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Airline firm boundary and ticket distribution in electronic markets

Kuangnen Cheng [a,1], Zu-Hsu Lee [b,*], Hamid Shomali [c,2]

[a] KNC Travel Service, Inc., San Francisco, CA 94109, USA
[b] School of Management, Marist College, Poughkeepsie, NY 12601, USA
[c] Golden Gate University, San Francisco, CA 94105, USA

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ABSTRACT

The electronic markets hypothesis (EMH) predicts that the intense intrusion of information technology (IT) into the market system has a strong influence on the degree of market coordination. As transaction costs go down due to inexpensive IT-enabled exchange of information, market-based economic activities increase. Contrary to the predictions of the EMH, US legacy airlines have increasingly relied on hierarchical governance and oppose market-based economic activities. Using US legacy airline distribution strategies as an example, this paper demonstrates that even dominant players in an oligopolistic industry, operating during the explosive evolution of electronic markets, are subject to the predictions set by the EMH. Predictions of the EMH are tested by analyzing 17 years of operational data, using the DEA (data envelopment analysis) method. Tobit regression is executed in tandem with DEA to test the hypothesis that various strategies deployed by the legacy airlines have a strong impact on operational performance. Despite the perceived market power possessed by the strongest players, and the apparent inverse relationship between IT-driven distribution and production within hierarchies, the end results reveal that legacy airline business strategies, such as disintermediation to exclude downstream players or vertical integration to compete with rivals, have created a negative impact on the business performance of airlines. Operational efficiency has not improved.

1. Introduction

Legacy airlines, (American Airlines, Continental Airlines, Delta Air Lines, Northwest Airlines and United Airlines) commonly known as the "Big Five", existed prior to the Airline Deregulation ACT of 1978 (with the exception of US Airways, which came into the fold much later and used a different distribution strategy), supply 80% of US domestic air travel and possess monopoly power over ticket distribution. They collaborate on business decisions and collectively deploy one distribution strategy. Their strategy, in parallel with information technology (IT) development, has shifted from erecting entry barriers by controlling all GDSs (Global Distribution Systems) to purposely eradicating rival inventory by concealing certain information, and from disintermediating their former strategic partners by eliminating commissions and forming a vertically integrated airlines agency, Orbitz. At each stage, the strategy they implemented not only inevitably altered the industry's structure, and consequently put pressure on players to apply appropriate approaches to successfully compete, but also attracted attacks from rivals.

The electronic markets hypothesis (EMH) predicts IT reduces the costs of market coordination between suppliers and consumers. Consequently, market-based economic activities increase. More than two decades after the introduction of EMH, electronic markets have evolved from opaque to transparent, from biased to unbiased, and finally to personalized (Malone, 1985); yet legacy airlines keep searching for the right balance between markets and hierarchies. The method of distribution has been gradually transformed, moving from GDS-centric during the early 1960s to mid 1990s towards Internet-centric during mid 1990s to early 2000s. After that, it moved to Orbitz-centric[3] from early 2000s until 2005. Finally, since 2005, it has become meta-search-agent-centric. Meta-search-agent is an interface that searches simultaneously through the results collected from multiple search engines. Sidestep.com, FareChase.com and Kayak.com are examples. With advances in IT, it is not clear whether market-based or hierarchical forms of ticket

* Corresponding authoer. Tel.: +845 575 3000x2081.
E-mail addresses: knc@knctravel.com (K. Cheng), zuhsu.lee@marist.edu (Z.-H. Lee), hshomali@ggu.edu (H. Shomali).
[1] Tel.: +415 771 2000.
[2] Tel.: +415 442 6582.

[3] Orbitz is considered as a distribution powerhouse, formed by the "Big Five" in 2001 to directly compete with the newly formed online agencies. Orbitz reduced booking fees, displayed fares and schedules bias-free. The force to make Orbitz, the vertical integrated airlines agency, attractive to customers is that Orbitz applied user-friendly Web interfaces to increase structural market transparency levels (Granados et al., 2007).

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distribution can achieve optimal distribution efficiency. This group of airlines keeps voluntarily and involuntarily swinging between markets and hierarchies when distributing its products.

When market structure changes, a one-dimensional interpretation of the principle "structure follows strategies" (Chandler, 1962) appears to inhibit strategy implementation. In an oligopolistic industry packed with agile and nimble low cost carriers, legacy airlines face multiple challenges. For instance, conflicts are looming with travel agents over ticket distribution, and there are attacks from better, faster search engines. The change by legacy airlines in shifting their distribution strategies from "firm as governance structure," relying on middlemen, to "firm as production function" (Williamson, 2002) creating a vertical integrated airlines agency, may have theoretical support. Market transparency increases the degree of middleman bypass (Weber, 1994), and an unbiased market ensures information efficiency (Fama, 1996). Vertical integration guarantees resource acquisition (Barney, 2002), minimizes opportunistic behavior (Williamson, 1985) and mitigates the negative impact of uncertainty (Kogut, 1991).

Strategy formulations by legacy airlines seem to reflect external business environment changes, yet contradictions exist. For example, while disintermediation gained momentum, it only accelerated the transformation of intermediaries. It has not eliminated them. Incomplete contracts may have created opportunism and induced higher unit transaction costs, but "firm as governance structure" appears to be more efficient than "firm as production function". Contrary to the assertion of EMH (Malone et al., 1987), the hierarchical form apparently dominates the distribution industry (Golden et al., 2003) even though IT has reduced coordination and transaction costs associated with ticket distribution. So, do firm boundaries matter? How does market or hierarchy impact firms' operational performance? Does a vertically integrated airlines agency such as Orbitz improve distribution efficiency? Scrutinizing the history of firms' operational performance in relation to the evolutionary dynamics of the business environment may provide insights into these questions. This is the main motive for our study.

