DMU18	1.000	Effi.	-
DMU19	0.774	INEffi.	9, 14, 18, 38, 39
DMU20	0.641	INEffi.	18, 28, 39
DMU22	0.900	INEffi.	2, 3, 9
DMU23	0.284	INEffi.	1, 2, 3, 18, 38
DMU24	0.993	INEffi.	1, 2, 18, 38
DMU25	0.379	INEffi.	1, 2, 3, 18, 38
DMU26	0.517	INEffi.	2, 9, 18, 40
DMU27	0.661	INEffi.	1, 14, 38, 39
DMU28	1.000	Effi.	-
DMU33	1.000	Effi.	-
DMU34	0.851	INEffi.	3, 38, 39
DMU36	0.539	INEffi.	1, 14, 38, 39
DMU38	1.000	Effi.	-
DMU39	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU43	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	0.383	INEffi.	1, 3, 18, 28
DMU46	1.000	Effi.	-
DMU47	0.501	INEffi.	38, 39

) Effi. : DMU, INEffi. : DMU

< 4- 11>

DMU Slack Variables(1998)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU4	0.957	0.957	-	-	-	-	-	1.333	0.382	-	-	0.274	-
DMU7	0.692	1.103	-	-	-	-	-	0.472	1.873	-	0.069	-	-
DMU8	0.794	1.929	-	-	0.2516	-	-	-	0.176	-	2.176	-	33.639
DMU10	0.983	0.607	0.634	-	1.6760	-	-	-	-	-	-	22.692	-
DMU13	0.732	1.359	0.032	0.388	-	4.675	-	-	-	-	-	-	1.815
DMU14	0.829	-	2.595	3.151	-	-	11.838	-	-	-	-	18.510	-
DMU17	0.248	0.779	-	0.091	-	-	1.135	-	1.175	-	-	-	-
DMU19	0.543	-	0.501	0.961	1.1773	-	-	-	1.252	-	-	1.847	25.288
DMU21	0.458	1.849	-	0.216	-	-	2.694	-	2.790	-	-	-	-
DMU23	0.353	0.722	0.109	0.511	-	2.184	1.539	-	-	-	-	-	1.287
DMU25	0.566	-	-	2.938	-	-	6.945	-	-	-	6.771	-	-
DMU27	0.432	-	0.071	1.932	-	4.469	-	-	1.214	-	-	-	-
DMU32	0.490	2.723	-	-	0.1238	0.432	-	1.189	4.414	-	-	-	-
DMU33	0.364	1.994	-	-	0.1004	4.962	-	-	-	-	1.431	-	-
DMU34	0.618	6.723	0.063	-	-	-	20.024	-	-	-	-	4.371	-
DMU36	0.636	1.724	1.892	-	-	7.491	-	-	-	-	-	3.407	-
DMU41	0.703	-	7.199	-	-	-	-	-	8.508	25.838	-	-	-
DMU43	0.347	1.543	0.945	-	-	-	4.747	-	0.039	-	4.386	-	-
DMU45	0.110	5.488	-	1.381	-	-	16.527	-	2.271	-	4.793	-	-
DMU47	0.425	1.689	-	1.862	-	-	-	0.476	0.585	-	-	-	65.824

< 4- 12>

DMU Slack Variables(1997)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU4	0.901	1.287	-	1.101	-	-	-	1.031	2.702	-	-	-	-
DMU7	0.764	1.787	-	1.552	-	-	-	0.636	7.937	-	-	-	-
DMU8	0.828	3.249	-	1.998	-	-	-	-	4.155	-	0.993	2.458	21.804
DMU13	0.661	3.034	-	1.054	-	3.341	-	-	3.371	-	-	-	-
DMU17	0.401	1.711	-	1.463	-	-	-	1.370	3.591	-	-	-	-
DMU19	0.774	-	0.701	5.020	0.645	-	-	-	4.630	-	-	13.506	12.106
DMU20	0.641	-	3.894	-	0.440	-	-	-	7.390	-	-	-	26.483
DMU22	0.900	5.124	-	3.203	-	-	-	-	7.186	-	-	-	52.195
DMU23	0.284	1.366	-	1.105	-	1.113	1.184	-	1.380	-	-	-	1.459
DMU24	0.993	7.333	-	1.269	-	2.447	17.605	-	-	-	-	-	3.931
DMU25	0.379	1.363	-	3.884	-	-	4.050	0.487	2.174	4.126	-	-	-
DMU26	0.517	5.386	-	-	-	-	1.021	-	2.960	0.064	-	20.112	-
DMU27	0.661	-	1.869	4.758	-	1.819	-	-	5.235	-	-	12.065	-
DMU34	0.851	-	9.982	-	-	4.998	-	-	16.521	-	-	2.052	-
DMU36	0.539	-	1.441	3.668	-	1.403	-	-	4.036	-	-	9.301	-
DMU45	0.383	21.912	-	39.039	-	-	-	-	79.235	-	110.392	-	0.566
DMU47	0.501	-	4.195	-	-	-	-	-	7.363	-	-	-	28.862

33 DMU DMU 13 ,

DMU

DMU < 4- 13>, < 4- 14>, < 4- 15>, < 4- 16> .

< 4- 13> (1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	13	830589.23	669367.91	254421.00	2286261.00
U2	13	275231.23	364831.24	14000.00	1249198.00
U3	13	849465.46	942393.84	182000.00	2910398.00
U4	13	269760.15	238878.30	6797.00	777491.00
V1	13	2674.15	2301.57	181.0000000	7457.00
V2	13	1289735.23	1416004.30	105000.00	5127000.00
V3	13	17.00	13.86	2.00	43.00
V4	13	24.46	22.73	1.00	87.00
V5	13	66.66	85.00	2.00	293.00
V6	13	83.15	112.31	2.00	431.00
V7	13	94.23	87.10	13.00	256.00
V8	13	228604.23	429170.70	5000.00	1535000.00

< 4- 14> (1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	13	830589.23	669367.91	254421.00	2286261.00
U2	13	275231.23	364831.24	14000.00	1249198.00
U3	13	849465.46	942393.84	182000.00	2910398.00
U4	13	269760.15	238878.30	6797.00	777491.00
V1	13	2674.15	2301.57	181.0000000	7457.00
V2	13	1289735.23	1416004.30	105000.00	5127000.00
V3	13	17.00	13.86	2.00	43.00
V4	13	24.46	22.73	1.00	87.00
V5	13	66.66	85.00	2.00	293.00
V6	13	83.15	112.31	2.00	431.00
V7	13	94.23	87.10	13.00	256.00
V8	13	228604.23	429170.70	5000.00	1535000.00

< 4- 15>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	20	652750.90	590646.37	42665.00	2530000.00
U2	20	200281.30	121399.18	3657.00	540000.00
U3	20	714155.75	540277.64	37586.00	2520000.00
U4	20	143150.85	150493.42	4204.00	527518.00
V1	20	4432.40	3599.97	1297.00	15585.00
V2	20	1785700.00	1633659.27	235500.00	7156000.00
V3	20	21.25	12.16	6.00	48.00
V4	20	33.75	23.56	8.00	96.00
V5	20	113.85	99.53	5.00	444.00
V6	20	93.15	92.51	15.00	374.00
V7	20	141.55	136.08	14.00	590.00
V8	20	142180.50	137701.83	16000.00	417200.00

< 4- 16>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	20	652750.90	590646.37	42665.00	2530000.00
U2	20	200281.30	121399.18	3657.00	540000.00
U3	20	714155.75	540277.64	37586.00	2520000.00
U4	20	143150.85	150493.42	4204.00	527518.00
V1	20	4432.40	3599.97	1297.00	15585.00
V2	20	1785700.00	1633659.27	235500.00	7156000.00
V3	20	21.25	12.16	6.00	48.00
V4	20	33.75	23.56	8.00	96.00
V5	20	113.85	99.53	5.00	444.00
V6	20	93.15	92.51	15.00	374.00
V7	20	141.55	136.08	14.00	590.00
V8	20	142180.50	137701.83	16000.00	417200.00

4.2. BCC

4.1. , Data
CCR 가 BCC
가 <
4- 17>, < 4- 18> DMU 98 68
46 , 97 66 47
, DMU
DMU 가 가 .
, .
가 .
< 4- 17> < 4- 18>
DMU DMU
(Reference Set) . DEA ,
DMU
, < 4- 19>, <
4- 20> . slack
DMU , .
DMU DMU
< 4- 21>, < 4- 22>, < 4- 23>, < 4- 24> .

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	1.000	Effi.	-
DMU14	0.653	INEffi.	70, 151, 192, 203
DMU19	1.000	Effi.	-
DMU20	1.000	Effi.	-
DMU25	0.586	INEffi.	1, 4, 19, 60, 151, 191, 192, 200, 206
DMU30	1.000	Effi.	-
DMU31	1.000	Effi.	-
DMU32	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	0.721	INEffi.	4, 32, 70, 139, 151, 192
DMU48	1.000	Effi.	-
DMU60	0.904	INEffi.	1, 2, 4, 40, 151, 172, 192, 206
DMU70	1.000	Effi.	-
DMU90	1.000	Effi.	-
DMU101	1.000	Effi.	-
DMU102	0.066	INEffi.	3, 4, 70, 152, 191, 192
DMU103	0.919	INEffi.	1, 40, 70, 105, 107
DMU104	0.670	INEffi.	108, 139, 140, 191
DMU105	1.000	Effi.	-
DMU106	0.811	INEffi.	70, 108, 172, 191, 197
DMU107	1.000	Effi.	-
DMU108	1.000	Effi.	-
DMU109	0.071	INEffi.	140, 191, 197
DMU111	1.000	Effi.	-
DMU115	1.000	Effi.	-
DMU130	0.590	INEffi.	70, 111, 172, 200, 203, 206
DMU131	0.921	INEffi.	1, 40, 44, 70, 200
DMU132	1.000	Effi.	-
DMU133	0.488	INEffi.	1, 40, 152, 172, 191, 192
DMU135	0.788	INEffi.	1, 20, 40, 70, 152, 191, 200
DMU136	0.782	INEffi.	70, 111, 139, 181, 192
DMU137	0.839	INEffi.	1, 139, 191, 192
DMU138	0.338	INEffi.	2, 4, 48, 70, 181, 192, 203
DMU139	1.000	Effi.	-
DMU140	1.000	Effi.	-
DMU141	0.471	INEffi.	1, 4, 191, 192
DMU150	0.222	INEffi.	20, 70, 151, 152, 174, 191, 203
DMU151	1.000	Effi.	-
DMU152	1.000	Effi.	-
DMU169	1.000	Effi.	-
DMU172	1.000	Effi.	-
DMU173	0.111	INEffi.	1, 2, 40, 152, 174, 191, 203
DMU174	1.000	Effi.	-
DMU175	0.976	INEffi.	174
DMU176	0.913	INEffi.	174
DMU177	0.821	INEffi.	174
DMU178	0.735	INEffi.	174
DMU179	1.000	Effi.	-
DMU180	1.000	Effi.	-
DMU181	1.000	Effi.	-
DMU187	0.441	INEffi.	1, 2, 40, 70, 152, 191
DMU189	1.000	Effi.	-
DMU191	1.000	Effi.	-
DMU192	1.000	Effi.	-
DMU196	0.214	INEffi.	1, 2, 151, 174, 191, 192
DMU197	1.000	Effi.	-
DMU200	1.000	Effi.	-
DMU202	0.226	INEffi.	1, 172, 178, 191, 192
DMU203	1.000	Effi.	-
DMU204	0.109	INEffi.	1, 44, 70, 90, 200
DMU205	0.766	INEffi.	4, 139
DMU206	1.000	Effi.	-
DMU209	1.000	Effi.	-

