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e-companion

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Electronic Companion—"Network Design and Allocation Mechanisms for Carrier Alliances in Liner Shipping" by Richa Agarwal and Özlem Ergun, *Operations Research*, DOI 10.1287/opre.1100.0848.

Online Supplement: An Example with Empty Core

Consider a network with three ports (at the vertices of an equilateral triangle) as represented in Figure 1 and three carriers A, B and C with fleet size and demand data as represented in Table 1. Let all ships be identical with capacity 100 TEU and the operational costs be negligible. Furthermore, assume that a ship takes one week to go from one port to another.

Figure 1 An example with empty core.

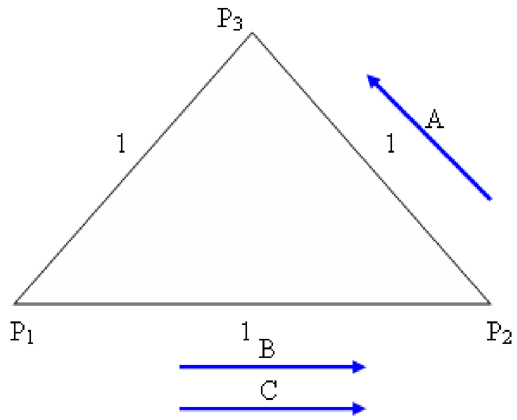

Table 1 An example with empty core.

Carrier	# Ships	Demand Information			
		From	To	Demand	Revenue
A	2	P_2	P_3	100 TEU	\$1
B	1	P_1	P_2	100 TEU	\$1
C	1	P_1	P_2	100 TEU	\$1

The maximum revenue generated by the set $\{A, B, C\}$ is obtained by operating the service route $P_1 - P_2 - P_3 - P_1$ and satisfying 100 TEUs of demand from P_2 to P_3 and 100 TEUs of demand from P_1 to P_2 with $opt(\{A, B, C\}) = \$200$. Note that the same revenue is obtained by operating on service routes $P_2 - P_3 - P_2$ and $P_1 - P_2 - P_1$. Similarly, it is easy to see that:

$$opt(\{A\}) = \$100, \; opt(\{B\}) = opt(\{C\}) = \$0,$$
$$opt(\{A, B\}) = opt(\{A, C\}) = \$200, \; opt(\{B, C\}) = \$100.$$

For an allocation (x^A, x^B, x^C) to be in the core we must have that the sum of the payoffs over all carriers be their maximum attainable revenue i.e.

$$x^A + x^B + x^C = 200.$$

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However, the sum of two carrier rationality constraints requires

$$x^A + x^B + x^C \geq 250.$$

Thus the core of this game is empty.