Firm Boundary and Performance in the Airline Ticket Distribution Industry: Effects of the Evolution of Electronic Markets

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ABSTRACT

More than two decades after the introduction of the electronic market hypothesis (EMH), electronic markets have evolved from opaque to transparent, from biased to unbiased, and finally to personalized; yet, airline ticket distribution keeps searching for the right balance between markets and hierarchies. With advances in IT (Information Technology), it is not clear whether market-based or hierarchical forms of ticket distribution can achieve the optimal distribution efficiency. 17 years of operational data was analyzed by using data envelopment analysis (DEA) and Tobit regression to explore the relationship between firm performance and forces causing the transformation of electronic markets in the airline ticket distribution industry. The end results reveal that, despite the apparent inverse relationship between IT-driven distribution and production within hierarchies, airline business decisions, such as disintermediation to exclude downstream players or vertical integration to compete with rivals, created negative impacts on their performance and did not improve operational efficiency.

Keywords: *airline industry, DEA (data envelopment analysis), disintermediation, electronic markets, IT, TCE (transaction cost economics) theory.*

INTRODUCTION

Due to its information-intensive nature, the airline ticket distribution industry structure is vulnerable to any technology-driven change (Granados, Kauffman & King, 2008). As the industry has evolved from opaque to transparent, from biased to unbiased, and finally to a personalized market (Malone, 1985), the distribution portal has shifted from GDS-centric (Global Distribution System) to Internet-centric to Orbitz-centric and finally to meta-search-agent-centric. In other words, while electronic markets have evolved in parallel with IT development, it is difficult to determine whether distribution should be performed in markets or produced within hierarchies. To achieve optimal efficiency, firms keep voluntarily and involuntarily swinging between markets and hierarchies when it comes to distributing their products.

These four portal types reflect the stages of evolution of electronic markets in the airline ticket distribution industry. Forces behind this transformation were hefty sunk costs related to developing GDSs that erected entry barriers and stabilized the industry (Rosenbaum & Lamort, 1992); faster and better information search tools developed by GDSs, such as Expedia and Travelocity; Orbitz's user-friendly Web interfaces to increase structural market transparency levels (Granados, Gupta & Kauffman, 2007) and the ability of mass-customization and value-added function provided by meta-search agents such as Sidestep, FareChase and Kayak.

The change of distribution portals seems to reflect external business environment changes; yet, questions remain. Incomplete contracts may have translated to opportunism and induced

higher unit transaction costs but "firm as governance structure" appears to be more efficient than "firm as production function" (Williamson, 2002). In contradiction to the assertion of the electronic markets hypothesis (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. Thus, do firm boundaries matter? How do markets and hierarchies impact firms' operational performance? Does the vertical integrated airlines agency such as Orbitz improve distribution efficiency? Scrutinizing the history of firms' operational performance may provide some answers to these questions.

It is difficult to quantify the impact of forces exerted by the IT on operational performance and efficiency. Relevant data are not easy to obtain. Also, firm boundary decisions typically are endogenous (Ackerberg & Botticini, 2002; Masten, 1993). Many potentially relevant determinants are either unobservable, partially unobservable or observable with error by analysts, industry experts or econometricians (Hausman, 2001; Hubbard, 2008). In addition, the dispute over the appropriate efficiency concept and the appropriate measure method leaves the question of how the evolution of electronic markets impacts firm performance unanswered. In this study, the data envelopment analysis (DEA) method (Charnes et al., 1978) is employed to assess firms' performance. DEA is a non-parametric method of evaluating efficiencies in economic activities, such as firm level efficiency. DEA has been an accepted method of efficiency analysis since its introduction into the Operations Research (OR) literature in 1978. Seiford (1994) in his DEA bibliography lists 472 published articles and accepted Ph.D. dissertations even as early as 1992. Tavares (2002) lists 1259 papers using DEA from 2,152 authors. Ray (2004) describes the method of DEA in a great detail.