However, evaluating the impact of strategies on operational performance and efficiency appears to be a challenging task. Firstly, according to ATA (Air Transport Association of America, the largest trade group of principal US airlines), there is no industry standard for calculating costs associated with the distribution of an airline ticket. This is the reason why ATA does not collect any distribution-related data from its members. As such, no central, official source exists for volume, revenue or cost associated with ticket distribution, and thus analysts, econometricians and industry experts cannot agree on a method to determine the better and more efficient way to deliver product to customers (Air Transport Association of America (ATA), 2008). Secondly, relevant data is difficult to measure and not easy to obtain. Firm boundary decisions typically are endogenous (Ackerberg and Botticini, 2002; Masten, 1993). Many potentially relevant determinants are unobservable or partially observable, or may contain errors made by analysts, industry experts or econometricians (Hausman, 2001; Hubbard, 2008). In addition, the dispute over the appropriate efficiency concept and the appropriate measurement method leaves the question unanswered of how strategies impact firm performance.

Cheng (2010) compares the distribution efficiency of different airline companies, based on an efficiency score using the DEA (data envelope analysis) method. Our paper builds on that result, and further investigates both the effects of the evolution of electronic markets and the factors which influence airline firms' performance. A Tobit Model is employed. To provide a complete picture of this study, the above DEA analysis and result are presented in Sections 3.1 and 4.1, followed by our investigation and the implications behind the investigation result.

2. Literature review

Real business cycles (RBC) theory advocates that business cycles are inevitably caused by random shocks; however, technology shocks are more important than other factors (Kydland and Prescot, 1982; Lucas, 1977), such as monetary shocks or government purchases. Technology shocks contribute to economic efficiency. Firms with superior internet information technology can quickly dominate the market. "Creative destruction" (Schumpeter, 1942) is especially prevalent in airline ticket distribution. In this industry, a few firms control a significant share of market, but those who employ innovative ideas can easily challenge the status quo of the industry leaders.

In the service context, firms with more focused operations are likely to outperform others (Heskett, 1986; Johnston, 1996; Lapre and Tsikriktsis, 2006; Tsikriktsis, 2007). The essential strategy of airlines is to seize opportunities that increase profitability now, like fleet standardization and aircraft ownership (rather than leasing) (Weiss and Maher, 2009)[4] , and can create a buffer against future downturns. Additionally, the impact of IT development when pursuing efficiency needs to be addressed. IT leads to higher output, higher wages and higher consumption (Noam, 2006). Information streamlining allows decision makers across different enterprises to work from the same pool of information. On the other hand, that very same technology may cause overproduction (Onyemelukwe, 2004), due to the difficulty of forecasting sales that new technology might generate. Gallagher (2003) proved that technological innovation actually had a negative effect on fluctuations in the business cycle.

The more IT usage, the more vertical firm boundaries will be dismantled (Malone et al., 1987). By reducing the coordination cost, IT usage should favor the movement of goods or services across independent firms without producing hierarchies within a single firm. In addition, the EMH predicts that due to the nature of competition, there will be a shift away from biased to unbiased personalized markets. However, as IT increasingly affects the IT-driven airline ticket distribution industry, one should expect market-based economic exchanges (e.g. exchanges through third parties) to become more common, according to the EMH (Granados et al., 2006).

To seek an explanation for why airlines have relied upon hierarchical governance to distribute products, as opposed to market-based economic activities, a closer look at stage-wise market evolution and market-base inclination indicates that the force behind the changes is the quest for lower transaction costs, or "actual and opportunity costs of transaction under various governance structures" (Coase, 1937). Costs associated with transactions may be more dependent on the governance structure than on technology (Williamson, 1975).

Transaction cost is defined as a cost incurred in making an economic exchange. Whenever goods or services are transferred from a producer to a user, transaction costs occur. When carrying out a market transaction, certain costs are incurred, such as search and information costs, bargaining and decision costs, as well as policing and enforcement costs. Note that production costs should not be treated the same as transaction costs. When transactions occur within a firm, costs associated with the transactions include managing and monitoring personnel as well as procuring input. In contrast, when transactions take place in a market, costs can include source selection, contract management and performance monitoring (Pint and Baldwin, 1997).

[4] The 1978 Airline Deregulation Act has indirectly improved airlines' productivity efficiency. After deregulation, those survival US carriers not only gained global leadership in cost competitiveness but also increased efficiency (see Oum et al., 2005; Fethi et al., 2000).