) Effi. : DMU, INEffi. : DMU

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	1.000	Effi.	-
DMU14	0.673	INEffi.	70, 151, 187, 198
DMU16	1.000	Effi.	-
DMU19	1.000	Effi.	-
DMU20	0.550	INEffi.	16, 70, 152, 186, 187, 195, 201
DMU25	0.399	INEffi.	4, 90, 151, 186, 187, 190, 195
DMU30	1.000	Effi.	-
DMU31	1.000	Effi.	-
DMU35	0.502	INEffi.	16, 70, 134, 151, 152
DMU36	0.874	INEffi.	1, 16, 70, 151, 181, 186, 195
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	0.710	INEffi.	1, 30, 139, 151, 187
DMU48	0.680	INEffi.	1, 2, 4, 70, 139, 151
DMU60	1.000	Effi.	-
DMU63	1.000	Effi.	-
DMU68	1.000	Effi.	-
DMU69	1.000	Effi.	-
DMU70	1.000	Effi.	-
DMU71	0.562	INEffi.	1, 2, 4, 16, 70
DMU76	0.697	INEffi.	1, 2, 4, 16, 70, 151, 190
DMU90	1.000	Effi.	-
DMU101	1.000	Effi.	-
DMU102	0.207	INEffi.	2, 70, 186, 187, 201
DMU103	1.000	Effi.	-
DMU104	1.000	Effi.	-
DMU108	0.571	INEffi.	186, 190
DMU111	1.000	Effi.	-
DMU115	0.972	INEffi.	151, 152, 186, 187, 201
DMU134	1.000	Effi.	-
DMU135	0.469	INEffi.	1, 2, 4, 16, 70, 152, 186
DMU136	0.239	INEffi.	1, 19, 70, 139, 151
DMU137	0.589	INEffi.	4, 16, 30, 151, 187
DMU138	0.262	INEffi.	1, 19, 70, 139, 151
DMU139	1.000	Effi.	-
DMU140	0.935	INEffi.	70, 139, 186, 190
DMU141	0.482	INEffi.	1, 4, 16, 70, 186, 187
DMU150	0.205	INEffi.	2, 16, 70, 152, 174, 198
DMU151	1.000	Effi.	-
DMU152	1.000	Effi.	-
DMU153	1.000	Effi.	-
DMU154	1.000	Effi.	-
DMU155	1.000	Effi.	-
DMU169	0.490	INEffi.	1, 4, 40, 70, 152, 190
DMU170	0.296	INEffi.	1, 4, 70, 139, 190
DMU174	0.130	INEffi.	1, 16, 40, 70, 152
DMU176	0.708	INEffi.	1, 186, 187, 190
DMU181	1.000	Effi.	-
DMU182	0.628	INEffi.	1, 2, 70, 152, 186, 187
DMU184	1.000	Effi.	-
DMU186	1.000	Effi.	-
DMU187	1.000	Effi.	-
DMU190	1.000	Effi.	-
DMU191	0.281	INEffi.	1, 151, 186, 187
DMU195	1.000	Effi.	-
DMU197	0.281	INEffi.	1, 151, 174, 187, 198
DMU198	1.000	Effi.	-
DMU199	0.187	INEffi.	40, 44, 68, 69, 190, 195
DMU200	0.609	INEffi.	1, 4, 186, 190
DMU201	1.000	Effi.	-
DMU202	1.000	Effi.	-
DMU204	1.000	Effi.	-

) Effi. : DMU, INEffi. : DMU

DMU	Efficiency	Output					Input							
		U1	U2	U3	U4	U0	V1	V2	V3	V4	V5	V6	V7	V8
DMU14	0.630	0.000018	-	-	-	-	-	-	1.716	-	-	-	-	0.000029
DMU25	0.586	0.000013	-	-	-	-	-	-	-	0.074	0.087	0.088	-	-
DMU45	0.721	-	-	-	-	-	-	-	-	-	0.181	-	0.014	-
DMU60	0.904	-	-	-	-	-	0.000365	-	-	0.041	0.031	0.022	0.001	-
DMU102	0.066	-	-	0.000100	-	-	-	-	0.207	0.074	-	-	-	0.000117
DMU103	0.919	0.000074	-	0.000370	-	-	-	0.000019	-	0.949	0.028	-	-	0.000020
DMU104	0.670	0.000029	0.000016	0.000120	-	-	-	0.000053	-	0.018	-	-	-	-
DMU106	0.810	0.000011	-	-	0.000035	-	-	0.000022	0.008	0.228	-	-	-	-
DMU130	0.590	0.000011	-	0.000010	-	-	-	-	-	0.109	0.006	-	-	-
DMU131	0.921	-	-	-	-	0.0576	-	-	-	0.081	-	-	-	-
DMU133	0.488	-	-	-	-	-	0.000151	-	0.044	0.044	-	-	0.017	-
DMU135	0.788	-	-	-	-	-	0.000474	-	-	0.066	-	-	-	-
DMU136	0.782	0.000016	0.000020	0.000017	-	-	-	-	-	-	0.087	-	-	-
DMU137	0.839	-	-	-	-	-	-	-	-	-	0.080	-	-	-
DMU138	0.338	-	-	-	-	-	0.000502	-	0.061	-	-	-	-	-
DMU141	0.471	-	-	-	-	-	-	-	0.047	-	-	-	-	-
DMU150	0.222	0.000014	0.000015	-	-	-	0.002232	-	-	0.123	-	-	-	0.000012
DMU173	0.111	0.000014	0.000015	-	-	-	0.003351	-	-	0.118	-	0.021	-	-
DMU175	0.976	-	-	0.000099	-	-	0.008616	-	-	1.328	-	0.447	0.642	-
DMU176	0.913	0.000111	-	-	-	-	0.024656	-	-	0.894	-	-	0.288	0.000029
DMU177	0.821	0.000111	-	-	-	-	-	-	-	0.960	-	-	1.825	-
DMU178	0.735	0.000111	-	-	-	-	0.023754	0.000021	1.213	0.652	0.093	-	0.320	-
DMU187	0.441	-	-	-	-	-	0.001085	-	-	0.045	-	0.006	-	-
DMU196	0.213	-	-	-	-	-	0.002443	-	-	0.006	0.002	-	-	-
DMU202	0.226	0.000078	0.000075	-	0.000069	-	0.011415	-	-	-	-	-	-	0.000018
DMU205	0.766	0.000030	-	-	-	-	-	0.000060	-	-	-	0.037	-	-

DMU	Efficiency	Output					Input							
		U1	U2	U3	U4	U0	V1	V2	V3	V4	V5	V6	V7	V8
DMU14	0.673	0.000016	-	-	-	-	-	-	1.927	-	-	-	-	0.000025
DMU20	0.550	-	-	-	-	0.047072	-	-	-	0.026	-	-	-	-
DMU25	0.399	-	-	-	-	-	-	-	-	0.090	0.072	0.037	-	-
DMU35	0.502	-	-	-	-	-	-	0.00982	-	-	0.034	-	-	-
DMU36	0.874	-	-	-	-	-	-	-	-	0.051	0.046	0.024	-	0.005
DMU45	0.709	-	-	-	-	-	-	-	-	-	0.232	-	0.008	-
DMU48	0.758	0.000025	-	0.000014	0.000030	-	0.002875	-	-	-	0.054	-	-	-
DMU71	0.562	-	-	-	-	-	0.002034	-	-	0.033	-	-	-	-
DMU76	0.697	-	-	-	-	-	0.000882	-	0.111	0.009	-	0.013	-	-
DMU102	0.211	-	0.000011	-	0.000015	-	0.000547	-	-	-	-	-	-	0.000044
DMU108	0.571	0.000016	-	-	-	-	-	0.000056	-	-	-	-	-	-
DMU115	0.972	-	0.000011	-	-	-	-	-	-	0.147	-	-	-	0.000178
DMU135	0.469	-	-	-	-	-	0.000426	-	-	0.020	-	-	0.002	-
DMU136	0.239	0.000013	0.000034	-	0.000024	-	-	-	-	-	0.173	-	-	-
DMU137	0.589	-	-	-	-	-	-	-	0.144	-	-	-	-	-
DMU138	0.997	-	-	-	-	-	-	-	-	-	0.094	-	0.005	-
DMU140	0.935	-	-	-	-	-	-	0.000012	0.070	-	-	-	-	0.000015
DMU141	0.482	-	-	-	-	-	-	-	0.037	0.005	-	-	-	-
DMU150	0.205	-	-	-	-	-	0.002467	-	-	0.076	-	-	-	-
DMU169	0.490	-	-	-	-	-	-	-	0.075	0.005	-	-	0.008	-
DMU170	0.296	-	-	-	-	-	0.001401	0.000012	-	-	0.014	-	-	-
DMU174	0.130	-	-	-	-	-	0.002292	-	-	0.198	-	-	0.017	-
DMU176	0.708	-	-	-	-	-	-	-	-	-	0.040	-	-	-
DMU182	0.628	-	-	-	-	-	0.000989	-	-	0.052	-	-	0.004	-
DMU191	0.237	-	0.000012	-	-	-	0.000733	-	-	0.096	-	-	-	-
DMU197	0.281	-	0.000051	0.000010	-	-	0.008861	-	-	-	-	0.014	-	-
DMU200	0.527	0.000025	-	-	-	-	-	0.000050	-	-	-	0.100	-	-

가 DMU 가 DMU , DMU DMU

< 4- 21>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	46	265593.85	289823.65	9042.00	1830431.00
U2	46	94373.65	117975.10	1522.00	496629.00
U3	46	319900.93	370131.02	10121.00	2245854.00
U4	46	58779.85	65733.51	0	288924.00
V1	46	1144.07	850.96	181.00	3292.00
V2	46	491718.65	484331.99	17845.00	2472500.00
V3	46	7.93	5.69	2.00	32.00
V4	46	16.96	23.02	1.00	129.00
V5	46	30.43	32.65	1.00	189.00
V6	46	31.46	28.86	2.00	146.00
V7	46	60.30	56.56	0	230.00
V8	46	67900.80	98975.24	2500.00	479723.00

< 4- 22>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	47	311222.87	337901.67	8754.00	2083734.00
U2	47	80305.79	83403.02	800.00	409255.00
U3	47	345235.96	398330.08	9875.00	2439713.00
U4	47	55455.85	63950.71	887.00	290205.00
V1	47	1325.28	932.03	181.00	4500.00
V2	47	633851.23	575554.10	17845.00	2685000.00
V3	47	8.68	6.39	1.00	32.00
V4	47	17.15	22.10	1.00	129.00
V5	47	31.38	35.64	3.00	189.00
V6	47	29.79	27.56	2.00	115.00
V7	47	56.51	58.67	1.00	255.00
V8	47	104098.83	188556.97	4215.00	887250.00

< 4- 23>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	22	54295.73	63895.97	2833.00	205548.00
U2	22	20732.59	26280.32	784.00	86546.00
U3	22	63425.82	76255.17	5567.00	252757.00
U4	22	10693.09	13029.88	67.00	34300.00
V1	22	616.86	405.57	160.00	1240.00
V2	22	299745.59	203392.89	15500.00	600453.00
V3	22	4.64	2.80	1.00	12.00
V4	22	7.41	9.54	1.00	31.00
V5	22	34.64	28.90	4.00	102.00
V6	22	27.46	22.82	2.00	77.00
V7	22	42.27	36.21	0	154.00
V8	22	22707.91	17517.33	2700.00	88900.00

