Transport Policy 23 (2012) 88–94

Contents lists available at SciVerse ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Ocean shipping reform act promotes competition in the trans-Atlantic trade route

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ARTICLE INFO

Available online 17 July 2012

Keywords:
Ocean Shipping Reform Act (OSRA)
Trans-Atlantic Conference Agreement (TACA)
Westbound
Eastbound
Smith's condition of joint product

ABSTRACT

Substantial pro-competitive changes were made to the Shipping Act by the Ocean Shipping Reform Act (OSRA). Of these changes, the most notable was the shift away from public tariffs and publicly available contract rates to confidential rates using individually negotiated service contracts. The number of individual member service contracts has risen dramatically since OSRA went into effect in 1999. These statistics from reports of the European Commission support the argument that OSRA was able to instill more competition into the industry. However, the empirical evidence on the Act's success in improving the performance of the containerized liner industry serving the Trans-Atlantic trade route is not so compelling. This paper applies the theory of joint product to assess the impact of OSRA on the structure and competition of shipping market after 1999. Trans-Atlantic eastbound and westbound routes were regarded as joint products. A simple statistical equation is derived to reinterpret Smith's condition of joint product. Empirical results obtained confirm the competitive market structure of the Trans-Atlantic trade route.

1. Introduction

In the early 20th century, following the lead of the British government, the US granted the ocean shipping industry limited protection from antitrust regulations by allowing companies servicing the liner shipping market in the US to form conferences and benefit from a system of price-fixing. However, the economic regulation of transportation in the US had changed significantly in the last three decades. New laws liberalizing transportation have affected the structure and performance of the maritime shipping industry.

Prior to OSRA, carriers and shippers could assess directly the contract rates and terms of their competitors, and relied heavily on the published essential terms of service contracts as benchmarks in their own negotiations. Contract terms achieved by a particular shipper were published and made available to any similarly situated shipper through the "me-too" provision. Accordingly, carriers were more reluctant to grant specific contract concessions to a particular shipper for fear that their other customers could request equal treatment. The transparency of information constrained the commercial benefits of contract specialization for both carriers and shippers.

In crafting OSRA, the Congress understood well that in a dynamic, international industry like liner shipping, additional future efficiency-enhancing, pro-competitive reforms might be warranted and desirable. Significant pro-competitive changes were made by OSRA. Of these, the most notable was the shift away from public tariffs and publicly available contract rates to confidential rates in individually negotiated service contracts. Conferences and consortia can no longer restrict their members from directly negotiating contracts with shippers. The number of individual member service contracts has risen dramatically since 1999 (European Commission, 2005, p. 53). In 2004, more than 80% of liner business was done through confidential service contracts (Haralambides, 2004, p. 25).

The main cargo flow on the Trans-Atlantic route is from North Europe to North America. The Trans-Atlantic Conference Agreement (TACA) of 1994 was originated from the Trans-Atlantic Agreement (TAA), which was formed in 1992 and operated in the U.S. under the Federal Maritime Commission (FMC) Agreement 202-011375 (European Commission, 2005, p. 92). Under OSRA 1998, the US no longer permits conferences to publish terms of service contracts, making this route a matter of special interest for this paper.

The European Commission's report claims that OSRA has greatly affected the functions of traditional conference since it went into effect in 1999. One of the major pieces of evidence for the success of the Act is the conference's market share. In 1995, TACA controlled about two-thirds of the market in both

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http://dx.doi.org/10.1016/j.tranpol.2012.06.007

eastbound and westbound trade. The biggest decline in market share came between 1998 and 1999, the years immediately preceding and following OSRA, respectively. The year 1999 was the first in which TACA controlled less than half the market in both westbound and eastbound trade (European Commission, 2005, p. 94).

Another piece of evidence is the changing rate structure after year 1999. Up till mid 1999, the eastbound route was charging a premium comparable with the westbound route, although the eastbound trade suffered from over capacity, and ships on the return trip to Europe came back partially empty. It appears that the conference may have been successful in suppressing the directional rate differential before 1999. Eastbound rates have been declining since 1998 (C.I. Online, 2010). Intense competition after 1999 has apparently driven down rates on the direction with excess capacity, eastbound; and driven up rates on the direction where the capacity constraint tends to be binding, westbound. Westbound trade operated at a premium during the period Q3/1999 and Q2/2008.

To examine the existence of the direction-related rate structure (Hoffmann and Kumar, 2010) in the shipping market after 1999, this paper considers round-trip container shipment as an example of joint product, and examines the effect of OSRA on price setting of eastbound and westbound container movements in the Trans-Atlantic. A joint-supply pricing equation is useful as an illustration of price setting not only because it is simple, but also because it is economically important in determining the direction-related transport prices. By applying the data of eastbound and westbound freight rates (C.I. Online, 2010) to a linear pricing equation, this paper finds that the statistics meet not only Smith's condition of joint product, but also support the contention that the Trans-Atlantic containerized liner market has indeed become more competitive after OSRA took effect on May 1, 1999.