The TCE (Transaction Cost Economics) theory investigates the functions of a firm or a market from an efficient contracting and/or comparative organizational perspective. It differs from that of a neoclassical firm as a production function (Williamson, 1996). Transactions sometimes favor hierarchies, and sometimes markets, as an economic governance structure. Players in the distribution chain naturally seek better methods for delivering products and services to customers. As the distribution method is being transformed from labor-intensive to more Internet-based, production costs are expected to be lower than where distribution is heavily dependent on travel agencies or GDSs. Although IT creates a positive impact on the production of services (Menon et al., 2000), the question is whether IT alone provides a strategic advantage (Marquis, 2006). On the other hand, Malone et al. (1987) suggest that IT shape organizational forms, since IT easily reduces production, coordination and vulnerability costs. The reduction of coordination's "unit costs" and various production switch-over costs prompts the procurement of goods or services from electronic markets (vs. hierarchies). Clearly, the above discussion highlights an interesting dilemma when a vertical integrated distribution portal, such as Orbitz, is used. This leads to the need for further interpretation by managers with regard to whether firms should be treated as production functions or as governance structures (Williamson, 2002) in the IT-driven distribution industry.

When airlines and travel agencies are locked into a bilateral non-integrated vertical relationship, *ex post* opportunism arises. Since a complete contract is impossible to write, agencies may extract additional quasi-rents, thus hurting producer profits. A vertically integrated airline agency would automatically discourage such opportunism. Fewer firms distributing tickets in the value chain should translate into more bargaining power (Williamson, 1975) for the legacy airlines. Therefore, the debut of Orbitz in 2001 should have significantly improved airline distribution efficiency. Stigler (1951) proposed that vertical integration is positively related to demand growth and industry concentration. On the other hand, within the hierarchy, when the range of functions becomes wider, the task of coordination is harder. In fact, vertical integration has a negative impact on the control of production cost and effective information transfer; as information is distributed asymmetrically, it may affect inter-firm and intra-firm efficiency. The above study suggests that the motivation for vertical integration should be operation efficiency, as the benefits of economies of scale easily outweigh the costs of management and coordination. It is commonly believed that efficiency can be realized when different stages of production are organized within one firm.

In summary, the TCE and vertical integration theories provide a theoretical understanding of what determines where firms draw their boundaries. However, whether the above theories or IT infusion and development may address the dynamics of airline ticket distribution remains debatable (e.g. firms should be considered in the industry as "governance structures" or "production functions"). The following analysis aims to reveal whether IT-emphasized strategies created a "winner takes all" effect, or whether the forceful assertions postulated by TCE prevail; or if firm boundaries do not have significant effect on distribution efficiency.

3. Data collection and sample construction

The analysis is in two stages. Stage one is to obtain the efficiency score, using DEA to assess the efficiency of ticket distribution. The second stage is to identify the effects of various explainable variables on the above efficiency (e.g. variables associated with business environment changes between hierarchies and markets, IT infusion, etc.). The Tobit model is applied for this stage.

3.1. Stage one: variables for the DEA

Samples are drawn from all US airlines that posted more than $1 billion in revenue (also defined as major airline carriers by the Department of Transportation) during each fiscal year. Non-passenger carriers are excluded. In 2009, major passenger carriers included: American Airlines, AirTran Airways, Alaska Airlines, Continental Airlines, Delta Air Lines, Frontier Airlines, JetBlue Airways, Northwest Airlines (bought by Delta in 2008), Southwest Airlines, United Airlines and US Airways. Overall, there are eleven major airlines. They can be divided into three different groups:

1. Low-cost carriers (LCC): AirTran, JetBlue and Southwest. They sell their seats directly to customers, mostly without middlemen, and over the Internet, to avoid paying fees and commission to GDSs and agencies.
2. Non-Orbitz-owner carriers (NOC): Alaska, Frontier and US Airways. They have their own websites; however, travel agencies still play an important role in distribution.
3. Orbitz-Owner carriers (OOC): American, Continental, Delta, Northwest and United. These airlines are former GDS owner airlines (in this paper, OOC and legacy airlines are inter-changeable).

Assessing the relationship between operational performance and the distribution method of any particular airline can be difficult, as most airlines carry high aircraft leasing costs, and data quantifying the impact of firm boundaries on economic outcome is typically endogenous. Large leased assets distort the comparability of profit and loss accounts and balance sheet information. A possible solution is to use published operating and nonfinancial data. The primary source of panel data for DEA calculations was the "operating data" section of Form 10-K filed by each individual airline with the SEC (US Securities and Exchange Commission). The period under study covered 1992 to 2008. It coincided with the debut of the Mosaic web browser, which opened the Internet to commercial use. Overall, seventeen years worth of operating data was collected for analysis from eleven major passenger carriers. Input and output variables to calculate the efficiency frontier are presented as follows.

In airline economics, there are five common industry metrics to measure the efficiency of an airline operation:

1. The load factor, defined as the percentage of available seats occupied per year relative to total aircraft seat capacity.
2. Available seat miles (ASM), defined as the number of paid seats available to passengers multiplied by the number of miles flown, commonly used to track airline seat supply.
3. Revenue passenger miles (RPM), defined as the number of miles traveled by paying passengers.
4. Cost per available seat mile (CASM), defined as operating expenses divided by ASM.
5. Yield per revenue passenger miles, defined as the amount of revenue earned per RPM.

There are several ways to choose input and output variables. In general, input is asset and cost related, while output is revenue related. External demand for services or goods provided or produced by the DMUs (decision making units, or individual airlines – in this research), the economic, financial and regulatory environment and other factors, determine the relationship between input and output. The input and output of each in the model reflects operational characteristics of the industry. Input normally refers to operations, such as aircraft utilization and maintenance, fuel and labor costs, schedule, pricing of service, etc. They are the variables over which airlines have autonomous decision rights and they are independent from the demand environment. Output refers to

operational or financial results. Although the criteria for selecting relevant financial and operating data is based on studies of airline efficiency by Liedtka, 2002; Gonenc and Nicoletti, 2001; Fethi et al., 2000, and Schefczyk, 1993, the selection of input and output for the DEA method follows Schefczyk's model. For input variables, distribution cost, ASM and CSM (defined as the product of ASM and CASM) are selected. For output variables, RSM (defined as the product of ASM and the load factor) and POR (passenger operating revenue) are selected.