< 4- 24>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	19	107434.00	118643.48	6875.00	459645.00
U2	19	21783.26	27510.96	1883.00	96155.00
U3	19	106779.21	131666.56	15129.00	528000.00
U4	19	15847.37	17276.95	1305.00	70000.00
V1	19	828.53	714.937	160.00	3217.00
V2	19	267249.79	202516.40	15500.00	750000.00
V3	19	6.63	3.30	2.00	12.00
V4	19	12.21	11.02	2.00	40.00
V5	19	21.21	22.96	3.00	102.00
V6	19	33.11	22.50	2.00	66.00
V7	19	66.00	55.68	5.00	203.00
V8	19	40605.74	82689.95	2700.00	377000.00

4.1. 가 4.2.

scale infeasible

(4) 가 1

$$Vi' = \frac{Vi}{\max(Vi)} \text{ for each } i, \quad Ui' = \frac{Uj}{\max(Uj)} \text{ for each } j ; \quad (4)$$

DEA

< 4-25>, < 4-26>, < 4-27>, < 4-28>

< 4-25> CCR Model (1998)

DMU	Efficiency		Reference Set
DMU3	1.000	Effi.	-
DMU4	1.000	Effi.	-
DMU5	1.000	Effi.	-
DMU7	0.841	INEffi.	3, 12, 18, 40
DMU8	0.794	INEffi.	3, 18, 39, 40
DMU9	1.000	Effi.	-
DMU10	0.983	INEffi.	3, 9, 39
DMU12	1.000	Effi.	-
DMU13	0.732	INEffi.	3, 5, 18, 42, 44
DMU14	0.829	INEffi.	3, 38, 39
DMU17	0.248	INEffi.	3, 18, 40
DMU18	1.000	Effi.	-
DMU19	0.543	INEffi.	1, 18, 38, 39, 40
DMU21	0.458	INEffi.	3, 18, 40
DMU23	0.353	INEffi.	3, 5, 18, 24, 38
DMU24	1.000	Effi.	-
DMU25	0.566	INEffi.	3, 38
DMU27	0.432	INEffi.	3, 5, 38
DMU28	1.000	Effi.	-
DMU32	0.490	INEffi.	3, 12, 18, 40
DMU33	0.364	INEffi.	3, 18, 42
DMU34	0.618	INEffi.	3, 18, 38
DMU36	0.636	INEffi.	3, 5, 39
DMU38	1.000	Effi.	-
DMU39	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU41	0.703	INEffi.	3, 38
DMU42	1.000	Effi.	-
DMU43	0.347	INEffi.	3, 24, 38, 39
DMU44	1.000	Effi.	-
DMU45	0.110	INEffi.	3, 18, 24, 38
DMU46	1.000	Effi.	-
DMU47	0.425	INEffi.	3, 38, 39, 46

) Effi. : DMU, INEffi. : DMU

DMU	Efficiency		Reference Set
DMU1	1.000	Effi.	-
DMU2	1.000	Effi.	-
DMU3	1.000	Effi.	-
DMU4	0.995	INEffi.	1, 3
DMU5	1.000	Effi.	-
DMU7	0.937	INEffi.	3, 12, 18, 33
DMU8	0.828	INEffi.	3, 9, 18, 40
DMU9	1.000	Effi.	-
DMU10	1.000	Effi.	-
DMU12	1.000	Effi.	-
DMU13	0.661	INEffi.	1, 3, 18
DMU14	1.000	Effi.	-
DMU17	0.401	INEffi.	1, 3, 18
DMU18	1.000	Effi.	-
DMU19	0.899	INEffi.	1, 3, 9, 14, 18, 39
DMU20	0.712	INEffi.	3, 18, 38, 39
DMU22	0.900	INEffi.	2, 3, 9
DMU23	0.284	INEffi.	1, 2, 3, 18, 38
DMU24	1.000	Effi.	-
DMU25	0.379	INEffi.	1, 2, 3, 18, 38
DMU26	0.517	INEffi.	2, 9, 18, 40
DMU27	0.661	INEffi.	1, 14, 38, 39
DMU28	1.000	Effi.	-
DMU33	1.000	Effi.	-
DMU34	0.851	INEffi.	3, 38, 39
DMU36	0.539	INEffi.	1, 14, 38, 39
DMU38	1.000	Effi.	-
DMU39	1.000	Effi.	-
DMU40	1.000	Effi.	-
DMU42	1.000	Effi.	-
DMU43	1.000	Effi.	-
DMU44	1.000	Effi.	-
DMU45	0.383	INEffi.	1, 3, 18, 28
DMU46	1.000	Effi.	-
DMU47	0.501	INEffi.	38, 39

) Effi. : DMU, INEffi. : DMU

< 4-27>

DMU Slack Variables(1998)

DMU	Efficiency	Output					Input							
		U1	U2	U3	U4	U0	V1	V2	V3	V4	V5	V6	V7	V8
DMU7	0.841	1.402	-	-	0.427	0.2196	-	-	-	2.881	-	0.580	-	-
DMU8	0.794	1.929	-	-	0.252	-	-	-	-	0.176	-	2.176	-	33.64
DMU10	0.983	0.607	0.634	-	1.676	-	-	-	-	-	-	-	22.69	-
DMU13	0.741	1.487	-	0.313	-	0.0199	4.720	-	-	-	-	-	0.047	14.18
DMU14	0.830	-	2.595	3.151	-	-	-	11.84	-	-	-	-	18.51	-
DMU17	0.248	0.779	-	0.091	-	-	-	1.135	-	1.175	-	-	-	-
DMU19	0.543	-	0.501	0.961	1.177	-	-	-	-	1.252	-	-	1.847	25.29
DMU21	0.458	1.849	-	0.216	-	-	-	2.694	-	2.790	-	-	-	-
DMU23	0.353	0.722	0.109	0.511	-	-	2.184	1.539	-	-	-	-	-	1.287
DMU25	0.566	-	-	2.938	-	-	-	6.945	-	-	-	6.771	-	-
DMU27	0.432	-	0.071	1.932	-	-	4.469	-	-	1.214	-	-	-	-
DMU32	0.490	2.723	-	-	0.124	-	0.432	-	1.189	4.414	-	-	-	-
DMU33	0.364	1.994	-	-	0.100	-	4.962	-	-	-	-	1.431	-	-
DMU34	0.618	6.723	0.063	-	-	-	-	20.02	-	-	-	-	4.371	-
DMU36	0.636	1.724	1.892	-	-	-	7.491	-	-	-	-	-	3.407	-
DMU41	0.703	-	7.199	-	-	-	-	-	-	8.508	25.838	-	-	-
DMU43	0.347	1.543	0.945	-	-	-	-	4.747	-	0.039	-	4.386	-	-
DMU45	0.110	5.488	-	1.381	-	-	-	16.53	-	2.271	-	4.793	-	-
DMU47	0.425	1.689	-	1.862	-	-	-	-	0.476	0.585	-	-	-	65.82

< 4-28>

DMU Slack Variables(1997)

DMU	Efficiency	Output					Input							
		U1	U2	U3	U4	U0	V1	V2	V3	V4	V5	V6	V7	V8
DMU4	0.996	8.519	-	-	-	2.024	-	-	-	7.170	-	-	-	-
DMU7	0.937	4.596	-	0.611	-	0.283	-	-	-	13.20	-	0.577	-	-
DMU8	0.828	3.249	-	1.998	-	-	-	-	-	4.155	-	0.993	2.458	21.80
DMU13	0.661	3.034	-	1.054	-	-	3.341	-	-	3.371	-	-	-	-
DMU17	0.401	1.711	-	1.463	-	-	-	-	1.370	3.591	-	-	-	-
DMU19	0.898	-	3.381	5.430	0.957	0.414	-	-	-	5.847	-	-	14.88	6.987
DMU20	0.712	-	5.101	-	0.458	0.458	-	-	-	7.390	-	-	-	21.95
DMU22	0.900	5.124	-	3.203	-	-	-	-	-	7.186	-	-	-	52.20
DMU23	0.284	1.366	-	1.105	-	-	1.113	1.184	-	1.380	-	-	-	1.459
DMU25	0.379	1.363	-	3.884	-	-	-	4.050	0.487	2.174	4.126	-	-	-
DMU26	0.517	5.386	-	-	-	-	-	1.021	-	2.960	0.064	-	20.11	-
DMU27	0.661	-	1.869	4.758	-	-	1.819	-	-	5.235	-	-	12.06	-
DMU34	0.851	-	9.982	-	-	-	4.998	-	-	16.52	-	-	2.052	-
DMU36	0.539	-	1.441	3.668	-	-	1.403	-	-	4.036	-	-	9.301	-
DMU45	0.383	21.91	-	39.03	-	-	-	-	-	79.24	-	110.3	-	0.566
DMU47	0.501	-	4.195	-	-	-	-	-	-	7.363	-	-	-	28.86

33 DMU DMU 13 ,
 DMU
 < 4-29>, < 4-30>, <
 4-31>, < 4-32> .

< 4-29> (1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	13	830589.23	669367.91	254421.00	2286261.00
U2	13	275231.23	364831.24	14000.00	1249198.00
U3	13	849465.46	942393.84	182000.00	2910398.00
U4	13	269760.15	238878.30	6797.00	777491.00
V1	13	2674.15	2301.57	181.0000000	7457.00
V2	13	1289735.23	1416004.30	105000.00	5127000.00
V3	13	17.00	13.86	2.00	43.00
V4	13	24.46	22.73	1.00	87.00
V5	13	66.66	85.00	2.00	293.00
V6	13	83.15	112.31	2.00	431.00
V7	13	94.23	87.10	13.00	256.00
V8	13	228604.23	429170.70	5000.00	1535000.00

< 4-30> (1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	13	830589.23	669367.91	254421.00	2286261.00
U2	13	275231.23	364831.24	14000.00	1249198.00
U3	13	849465.46	942393.84	182000.00	2910398.00
U4	13	269760.15	238878.30	6797.00	777491.00
V1	13	2674.15	2301.57	181.0000000	7457.00
V2	13	1289735.23	1416004.30	105000.00	5127000.00
V3	13	17.00	13.86	2.00	43.00
V4	13	24.46	22.73	1.00	87.00
V5	13	66.66	85.00	2.00	293.00
V6	13	83.15	112.31	2.00	431.00
V7	13	94.23	87.10	13.00	256.00
V8	13	228604.23	429170.70	5000.00	1535000.00

< 4-31>

(1998)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	20	652750.90	590646.37	42665.00	2530000.00
U2	20	200281.30	121399.18	3657.00	540000.00
U3	20	714155.75	540277.64	37586.00	2520000.00
U4	20	143150.85	150493.42	4204.00	527518.00
V1	20	4432.40	3599.97	1297.00	15585.00
V2	20	1785700.00	1633659.27	235500.00	7156000.00
V3	20	21.25	12.16	6.00	48.00
V4	20	33.75	23.56	8.00	96.00
V5	20	113.85	99.53	5.00	444.00
V6	20	93.15	92.51	15.00	374.00
V7	20	141.55	136.08	14.00	590.00
V8	20	142180.50	137701.83	16000.00	417200.00

< 4-32>

(1997)

Variable	N	Mean	Std Dev	Minimum	Maximum
U1	20	652750.90	590646.37	42665.00	2530000.00
U2	20	200281.30	121399.18	3657.00	540000.00
U3	20	714155.75	540277.64	37586.00	2520000.00
U4	20	143150.85	150493.42	4204.00	527518.00
V1	20	4432.40	3599.97	1297.00	15585.00
V2	20	1785700.00	1633659.27	235500.00	7156000.00
V3	20	21.25	12.16	6.00	48.00
V4	20	33.75	23.56	8.00	96.00
V5	20	113.85	99.53	5.00	444.00
V6	20	93.15	92.51	15.00	374.00
V7	20	141.55	136.08	14.00	590.00
V8	20	142180.50	137701.83	16000.00	417200.00

4.3. CCR

4.1.CCR 1998
(, , CFS :
) CCR 가
< 4-33>, < 4-34>, < 4-35>, < 4-36> DMU
(30) 23, 21. 23, 20
, 4.1. 4.2. 4.3. < 4-37> <
4-38>, < 4-39> < 4-40> DMU
DMU (Reference Set)
DEA , DMU
, < 4-19>, < 4-20> .
Slack DMU ,
. 4.3. CCR 4.1. CCR
DMU135, DMU137 ,
DMU14, DMU135 DMU138, DMU138,
DMU150, DMU175 DMU178, CFS DMU130, DMU175,
DMU176, DMU187, DMU204가 .
DMU14, DMU130, DMU135 DMU138, DMU150,
DMU175 DMU178, DMU187, DMU204 . , DMU135 DMU138
가 가 Klang 4
(Klang Container Terminal, Klang Multi Terminal, Klang Port Container
Terminal, WestPort Terminal) .