LITERATURE REVIEW

As the distribution method is transforming itself from labor-intensive to more Internet-based, the industry also experiences different competitive dynamics (McAfee & Brynjolfsson, 2007). Players in the distribution chain naturally seek better methods to deliver products and services to customers. IT creates a positive impact on the production of services (Menon et al., 2000). However, whether IT alone provides a strategic advantage is still questionable (Marquis, 2006). Malone (1987) suggests that IT shapes 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 goods or services to be recruited from electronic markets (vs. hierarchies) (Malone et al., 1987). As such, a vertical integrated distribution portal such as Orbitz presents an interesting dilemma. Whether firms should be treated as production functions or as governance structures (Williamson, 2002) in the IT-driven distribution industry requires managers' further interpretation.

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 for the Orbitz-owner airlines (Williamson, 1975: 16-19). Thus, 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. Within the hierarchy, when the range of functions becomes wider, the task of coordination is harder. Thus, he suggested the motivation for vertical integration is operation efficiency as the benefits of economies of scale

easily outweigh the costs of managing and coordination. As such, vertical integration has a negative impact on the control of production cost and effective information transfers. When information is distributed asymmetrically, it may affect inter-firm and intra-firm efficiency. It is believed that efficiency can be realized when different stages of production are organized within one firm.

As IT-driven distribution industry evolves, Malone et al. (1987) predict that due to the nature of competition, there will be a shift away from biased to unbiased and personalized markets. A closer look at stage-wise market evolution indicates that the force behind these changes is the power of lower transaction costs or "actual and opportunity costs of transaction under various governance structures" (Coase, 1937). Transaction cost is a cost incurred in making an economic exchange. Whenever a good or service is transferred from a producer to a user, transaction costs occur. Costs associated with transactions depend on the governance structure. In 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. When transactions occur within a firm, costs associated with the transactions include managing and monitoring personnel as well as procuring inputs. In contrast, when transactions take place in a market, costs can include source selection, contract management and performance monitoring (Pint & Baldwin, 1997).

DATA COLLECTION AND SAMPLE CONSTRUCTION

Stage one variables for the DEA

Samples are drawn from all U.S. airlines that posted at least $1 billion in revenue (also defined as major carriers by the Department of Transportation) during each fiscal year. Non-passenger carriers are excluded. As of 2009, major carriers include: 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. There are eleven major airlines and can be divided into three different groups:

1. Low cost carriers (LCC): AirTran, JetBlue and Southwest. They sell their seats directly to customers and over the Internet to avoid fees and commissions to middlemen.
2. Non-Orbitz-owner carriers (NOC): Alaska, Frontier and US Airways. They do have their own websites; however, travel agencies still play an important role in their distribution.
3. Orbitz-owner carriers (OOC): American, Continental, Delta, Northwest and United. These airlines are former GDS owner airlines.

The primary source of panel data for DEA calculations is the "operating data" section of Form 10-K filed by each individual airline with the SEC (U.S. Securities and Exchange Commission). The period under study is between 1992 and 2008, coinciding with the debut of the Mosaic web browser when the Internet was effectively opened to commercial use. Overall, seventeen years worth of operating data were collected and analyzed for eleven major passenger carriers.

Input and output variables to calculate the efficiency frontier

In general, inputs are asset and cost related while outputs are revenue related. External demand for services or goods provided or produced by DMUs (decision making units, or

individual airlines – in this research), the economic, financial, and regulatory environment and other factors determine the relationship between inputs and outputs. Each input and output in the model reflects an operational characteristic of the industry. Inputs normally refer to operations (aircraft utilization and maintenance, fuel and labor costs, schedule, pricing of service, etc.). As such, they are the variables over which airlines have autonomous decision rights and they are independent from the demand environment. Outputs are operational or financial results. The selection of inputs and outputs for the DEA method follows Schefczyk's (1993) model. For input variables, distribution cost, ASM (available seat miles) and CSM (cost per seat mile, defined as the product of ASM and CASM (cost per available seat mile)) are selected. For output variables, RSM (revenue per seat mile, defined as the product of ASM and the load factor) and POR (passenger operating revenue) are selected.

Stage two variables for the Tobit model

Proposed determinants to business decisions and business environment

AgyNbr (numbers of travel agency in the U.S.), ComCut (commission cut) and TtlCom (total commission paid to travel agencies) are selected. Data are drawn from the Airlines Reporting Corporation, an airline-owned company handling ticket settlement in the U.S., to reflect impacts of airlines' business decisions such as disintermediation to cut off travel agencies and GDSs from their distribution value chain.