3.2. Stage two: variables for the Tobit model

Proposed determinants with regard to business decisions and business environment are presented as follows. First of all, Agency# (numbers of travel agency in the US), CommissionCut (the intensity/level airlines cut commission paid to travel agencies; the value is assigned to be between 0 and 1, where 0 represents no commission cuts at all, i.e., full commission, and 1 stands for zero commission) and TtlCommission (total commission paid to travel agencies) are selected. Data is drawn from the Airlines Reporting Corporation, an airline-owned company handling ticket settlement in the US, to reflect the impact of airlines' business decisions, such as disintermediation to cut off travel agencies and GDSs from their distribution value chain.

Secondly, OrbitzOwner (the level of Orbitz ownership), and MetaAgt (the appearance of meta-search agents, 0 or 1), are selected to represent changes of business environment between hierarchies and markets. Data is orchestrated based on the intensity of carriers' participation level with Orbitz (e.g. some are owners, some are charter members, and some are neither members nor owners) and the year that meta-search agents first appeared. The purpose of these sets of data is to test the hypothesis on distribution efficiency within hierarchies vs. efficiency across markets.

Finally, Internet(E)Users (percentage of the Internet users in the US) and Ecommerce% (e-commerce percentage of ticket distribution revenue) are selected to reflect the level of IT infusion throughout the industry and the spread of Internet usage in the US. Data sources are from The International Telecommunication Union and US Census Bureau, respectively.

4. Results and Validity of results

Efficiency score (between 0 and 1) is the output of the DEA method which is obtained here using the EMS (Efficiency Measurement Software), version 1.3. In any given year, those DMUs on the efficiency frontier have the same efficiency score of 100%. To show a full efficiency ranking of DMUs, the calculation is set at "super efficiency" (calculated based on the modified DEA model) when using the EMS, where the DMUs on the efficiency frontier may have different scores that are greater than 100% (so the efficiencies of these DMUs can be ranked based on these super efficiency scores). The result is presented in Table 1, where airlines are the DMUs and their names are presented using International Air Transport Association (IATA) two-letter codes.

Not all airlines have their complete financial or operating data available, due to not being in business during the entire period of this study. For example, Frontier was launched in July of 1994, AirTran was launched in October of 1993, but went public in 1994 (and 1996 is the first year it filed public data), and JetBlue was launched in February 2000.

4.1. DEA results, interpretations and discussions

Fig. 1 illustrates the performance of the three airline groups based on their weighted average efficiency scores, where POR is used as the weight for a carrier. The result is similar when using RSM as the weight (see Cheng, 2010). Fig. 2 shows the comparison of the weighted average scores of all airlines, when using POR and RSM, respectively. Fig. 1 identifies that the best performing group, LCC, has the highest scores from 1992 to 2008, except between 1996 and 1999. This may have been caused by the new entrant into the group, AirTran in 1997. In addition, an abnormal spike at the time immediately following the debut of Orbitz, the year of 2001, indicates that Orbitz not only had a negative impact on the performance of the OOC group, but also helped the LCC group. LCC performance also shows a spike during and after year 2004. The appearance of meta-search agents may explain this phenomenon, as LCC group has traditionally relied on its own website to distribute its own products. Orbitz and other GDSs used by travel agencies, do not display LCC group's data. Therefore, meta-search agents provided LCC with a significant new channel to access its potential customers. The OOC group has no significant performance variation during the seventeen years of operation, regardless of the impact of Orbitz. Attention is specifically given to the year 2001, when Orbitz began operating. OOC performance is more or less below the frontier line except for 2001.

The NOC group had a stronger performance in the early years when all peers shared a level playing field; that is, when all carriers distributed most of their products through travel agencies, paid the same percentage commission, and there were no monopolistic vertically integrated online agencies. Their performance worsened between 2000 and 2004 after all carriers abolished agency commissions, and Orbitz changed the structure of the market. This flat performance can be explained by two factors:

1. The new distribution force of Orbitz did not help the performance of NOC, since the carriers in the NOC group are not Orbitz carriers.
2. In year 2002 all airlines eliminated commission payment to agencies. Then travel agencies had little incentive to sell NOC's products. Yet NOC traditionally had relied on the travel agency community to distribute their products. Prior to 2000, the performance of NOC was nearly as good as that of LCC.

The efficiency scores of OOC have fallen below the frontier line since the onset of Orbitz, except between 1999 and 2000. Apparently, the debut of Orbitz did not significantly change the distribution efficiency. However, LCC show a significant improvement of the distribution efficiency following the appearance of Orbitz. NOC show a decline in efficiency after 2001. From 2005 onwards, NOC show a gain in efficiency scores. This may have been caused by the appearance of the second and the third generation of meta-search agents. Meta-search agents made NOC products more noticeable, as NOC traditionally had relied on offline agencies to distribute their products.