2. Literature review

Before OSRA 1998 came into effect, conferences had the power to impose conference tariff on their members, and set various surcharges on shippers (European Commission, 2005, p. 151). The provision in OSRA concerning confidential service contracts, which was intended to encourage carriers to compete on rates, is considered the most pro-competitive inclusion in the Act. Several studies have been conducted on the roles of the confidential service contract in liner shipping. Study reports of the European Commission stated that rate confidentiality has spurred freight rate competition, leading to opaqueness about the level of rates. Collusion has become more difficult, since rates are confidential and singular in nature. With deregulation, market forces resulted in a healthier liner industry (European Commission, 2005, p. 154).

Fusillo (2005) published a paper on the competitive behavior in liner shipping after OSRA. He considered long-term confidential contracting a key provision of OSRA legislation. In his study, the stability of service supply was measured by examining the market share variability of the carriers. Fusillo (2005) concluded that OSRA 1998 shifted significantly the industrial structure of liner markets from one dominated by price-fixing liner shipping conferences to one dominated by non-binding discussion agreements, global alliances and long-term confidential contracting.

ICF Consulting (2005) prepared a study for DG TREN, analyzing the probable effects of the abolition of the conference system on the market and the potential significant impact on liner shipping. No significant impact on competition, market concentration, or provision of capacities in the largest trades could be found. That is, abolishing conferences did not affect large trades. Accordingly, most papers turned to investigate market share variability, market concentration, rate stability (Erasmus University Rotterdam, 2003) and contestable market (Panayides and Cullinane, 2002). Instead, our study focuses on pricing formation and applies Smith's condition of joint product to examine market structure and competition in the liner industry. The review of the literature of joint product is as follows:

Ekelund and Thompson (2001) traced the evolution of joint supply over two centuries, from early Smith–Mill–Marshall construction to today's peak-load pricing theory. They reviewed various models related to joint supply theory, and pointed out the differences among microeconomic models of joint product, public goods and price discrimination. According to their paper, joint supply includes joint product, backhauls, peak-load pricing, and some aspects of public goods.

In reviewing Smith's contribution to the theory of joint product, Ekelund and Thompson (2001, p. 580) found that Smith, instead of examining the presence of joint product from the production side, turned to the market side and proposed: "*Equilibrium requires that the price of all joint products at least cover the total cost of production; in a competitive market, of course, the summed prices and the cost would be equal. Ceteris paribus, the prices of the joint products will be inversely related. If the price of meat falls, the price of hides must increase enough to again cover the cost of the animal.*" Their review confirmed that Smith (1904) did set a condition for the presence of joint supply; i.e., assuming individual goods to be produced in constant proportions, and that an increase in the demand for one good (hides/meat) must reduce the price of the other (meat/hides). If this condition is not met, joint supply does not exist.

Bell (1968) on the impact of the decision by Pope Paul VI to allow Catholics to eat meat on Fridays has become one of the most familiar illustrations of the demand theory. Bell showed that the Pope's decree had a negative influence on fish prices. Thornton (1992) also studied this event and found that the demand for beef and other meats did indeed increase when the Catholic ban on meat eating on Fridays and during Lent was lifted in the US and elsewhere. As cattle production increased to meet this new demand, the quantity of leather, which was jointly supplied with beef, also increased.

A lot of quantity data were quoted from the OECD by Thornton (1992) to explain the phenomena of joint product; i.e., the increase in the demand for beef resulting from the Pope's decree was indeed accompanied by a noticeable increase in the quantity of cowhides. Although Thornton did point out that the nominal price of leather fell almost 25% between 1966 and 1972 (OECD, 1976), only limited pricing data were provided to support his argument of joint product. Since Thornton's study concerned mainly the problem of joint supply, from the statistical point of view, he did not provide enough pricing evidence to fulfill Smith's condition of joint product.

In their study on direction-dependent prices in public transport, Rietveld and Roson (2002) also considered the backhaul problem as a phenomenon of joint cost. Ferguson (1972) developed a model to explain the effect of spatial traffic imbalances on rates and applied it to wool transport in Australia. He argued that the price for which joint products might be sold depended on the elasticities of demand for the products. By assuming a highly competitive market, he examined the following equation:

$$P_{ij} + P_{ji} = LRAC_{ij}$$

where P_{ij} is the price charged for the service from i to j, P_{ji} is the price for the return journey, and $LRAC_{ij}$ is the long-run average cost (LRAC) of providing the "bundle" of services ij and ji. Ferguson (1972) visualized three possibilities for P_{ij}, P_{ji} and the additional costs incurred in the backhaul transport. He examined the actual and estimated route-by-route haul rates for the transport of wool in Australia around 1970. He found that relative forward and backhaul rates were dependent on relative demands, and forward and backhaul rates put together would approximate the sum of separable and joint costs.