DMU	Efficiency		Reference Set
DMU1	1.0000	Effi	-
DMU2	1.0000	Effi	-
DMU3	1.0000	Effi	-
DMU4	1.0000	Effi	-
DMU20	1.0000	Effi	-
DMU30	1.0000	Effi	-
DMU31	0.8327	INEffi	1, 2, 151, 191, 203
DMU40	1.0000	Effi	-
DMU42	0.8812	INEffi	1, 20, 40, 191, 200, 206
DMU44	1.0000	Effi	-
DMU90	1.0000	Effi	-
DMU 101	0.9612	INEffi	1, 2, 151, 203, 206
DMU 111	1.0000	Effi	-
DMU 131	1.0000	Effi	-
DMU 135	0.8591	INEffi	4, 20, 40, 151, 169, 191, 200
DMU 137	0.8394	INEffi	1, 139, 191, 192
DMU 139	1.0000	Effi	-
DMU 141	0.4711	INEffi	1, 4, 191, 192
DMU 151	1.0000	Effi	-
DMU 169	1.0000	Effi	-
DMU 179	1.0000	Effi	-
DMU 180	0.7182	INEffi	4, 192, 203
DMU 181	1.0000	Effi	-
DMU 189	1.0000	Effi	-
DMU 191	1.0000	Effi	-
DMU 192	1.0000	Effi	-
DMU 200	1.0000	Effi	-
DMU 203	1.0000	Effi	-
DMU 206	1.0000	Effi	-
DMU 209	1.0000	Effi	-

) Effi. : DMU, INEffi. : DMU

< 4- 34>

CCR Model

(1998)

DMU	Efficiency		Reference Set
DMU3	1.0000	Effi	-
DMU4	1.0000	Effi	-
DMU14	0.9619	INEffi	4, 111, 151, 192
DMU19	1.0000	Effi	-
DMU20	1.0000	Effi	-
DMU30	1.0000	Effi	-
DMU31	1.0000	Effi	-
DMU40	1.0000	Effi	-
DMU42	0.9050	INEffi	40, 191, 200, 206
DMU90	1.0000	Effi	-
DMU101	1.0000	Effi	-
DMU111	1.0000	Effi	-
DMU135	0.8591	INEffi	4, 20, 40, 151, 169, 191, 200
DMU136	0.5051	INEffi	4, 111, 139, 151, 192
DMU137	0.8643	INEffi	139, 191, 192
DMU138	0.3926	INEffi	4, 40, 111, 139, 192, 206
DMU139	1.0000	Effi	-
DMU141	0.6137	INEffi	4, 40, 191, 192
DMU151	1.0000	Effi	-
DMU169	1.0000	Effi	-
DMU179	1.0000	Effi	-
DMU180	0.7372	INEffi	4, 192
DMU181	1.0000	Effi	-
DMU189	1.0000	Effi	-
DMU191	1.0000	Effi	-
DMU192	1.0000	Effi	-
DMU200	1.0000	Effi	-
DMU204	0.1053	INEffi	40, 191, 200
DMU206	1.0000	Effi	-
DMU209	1.0000	Effi	-

) Effi. : DMU, INEffi. : DMU

< 4-35>

CCR Model

(1998)

DMU	Efficiency		Reference Set
DMU3	1.0000	Effi	-
DMU4	1.0000	Effi	-
DMU20	1.0000	Effi	-
DMU30	1.0000	Effi	-
DMU31	1.0000	Effi	-
DMU40	1.0000	Effi	-
DMU42	1.0000	Effi	-
DMU90	1.0000	Effi	-
DMU101	1.0000	Effi	-
DMU111	1.0000	Effi	-
DMU135	1.0000	Effi	-
DMU137	1.0000	Effi	-
DMU138	0.3579	INEffi	1, 111, 172, 192, 203
DMU141	0.7470	INEffi	4, 90, 192
DMU150	0.2285	INEffi	4, 20, 151, 152, 192, 203
DMU151	1.0000	Effi	-
DMU152	1.0000	Effi	-
DMU169	1.0000	Effi	-
DMU172	1.0000	Effi	-
DMU174	1.0000	Effi	-
DMU175	0.9757	INEffi	174
DMU176	0.9132	INEffi	174
DMU177	0.8210	INEffi	174
DMU178	0.7349	INEffi	174
DMU189	1.0000	Effi	-
DMU192	1.0000	Effi	-
DMU196	1.0000	Effi	-
DMU200	1.0000	Effi	-
DMU203	1.0000	Effi	-
DMU209	1.0000	Effi	-

) Effi. : DMU, INEffi. : DMU

< 4-36> CFS CCR Model (1998)

DMU	Efficiency		Reference Set
DMU1	1.0000	Effi	-
DMU4	1.0000	Effi	-
DMU20	1.0000	Effi	-
DMU30	1.0000	Effi	-
DMU31	1.0000	Effi	-
DMU32	1.0000	Effi	-
DMU40	1.0000	Effi	-
DMU42	0.9119	INEffi	1, 20, 40, 44
DMU44	1.0000	Effi	-
DMU60	1.0000	Effi	-
DMU90	1.0000	Effi	-
DMU 101	1.0000	Effi	-
DMU 104	1.0000	Effi	-
DMU 105	1.0000	Effi	-
DMU 106	1.0000	Effi	-
DMU 107	1.0000	Effi	-
DMU 130	0.7514	INEffi	1, 4, 20, 60, 203
DMU 131	0.9978	INEffi	1, 4, 20, 90
DMU 132	0.8737	INEffi	1, 4, 44, 203
DMU 133	0.6478	INEffi	1, 4, 20, 90, 135, 169
DMU 135	1.0000	Effi	-
DMU 136	1.0000	Effi	-
DMU 141	0.7869	INEffi	1, 30, 60, 90, 203
DMU 169	1.0000	Effi	-
DMU 174	1.0000	Effi	-
DMU 175	0.9757	INEffi	174
DMU 176	0.9132	INEffi	174
DMU 187	0.6811	INEffi	1, 4, 20, 30, 90
DMU203	1.0000	Effi	-
DMU204	0.1144	INEffi	1, 20, 44, 90

) Effi. : DMU, INEffi. : DMU

< 4-37>

Terminal DMU slack variables(1998)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU31	0.8327	-	-	-	-	0.001108	-	-	-	0.000380	-	-	-
DMU42	0.8812	-	-	-	-	0.000130	-	0.001696	0.003705	-	-	-	-
DMU101	0.9661	-	-	-	-	0.000913	-	-	-	0.011695	-	-	-
DMU135	0.8591	-	-	-	-	0.000741	-	-	0.054999	-	-	0.000581	-
DMU137	0.8394	-	-	-	-	-	-	-	-	0.080037	-	-	-
DMU141	0.4711	-	-	-	-	-	-	0.046629	-	-	-	-	-
DMU180	0.7182	-	-	-	-	-	-	0.148074	-	-	-	-	-

< 4-38>

Terminal DMU slack variables(1998)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU14	0.9618	0.000031	0.000013	-	-	-	-	1.631485	-	-	-	-	-
DMU42	0.9050	-	-	-	-	0.000101	-	-	0.043798	-	-	-	-
DMU135	0.8591	-	-	-	-	0.000741	-	-	0.054999	-	-	0.000581	-
DMU136	0.5051	-	-	-	-	-	-	-	-	0.079704	-	0.006995	-
DMU137	0.8643	-	-	-	-	-	-	-	-	0.083467	-	-	-
DMU138	0.3926	-	-	-	-	0.000171	-	0.105304	-	-	-	-	-
DMU141	0.6137	-	-	-	-	-	-	0.047423	0.010979	-	-	-	-
DMU180	0.7372	-	-	-	-	-	-	0.154704	-	-	-	-	-
DMU204	0.1052	-	-	-	-	-	-	0.084206	0.138358	-	-	-	-

< 4-39>

Terminal DMU slack variables(1998)

DMU	Efficiency	Output				Input							
		U1	U2	U3	U4	V1	V2	V3	V4	V5	V6	V7	V8
DMU138	0.3579	-	-	-	-	-	-	0.093284	-	0.007210	-	-	-
DMU141	0.7470	-	-	-	-	-	-	-	0.005811	-	-	-	-
DMU150	0.2285	0.000010	-	-	-	0.002039	-	-	0.064573	-	-	-	0.000012
DMU175	0.9757	-	-	0.00099	-	0.044598	0.000021	2.697330	-	-	-	-	-
DMU176	0.9132	0.000111	-	-	-	-	-	-	1.062651	-	-	1.522132	-
DMU177	0.8210	0.000111	-	-	-	0.007796	0.000078	-	0.693967	-	-	1.872235	0.001985
DMU178	0.2053	0.000111	-	-	-	0.016563	0.000012	-	1.054222	-	-	0.331772	0.000169

< 4-40> CFS

Terminal DMU slack variables(1998)

DMU	Efficiency	Output					Input							
		U1	U2	U3	U4	U0	V1	V2	V3	V4	V5	V6	V7	V8
DMU14	0.630	0.000018	-	-	-	-	-	-	1.716	-	-	-	-	0.000029
DMU25	0.586	0.000013	-	-	-	-	-	-	-	0.074	0.087	0.038	-	-
DMU45	0.721	-	-	-	-	-	-	-	-	-	0.181	-	0.014	-
DMU60	0.904	-	-	-	-	-	0.000365	-	-	0.041	0.031	0.022	0.001	-
DMU102	0.066	-	-	0.000100	-	-	-	-	0.207	0.074	-	-	-	0.000117
DMU103	0.919	0.000074	-	0.000370	-	-	-	0.000019	-	0.949	0.028	-	-	0.000020
DMU104	0.670	0.000029	0.000016	0.000120	-	-	-	0.000053	-	0.018	-	-	-	-
DMU106	0.810	0.000011	-	-	0.000035	-	-	0.000022	0.008	0.228	-	-	-	-
DMU202	0.226	0.000078	0.000075	-	0.000069	-	0.011415	-	-	-	-	-	-	0.000018
DMU205	0.766	0.000030	-	-	-	-	-	0.000060	-	-	-	0.037	-	-

4.4.