OOC stayed inefficient throughout almost all of the seventeen years. The distribution of their products through the vertically integrated airline agency did not help their efficiency scores. Judging from the efficiency scores in Table 1, only Northwest (former owner of the Worldspan GDS) and United (promoter of Star Alliance, the largest airline alliance) showed any improvement after 2001. In other words, Orbitz helped Northwest and United but on a small scale. Vertical integration had no positive impact on the other three OOC members. A closer look at this graph reveals that all the airlines that survived industry turbulence have been distributing their products more or less above the 100% efficiency line. Other than negative shocks created by the 9/11 attacks in 2001, the more transparent the electronic market is, the more efficient it is. The appearance of Orbitz and meta-search agents shows significant improvement of efficiency compared to the Internet-centric period.

Table 1
Super efficiency scores (airline names presented using IATA airline codes).

		1992	1993	1994	1995	1996	1997	1998	1999
AA (%)		98.69	95.90	103.46	97.49	97.51	97.60	99.77	98.53
CO (%)		105.56	93.03	95.66	98.93	98.77	99.93	103.78	100.91
DL (%)		92.96	94.52	95.52	94.19	93.31	98.21	100.49	103.05
NW (%)				100.21	103.52	104.13	106.40	101.66	103.55
UA (%)		104.50	98.31	104.56	99.52	98.88	98.16	98.59	96.69
FL (%)							75.49	87.43	96.97
B6 (%)									
WN (%)		113.85	132.24	117.28	128.09	117.36	107.04	110.61	111.99
AS (%)		87.46	108.05	109.61	124.10	113.07	133.97	105.49	107.64
F9 (%)							79.78	95.31	98.48
US (%)		129.15	114.51	116.99	112.84	122.66	118.18	135.47	129.31
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
AA (%)	100.50	97.81	93.45	93.27	92.48	97.10	96.81	97.70	97.28
CO (%)	107.78	112.97	98.67	92.17	96.41	96.37	97.60	98.16	97.99
DL (%)	98.61	94.48	96.23	96.06	93.27	92.82	94.77	96.50	99.37
NW (%)	105.27	99.41	99.65	101.70	102.70	100.56	103.34	102.93	103.57
UA (%)	100.88	95.73	109.64	112.41	108.55	102.99	101.96	102.20	99.16
FL (%)	99.01	98.86	92.80	98.92	93.47	92.21	89.81	94.30	99.54
B6 (%)	98.25	123.71	145.14	158.12	157.96	140.39	126.59	122.31	113.58
WN (%)	127.79	110.28	123.68	112.73	158.58	210.35	210.83	217.07	235.55
AS (%)	103.48	108.36	114.62	108.12	112.18	93.10	92.51	92.46	95.29
F9 (%)	102.30	94.23	83.59	93.46	90.34	91.86	90.59	94.72	99.73
US (%)	108.56	99.86	99.87	100.79	96.77	115.04	118.13	111.53	132.93

AA – American Airlines.
CO – Continental Airlines.
DL – Delta Airlines.
NW – Northwest Airlines.
UA – United Airlines.
FL – AirTran Airlways.
B6 – JetBlue Airways.
WN – Southwest Airlines.
AS – Alaska Airlines.
F9 – Frontier Airlines.
US – US Airways.

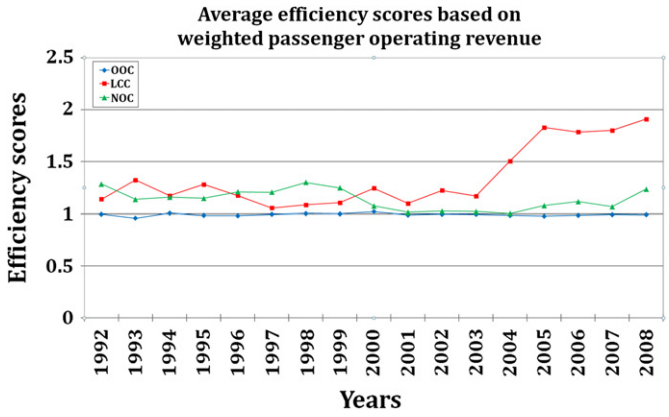

Fig. 1. Weighted average efficiency scores of three groups (weighted by POR).

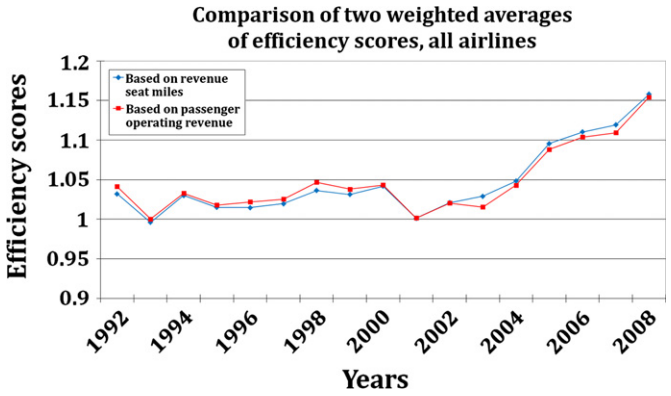

Fig. 2. Comparison of two weighted averages of efficiency scores of all airlines (by POR and RSM).

We conducted further statistical testing. It shows that firm size [5] (based on passenger revenue) does not affect product distribution efficiency much, as the Pearson correlation coefficient is found to be −0.0919 using SPSS 13.0 software. Simply based on the DEA result, larger firms appear to distribute their products less efficiently than smaller ones.