Under the assumption of perfect competition, Jonkeren et al. (2010) also applied the following joint pricing equation to analyze the backhaul pricing problem

$$P_{ij}(X_{ij})+P_{ji}(X_{ji})=2^*C$$

where P_{ij} is the price charged for the service from i to j, P_{ji} is the price for the return journey, X_{ij} (or X_{ji}) denotes the quantity of commodity X demanded in region j (or i) for goods from region i (or j), and C denotes the one-way cost of transporting commodities between regions for a carrier. The above equation formalizes the idea, that, given the joint costs of transport between regions, transport prices do not equal the one-way transport cost, C, but vary with the relative demand for the transport service between regions. They concluded that imbalances in trade flows (i.e., $X_{ij}-X_{ji}>0$) had substantial affects on transport traffic service prices. Takahashi (2011) also examined how and why transport prices became imbalanced with respect to the direction of shipments and how this affected economic geography.

In contrast to the studies of Ferguson (1972) and Jonkeren et al. (2010), this paper is explicitly designed to clarify Smith's condition of joint product; i.e., two transport prices (P_{ij} and P_{ji}) move in opposite directions. To look for the presence of joint product between eastbound and westbound container shipments in the Trans-Atlantic trade lane, pairs of eastbound and westbound freight rates were collected from Containerisation International Online (2010), and the linear equation, $P_{ij}+P_{ji}=$ constant, was subjected to statistical analysis.

3. Theoretical model

According to the theory of joint product, the competitive market will automatically allocate a higher proportion of the trip cost to the head haul (westbound) route and a smaller proportion to the backhaul (eastbound) route. The economic analysis of assigning costs to each half of a joint product is shown in Fig. 1. As can be seen, the horizontal axis measures the number of round trips made during a year by container ships, where the vertical axis represents the prices for a round trip (P_{rt}) and two individual one-way trips (P_{ij} and P_{ji}), respectively (Hoffmann and Kumar, 2010, p. 89). The two demand curves shown are for the use of a ship to carry containers from Europe to US (D_{ij}) and to carry containers from US to Europe (D_{ji}). A combined demand for a ship's round trips (D_{rt}) is derived by summing D_{ij} and D_{ji} vertically, since the consumption of westbound and eastbound are non-competing. The combined demand curve (D_{rt}) shown in Fig. 1 has a kink corresponding to the number of voyages from the US to Europe under no charge (Demirel et al., 2010) for using the ship in that direction. The specific number of voyages at zero price is shown as Q'' in Fig. 1. If the number of voyages is smaller than Q'', both westbound and eastbound shippers are willing to pay a positive price to use the ship. The combined demand curve (D_{rt}), shown as a bold line in Fig. 1, is steeper than either of the directional demand curves since it represents changes in the combined willingness of westbound and eastbound shippers to pay with changes in the number of voyages.

The positive slope line in Fig. 1 shows the supply curve of round-trip voyages. The vertical axis in Fig. 1 represents the prices for a round trip (P_{rt}) and two individual one-way trips (P_{ij} and P_{ji}). In equilibrium, the number of voyages is presented in Fig. 1 as Q*, which is the quantity equating a ship's demand and supply. P_{ij} is the price paid by the shipper for Trans-Atlantic westbound shipment (D_{ij}), whereas P_{ji} is the price charged for Trans-Atlantic eastbound shipment (D_{ji}). In a competitive market, this sharing of the costs of a westbound and eastbound trip balances exactly the revenue (P_{rt}) obtained from westbound and eastbound shippers.

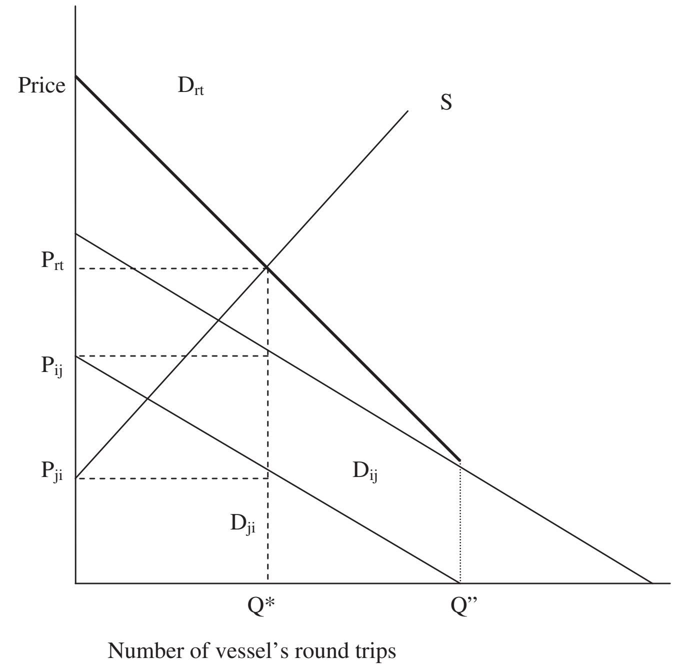

Fig. 1. Contribution to round-trip cost (LRAC) by both homebound and outbound trips.

