A Longitudinal Categorization of US Airline Industry via Dynamic Stock Return Method

Seong-Ho Cho

School of Business Administration, Hongik University, Seoul, Korea

Email address:
shcho11@hongik.ac.kr

Abstract: In this exploratory paper, the dynamic stock return method (DSRM) initially proposed as an effective and replicable method by [14], [4], [5], [6] is deliberately applied to the US airline industry over the period from 1979 to 1992 (14 years). The longitudinal categorization or strategic group (SG) results from the DSRM show good face validity. They are consistent with the industry's fact-based historical progress. We also observe that the operational measures such as market share or productivity tend to support the grouping results. Furthermore, the results of 15- and 7-year analysis of relative closeness of stock responsive movements between two representative airline firms (American and Hawaiian airlines, respectively) could be inferred that the SGs derived from the DSRM are valid and robust over a longer time span. We conclude that the DSRM could be a good alternative instrument for the longitudinal study of industry substructure.

Keywords: Categorization, Strategic Group, Niche, Industry Substructure, Cluster, US Airline Industry,
Longitudinal Structural Dynamics, Longitudinal Study

1. Introduction

Although several empirical attempts have been made to analyze longitudinal dynamics of strategic groups (SGs) or distinctive categories within an industry [7]; [10], [11]; [12]; [8]; [3]; [15]; [16], their methods have been attacked by their known limitations such as statistical artifact and subjectivity [1]; [4], [5], [6]; [3]; [16]. In fact, the arbitrary choice of some critical strategic behaviors is not likely to produce objective and replicable categories or SG groupings. While the longitudinal analysis is required to capture and reflect any dynamic changes over time in critical strategic behaviors among member firms, furthermore, the conventional methods appear to fail to accommodate them properly [1]; [6]; [3]; [16]. Specifically, in the conventional methods it may not be easy to reconfigure persuasively the crucial strategic dimensions across different stable strategic time periods (SSTPs).

In this exploratory paper, the dynamic stock return method (DSRM) initially proposed as an effective and replicable method by [14], [4], [5], [6] is deliberately applied to the US airline industry over the period from 1979 to 1992 (14 years). There are three reasons for this. First, the US airline firms are

doing single business due to regulatory requirement. Second, the industry's historical progress is well documented especially post to the critical event of its deregulation in 1978. Third, since deregulation the US airline industry has been very competitive and variant players have tried to survive in their own ways. Therefore, there could be various categories, SGs or niches within the industry.

In order to check the face validity, the SG clustering results derived from the DSRM are referenced to the industry's historical progress over the 14 years of time period. As for the post analysis to see whether the categories found are supported, the operational measures such as market share and productivity are analyzed. As a case study of two representative airline firms (American and Hawaiian Airlines), their longitudinal relative closeness in their stock movements is measured over 15 and 7 years, respectively (due to data availability). The statistical results of 15- and 7-year analysis of relative closeness between two airlines could be inferred as the categories or SGs derived from the DSRM are valid and robust over a longer time span.

The remaining sections are presented as follows: Section 2 describes the sample data and outlines the method. Results are discussed in section 3. Discussions and conclusions are

presented in section 4.

2. Method

2.1. Sample: US Airline Industry

The sample firms represent all the firms with SIC designation of 4511 or 4512 during the study period between 1979 and 1992. The sample of 30 airline firms is highly specialized in the airline business mainly because of legal constraints (although Worldcorp Inc. is obviously not an airline company, we decide to include it in the sample for the test purpose). The airline industry is particularly chosen because the industry's historical progress is well documented post to its deregulation in 1978. The sample firms are listed in the New York or American Stock Exchanges and have complete stock returns of one year or 50 weeks over the sample period from 1979 to 1992 in the University of Chicago's Center for Research in Security Prices (CRSP) data tapes. The sample period of this study includes 171-month periods (1979-1992) after the signing of the Airline Deregulation Act in October 1978 when business environment became increasingly less regulated.

With gradual deregulation of the domestic US air transportation beginning in 1978, and the reduced involvement of the Civil Aeronautics Board in the industry, airlines have adopted quite different growth strategies and have adjusted their structures according to the new environment. Thus, we expect to observe industry-wide structural changes due to environmental changes in the years following the deregulation decision. For example, United Airlines has extended its route structure to nationwide resulting in significant changes in its route structure by mid-1979 (Business Week, 1980). In 1978, Alaska Airlines served only 10 Alaskan cities and Seattle, but shortly after the Deregulation, Alaska extended operations into California.