[5] Sutton (1991, 1997, 1998) indicates that larger firms are structurally older and have substantial unprofitable investments in outdated distribution networks. Newer, smaller firms have advantages in adopting more modern and cheaper technology to compete with their counterparts.

4.2. *Explaining inefficiency and effects of the evolution of electronic markets*

This stage of analysis tests the hypothesis that business decisions and the business environment have a strong influence on firm performance during the evolution of electronic markets. All Tobit results were computed using Stata software. 156 observations were used for the Tobit stage of this investigation (see Table 2). The Tobit model uses inefficiency score as the dependent variable. The inefficiency score of DMU i is defined as $Y_i=(1/\theta_i)-1$, where θ_i is the efficiency score (between 0 and 1) obtained by DEA. Thus, the inefficiency score of 0 corresponds to

Table 2
Data summary.

Variable	Observations	Mean	Std. deviation	Minimum	Maximum
InEfficiencyScore	156	.0262538	.0463226	0	.3246788
CommissionCut	156	.5288462	.3587930	0	1
OrbitzOwner	156	.3290598	.4147585	0	1
MetaAgt	156	.3055556	.344872	0	1
Agency#	156	27,273.42	5843.71	18,261	33,715
Internet(E)Users	156	42.56436	24.97166	1.75	73.59
Ecommerce%	156	15.44423	10.41689	0	24.1
TtlCommission	156	3,261,236	2,891,529	0	6,642,849

Table 3
Data correlation.

	CommissionCut	OrbitzOwner	MetaAgt	Agency#	Internet(E)Users	Ecommerce%	TtlCommission
CommissionCut	1.0000						
OrbitzOwner	0.8149	1.0000					
MetaAgt	0.6554	0.6156	1.0000				
Agency#	−0.7450	−0.7383	−0.9012	1.0000			
Internet(E)Users	0.8581	0.7103	0.8298	−0.9191	1.0000		
Ecommerce%	0.8123	0.5693	0.6158	−0.7029	0.8867	1.0000	
TtlCommission	−0.7548	−0.7574	−0.8062	0.9687	−0.9069	−0.7194	1.0000

Table 4
Tobit regression output.

Predictors	Coefficient	Standard error
CommissionCut	0.141*	0.06
OrbitzOwner	−0.036	0.03
MetaAgt	−0.026	0.06
Agency#	−0.000	0.00
Internet(E)Users	0.000	0.00
Ecommerce%	−0.005*	0.00
TtlCommission	−0.000	0.00
_cons[a]	0.034	0.23

[a] Intercept (i.e. if all of the predictor variables are evaluated at 0, the predicted inefficiency score would be _cons = 0.034).

* $p < 0.05$.

perfect efficiency, and any positive number is a measure of inefficiency.

Table 3 shows the correlations in data, where these coefficients are all statistically significant at the level of 0.001. The data reveals that the number of travel agencies and the appearance of meta-search agents are noticeably inversely correlated (−0.9012). It is understandable that as travel agencies are disappearing, consumers have to turn to meta-search agents for help. Further, the more Internet users there are, the less valuable travel agents have become; thus, Agency# and Internet(E)Users have an inverse relationship as well. By the same token, total commission paid to travel agencies positively correlates with numbers of travel agencies, and is inversely related to the percentage of Internet users.

The model considers commission cut, Orbitz ownership, the appearance of meta-search agents, the number of travel agencies, the percentage of the Internet users, e-commerce percentage of ticket distribution revenue and the total commission paid to travel agencies, to predict carrier distribution efficiency. Table 4 addresses the effect of each predictor on the inefficiency score.

We also have applied the Tobit regression model using different predictors combined (based on the above predictors). Table 4 presents just one result where all the above predictors are included, showing the relationships between proposed determinants and distribution efficiency. In this example, a unit increase in commission cut and the percentage of e-commerce ticket distribution leads to a 0.141 increase and a 0.005 decrease in inefficiency score, respectively. While Orbitz ownership and the appearance of meta-search agents may increase efficiency, the effect is not statistically significant. In the same fashion, the decreasing agency numbers and the increasing numbers of Internet users have no significant effect on distribution efficiency. We apply the testing results we have obtained in the following discussion.

4.3. Discussions and insights

In an oligopolistic industry with homogeneous products and limited GDS systems, incumbent firms had strong market power to maximize their profit. GDSs were created, used and manipulated by biased organizations, and leveraged for specific purposes (Butler, 2002). Prior to 1990, OOC developed effective entry barriers (Borenstein, 1989) by controlling distribution technologies and selectively concealing or revealing information to travelers (Granados et al., 2006). Unfortunately, when human intervention was essential to commerce, even in a biased electronic market, the costs to distribute products were unbearable for airlines. Distribution costs were the third largest expense after labor and fuel. Until the mid-1990s, commissions paid to travel agencies by airlines were about 10% of each fare. More than 80% of tickets were processed by GDSs and then sold via agencies.

Contrary to the prediction of Malone et al. (1987), hierarchical transactions have overtaken market-based transactions, despite IT's capability to reduce coordination costs. OOC could have maximized their profit simply by considering their "firm-as-governance" structure, rather than "firm-as-production" function. Yet they mistakenly believed that the Internet alone could replace GDSs and travel agents. Consequently, the removal of agency commissions and the concealment of inventory from their GDSs, *disintermediation*, sped up intermediaries' transformation rather than led to their elimination. Southwest Airlines is credited with offering the first e-tickets to passengers in 1994, because they had no other distribution outlet.