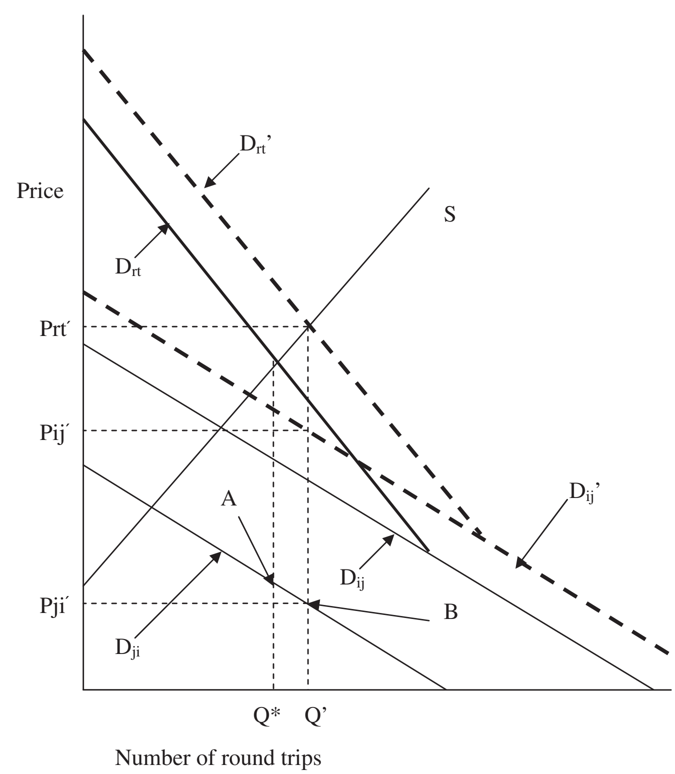

Fig. 2. Increase in demand for Trans-Atlantic westbound shipments.

Smith's condition of joint product, i.e., two transport prices (P_{ij} and P_{ji}) move in opposite directions, is shown by dashed lines in Fig. 2. An increase in the demand for Trans-Atlantic westbound trips, for instance, will shift the demand curve to D_{ij}' and the combined demand for a ship's round trips D_{rt} will shift to D_{rt}'. As the freight rate of a round-trip shipment rises to P_{rt}', the freight rate of westbound trip rises to P_{ij}', while that of eastbound voyage falls to P_{ji}'. With more voyages traveled, to accommodate the increase in demand for westbound trips, the freight rate of eastbound voyage must fall because there was no increase in demand for eastbound trips, only an increase in quantity demanded of eastbound shipment (from point A to point B).

The above equilibrium condition of Smith's joint product can be summed as follows:

$$P_{ij}+P_{ji}=P_{rt}=LRAC \text{ or } P_{ji}=a-b^{*}P_{ij}$$

where a and b are parameters. The focus of this study is on testing whether there is a statistically significant inverse relationship (i.e., b is positive parameter) between the freight rates of Trans-Atlantic westbound and eastbound container shipments. That is, if P_{ij} rises, P_{ji} must fall enough to cover the LRAC. Statistically speaking, the most interesting parameter in the above linear equation is to test if the value of coefficient b is positive.

4. Empirical results

The provision in OSRA concerning service contracts is the most pro-competitive inclusion in the Act. The thrust of the pro-competition tenor of OSRA is clear with regard to service contracts, i.e., contracts are filed confidentially. The terms of these contracts are no longer required to be filed in the tariff format for public review. Meanwhile, in Europe, neither carriers nor shippers are required to report the freight rates charged to any industry or government organization (European Commission, 2005, p. 152). This rate confidentiality on both sides of the Atlantic spurs freight rate competition and makes the Trans-Atlantic trade route a matter of special interest for this paper.

The Trans-Atlantic cargo flow is mainly from North Europe to North America. Table 1 shows the westbound and eastbound TEUs, flowing over the trade route, according to the statistics from Drewry Container Market Quarterly (1999–2010). In 2000, there were about 1,487,000 TEUs moving eastbound over the trade route, and 2,181,000 TEUs moving westbound. In 2002, for every TEU shipped to Europe, about 1.5 TEUs were imported from Europe to North America. However, the ratio declined after 2003, and eastbound traffic grew faster than westbound traffic, reducing the imbalance in west–east volume. As seen in Table 1, the ratio between westbound and eastbound container shipments has fallen substantially. In 2008, the ratio actually declined to 1.02; that is, westbound and eastbound shipments were roughly the same.

Table 1
Europe westbound and eastbound container shipment (unit: thousand TEUs).
Sources: Drewry Container Market Quarterly 1999–2010.