OrbOwn (Orbitz ownership), MetAgt (the appearance of meta-search agents) are selected to represent changes of business environment between hierarchies and markets. Data are orchestrated based on the intensity of carriers' participation level with Orbitz and the year of meta-search agents' appearance. The purpose of these sets of data is to test the hypothesis on distribution efficiency within hierarchies vs. efficiency across markets.

EUsers (percentage of the Internet users in the U.S.) and EPerct (e-commerce percentage of ticket distribution revenue) are selected to reflect the level of IT infusion in the industry and the spread of Internet usage in the U.S. Data sources are from The International Telecommunication Union and U.S. Census Bureau, respectively.

RESULTS AND VALIDITY OF RESULTS

The following table of efficiency scores is the output of the DEA performed by EMS software, version 1.3. In any given year, an efficiency score of 100% means that its corresponding DMU is on the efficiency frontier. The model of this calculation was set at "super efficiency" to show true efficiency scores. As long as a score is higher than 100%, the DMU is on the efficiency frontier. Airline names in the table are presented as their respective stock symbols. Note that here LCC is the stock symbol of US Airways, different from the LCC (low-cost carriers) acronym. 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.

Table 1: Super Efficiency Scores

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

DEA RESULTS, INTERPRETATIONS AND DISCUSSIONS

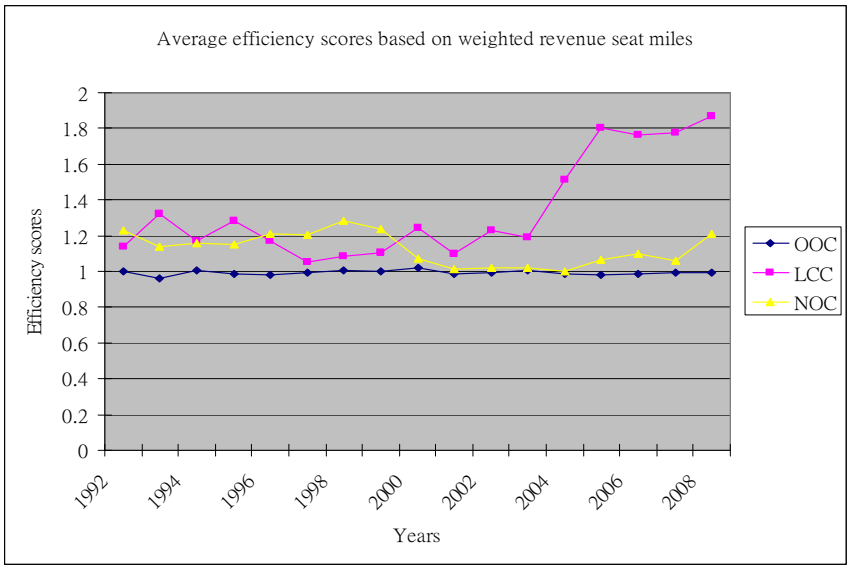

Figure 1: Average Efficiency Scores (Weighted by RSM)

Figure 1 illustrates performance of three airline groups by using average efficiency scores based on weighted RSM (when performed based on weighted POR, the result is similar). This graph identifies that the best performing group, LCC, has highest scores from 1992 to 2008, except between 1996 and 1999. This may have been caused by a 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 on 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 of 2001 when Orbitz started the operation. OOC performance is always below the frontier line except for 2001.

The NOC group had stronger performance in the early years when all peers had a level playing field (i.e., when all carriers distributed most of their products through travel agencies, paid the same commission percentage and there were no monopolized vertically integrated online agencies). Their performance worsened between 2000 and 2004 after all carriers removed all 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 does not help the performance of NOC since NOC are not Orbitz carriers; and 2) travel agencies have no incentive to sell NOC's products, yet NOC traditionally rely 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 been falling below the frontier line, except between 1999 and 2000 which is the onset of Orbitz. Apparently, the debut of Orbitz did not significantly change their 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 onward, 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 rely 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 these two graphs reveals that all 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 efficiency improvement compared to the Internet-centric period.