The first half of 1980s could be described as a period of tense competition amongst incumbents. Firms in the industry have explored various possibilities for survival in face of fierce competition and uncertainty. While new firms entered into the industry seeking for niches (i.e. geographical), existing firms (incumbents) tried to outperform though creative services and products. However, the successfully invented services and products were easily replicated by major competitors. An example would be the frequent fliers' mileage program launched first by American Airlines in 1981. In the same year, United counters with its own program, followed by TWA, Delta, Northwest, and Continental. During the second half of the 1980s, on the other hand, there were a significant number of mergers and acquisitions in the airline industry. In 1986, the acquisition activities were especially significant. It can be referred as a period of consolidation from diversified variation during the first half of 1980s.

2.2. Variables

As suggested by [6], the variables used for clustering are the correlation coefficients of stock return residuals for each firm in the sample. Once the weekly stock return residuals (WARs) after eliminating systematic risk are obtained via market model, they are correlated between the sample firms each week to produce the correlation coefficient matrix between firms. Therefore, the between-firm correlation coefficient or r_{ij} is a measure that summarizes the closeness of WAR movements between firm i and firm j over the time span.

The variables are regarded to capture magnitudes and directions of instaneous stock return movements reflecting disturbances over each sample year (s). In the sample of 30 firms, a complete set of 50, 100, 150, 250 weekly stock returns in the sample period from 1979 to 1992 are used for study.

2.3. Cluster Identification

Table 1. *List of Sample firms (N=30).*

COMPANY NAME	BEG-END*	SIC
AIRCAL INC	850102-870429	4511
AMERICAN AIR LINES INC	620702-921231	4511
ALASKA AIRGROUP INC	620702-921231	4511
ALOHA AIRLINES INC	791214-861226	4511
BRANIFF INT'L CORP	620702-820527	4511
BRITISH AIRWAYS PLC	870211-921231	4511
CONTINENTAL ARLNS HLDGS	780406-920320	4512
DELTA AIRLINES INC DE	620702-921231	4511
EASTERN AIRLINES INC	620702-861123	4511
FRONTIER AIRLINES INC	640415-851121	4511
HAWAIIAN AIRLINES INC	740523-921231	4511
JET AMERICAN ARLNS INC	841003-861226	4511
KLM ROYAL DUTCH ARLNS	620702-921231	4511
MGM GRAND INC	891213-921231	4512
MIDWAY AIRLINES INC	880609-911001	4512
NORTHWESTERN ARLNS INC	620702-890726	4511
OZARK AIRLINES INC	670508-860915	4511
PAN AM CORP	620702-910925	4511
PIEDMONT AVIATION INC	780925-871104	4511
REPUBLIC AIRLINES INC	730522-860812	4511

COMPANY NAME	BEG-END*	SIC
SEABOARD WORLD ARLNS INC	620702-800930	4511
SOUTHWEST AIRLINES CO	751024-921231	4511
TIGER INT'L INC	620702-890215	4511
TRANS WORLD ARLNS INC	830303-881024	4511
UNITED AIR LINES CORP	620702-921231	4512
US AIR GROUP INC	620702-921231	4511
W T C INT'L NV	700709-870903	4511
WESTAIR HOLDING INC	881025-920529	4512
WESTERN AIRLINES INC	620702-861218	4511
WORLDCORP INC	670424-921231	4511

* BEG-END is the beginning and ending dates of CRSP's available data. For instance, AirCal's CRSP data is available from January 2, 1985 through April 29, 1987.

As suggested by the DSRM, Ward's minimum variance method is used for cluster analysis due to its superior performance. In order to evaluate its robustness against outliers, the outliers exceeding the 1, 3, 5, 7 percent limits were respectively deleted. Ward's method produced the same SG results up to 5 percent deletions.[1] As also proposed by the DSRM, we apply stopping rules of both Pseudo F statistic [2] and Pseudo T^2 statistic [9].

2.4. Longitudinal SSTPs in the US Airline Industry

An SSTP is defined as time periods of homogeneity with regard to competitive strategic behavior [10]. As suggested by [6], in the DSRM an SSTP could be determined and identified by comparing pooled and unpooled clustering results over time. If the grouping structure of 1-year window, say, 1979 (unpooled) is similar with that of 2-year window or 1979-1980 (pooled), we use 1979-1980 as an SSTP. Otherwise, 1979 is regarded as a separate SSTP. As suggested by Cho [6], Bartlett's test and Hoteling's T^2 test are used to check whether the pooled and unpooled clustering matrices are similar.