	Trans-Atlantic westbound	Trans-Atlantic eastbound	Westbound/ eastbound (%)
1998	1756	1535	114
1999	1962	1486	132
2000	2181	1487	147
2001	2105	1455	145
2002	2199	1464	150
2003	2146	1570	137
2004	2222	1667	133
2005	2292	1752	131
2006	2382	1811	132
2007	2322	2066	112
Q1 2008	541	578	
Q2 2008	589	601	
Q3 2008	569	561	
Q4 2008	545	469	
2008 total	2244	2209	102
Q1 2009	500	526	
Q2 2009	570	570	
Q3 2009	572	552	
Q4 2009	571	484	
2009 total	2213	2132	104

4.1. Structural breaks

According to the data shown in and Tables 1 and 2, the historical relationship between freight rates (C.I. Online 2010) and the volume of containers shipped on the Trans-Atlantic trade route can be divided into three periods: namely from Q1/1994 to Q2/1999, from Q3/1999 to Q4/2004, and from Q1/2005 to Q4/2009, with details as follows:

1. *From Q1/1994 to Q2/1999*: the eastbound route was charging a premium comparable with the westbound route, despite the existing imbalance between westbound and eastbound trade volume. Looking at the freight rate series in Table 2 we observe that until 1999, westbound and eastbound rates moved together, showing a small rate differential, and eastbound rates were significantly higher than westbound rates. It appears that the conference may have been successful in suppressing the directional rate differential before Q2/1999.
2. *From Q3/1999 to Q4/2004*: westbound container shipment continued to surpass the volume of eastbound shipments. However, changes in premium led to steady divergence between westbound and eastbound freight rates. Intense competition after Q3/1999 combined with a directional volume disparity had apparently driven down rates on the direction with excess capacity, eastbound; and driven up rates on the direction where the capacity constraint tended to be

Table 2
Trans-Atlantic westbound and eastbound freight rates (all-in rate in unit of US$).
Sources: Containerisation International Online (2010).

Quarter/ Year	Westbound rates	Eastbound rates	Quarter/ Year	Westbound rates	Eastbound rates
Q1 1994	1298	1408	Q1 2002	1189	912
Q2 1994	1305	1395	Q2 2002	1156	862
Q3 1994	1333	1374	Q3 2002	1191	865
Q4 1994	1377	1382	Q4 2002	1176	774
Q1 1995	1434	1403	Q1 2003	1212	771
Q2 1995	1388	1412	Q2 2003	1341	774
Q3 1995	1374	1386	Q3 2003	1395	778
Q4 1995	1349	1442	Q4 2003	1432	795
Q1 1996	1384	1480	Q1 2004	1478	800
Q2 1996	1344	1496	Q2 2004	1463	797
Q3 1996	1339	1600	Q3 2004	1487	831
Q4 1996	1341	1621	Q4 2004	1521	876
Q1 1997	1302	1459	Q1 2005	1544	886
Q2 1997	1246	1446	Q2 2005	1655	906
Q3 1997	1306	1611	Q3 2005	1725	935
Q4 1997	1288	1471	Q4 2005	1815	1009
Q1 1998	1284	1472	Q1 2006	1829	995
Q2 1998	1210	1477	Q2 2006	1829	1010
Q3 1998	1221	1397	Q3 2006	1854	1041
Q4 1998	1188	1308	Q4 2006	1762	1066
Q1 1999	1100	1165	Q1 2007	1692	1032
Q2 1999	1045	1111	Q2 2007	1653	1067
Q3 1999	1054	1040	Q3 2007	1667	1144
Q4 1999	1127	1030	Q4 2007	1707	1175
Q1 2000	1148	939	Q1 2008	1637	1261
Q2 2000	1198	958	Q2 2008	1610	1381
Q3 2000	1264	1022	Q3 2008	1600	1644
Q4 2000	1255	987	Q4 2008	1600	1731
Q1 2001	1290	938	Q1 2009	1325	1481
Q2 2001	1236	943	Q2 2009	1168	1431
Q3 2001	1253	890	Q3 2009	1133	1424
Q4 2001	1223	899	Q4 2009	1250	1527

binding, westbound. By 2004, the westbound rates were almost twice the eastbound rates, with a large directional volume imbalance (0.55 million TEUs) between westbound and eastbound routes.

3. *From Q1/2005 to Q4/2009*: Fuel prices rose dramatically after year 2005. Bunker prices in Singapore on July 2, 2008 had broken the $700/ton mark for the first time ever. In 2007, fuel costs represented as much as 50–60% of total vessel operating costs, depending on the type of ship and service (Lloyd's Ship Manager, 2008). After year 2005, soaring crude oil price put additional pressure on shipping companies to raise substantially their bunker adjustment factor (BAF) for container shipments. For instance, during the four-year period from 2005 to 2008, the bunker surcharge of the Far East Freight Conference (2003–2008) increased from $171 to $610 per TEU. All companies cited rising fuel prices as the main cause for increasing BAF (Wang et al., 2011).