1)

DEA 4.1. CCR
 , 4.2. BCC . 4.3.
 4.1. CCR 4
 30 .
 4.1. .
 , 1998 1997 50
 98 33 68 , 97
 35 68 98 13 , 97 18
 , 98 48 , 97 47
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 4
 < 4-1> < 4-2> , < 4-9>

< 4-10> . <
 4-3> < 4-4> , < 4-11> < 4-12>
 . (,)
 가 .
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 ,
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 가

2)
 가 DEA . DEA
 , DMU , slack
 DMU ,
 4 < 4-3> DMU14(Britt-
 annie Terminal : Rotterdam Port) , 0.631 DMU14가
 , 1 0.369 가 가
 , (Output) U1() , 1(
) 가 23063 (0.369/0.000016 23063) TEU
 DMU가 . DMU14 2 3 TEU

, DMU 가 .
 , DMU14
 . V3(Container Gantries) 1.328 1() 가
 0.278 (0.369/1.328 0.278) TEU DMU가
 . V3 1/4 가
 1/4
 가 가 ()
)
 V4(1) V8(CFS) 가 . V4
 7 (0.369/0.053 7), V8 16773m²(0.369/0.000022 16773)
 V4 1 7 V8 CFS 16773
 m² 가 . U1 V3, V4,
 V8 U1, V3, V4, V8
 , 가 .
 가 .
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 가 .
 3)
 4 가
 .
 - 100%
 98 20.42%, 97 21.11%
 1998(46%), 1997(16%) , , 98 3 ()
 97 2) -

(HBCT, PECT, UCT) DEA(CCR) 4
 < 4-1> < 4-2> DMU30, 31, 32가 . 97
 가 98
 .
 .
 . 3 < 3-7> 97
 1,105 TEU < 3-8> 5234
 TEU 21.11%가 , 98 20.42% (1214
 TEU/5946 TEU=20.42%)가 .
 97 15% , 98 45%
 .
 가 . 98
 97 6%
 314 TEU가 .
 .
 10% (< 3-8 >) , 98
 45%
 , 가 45%

4.2. BCC

CCR

U_0

. DEA

, DEA

BCC

U_0

. BCC

U_0

U_0^*

$U_0^* < 0$

, $U_0^* = 0$

, $U_0^* > 0$

5

5.1.

DEA 1 ,
가 . DEA
가
DEA
'CI
(Containerisation International Year Book)

가 , 가 가
DEA . 가
가
DEA 가
DMU
DMU가
DEA
DMU 가

CCR

BCC

5.2.

() 10

가

(10 20)

< 5-1>

< 5-1> 4000TEU

()	(TEU)			
Evergreen	4,227	3	1993	Mitsubishi
	5,364	13	1999 2001	
Maer	4,300	4	1999 2000	
UASC	4,400	3	1999	
Hapag - Lloy d	4,612	1	1998	
	4,800	4	2000	
NV()	4,800	3	2000	
P&ON	5,000	5	2000	MTW, KW IHI
	6,674	2	1998	
YML	5,200	5	2000 2001	
	5,300	2	1998	
Costamere	5,550	5	2000	
Maersk	8,700	5	1998 1999	Odense Steel

: '99. 4. 7 p49 < 3>

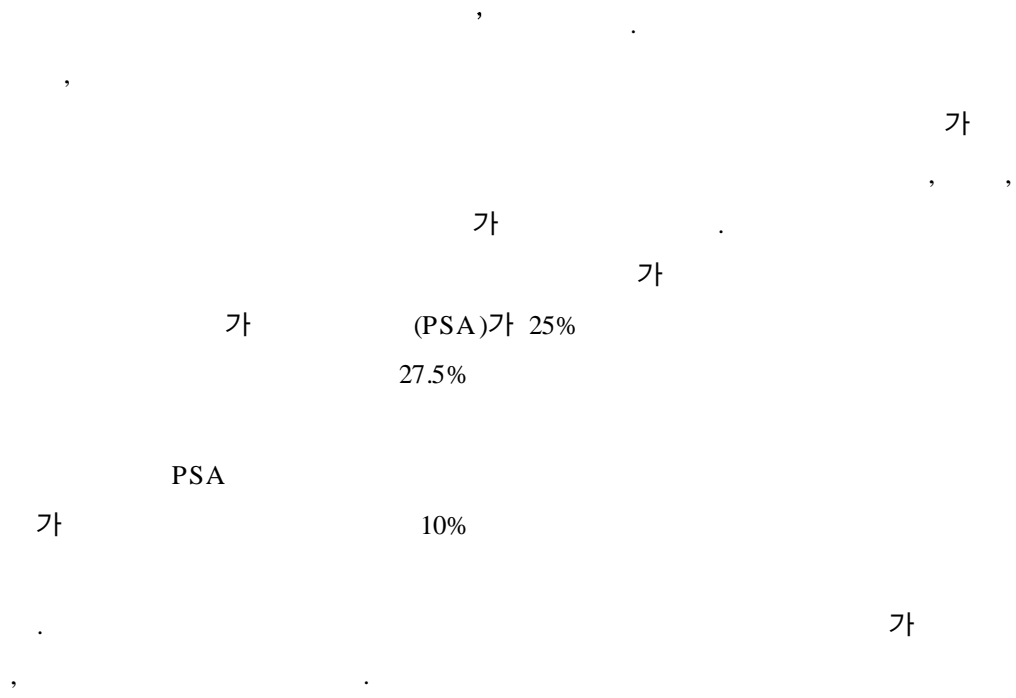
< 5-2> 6 TEU 347M, 8 TEU 393M가
 250M 360M 가
 300M 가 , 6 8 TEU 가 8700TEU 5
 98 99 <
 5-1> . < 5-2> 4 TEU 5 TEU
 6 TEU , 8 TEU 가

< 5-2>

	(L)	(B)	(L+B)	
1000TEU	190M	27M	217M	
6000TEU	309M	38M	347M	
8000TEU	355M	38M	393M	

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가
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, “ ”,
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[1]

< 1 >

(1998/ 1999)

(: TEU)

		1998	1999	가 (%)
1		14,650,000	16,100,000	9.9
2	가	15,100,000	15,900,000	5.3
3		6,271,053	6,958,361	11.0
4		5,752,955	6,439,589	11.9
5		6,032,000	6,400,000	6.1
6		4,097,689	4,408,480	7.6
7		3,066,000	4,210,000	37.3
8		3,378,218	3,828,852	13.3
9		3,550,000	3,750,000	5.6
10		3,265,750	3,614,264	10.7
11	/	2,450,000	2,863,342	16.9
12		2,800,000	2,844,634	1.6
13		2,450,000	2,700,000	10.2
14		2,500,000	2,700,000	8.0
15		-	2,550,419	-
16		1,898,069	2,273,303	19.8
17		2,125,640	2,253,401	6.0
18		2,087,000	2,200,000	5.4
19		2,200,000	2,200,000	-
20	/	-	2,180,955	-

: ([http:// www.kca.or.kr/ KOR/ menu3/ statistics.htm](http://www.kca.or.kr/KOR/menu3/statistics.htm))

< 2 >

(1997/ 1998)

(: TEU)

		1997	1998	가 (%)
1	가	14,120,000	15,100,000	6.9
2		14,500,000	14,650,000	1.0
3		5,693,339	6,271,053	10.1
4		5,340,000	6,032,000	13.0
5		5,233,880	5,752,955	9.9
6		3,504,603	4,097,689	16.9
7		3,337,000	3,550,000	6.4
8		2,959,715	3,378,218	14.1
9		2,969,189	3,265,750	10.0
10		2,520,000	3,066,000	21.7
11		2,600,102	2,800,000	7.7
12		2,212,800	2,500,000	13.0
13		2,322,000	2,450,000	5.5
14	/	2,470,000	2,450,000	-0.8
15		2,330,000	2,200,000	-5.6
16		-	2,125,640	-
17		2,100,000	2,087,000	-0.6
18		-	1,992,150	-
19		1,900,000	1,898,069	-0.1
20		-	- 1,825,614	-

: ([http:// www.kca.or.kr/ KOR/ menu3/ statistics.htm](http://www.kca.or.kr/KOR/menu3/statistics.htm))

		1996	1997	가 (%)
1		13,460,343	14,500,000	7.7
2	가	12,943,900	14,120,000	9.1
3		5,063,048	5,693,339	12.4
4		4,935,616	5,340,000	8.2
5		4,725,206	5,233,880	10.8
6		3,067,334	3,504,603	14.3
7		3,054,320	3,337,000	9.3
8		2,653,909	2,969,189	11.9
9		2,683,025	2,959,715	10.3
10		2,247,024	2,600,102	15.7
11		1,930,000	2,520,000	30.6
12	/	2,269,145	2,470,000	8.9
13		2,374,912	2,330,000	- 1.9
14		2,311,453	2,322,000	0.5
15		2,042,423	2,212,800	8.3
16		1,971,524	2,114,583	7.3
17		2,229,320	2,100,000	- 5.8
18		2,320,397	1,981,175	- 14.6
19		1,421,693	1,900,000	33.6
20	/	1,543,405	1,700,000	10.1

: (<http://www.kca.or.kr/KOR/menu3/statistics.htm>)

< 4 >

(1995/ 1996)

(: TEU)

		1995	1996	가 (%)
1		-	13,460,343	-
2	가	-	12,943,900	-
3		-	5,063,048	-
4		-	4,935,616	-
5		-	4,725,206	-
6		-	3,067,334	-
7		-	3,054,320	-
8		-	2,683,025	-
9		-	2,653,909	-
10		-	2,374,912	-
11		-	2,320,397	-
12		-	2,311,453	-
13	/	-	2,269,145	-
14		-	2,247,024	-
15		-	2,229,320	-
16		-	2,042,423	-
17		-	1,971,524	-
18		-	1,930,000	-
19	/	-	1,543,405	-
20		-	1,421,693	-

: ([http:// www.kca.or.kr/ KOR/ menu3/ statistics.htm](http://www.kca.or.kr/KOR/menu3/statistics.htm))

[2] DEA

< 1> 98 Port Total - Input data

	(Port)	V1	V2	V3	V4	V5	V6	V7	V8
1	HngKng	609	2,187,714	12	243	177	4	29	546,972
2	Singapore	7,235	2,979,211	0	337	51	147	150	29,000
3	Kochiung	5,182	2,074,000	25	38	19	58	0	67,613
4	Rotterdam	11,720	3,553,000	26	47	175	194	1513	138,500
5	Pusan	3,147	1,845,358	17	87	48	134	256	254,319
6	Long Beach	7,235	3,249,000	40	27	25	75	67	21,459
7	Hamburg	75,23	2,995,000	31	23	196	74	228	417,200
8	Yokohama	4,745	1,401,283	35	21	46	41	97	34,428
9	Los Angeles	6,392	2,344,000	43	27	24	79	54	33,576
10	Antwerp	15,585	7,156,000	21	79	444	40	26	231,400
11	Tokyo	3,359	991,000	22	23	64	58	100	111,200
12	New York/ New Jersey	7,457	5,120,000	42	1	293	431	90	614,000
13	Dubai	2,988	1,724,860	27	37	166	156	218	100,400
14	Keelung	2,992	339,000	0	0	28	15	14	29,000
15	Kobe	4,400	1,494,976	25	60	81	154	191	42,480
17	Shanghai	2,281	858,000	16	49	52	52	0	127,267
18	Manila	6,705	2,061,530	16	46	176	119	237	184,385
19	San Juan	1,688	294,200	6	0	2	0	0	21,800
21	Oakland	4,756	2,048,474	31	20	115	127	50	35,365
22	Seattle	4,358	1,741,810	25	0	78	169	153	30,000
23	Nagoya	3,370	1,085,000	23	0	87	0	0	0
24	Tanjung Priok	1,410	635,351	12	32	31	53	97	9,343
25	Port Klang	4,579	1,350,000	37	91	134	264	291	80,840
26	Canton	1,899	262,000	17	39	32	0	251	22,347
28	Bangkok	3,217	480,000	12	40	36	34	182	377,000
29	Osaka	3,365	895,967	18	29	42	32	46	82,000
30	Hampton Roads	2,561	3,954,800	16	21	57	43	0	53,000
31	Charleston	3,102	2,138,000	18	16	113	2	0	1,535,000
32	Tacoma	2,249	999,000	17	4	198	90	15	22,752
33	Jacksonville	3,661	628,000	10	3	14	2	0	61,000
34	Le Havre	5,250	1,900,000	22	4	152	109	507	35,000
35	Durban	2,128	1,055,000	12	0	52	63	56	0
36	Melbourne	2,588	1,369,553	13	1	131	18	40	23,000
37	La Spezia	1,297	270,000	8	11	29	25	33	19,000
38	Montreal	2,820	736,000	14	40	22	92	80	44,215
39	Genoa	1,720	923,000	12	30	32	21	0	55,000
40	Tianjin	1,300	575,000	18	18	19	51	54	600,000
41	Laem Chabang	1,600	105,000	0	8	0	0	0	12,000
42	Qingdao	1,189	470,000	3	25	10	7	13	7,240
43	Southampton	1,357	620,000	12	4	58	12	0	15,500
44	Houston	1,525	779,000	0	0	0	0	0	0
45	Santos	510	419,000	5	11	28	40	45	58,000
46	Barcelona	3,876	934,000	9	35	98	12	4	104,000
47	Jeddah	181	768,000	2	22	189	115	78	235,000
48	Sydney(Harbour)	1,883	235,500	3	2	14	2	16	47,457
49	Khor Fakkan	1,060	300,000	8	10	13	29	49	5,000
50	Valencia	2,940	1,719,000	12	32	53	94	120	16,000