In our sample of US airline firms in 1979-1992, SSTP $_{1979-83}$, SSTP $_{1984-88}$, SSTP $_{1988-92}$ and SSTP $_{1981-85}$ are further analyzed to examine the evolutionary paths of SGs or niches within the industry. It is well known that the industry has gone through volatile structural changes including fierce competition due to regulatory deregulation (the first half of 1980s) and industry-wide mergers and acquisitions for consolidation (peak at 1986). During the period 1979-1983, the average number of firms in the industry was 16 which are 4 less than that of 1981-1985. In 1988-1992, there were only 10 airline firms in the industry after all. Around 1986, its industry-wide consolidation has been made through mergers and acquisitions. A comparison of the mean vectors using Hotelling's T^2 tests and variance-covariance matrices using Bartlett's test shows statistically significant differences among the SSTP $_{1979-83}$, SSTP $_{1984-88}$, SSTP $_{1988-92}$, and SSTP $_{1981-85}$. In Table 2, the longitudinal strategic groups in SSTP $_{1979-83}$, SSTP $_{1984-88}$, SSTP $_{1988-92}$, and SSTP $_{1981-85}$ are respectively presented.

2.5. Post Analysis

As for post analysis, some representative firms are chosen from the evolutionarily persistent three strategic groups, namely, domestic leading group (American, United, Delta), foreign leading group (British, KLM), and niche group (Alaska, Hawaiian). Although the group memberships already show a high level of face validity, we would like to examine each group's characteristics in terms of operational measures such as revenue, net income, and productivity. Further, this paper attempts to explore to measure the closeness of the evolutionary paths of two firms within an industry by analyzing the closeness of stock return movements as shown in the Method section.

In our exploratory paper, American Airlines and Hawaiian Airlines will be examined as representative firms mainly because they are distinguishable from the stand point of face validity. In order to analyze the longitudinal movements of other airline companies (i.e. Delta) relative to a representative firm, say, American Airlines (see table 6), we develop a grand summary statistic which summarizes stock movements between an airline company (i.e. Delta) and a representative firm (i.e. American) over the period of 1978 through 1992 or 15 years. A grand summary statistic is an average of annual coefficients for the 15 years, which measure the closeness of stock return movements over 50 weeks or one year. We use the average of annual coefficients for 15 years as a proxy for the closeness of the evolutionary paths of two firms. Similarly, Table 7 shows the result of the grand summary statistic of Hawaiian Airlines with respect to other airlines including Aloha.

3. Results

3.1. The Nature of the Clusters

According to the DSRM, there are 3 SSTPs in the 1979-1992 time horizon in the US airline industry, say, SSTP $_{1979-83}$, SSTP $_{1984-88}$, SSTP $_{1988-92}$ as exhibited in Table 2. These SSTPs appear to confirm the industry's fact-based historical progress as described in section 2.1.

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1 With 1, 3, 5% deletions of outliers, the SG results are robust and classification power increases. Although they becomes less robust with 7% deletion, but the SG outcome is the same.

Table 2. Composition of the Derived Categories or SGs.

	1979-83	1984-88	1988-92	1981-85*
I	AMERICAN AIR LINES INC UNITED AIR LINES CORP NORTHWESTERN ARLNS INC DELTA AIRLINES INC DE TRANS WORLD ARLNS INC US AIR GROUP INC	AMERICAN AIR LINES INC DELTA AIRLINES INC DE UNITED AIR LINES CORP US AIR GROUP INC NORTHWESTERN ARLNS INC	AMERICAN AIR LINES INC DELTA AIRLINES INC DE UNITED AIR LINES CORP SOTHWEST AIRLINES CO US AIR GROUP INC ALASKA AIRGROUP INC	AMERICAN AIR LINES INC UNITED AIR LINES CORP DELTA AIRLINES DE US AIR GROUP INC NORTHWESTERN ARLNS INC OZARK AIRLINES INC PIEDMONT AVIATION INC TRANS WORLD ARLNS INC SOUTHWEST AIRLINES CO ALASKA AIRGROUP INC
II	FRONTIER AIRLINES INC OZARK AIRLINES INC PIEDMONT AVIATION INC WESTERN AIRLINES INC SOUTHWEST AIRLINES CO	ALASKA AIRGROUP INC SOUTHWEST AIRLINES CO KLM ROYAL DUTCH ARLNS PAN AM CORP TIGER INTL INC	BRITISH AIRWAYS PLC KLM ROYAL DUTCH ARLNS	EASTERN AIRLINES INC REPUBLIC AIRLINES INC PAN AM CORP WESTERN AIRLINES INC KLM ROYAL DUTCH ARLNS
III	REPUBLIC AIRLINES INC TIGER INTL INC	CONTINENTAL ARLNS HLDGS		CONTINENTAL ARLNS HLDGS TIGER INTL INC
IV	W T C INTL NV			ALOHA AIRLINES INC HAWAIIAN AIRLINES INC