How increasing BAF affects rate structure of both westbound and eastbound shipments on the Trans-Atlantic trade route has not been conclusively explored. Does Smith's condition of joint product still hold under high BAF? Table 2 also shows that westbound rates were significantly higher than eastbound rates between Q1/2005 and Q2/2008. However, eastbound and westbound rates reached a par when westbound and eastbound shipments were roughly the same in Q3/2008. The premium switched again after Q3/2008. During this period, eastbound rates were on average about 14% higher than westbound rates, despite the cargo demanded on these two routes being roughly equal in both directions. Fig. 3 shows the trends for both eastbound and westbound freight rates. In Table 6, descriptive statistics is employed to summarize and analyze the data of eastbound and westbound freight rates series.

4.2. Impact of OSRA after 1999

With the above different time periods, we can examine Smith's condition of joint product estimation with the data in Table 2. Estimating separately the first 22 quarters (from Q1/1994 to Q2/1999) and the second 22 quarters (from Q3/1999 to Q4/2004), we obtained the following results.

From Q1/1994 to Q2/1999

$$P_{ji} = \underset{(1.281)}{368.880} + \underset{(3.671)}{0.815} * P_{ij} \tag{1}$$

$R^2 = 0.403$, Residual sum of square $= 184{,}647$, $n = 22$.

From Q3/1999 to Q4/2004

$$P_{ji} = \underset{(8.425)}{1358.963} - \underset{(-2.950)}{0.371} * P_{ij} \tag{2}$$

$R^2 = 0.303$, Residual sum of square $=$ 115,638.6, $n = 22$.

Statistics results revealed by the negative slope of Eq. (2) did confirm that Smith's condition of joint product was valid during the period Q3/1999 to Q4/2004. The change from positive to negative slope indicates a 'fundamental structural change' after May 1999. To further confirm that there was indeed a structural change after OSRA came into effect in May 1999, the Chow test (Maddala, 1977, p. 198) was adopted to test the stability of coefficients during two different periods of study. It estimates the regression equation with and without restrictions and uses the F test

$$F = \frac{(RRSS - URSS)/(k+1)}{URSS/(n1 + n2 - 2k - 2)}$$

where F is a distribution with degrees of freedom $(k+1)$ and $(n1+n2–2k-2)$. The restricted residual sum of squares ($RRSS$) is

Table 3
TACA: BAF.
Sources:
(1) C.I. Online, 2010. TACA announces 1999 business plan.
(2) Meyrick and Associates, 2008. Review of BAFs—Trans-Atlantic and Europe/Far East Trades, Prepared for European Shipper Council (ESC), Final Report.
(3) The Journal of Commerce Online, 2003, April 15.
(4) AARHUS, 2004. Shipping Logistic A/S 18th Oct.
(5) Transport Council Agenda, 2005. The ESCs policy and transport news update, 18 April.
(6) OOCL Germany, 2006–2009. www.oocl.com/germany/eng/localnew

Year	Month	BAF	Sources
1999	Jan.	$40/TEU	(1)
2002	April to Sept.	$90/TEU	(2)
2002	Oct.	$140/TEU	(2)
2003	March	$140/TEU	(2)
2003	May	$158/TEU	(3)
2003	June	$158/TEU	(3)
2004	Dec.	$210/TEU	(4)
2005	Jan.	$210/TEU	(4)
2005	May-June	$304/TEU	(5)
2006	Oct	$395/TEU	(6)
2007	April	$395/TEU	(6)
2007	May	$494/TEU	(6)
2007	Nov.	$725/TEU	(6)
2008	Jan.	$607/TEU	(6)
2008	April	$607/TEU	(6)
2008	June	$368/TEU	(6)
2008	July	$368/TEU	(6)
2008	Sept.	$409/TEU	(6)
2008	Oct.	$269/TEU	(6)
2008	Dec.	$168/TEU	(6)
2009	Feb.	$106/TEU	(6)
2009	April	$125/TEU	(6)
2009	May	$138/TEU	(6)
2009	July	$189/TEU	(6)
2009	Nov.	$211/TEU	(6)

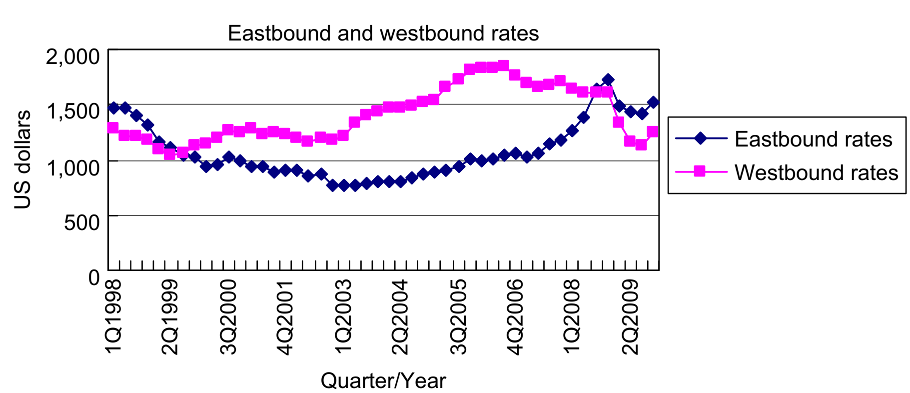

Fig. 3. Eastbound and westbound rates.