Empirical results based on seven years of data since the debut of Orbitz indicate that as firms expand, internal distribution is no

longer beneficial. There is no evidence that a vertically integrated form of ticket distribution has improved efficiency. To the contrary, the results indicate that Orbitz ownership is detrimental to distribution efficiency, and airlines' sequential commission cuts had a negative effect on their efficiency scores. OOC accounts for about 80% of the total US air market. Vertical integration within ticket retailing seems to be an unwise business decision. This evidence does not encourage internal production in the long run. TCE assumes that firms are oriented to maximize profit. Yet the tradeoff of the direct cost and/or the cost associated with internal or external production is still a mystery. Our investigation reveals that firms relying on third parties, as evidenced by performance of NOC excluding LCC, perform better than those who do not. Even though LCC traditionally rely on their own distribution tools, their performance was better during the Orbitz era rather than before it. Thus, the advent of Orbitz had a negative effect on OOC owners. Obviously, in the long run, the benefits of producing in-house disappear faster than the costs.

There are numerous things IT cannot do. The current market structure of the air ticket distribution system has a series of technologically separable stages. Functions performed by the various stages can be procured or produced within. Williamson (1975) claimed that problems arise in conjunction with contract renegotiation/renewal within internal labor markets and in intermediate product markets. It is unreasonable to conclude that the force of vertical integration has destroyed the old structure, the role of GDSs or travel agencies. Fig. 1 indicates that market transparency (the advent of meta-search agents) has had a mixed impact on different groups. In general, distribution efficiency has increased; but it has not been uniform, whether positive or negative. This unique result may reflect complicated relationships between players in the value chain. When information was opaque and consumers had to depend on agents, carriers performed better.

5. Concluding remarks

IT may have improved industry transparency; however, the same transformation led to mixed results in distribution efficiency. The Internet has helped LCC's performance following the point in time when most GDSs refused to display LCC's inventory[6]. One may suppose that Orbitz should have helped OOC's performance. On the contrary, the results of this study appear to disagree with the assertion that vertical integration has had a positive effect. TCE theory asserts that there is an incentive to vertically integrate retailing when costs and difficulties associated with market transactions are significant. However, advanced technology has not improved distribution performance. One possible explanation of this phenomenon is that, in the airline industry, exchanges have not been complex or uncertain; the environment has been fairly stable and traders have been highly regulated. Thus, no external or internal controls are needed to reduce the risk of exchanges. Transactions procured across a market are just as efficient as within a hierarchy. Indeed, as IT's capabilities advanced, industry organization has shifted from hierarchical to market-based forms of economic activity. This suggests that management should carefully evaluate whether vertically integrated retailing saves costs and efficiently distributes products, or whether integration reduces trading opportunities and makes their firms less profitable.

[6] For example, Southwest's inventory was kicked out by the Apollo system (owned by United Airlines) in 1994 when Southwest refused to pay $2.50 per ticket fee.

Special attention should be given to the sharp performance divergence between LCC, NOC and OOC since the appearance of meta-search agents. Evidence shows, parallel to the claim of Malone et al. (1987), that market-based forms of economic activity will inevitably replace hierarchical forms. While legacy airlines may possess a market power monopoly, the force of meta-search agents should not be ignored. Meta-search agents exhibit referee-like functions which may pose a threat to the long-term viability of Orbitz. Certain data is extremely difficult to obtain. For one, there is no data available as to what percentage of bookings OOC receive from Orbitz. This data is typically considered a trade secret. A possible research project is a case study using qualitative methods, based on interviews of airline or Orbitz executives.

Data used in this study was carefully selected from different sources. However, missing reports from some carriers in some years may have handicapped the precision of analytical results; for example, data is incomplete for Northwest Airlines in early 1990s. Finally, although DEA is a popular method of determining efficiency, as it allows for multiple sources of input and many forms of output, its sensitivity to the selections of input and output affects efficiency scores. To enhance the results of this study, a similar study with different methods such as SFA (Stochastic Frontier Analysis) may be conducted.

References

Ackerberg, D.A., Botticini, M., 2002. Endogenous matching and the empirical determinants of contract form. Journal of Political Economy 110 (3), 564–591.

Air Transport Association of America, 2008. Airline product distribution. Retrieved September 12, 2008. Available from: 〈http://www.airlines.org/economics/specialtopics/Airline+Product+Distribution.htm〉.

Barney, J.B., 2002. Gaining and Sustaining Competitive Advantage. Prentice Hall, Upper Saddle River, NJ.

Borenstein, S., 1989. Hubs and high fares: Dominance and market power in the US airline industry. Journal of Economics 20 (3), 344–365.

Butler, D.L., Information control and the United States airline industry: The newest version. Written testimony before the National Commission to Ensure Consumer Information and Choice in the Airline Industry, 19 pp., 2002.

Chandler Jr., A.D., 1962. Strategy and Structure: Chapters in the History of the Industrial Enterprise. MIT Press.

Cheng, K., 2010. Evaluation of US legacy airline distribution strategies. Journal of Air Transport Management 16, 337–339.

Coase, R., 1937. The nature of the firm. Journal of Political Economy 4, 386–405.