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< 2> 97 Port Total - Input data

	(Port)	V1	V2	V3	V4	V5	V6	V7	V8
1	HngKong	689	218774	12	243	177	4	249	54672
2	Singapore	725	297211	0	37	51	147	150	2900
3	Kochiung	582	207400	25	38	19	58	0	6603
4	Rotterdam	1170	355300	26	47	175	194	1513	13500
5	Pusan	267	166100	13	77	47	117	231	25419
6	Long Beach	725	324000	40	27	25	75	67	21459
7	Hamburg	753	295000	31	23	196	74	228	41700
8	Yokohama	4745	1401283	35	21	46	41	97	3428
9	Los Angeles	692	234400	43	23	27	79	54	3376
10	Antwerp	1585	715000	21	79	444	40	26	23140
11	Tokyo	339	99000	22	23	64	58	100	11200
12	New York/New Jersey	747	512700	42	1	293	431	90	61400
13	Dubai	298	172480	27	37	166	156	218	10040
14	Keelung	292	33000	0	0	28	15	14	2900
15	Kobe	440	149476	25	60	81	154	191	42480
17	Shanghai	2281	88800	16	49	52	52	0	12727
18	Manila	605	206150	16	46	176	119	237	18485
19	San Juan	1688	29200	6	0	2	0	0	21800
21	Oakland	4756	204874	31	20	115	127	50	3536
22	Seattle	438	174180	25	0	78	169	153	3000
23	Nagoya	330	105000	23	0	87	0	0	0
24	Tanjung Priok	140	65351	12	32	31	53	97	9843
25	Port Klang	459	130000	37	91	134	264	291	8040
26	Colombo	189	26200	17	39	32	0	251	2237
28	Bangkok	3217	48000	12	40	36	34	182	37000
29	Osaka	3365	86967	18	29	42	32	46	8000
30	Hampton Roads	2561	356400	16	21	57	43	0	5300
31	Charleston	3102	213000	18	16	113	2	0	153000
32	Tacoma	2249	99000	17	4	198	90	15	22752
33	Jacksonville	3661	62800	10	3	14	2	0	6000
34	Le Havre	5280	190000	22	4	152	109	507	3500
35	Durban	2128	105000	12	0	52	63	56	0
36	Melbourne	2388	136553	13	1	131	18	40	2300
37	La Spezia	1297	27000	8	11	29	25	33	1900
38	Montreal	2830	73600	14	28	34	92	80	4215
39	Genoa	2920	137300	18	40	46	21	0	5000
40	Tianjin	130	57500	18	18	19	51	54	60000
41	Laem Chabang	160	16000	0	8	0	0	0	1200
42	Qingdao	1189	47000	3	25	10	7	13	7260
43	Southampton	1357	60000	12	4	58	12	0	1500
44	Houston	1525	79000	0	0	0	0	0	0
45	Santos	510	41900	5	11	28	40	45	5800
46	Barcelona	3376	93400	9	35	98	12	4	10400
47	Jeddah	181	76000	2	22	189	115	78	23000
48	Sydney(Harbour)	1833	23500	3	2	14	2	16	47457
49	Khor Fakkan	1060	30000	8	10	13	29	49	500
50	Valencia	2940	171900	12	32	53	94	120	1600

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< 3> 98 Port Total - Output data

	(Port)	U1	U2	U3	U4
1	HongKong	0	0	0	0
2	Singapore	0	0	0	0
3	Kaohsiung	2286,261	776,219	2896,394	312,179
4	Rotterdam	2530,000	540,000	2520,000	400,000
5	Pusan	1613,250	1,249,198	2910,398	172,768
6	Long Beach	0	0	0	0
7	Hamburg	1587,100	248,100	1381,400	330,400
8	Yokohama	932,850	119,203	782,621	256,746
9	Los Angeles	1715,414	124,949	794,448	743,187
10	Antwerp	1204,758	426,116	1413,196	221,680
11	Tokyo	0	0	0	0
12	New York/New Jersey	1150,000	95,000	860,000	350,000
13	Dubai	1134,637	245,662	874,358	527,518
14	Keelung	260,153	169,737	440,603	9,746
15	Kobe	0	0	0	0
17	Shanghai	0	0	0	0
18	Manila	748,892	121,726	571,559	319,035
19	San Juan	920,932	115,075	257,887	777,491
21	Oakland	458,470	237,176	747,064	132,696
22	Seattle	0	0	0	0
23	Nagoya	562,421	135,602	635,024	125,029
24	Tanjung Priok	0	0	0	0
25	Port Klang	645,896	280,463	820,365	73,294
26	Colombo	739,482	112,335	685,351	176,909
28	Bangkok	300,290	215,109	560,191	4,204
29	Osaka	0	0	0	0
30	Hampton Roads	428,202	198,244	633,768	34,147
31	Charleston	320,623	106,452	382,518	48,939
32	Tacoma	0	0	0	0
33	Jacksonville	0	0	0	0
34	Le Havre	0	0	0	0
35	Durban	437,310	82,543	437,145	122,694
36	Melbourne	443,026	64,677	394,261	113,882
37	La Spezia	230,000	135,000	316,000	19,000
38	Montreal	0	0	0	0
39	Genoa	389,460	244,579	584,388	47,169
40	Tianjin	0	0	0	0
41	Laem Chabang	254,421	496,629	801,265	6,797
42	Qingdao	260,000	310,000	500,000	130,000
43	Southampton	454,000	14,000	242,000	190,000
44	Houston	179,888	122,032	248,586	19,619
45	Santos	348,633	44,676	248,256	157,911
46	Barcelona	314,000	206,000	455,000	54,000
47	Jeddah	474,000	26,000	182,000	308,000
48	Sydney(Harbour)	42,665	3,657	37,586	7,158
49	Khor Fakkan	260,644	107,473	282,534	132,701
50	Valencia	225,000	210,000	430,000	45,000

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< 4> 97 Port Total - Otuput data

	(Port)	U1	U2	U3	U4
1	HongKong	52469	168928	641072	976186
2	Singapore	626900	827100	698300	948000
3	Kaohsiung	217380	640612	266402	217345
4	Rotterdam	2317824	467519	2474473	234839
5	Pusan	1908184	675978	2471440	183278
6	Long Beach	180688	0	1107324	0
7	Hamburg	1479100	236800	1410500	211000
8	Yokohama	109126	108967	909912	284630
9	Los Angeles	146262	138423	870926	487744
10	Antwerp	106645	394937	1397081	110726
11	Tokyo	0	0	0	0
12	New York/New Jersey	1112313	168002	871398	305173
13	Dubai	107872	230883	863001	435829
14	Keelung	21044	197307	426106	8143
15	Kobe	0	0	0	0
17	Shanghai	0	0	0	0
18	Manila	950288	109265	619280	442141
19	San Juan	851908	106379	237814	718727
21	Oakland	398157	288304	769172	75555
22	Seattle	515102	29007	627932	73773
23	Nagoya	612507	114980	625063	145587
24	Tanjung Piek	673901	108732	698282	57175
25	Port Klang	72931	126508	723353	105116
26	Canton	73089	115769	691851	148685
28	Bangkok	459645	96155	528000	1620
29	Osaka	604471	3599	323600	24392
30	Hampton Roads	407811	188804	608589	32521
31	Charleston	413036	191793	557476	55239
32	Tacoma	599400	0	543300	0
33	Jacksonville	0	0	0	0
34	Le Havre	0	0	0	0
35	Durban	32019	40089	341350	58197
36	Melbourne	42052	71451	395073	82779
37	La Spezia	174566	141486	286493	13059
38	Montreal	427046		443322	
39	Genoa	337035	243174	573146	2699
40	Tianjin	0	0	0	0
41	Laem Chabang	367637	158357	554714	23792
42	Qingdao	23200	27000	44000	8800
43	Southampton	446944	20250	308459	115784
44	Houston	29661	218282	412876	28081
45	Santos	123193	28349	274676	203268
46	Barcelona	296449	194672	429375	51425
47	Jeddah	427815	24955	165109	302982
48	Sydney(Harbour)	41003	5390	39355	5182
49	Khor Fakkan	263718	98673	276685	116741
50	Valencia	20435	197980	394022	35073

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< 5> 98 Terminal Total - Input data