Table 4
Data of dummy variable.
Sources: from Table 3.

Quarter/Year	BAF	Quarter/Year	BAF
Q1 1999	NA	Q3 2004	0
Q2 1999	NA	Q4 2004	0
Q3 1999	0	Q1 2005	1
Q4 1999	0	Q2 2005	1
Q1 2000	0	Q3 2005	1
Q2 2000	0	Q4 2005	1
Q3 2000	0	Q1 2006	1
Q4 2000	0	Q2 2006	1
Q1 2001	0	Q3 2006	1
Q2 2001	0	Q4 2006	1
Q3 2001	0	Q1 2007	1
Q4 2001	0	Q2 2007	1
Q1 2002	0	Q3 2007	1
Q2 2002	0	Q4 2007	1
Q3 2002	0	Q1 2008	1
Q4 2002	0	Q2 2008	1
Q1 2003	0	Q3 2008	1
Q2 2003	0	Q4 2008	1
Q3 2003	0	Q1 2009	0
Q4 2003	0	Q2 2009	0
Q1 2004	0	Q3 2009	1
Q2 2004	0	Q4 2009	1

Table 5
Euro exchange rates against US dollar.
Source: Bank of Finland http://www.suomenpankki.fi/en/tilastot.

Quarter/Year	Euro/Dollar	Quarter/Year	Euro/Dollar
1Q2001	0.9095	3Q2005	1.2256
2Q2001	0.8532	4Q2005	1.1856
3Q2001	0.9111	1Q2006	1.2020
4Q2001	0.8924	2Q2006	1.2650
1Q2002	0.8758	3Q2006	1.2727
2Q2002	0.9554	4Q2006	1.3213
3Q2002	0.9808	1Q2007	1.3242
4Q2002	1.0183	2Q2007	1.3419
1Q2003	1.0807	3Q2007	1.3896
2Q2003	1.1663	4Q2007	1.4570
3Q2003	1.1222	1Q2008	1.5527
4Q2003	1.2286	2Q2008	1.5553
1Q2004	1.2262	3Q2008	1.4370
2Q2004	1.2138	4Q2008	1.3449
3Q2004	1.2218	1Q2009	1.3050
4Q2004	1.3408	2Q2009	1.4016
1Q2005	1.3201	3Q2009	1.4562
2Q2005	1.2165	4Q2009	1.4614

Table 6
Descriptive statistics of eastbound and westbound freight rates.
Sources: Calculate from data set of Containerisation International Online (2010).

	P_{ji} Eastbound freight rates	P_{ij} Westbound freight rates
Mean	1171	1384.375
Standard error	35.08373	26.53282
Median	1089	1336
Mode	774	1341
Standard deviation	280.6698	212.2625
Sample variance	78,775.56	45,055.38
Kurtosis	−1.39202	−0.52368
Skewness	0.172674	0.669382
Range	960	809
Minimum	771	1045
Maximum	1731	1854
Sum	74,944	88,600
Count	64	64
Largest	1731	1854
Smallest	771	1045

obtained from a single regression of all data in the entire study period, while the unrestricted residual sum of squares (*URSS*) is obtained from separate regressions of different study periods.

For the whole period from Q1/1994 to Q4/2004

$$P_{ji} = \underset{(1.744)}{887.447} - \underset{(-0.527)}{0.208} * P_{ij} \qquad (3)$$

$R^2=0.007$, Residual sum of square=3,633,795, $n=44$.

Testing whether Smith's condition of joint product was stable throughout the whole period; i.e., between Q1/1994 and Q4/2004, we obtained the following results: $URSS=(184{,}647 + 115{,}638.6)$, $RRSS=3{,}633{,}795$, $k+1=2$, and $(n1+n2-2k-2)=40$. $F=7507.14$, which is significant at the 5 percent probability level. The 5 percent point in the F tables for degrees of freedom 2 and 40 is 3.23. Hence, we rejected the hypothesis that the relationship for the whole period is stable.

Then, we also examined separately the second 22 quarters (from Q3/1999 to Q4/2004) and the third 20 quarters (from Q1/2005 to Q4/2009), and obtained the following results.

From Q3/1999 to Q4/2004

$$P_{ji} = \underset{(8.425)}{1358.963} - \underset{(-2.950)}{0.371} * P_{ij} \qquad (2.1)$$

$R^2=0.303$, Residual sum of square=115,638.6, $n=22$.

From Q1/2005 to Q4/2009

$$P_{ji} = \underset{(6.568)}{2365.403} - \underset{(-3.244)}{0.723} * P_{ij} \qquad (4)$$

$R^2=0.369$, Residual sum of square=799,414.8, $n=20$.