Fama, E., 1996. Multifactor portfolio efficiency and multifactor asset pricing. Journal of Financial and Quantitative Analysis 31 (Dec.), 441–465.

Fethi, M.D., Jackson, P.M. & Weyman-Jones, T.G., Measuring the efficiency of European airlines: an application of DEA and Tobit analysis. In: Annual Meeting of the European Public Choice Society, Siena, Italy, 2000.

Gallagher, P.C., 2003. The rise and fall of technology and the business cycle. Issues in Political Economy 12. 21 pp..

Golden, W., Higgins, E., Hughes, M. & Flynn, S., The Internet, a creator of electronic markets for airline tickets? In: Proceedings of Collector Conference, Galway, Ireland, 2003.

Granados, N.F., Gupta, A., Kauffman, R.J., 2006. IT-enabled transparent electronic markets: The case of the air travel industry. Information Systems and e-Business Management 5 (1), 65–91.

Granados, N.F., Gupta, A. & Kauffman, R.J., Information strategies for the information age: In search of a theory of IT-enabled market transparency. Working paper, Pepperdine University, Los Angeles, CA, USA, 2007.

Gonenc, R., Nicoletti, G., 2001. Regulation, market structure and performance in air passenger transportation. OECD Economic Studies 32, 183–227.

Hausman, J., 2001. Mismeasured variables in econometric analysis: Problems from the right and problems from the left. Journal of Economic Perspectives 15 (4), 57–67.

Heskett, J.L., 1986. Managing in the Service Economy. Harvard Business School Press, Boston, MA.

Hubbard, T., 2008. Viewpoint: Empirical research on firms' boundaries. Canadian Journal of Economics 41 (2), 341–359.

Johnston, R., 1996. Achieving focus in service organizations. Service Industries Journal 16 (1), 10–20.

Kogut, B., 1991. Joint ventures and the option to expand on acquisitions. Management Science 37, 19–33.

Kydland, F.E., Prescot, E.C., 1982. Time to build and aggregate fluctuations. Econometrica 50 (6), 1345–1370.

Lapre, M.A., Tsikriktsis, N., 2006. Organizational learning curves for customer dissatisfaction: Heterogeneity across airlines. Management Science 52 (3), 352–366.
Liedtka, S.L., 2002. The information content of nonfinancial performance measures in the airline industry. Journal of Business Finance and Accounting 29 (7/8), 1105–1121.
Lucas Jr., R.E., 1977. Understanding business cycles. Carnegi-Rochester Conference Series on Public Policy 5, 7–29.
Malone, T.W., Organizational structure and information technology: Elements of formal theory. CISR WP no. 130 Sloan WP no. 1710-85 90s WP no. 85-011, Center for Information Systems Research, MIT, 53 pp., 1985.
Malone, T.W., Yates, J., Benjamin, R.I., 1987. Electronic markets and electronic hierarchies. Communications of the ACM 30 (6), 484–497.
Marquis, H.A., 2006. Finishing off IT. MIT Sloan Management Review 47 (4), 12–15.
Masten, S.E., 1993. Transaction costs, mistakes and performance: Assessing the importance of governance. Managerial and Decision Economics 14 (2), 119–129.
Menon, N.M., Lee, B., Eldenburg, L., 2000. Production of information systems in the healthcare industry. Information System Research 11 (1), 83–92.
Noam, E.M., 2006. Fundamental instability: Why telecom is becoming a cyclical and oligopolistic industry. Information Economics and Policy 18 (3), 272–284.
Onyemelukwe, C.C., 2004. The Science of Economic Development and Growth. M. E. Sharpe, New York.
Oum, T.H., Fu, X., Yu, C., 2005. New evidences on airline efficiency and yields: a comparative analysis of major North American air carriers and its implications. Transport Policy 12, 153–164.
Pint, E.M. & Baldwin, L.H., Strategic Sourcing: Theory and Evidence from Economics and Business Management. Document MR-865-AR, Santa Monica, CA, USA, The Rand, 1997.
Schefczyk, M., 1993. Operational performance of airlines: An extension of traditional measurement paradigms. Strategic Management Journal 14, 301–317.
Schumpeter, J.A., 1942. Capitalism, Socialism & Democracy. Harper, New York.
Stigler, G., 1951. The division of labor is limited by the extent of the market. Journal of Political Economy 59, 185–193.
Sutton, J., 1998. Technology and Market Structure. MIT Press, Cambridge.
Sutton, J., 1997. Gibrats legacy. Journal of Economic Literature 35 (1), 40–59.
Sutton, J., 1991. Sunk Costs and Market Structure. MIT Press, Cambridge.
Tsikriktsis, N., 2007. The effect of operational performance and focus on profitability: A longitudinal study of the U.S. airline industry. Manufacturing & Service Operations Management 9 (4), 506–517.
Weber, B.W., 1994. Transparency and bypass in electronic financial markets. System Sciences 4, 865–874.
Weiss, D., Maher, M.W., 2009. Operational hedging against catastrophes. Journal of Operations Management 27, 362–373.
Williamson, O.E., 1975. Markets and Hierarchies. Free Press, New York.
Williamson, O.E., 1985. The Economic Institutions of Capitalism. Free Press, New York.
Williamson, O.E., 1996. The Mechanisms of Governance. Oxford University Press, Oxford.
Williamson, O.E., 2002. The theory of the firm as governance structure: From choice to contract. The Journal of Economic Perspectives 3, 171–195.