DMUs	Port	Terminal	V1	V2	V3	V4	V5	V6	V7	V8
DMU1	HongKong	Term 3	305	16800	3	8	3	2	60	479723
DMU2	HongKong	Term 8(East)	640	30000	9	33	15	2	77	12000
DMU3	HongKong	Term 1/2/5/8(West)	1822	792000	18	73	78	2	132	5249
DMU4	HongKong	Term 4/6/7	3292	930714	32	129	81	2	43	50000
DMU14	Rotterdam	Brittannie Term	1240	272000	1	5	26	14	75	9000
DMU19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)	1500	220000	4	5	7	12	12	8000
DMU20	Rotterdam	Home Term	1700	750000	12	5	48	47	208	25000
DMU25	Rotterdam	Waalhaven Pier 7	800	200000	4	5	5	6	10	7500
DMU30	Pusan	Jasungdae Con-Term	1447	647566	13	45	26	56	1	25119
DMU31	Pusan	Shinsundae Con-Term	1200	108534	11	32	21	61	230	229200
DMU32	Pusan	Uam Con-Term	500	159258	4	10	1	17	25	35450
DMU40	Hamburg	Burchardkai Term	2850	1500000	16	7	86	6	50	175000
DMU42	Hamburg	Eurogate Con-Term	1600	700000	10	4	55	27	100	113000
DMU44	Hamburg	TCT Tollerort Term	920	320000	6	2	35	10	10	60000
DMU45	Hamburg	Unikai Con-Term	613	166000	5	11	3	26	30	92000
DMU48	Yokohama	Term C3	305	175000	3	12	6	17	45	7559
DMU60	Los Angeles	Yang Ming Line Term	610	320000	5	9	8	8	22	55000
DMU70	Tokyo	Berth 2-OC	285	100000	2	7	6	7	26	6000
DMU90	Keelung	Keelung Harbor Bureau	2992	339000	21	8	28	15	14	29000
DMU101	Manila	Manila International Con-Term	1300	940000	11	25	15	71	170	66309
DMU102	Manila	Manila Slipway	280	98672	2	5	15	32	38	2700
DMU103	Manila	Pier 10	220	17845	4	1	4	25	32	20000
DMU104	Manila	Pier 12	221	17845	6	3	28	41	46	60000
DMU105	Manila	Pier 14	222	17856	4	1	26	35	41	55400
DMU106	Manila	Pier 16	250	25452	3	2	22	26	52	77500
DMU107	Manila	Pier 2	444	39680	4	2	20	33	64	124200
DMU108	Manila	Pier 4	217	18000	6	2	7	18	25	13376
DMU109	Manila	Pier 6	217	18000	3	4	21	45	55	14520
DMU111	Manila	South Harbor	3114	850000	5	9	6	48	67	22000
DMU115	Oakland	Ben E Nutter Con-Term	898	255474	5	3	21	41	38	5707
DMU130	Nagoya	Kinjo Pier	800	176000	5	5	18	22	40	88900
DMU131	Nagoya	NCB Term	900	289000	6	6	69	44	84	168000
DMU132	Nagoya	Tobishima North Pier	620	170000	4	4	48	32	46	87500
DMU133	Nagoya	Tobishima South Pier	700	225000	5	5	27	23	30	154200
DMU135	Port Klang	Klang Con-Term	1079	440000	12	5	102	57	57	23592
DMU136	Port Klang	Klang Multi Term	1200	160000	9	30	6	65	75	23566
DMU137	Port Klang	Klang Port Con-Term	1100	340000	7	31	20	77	84	20000
DMU138	Port Klang	WestPort Term	1200	410000	9	30	6	65	75	13682
DMU139	Colombo	Jaye Con-Term	1474	207000	14	39	11	146	198	14917
DMU140	Colombo	Queen Elizabeth Quay Con-Term	425	55000	3	36	21	45	53	7430
DMU141	Bangkok	Bangkok	3217	480000	12	40	36	34	182	377000
DMU150	Hampton Roads	Newport News Marine Term	512	596100	4	3	30	32	154	19000
DMU151	Hampton Roads	Norfolk International Term	1290	2472500	7	17	3	32	84	19000
DMU152	Hampton Roads	Portsmouth Marine term	759	886200	5	1	24	11	25	15000
DMU169	Durban	Con-Term	2128	1065000	12	3	52	63	56	142300
DMU172	Melbourne	East Swanson Dock	885	350000	6	2	28	12	18	14230
DMU173	Melbourne	TT-Line Term	220	330000	8	4	48	7	19	22450
DMU178	Melbourne	Webb Dock Term	183	60453	2	1	70	5	0	23000
DMU179	Melbourne	West Swanson dock	980	320000	5	6	30	21	12	21450
DMU180	Melbourne	West Swanson dock	980	320000	5	46	30	23	33	22365
DMU181	La Spezia	La Spezia Con-Term	987	170000	8	11	12	21	33	19000
DMU187	Genoa	Southern European Cn-Hub-Term	520	173000	4	6	16	21	45	47000
DMU189	Genoa	Voltri Term	1200	750000	8	24	16	29	22	8000
DMU191	Laem Chabang	Laem Chabang	1600	106000	12	8	37	45	55	12000
DMU192	Qingdao	Qingdao	1189	470000	3	25	10	7	13	7260
DMU196	Santos	Tecon Term	510	350000	5	6	25	40	45	20000
DMU197	Barcelona	Estibadera de Ponent	630	45000	8	6	8	8	12	2500
DMU200	Barcelona	TCB Term	1390	550000	9	1	26	13	26	15000
DMU202	Barcelona	Term Port-Nou	160	120000	4	8	25	11	31	22500
DMU203	Jeddah	Con-Term	181	768000	2	22	189	115	78	235000
DMU204	Sydney(Harbour)	Darling Harbour	949	220000	5	2	80	22	41	33100
DMU205	Sydney(Harbour)	White Bay	934	15500	3	6	14	2	16	14357
DMU206	Khor Fakkan	Khor Fakkan Con-Term	1060	300000	8	10	13	29	49	5000
DMU209	Valencia	Valencia Con-Term(Terport SA)	1500	1500000	8	23	9	80	120	10000

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< 6> 97 Terminal Total - Input data

DMUs	(Port)	(Terminal-Term)	V1	V2	V3	V4	V5	V6	V7	V8
Dmu 1	Hong Kong	Term 3	305	165000	3	8	3	2	60	479723
Dmu 2	Hong Kong	Term 8(East)	640	300000	9	33	15	5	77	12000
Dmu 3	Hong Kong	Term 1/2/5/8(West)	1822	792000	19	73	78	2	132	5249
Dmu 4	Hong Kong	Term 4/6/7	3292	930714	32	129	81	4	56	50000
Dmu 14	Rotterdam	brittannie Term	1240	272000	1	5	26	14	75	9000
Dmu 16	Rotterdam	Delta Term(Europahaven)	1650	920000	8	11	63	64	255	186000
Dmu 19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)	1500	220000	4	5	7	12	12	19200
Dmu 20	Rotterdam	Home Term	1700	750000	12	14	48	47	203	45200
Dmu 25	Rotterdam	Waalhaven Pier 7	800	200000	4	5	5	6	10	10120
Dmu 30	Pusan	Jasungdae Con-Term	1447	647566	13	45	26	56	1	25119
Dmu 31	Pusan	Shinsundae Con-Term	1200	1038534	8	32	21	61	230	229200
Dmu 35	Long Beach	ITS Term	701	405000	8	13	22	48	102	14000
Dmu 36	Long Beach	Longbeach Con-Term	884	405000	5	7	12	45	37	19230
Dmu 40	Hamburg	Burchardkai Term	2850	1500000	16	4	86	6	50	175000
Dmu 42	Hamburg	Eurogate Con-Term	1600	700000	9	4	55	27	100	113000
Dmu 44	Hamburg	TCT Tollerort Term	920	320000	6	1	35	10	10	60000
Dmu 45	Hamburg	Unikai Con-Term	613	165000	5	11	3	26	30	9200
Dmu 48	Yokohama	Term C3	305	175000	3	12	6	17	45	7559
Dmu 60	Los Angeles	Yang Ming Line Term	610	320000	5	3	8	11	22	19000
Dmu 63	Antwerp	Europe Term	3234	1570000	26	29	107	10	12	26000
Dmu 68	Antwerp	Seaport Term	4500	2685000	8	27	46	14	18	162000
Dmu 69	Antwerp	Westerlind	1920	880000	15	4	4	12	16	153000
Dmu 70	Tokyo	Berth 2-OC	285	100000	2	7	6	27	26	6000
Dmu 71	Tokyo	Berth 6-OG	300	111000	5	8	12	24	42	25000
Dmu 76	Tokyo	Berth 4-OE/5-OF	600	222000	4	9	11	21	47	56000
Dmu 90	Keelung	Keelung Harbor Bureau	2992	339000	24	4	28	15	14	29000
Dmu 101	Manila	Manila International Con-Term	1300	940000	11	25	15	71	170	66309
Dmu 102	Manila	Manila Slipway	280	98672	7	17	15	66	143	2700
Dmu 103	Manila	Pier 10	220	17845	10	1	4	32	45	20000
Dmu 104	Manila	Pier 12	221	17845	10	3	28	84	91	60000
Dmu 108	Manila	Pier 4	217	18000	10	2	7	42	66	13376
Dmu 111	Manila	South Harbor	3114	850000	5	9	6	48	67	22000
Dmu 115	Oakland	Ben E Nutter Con-Term	898	255474	5	3	21	41	38	5707
Dmu 134	Tanjung Priok	Tanjung Priok Con-Term	1410	635351	12	32	31	53	97	9343
Dmu 135	Port Klang	Klang Con-Term	1079	440000	12	22	102	57	57	23592
Dmu 136	Port Klang	Klang Multi Term	1200	160000	9	30	6	65	75	23566
Dmu 137	Port Klang	Klang Port Con-Term	1100	340000	7	31	20	77	84	20000
Dmu 138	Port Klang	WestPort Term	1200	410000	9	30	6	65	75	13682
Dmu 139	Colombo	Jaye Con-Term	1474	207000	14	39	11	68	198	14917
Dmu 140	Colombo	Queen Elizabeth Quay Con-Term	425	55000	3	21	21	42	53	7430
Dmu 141	Bangkok	Bangkok	3217	480000	12	40	36	34	182	377000
Dmu 150	Hampton Roads	Newport News Marine Term	512	596100	4	3	30	42	55	19000
Dmu 151	Hampton Roads	Norfolk International Term	1290	2472500	7	17	3	32	41	19000
Dmu 152	Hampton Roads	Portsmouth Marine term	759	886200	5	1	24	11	21	15000
Dmu 153	Charleston	Culumbus Street Term	1180	498000	3	9	4	2	8	283000
Dmu 154	Charleston	North Charleston Term	762	775000	6	2	94	2	8	587000
Dmu 155	Charleston	Wando Welch term	1160	865000	9	5	15	4	12	665000
Dmu 169	Durban	Con-Term	2128	1055000	12	19	52	63	56	887250
Dmu 170	Melbourne	Berth 1	180	51000	4	6	3	6	40	45050
Dmu 174	Melbourne	Webb Dock Term	183	600453	2	1	70	5	14	23000
Dmu 176	Melbourne	Webb Dock Term	987	170000	8	11	12	21	33	19000
Dmu 181	La Spezia	La Spezia Con-Term	651	251000	5	7	12	32	31	4215
Dmu 182	La Spezia	Term Del Golfo	520	173000	4	6	16	21	24	47000
Dmu 184	Montreal	Cast Term	1200	750000	8	24	16	12	16	8000
Dmu 186	Montreal	Racine Term	1600	105000	11	8	23	41	58	12000
Dmu 187	Genoa	Southern European Con-Hub-Term	1189	470000	3	25	10	7	13	7260
Dmu 190	Tianjin	Con-Term	610	69000	4	5	3	8	16	38000
Dmu 191	Laem Chabang	Laem Chabang	510	350000	5	6	25	40	45	20000
Dmu 195	Santos	Right Bank	1390	550000	9	1	26	3	6	15000
Dmu 197	Barcelona	Estibadora de Ponent	160	120000	2	8	25	2	5	22500
Dmu 198	Barcelona	Muelle Principe de Espana	181	768000	2	22	189	115	78	235000
Dmu 199	Barcelona	Saport Term	949	220000	8	2	9	4	8	33100
Dmu 200	Barcelona	TCB Term	934	15500	3	2	14	2	16	14357
Dmu 201	Barcelona	Term Catalunya	1060	300000	8	10	13	29	49	5000
Dmu 202	Barcelona	Term Port-Nou	1170	200000	4	7	38	14	14	6000
Dmu 204	Sydney(Harbour)	Darling Harbour	1500	1500000	8	23	9	80	120	10000

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< 7> 98 Terminal Total - Output data