As shown Table 2, in the SSTP $_{1979-83}$ which represents post 5-year period since 1978's liberalization in the airline industry, the leader group includes American, United, Northwest, Delta, TWA and US Air (Category I). Some non-market leaders like Frontier, Ozark, Pedimont, Western and Southwest Airlines are grouped together (Category II), while Tiger and Republic are classified as another group (Category III).

In the consolidating period of 1984-1988 or SSTP $_{1984-88}$, the leader group becomes more obvious (American, Delta, United, US Air, and Northwest) and the number of firms in the industry decreases from 21 to 12. Since 1986, mergers and acquisitions have become prevalent in the industry; in 1986, Continental bought People Express and Frontier Airlines, and Delta bought Los Angeles based Western Airlines; Alaska bought Long Beach-based Jet America Airlines and Seattle-based Horizon Air Industry; Northwest acquired Republic Airlines in 1987; American acquired Nashville Eagle Commuter Airlines. This period can be inferred as a consolidating period in which competitors survive through mergers and acquisitions of less competitive airlines (k-type) [13]. By 1987, the number of firms diminishes from 22 to 13.

In SSTP $_{1988-92}$ which is a period post to consolidation, overall industry substructure stays stable. There seem 3 categories or SGs in the industry, namely, domestic leading group (American, Delta, United), foreign leading group (British, KLM), and niche group (Southwest, Alaska). One notable category is the niche group where the newcomers like Southwest and Alaska become successful in their unique ways successfully to serve their own category of consumers like price-sensitive buyers.

SSTP $_{1981-85}$, the categories or SGs in the period of 1981 to 1985 is additionally exhibited in the last column of Table 2 in the hope of detecting possible industry substructure turmoil

before the blast of M&A waves. In the SSTP$_{1981-85}$, SGs look chaotic after industry liberalization. Significantly, the number of firms competing in the industry has been maximized and thus competition has become more intense. More firms have entered into the airline market which used to be lucrative but restricted. Among the incumbents including market leaders, the competition became fiercer in the fight to increase or maintain market share. For example, American was the first to launch the frequent flyer program in 1981, using the SABRE system to keep track of clients' mileages. However, this successful program was soon replicated by major competitors, and in the same year or 1981, United countered with its own program followed by TWA, Delta, Northwest, and Continental. SSTP$_{1981-85}$, could be inferred as r-type suggested by [13] in which competing firms in the industry explore various possible ways for survival or success under the increasingly competitive and uncertain environment.

Table 3 shows sales volume over the period from 1984 to 1992 for the representative firms from the 3 strategic groups. In terms of average annual revenue, American ($9,223 million) and United possess ($9,035 million) the largest market share in the industry followed by Delta ($6,924 million), British ($6,467 million), and Northwest ($5,477 million). US Air realizes a middle-to-low market share until 1987, but it boosts its market share to an upper middle level afterwards. Comparing the firms in the leader group in the period from 1984-1992 (3rd and 4th Columns in Table 2), American, United, and Delta are consistently in the same group and they stay in the highest hierarchy within the group. Although British Airlines has the 4th largest market share, it has not been grouped into the leader group. In the case of Southwest, although it possesses small market share ($1,011 million), it is grouped among the leaders, but in the lowest hierarchy within the group.