Statistics results revealed by the negative slopes of Eqs. (2) and (4) did confirm that Smith's condition of joint product was valid during the above two periods. To further test whether there was indeed structural change under increasing BAF during 2005 and 2009, the Chow test (Maddala, 1977) was also adopted to examine the stability of coefficients during the two different study periods.

For the whole period from Q3/1999 to Q4/2009

$$P_{ji} = \underset{(3.618)}{847.946} + \underset{(0.825)}{0.133} * P_{ij} \qquad (5)$$

$R^2=0.017$, Residual sum of square=2,475,073, $n=42$.

We obtained $URSS=(115{,}638.6 + 799{,}414.8)$, $RRSS=2{,}475{,}073$, $k+1=2$, and $(n1+n2-2k-2)=38$. $F=32.392$, which is significant at the 5 percent probability level. The 5 percent point in the *F* tables for degrees of freedom 2 and 38 is 3.30. Hence, we rejected the hypothesis that the relationship for the whole period is stable.

4.3. *Increasing BAF*

To accurately evaluate how OSRA and increasing BAF affect rate structures of both westbound and eastbound shipments on the Trans-Atlantic route, a BAF variable was added to Eq. (5). BAF is a dummy variable that can assume the value of either 0 or 1 (Table 4), where 1 represents the period of a substantial increase in bunker surcharge during Q1/2005 and Q4/2009, and 0 indicates that the bunker surcharge is less than \$150 per TEU during other periods (Table 3). The following statistics were obtained.

From Q3/1999 to Q4/2009

$$P_{ji} = \underset{(6.782)}{1734.823} - \underset{(-3.174)}{0.629} * P_{ij} + \underset{(5.021)}{478.230} * BAF \qquad (6)$$

$R^2=0.403$, Residual sum of square=1,503,371, $n=42$.

The use of dummy variable to evaluate structural change or coefficient stability is commonly described in econometrics texts (Maddala, 1977). The introduction of the BAF variable does raise the value of R^2 and also confirms the existence of Smith's condition of joint product (i.e., a negative slope) for the whole study period from Q3/1999 to Q4/2009.

4.4. Euro appreciation against US dollar

The Euro has experienced much turbulence since its creation. Having gone through a continuous depreciation in five quarters (January 2001 to March 2002) the Euro/US dollar exchange rate was subsequently established at 90 cents to 1 euro for 15 months (Table 5). This was followed by a sharp appreciation at the end of 2004. Thereafter, Euro has risen to its historic high of $1.5770 in July 2008 (Bank of Finland, 2012). Euro's appreciation since 2004 has already penalized European exports. Appreciation of Euro increases the price of exports and lowers the price of imports. The strength of Euro has a strong impact on European companies. The impact is manifested in the loss of competitiveness in the US market, with cheaper US products imported to EU. Thus, appreciation of Euro raises the volume of EU imports from US. In other words, eastbound shipments have increased substantially, followed by rise in its freight rates (P_{ji}). The impact of Euro's appreciation on P_{ji} and P_{ij} is examined as follows:

From Q1/2001 to Q4/2009

$$P_{ji} = \underset{(2.789)}{966.370} - \underset{(-3.348)}{0.660} * P_{ij} + \underset{(2.856)}{298.721} * BAF + \underset{(3.482)}{738.599} * Euro/Dollar \tag{7}$$

$R^2 = 0.568$, Residual sum of square $= 1{,}078{,}913$, $n = 36$.

Adding a Euro/Dollar variable did raise the value of R^2 and also confirmed the existence of Smith's condition of joint product (i.e., a negative slope) for the study period from Q1/2001 to Q4/2009.

5. Conclusion

The year 1999 was a watershed in the pricing history of the Trans-Atlantic trade route. The industry experienced an unprecedented change between Q2/1999 and Q3/1999, the quarters immediately preceding and following the implementation of OSRA, respectively. OSRA fostered competition and led to structural change in the liner industry. The effect of OSRA offers economists a natural case study demonstrating the impact of changing legislations on the liner industry's competition and structure.

For a long time, economists had brought up various theories, including theory of the core and contestable competition (Panayides and Cullinane, 2002), in the debate over changing the market structure of shipping industry. In contrast to these theories, a formal pricing equation is explicitly designed to test the changing market structure after Q3/1999. According to our empirical results, the change from positive to negative slope and the Chow test results on the stability of coefficients during two different periods of study did confirm that Smith's condition of joint product was valid during the period Q3/1999 to Q4/2009. From these statistical validation of Smith's condition, it was concluded that OSRA significantly shifted the industrial structure of the liner market from one dominated by price-fixing liner shipping conferences to one dominated by competition with market-driven rates and services.

The paper described OSRA as the prime reason for the major structural change in the Trans-Atlantic trade route. However, further research is still needed to assess the robustness of these preliminary conclusions and to further investigate the effects of the value of liner cargo behind the structural change. A deeper understanding of these effects would have an important impact on the development of shipping laws on the two shores of the Atlantic Ocean.

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