DMUs	Port	Terminal	U1	U2	U3	U4
DMU1	HongKong	Term 3	289559	182548	548818	46381
DMU2	HongKong	Term 8(East)	401677	178463	553376	76484
DMU3	HongKong	Term 1/2/5/8(West)	736957	239716	987316	73196
DMU4	HongKong	Term 4/6/7	1830431	474337	2245854	225219
DMU14	Rotterdam	brittannie Term	40000	20000	40000	10000
DMU19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)	130000	4000	76000	10000
DMU20	Rotterdam	Home Term	401650	79750	359600	76850
DMU25	Rotterdam	Waalhaven Pier 7	55488	18975	56730	13056
DMU30	Pusan	Jasungdae Con-Term	270593	317714	665568	31922
DMU31	Pusan	Shinsundae Con-Term	311776	248868	634532	30975
DMU32	Pusan	Uam Con-Term	69521	50245	172144	2479
DMU40	Hamburg	Burchardkai Term	754000	97000	597000	146000
DMU42	Hamburg	Eurogate Con-Term	338718	27072	279967	65294
DMU44	Hamburg	TCT Tollerort Term	183314	22577	159212	48227
DMU45	Hamburg	Unikai Con-Term	87000	29000	106000	8000
DMU48	Yokohama	Term C3	155424	24573	130970	36966
DMU60	Los Angeles	Yang Ming Line Term	142111	2016	56499	61459
DMU70	Tokyo	Berth 2-OC	181834	2426	132066	50591
DMU90	Keelung	Keelung Harbor Bureau	260153	169737	440603	9746
DMU101	Manila	Manila International Con-Term	333426	28233	248704	125330
DMU102	Manila	Manila Slipway	5196	3266	8478	461
DMU103	Manila	Pier 10	25163	2862	25580	67
DMU104	Manila	Pier 12	30241	20909	45702	1874
DMU105	Manila	Pier 14	25163	2862	25580	67
DMU106	Manila	Pier 16	31392	17926	42848	12198
DMU107	Manila	Pier 2	25918	4734	31837	1189
DMU108	Manila	Pier 4	40184	20529	43012	9201
DMU109	Manila	Pier 6	2833	2251	5567	745
DMU111	Manila	South Harbor	206354	8794	48783	149836
DMU115	Oakland	Ben E Nutter Con-Term	92330	38829	139039	29653
DMU130	Nagoya	Kinjo Pier	88505	7863	64053	32470
DMU131	Nagoya	NCB Term	241355	57206	281138	21466
DMU132	Nagoya	Tobishima North Pier	113418	16250	83406	34672
DMU133	Nagoya	Tobishima South Pier	81280	39288	182252	12381
DMU135	Port Klang	Klang Con-Term	205548	86546	252757	26065
DMU136	Port Klang	Klang Multi Term	133875	44625	137200	34300
DMU137	Port Klang	Klang Port Con-Term	205548	86546	252757	26065
DMU138	Port Klang	WestPort Term	133875	44625	137200	34300
DMU139	Colombo	Jaye Con-Term	586220	97246	587944	123961
DMU140	Colombo	Queen Elizabeth Quay Con-Term	153256	15085	97505	52836
DMU141	Bangkok	Bangkok	300290	215109	560191	4204
DMU150	Hampton Roads	Newport News Marine Term	25432	9894	33977	3836
DMU151	Hampton Roads	Norfolk International Term	219025	79887	257609	21806
DMU152	Hampton Roads	Portsmouth Marine term	127992	66172	229050	6655
DMU169	Durban	Con-Term	437310	82543	437145	122694
DMU172	Melbourne	East Swanson Dock	95726	26943	129860	204463
DMU173	Melbourne	TT-Line Term	7765	2965	9115	744
DMU178	Melbourne	Webb Dock Term	6645	784	6548	521
DMU179	Melbourne	West Swanson dock	209779	17071	152767	42114
DMU180	Melbourne	West Swanson dock	240567	19799	187788	37394
DMU181	La Spezia	La Spezia Con-Term	233000	100000	245000	12000
DMU187	Genoa	Southern European Con-Hub-Term	80555	41614	111061	10847
DMU189	Genoa	Voltri Term	222910	78361	278545	23877
DMU191	Laem Chabang	Laem Chabang	254421	496629	801265	6797
DMU192	Qingdao	Qingdao	260000	310000	500000	130000
DMU196	Santos	Tecon Term	13687	26470	36517	4050
DMU197	Barcelona	Estibadora de Ponent	26500	53000	95400	0
DMU200	Barcelona	TCB Term	260849	52506	233324	55480
DMU202	Barcelona	Term Port-Nou	7400	9100	16200	1800
DMU203	Jeddah	Con-Term	425103	24834	145500	288924
DMU204	Sydney(Harbour)	Darling Harbour	15033	1956	11473	1013
DMU205	Sydney(Harbour)	White Bay	25194	3700	24606	2930
DMU206	Khor Fakkan	Khor Fakkan Con-Term	260644	107473	282534	132701
DMU209	Valencia	Valencia Con-Term(Terport SA)	221234	130235	305108	69053

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< 8> 97 Terminal Total - Output data

DMUs	(Port)	(Terminal- Term)	U1	U2	U3	U4
Dmu1	HongKong	Term 3	423060	86729	477802	80447
Dmu2	HongKong	Term 8(East)	512426	142857	520898	95706
Dmu3	HongKong	Term 1/2/5/8(West)	736957	239716	987316	73196
Dmu4	HongKong	Term 4/6/7	2083734	409255	2439713	219585
Dmu14	Rotterdam	brittannie Term	40000	25000	45000	8000
Dmu16	Rotterdam	Delta Term(Europahaven)	832000	107000	815000	81000
Dmu19	Rotterdam	Hanno Term(Waalhaven Pier 5/6)	99852	2112	62148	3670
Dmu20	Rotterdam	Home Term	277000	78000	296000	31000
Dmu25	Rotterdam	Waalhaven Pier 7	47430	15810	55900	4860
Dmu30	Pusan	Jasungdae Con-Term	624891	220669	917711	44875
Dmu31	Pusan	Shinsundae Con-Term	590970	126861	653368	80837
Dmu35	Long Beach	ITS Term	162800	4500	117600	21100
Dmu36	Long Beach	Longbeach Con-Term	201600	800	98500	29000
Dmu40	Hamburg	Burchardkai Term	707000	100000	625000	112000
Dmu42	Hamburg	Eurogate Con-Term	292000	26000	269000	29000
Dmu44	Hamburg	TCT Tollerort Term	192657	20904	172482	27342
Dmu45	Hamburg	Unikai Con-Term	83000	26000	104000	7000
Dmu48	Yokohama	Term C3	141432	23154	127441	30481
Dmu60	Los Angeles	Yang Ming Line Term	122733	1392	68037	31466
Dmu63	Antwerp	Europe Term	459037	185608	660335	29923
Dmu68	Antwerp	Seaport Term	96000	60000	161000	18500
Dmu69	Antwerp	Westerlind	11002	6086	16236	1906
Dmu70	Tokyo	Berth 2-OC	217000	1850	147000	75000
Dmu71	Tokyo	Berth 6-OG	122500	6100	46800	32300
Dmu76	Tokyo	Berth 4-OE/5-OF	220000	6000	155000	70000
Dmu90	Keelung	Keelung Harbor Bureau	210414	197307	426106	8143
Dmu101	Manila	Manila International Con-Term	439358	11419	232426	218678
Dmu102	Manila	Manila Slipway	16256	10231	16356	5872
Dmu103	Manila	Pier 10	19648	14824	26289	12309
Dmu104	Manila	Pier 12	31272	15064	39666	1064
Dmu108	Manila	Pier 4	35724	7820	39324	4531
Dmu111	Manila	South Harbor	215334	4839	53877	169392
Dmu115	Oakland	Ben E Nutter Con-Term	93348	51686	160064	12010
Dmu134	Tanjung Priok	Tanjung Priok Con-Term	673901	103732	698282	57175
Dmu135	Port Klang	Klang Con-Term	229745	54040	261858	32984
Dmu136	Port Klang	Klang Multi Term	56066	7684	39030	10091
Dmu137	Port Klang	Klang Port Con-Term	241020	41000	314000	23980
Dmu138	Port Klang	WestPort Term	56066	7684	39030	10091
Dmu139	Colombo	Jave Con-Term	588073	96021	588288	111720
Dmu140	Colombo	Queen Elizabeth Quay Con-Term	142796	19748	103573	36965
Dmu141	Bangkok	Bangkok	459645	96155	528000	16200
Dmu150	Hampton Roads	Newport News Marine Term	24221	9423	32359	3653
Dmu151	Hampton Roads	Norfolk International Term	208595	76083	245342	20768
Dmu152	Hampton Roads	Portsmouth Marine term	121897	63021	218143	6338
Dmu153	Charleston	Culumbus Street Term	36660	34095	72621	4371
Dmu154	Charleston	North Charleston Term	97584	61797	170405	7249
Dmu155	Charleston	Wando Welch term	232582	102269	288869	42899
Dmu169	Durban	Con-Term	326019	40089	341350	58197
Dmu170	Melbourne	Berth1	36680	2268	31050	7200
Dmu174	Melbourne	Webb Dock Term	8754	1234	9875	887
Dmu176	Melbourne	Webb Dock Term	160381	96431	241901	10918
Dmu181	La Spezia	La Spezia Con-Term	195000	20000	230000	6000
Dmu182	La Spezia	Term Del Golfo	113155	39122	80385	5575
Dmu184	Montreal	Cast Term	178516	90207	266578	12110
Dmu186	Montreal	Racine Term	367637	158357	554714	23792
Dmu187	Cenoa	Southern European Con-Hub-Term	232000	270000	440000	88000
Dmu190	Tianjin	Con-Term	237700	26800	162700	123500
Dmu191	Laem Chabang	Laem Chabang	8032	19253	26938	1305
Dmu195	Santos	Right Bank	239448	73164	265137	27631
Dmu197	Barcelona	Estibadora de Ponent	6875	8504	15129	2086
Dmu198	Barcelona	Muelle Principe de Espana	393904	24955	143642	290205
Dmu199	Barcelona	Saport Term	21012	1883	17397	1338
Dmu200	Barcelona	TCB Term	26414	3687	23529	3998
Dmu201	Barcelona	Term Catalunya	263718	93673	276685	116741
Dmu202	Barcelona	Term Port-Nou	155122	96852	231682	35668
Dmu204	Sydney(Harbour)	Darling Harbour	171068	113430	263008	37697

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DEA 가

DMU 32((8) X (4)

= 32) 36(((8)+ (4))X3 = 36) . 가

33(35) , 98 68 (97 66) 가

Data CCR

가 . CCR 가

DMU 98 68 46 , 97 66 가

47 , DMU DMU 가

가 ,

가 .

DEA CCR BCC

CCR , 1998 1997

50 98 33

68 , 97 35 68 98 13 , 97

18 , 98 48 , 97 47

(,)

가 .

DMU14(Britt- annie Terminal : Rotterdam Port) ,

0.631 DMU14가 , 1 0.369

가 가 , (Output) U1()

, 1() 가 23063 (0.369/0.000016 23063) TEU

DMU가 . DMU14 2 3 TEU ,

DMU 가 .

DMU14

V3(Container Gantries) 1.328 1() 가 0.278

(0.369/1.328 0.278) TEU DMU가 . V3 1/4

가 1/4 가

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V4(1) V8(CFS) 가 . V4 7

(0.369/0.053 7), V8 16773m²(0.369/0.000022 16773) V4 1

7 V8 CFS 16773m² 가 .

U1 V3, V4, V8

U1, V3, V4, V8

(HBCT, PECT,

UCT) DMU30, 31, 32가 . 1998

97

1,105 TEU 5234 TEU

21.11%가 , 98 20.42% (1214 TEU/5946 TEU=20.42%)가 .

97 15% , 98 45%

가 . 98

97 6% 314 TEU가

10%

98 45%

가 45%

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(10 20)

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