Thus far, the DEA results show that larger firms distribute their products less efficiently than smaller ones. Further analysis shows that size does not affect product distribution efficiency as the Pearson correlation coefficient found in statistical analysis performed with SPSS 13.0

software is -0.091936. Therefore, the DEA results are reinforced.

Explaining inefficiency of effects of the evolution of electronic markets

This stage of analysis is to test the hypothesis that business decisions and business environment have a strong influence on firm performance in the evolution of electronic markets. All Tobit results were computed by using Stata software. 156 observations were used for the Tobit stage of this investigation. The Tobit model uses inefficiency score as the dependent variable. The inefficiency score defined as $Y_i = (1 / \theta) - 1$, where θ is the efficiency score obtained by DEA. Thus, the inefficiency score of 0 corresponds to perfect efficiency and any positive number is a measure of inefficiency.

	b/se model
ComCut	0.141*
	(0.06)
OrbOwn	-0.036
	(0.03)
MetAgt	-0.026
	(0.06)
AgyNbr	-0.000
	(0.00)
EUsers	0.000
	(0.00)
EPerct	-0.005*
	(0.00)
TtlCom	-0.000
	(0.00)
_cons	0.034
	(0.23)
	sigma
_cons	0.074***
	(0.01)

Legend: coefficient/(standard error), * p<0.05, ** p<0.01, *** p<0.001

Table 2: The Prediction of the Tobit Regression

This Tobit regression table reveals relationships between proposed determinants and distribution efficiency. For example, a unit change in commission cut and the percentage of e-commerce increasing leads to a 0.141 decrease and a 0.005 increase in efficiency, respectively. While Orbitz ownership and the appearance of meta-search agents may increase the efficiency, the effect is not statistically significant. In the same fashion, the decreasing agency numbers and the increasing Internet users have no significant effect on distribution efficiency.

In an oligopoly 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 (Bulter, 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 to airlines. Distribution costs were the third largest expense after labor and fuel. Commission rate was 11% and GDSs processed 80% of all air sales. Yet, 85% of tickets sold were through travel agencies.

Contrary to Malone et al. (1987) prediction, 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 eradication of displaying certain inventory from their GDSs, or the disintermediation, sped up intermediaries' transformation rather than lead to their elimination. Southwest Airlines is credited with offering the first e-tickets to passengers in 1994 after they were left with 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 not 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 U.S. air market. With this scope, vertical integration with retailing seems to be an unwise business decision. This evidence does not encourage internal production in the long run. TCE (transaction cost economics) assumes that firms are oriented to maximizing profit. Yet, the tradeoff of the direct cost and/or the cost associated with internal or external production is still a mystery. This investigation reveals that firms relying on third parties (as evidenced by performance of NOC excluding LCC) perform better than those who do otherwise. 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, the benefits of producing within disappear faster than the costs, in the long run.

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 stages can be procured or produced within. Williamson (1975: 82) 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. Figures 1 indicates that market transparency (the advent of meta-search agents) has had mixed impacts on different groups. In general, distribution efficiency has increased, but it was not uniformly 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.

CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

IT may have improved industry transparency; yet, the same transformation lead to mixed results in distribution efficiency. The Internet has helped LCC's performance since most GDSs refused to display LCC's inventory. One may think 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 advanced, industry organization has shifted from hierarchical to market-based forms of economic activity. This suggests that management should wisely evaluate whether vertically integrated

retailing saves costs and efficiently distributes products; or, whether integration reduces trading opportunities and makes their firms less profitable.

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 OOC may possess monopoly market power, the force of meta-search agents should not be ignored. Meta-search agents exhibit referee-like functions which may pose a threat to long-term sustainability 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 resources. However, missing reports from some carriers in some years may have handicapped the precision of analytical results (for example, incomplete data for Northwest Airlines in early 1990s). Finally, although DEA is a popular method of determining efficiency as it allows for multiple inputs and outputs, its sensitivity to the selection of inputs and outputs affects efficiency scores. To enhance results of this study, a similar study with different methods such as SFA (Stochastic Frontier Analysis) may be conducted.

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