Table 3. Sales of Representative Airlines in 1984-1992.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean
American Airlines	5,354	6,131	6,018	7,198	8,824	10,480	11,720	12,887	14,396	9,223
United Airlines	6,218	5,306	7,119	8,305	8,982	9,794	11,037	11,663	12,890	9,035
Delta Airlines	4,264	4,684	4,460	5,318	6,915	8,089	8,582	9,171	10,837	6,924
Northwest	2,445	2,655	3,589	5,142	5,650	6,576	7,426	7,683	8,128	5,477
US Air	1,630	1,765	1,835	3,001	5,707	6,252	6,559	6,514	6,686	4,439
Continental Airlines, Inc.	1,372	1,944	4,407	8,626	8,552	6,650	6,184	5,487	5,494	5,413
Trans World Airlines	3,657	3,867	3,185	4,056	4,361	4,507	4,606	3,660	3,634	3,948
British Airways PLC	-	2,036	4,511	5,245	7,091	7,184	7,971	8,632	9,069	5,749
KLM	1,618	2,310	2,637	3,002	2,792	3,386	3,426	4,290	4,549	3,112
Southwest Airlines	536	680	769	778	860	1,058	1,237	1,379	1,803	1,011
Alaska Airlines	362	433	468	710	814	917	1,047	1,104	1,115	774

Table 4 displays net incomes over the period of 1984 to 1992 for selected firms. On average, British ($279 million), American ($137 million), and Delta ($110 million) realize the largest net income in the industry. Southwest ($53 million) stays profitable even in the 1990s when most domestic firms are not doing well. Although United and Northwest achieve the largest market share in revenues, United and Northwest realize average net income (loss) of $57 million and ($213 million), respectively. Like other major domestic airlines, they suffered big losses since 1990. Comparing the firms in groups in the period of 1988-1992 (Table 2), British is obviously separated from American and Delta although it achieves comparable revenue and net income. On the other hand, United, Northwest, and Southwest are grouped together with American and Delta, although in the lowest hierarchy within the group.

Table 4. Net Incomes of Representative Airlines.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean
American Airlines	234	346	279	198	477	455	(40)	(240)	(475)	137
United Airlines	282	(49)	12	(4)	600	324	94	(332)	(417)	57
Delta Airlines	176	259	47	264	307	461	303	(324)	(506)	110
Northwest	56	73	77	103	135	75	(465)	(488)	(1482)	(213)
US Air	122	117	98	195	165	(63)	(454)	(305)	(601)	(81)
Continental Airlines, Inc.	28	49	42	(466)	(719)	(908)	(2403)	(306)	(125)	(534)
Trans World Airlines	30	(208)	(106)	45	250	(287)	(274)	(11)	(318)	(98)
British Airways PLC		120	280	238	285	295	405	166	443	279
KLM	84	122	148	169	175	178	(330)	68	(311)	32
Southwest Airlines	50	47	50	20	58	75	51	33	97	53
Alaska Airlines	24	26	18	13	37	43	16	10	(80)	12

In order to see productivity in conjunction with net incomes, Table 5 presents Income as% of sales over the period of 1984 to 1992. Southwest (5.7%) and British (4.6%) are the most productive followed by Alaska (2.5%), American (2.4%), and Delta (2.3%). Other major domestic firms in the leader group show low to moderate productivity or less than 1%. Comparing the firms in groups in the period of 1988-1992 (Table 2), British is grouped together with KLM (2.0%), and is separated from Southwest.

Table 5. % Net Incomes of Revenues for Representative Airlines.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean
Southwest Airlines	9.3%	6.9%	6.5%	2.6%	6.7%	7.1%	4.1%	2.4%	5.4%	5.7%
British Airways PLC		5.9%	6.2%	4.5%	4.0%	4.1%	5.1%	1.9%	4.9%	4.6%
Alaska Airlines	6.6%	6.0%	3.8%	1.9%	4.6%	4.7%	1.6%	0.9%	-7.2%	2.5%
American airlines	4.4%	5.6%	4.6%	2.8%	5.4%	4.3%	-0.3%	-1.9%	-3.3%	2.4%
Delta Airlines	4.1%	5.5%	1.1%	5.0%	4.4%	5.7%	3.5%	-3.5%	-4.7%	2.3%
KLM	5.2%	5.3%	5.6%	5.6%	6.3%	5.3%	-9.6%	1.6%	-6.8%	2.0%
United Airlines	4.5%	-0.9%	0.2%	0.0%	6.7%	3.3%	0.9%	-2.8%	-3.2%	0.9%
Us Air	7.5%	6.6%	5.4%	6.5%	2.9%	-1.0%	-6.9%	-4.7%	-9.0%	0.8%
Northwest	2.3%	2.7%	2.1%	2.0%	2.4%	1.1%	-6.3%	-6.4%	-18.2%	-2.0%
Trans World Airlines	0.8%	-5.4%	-3.3%	1.1%	5.7%	-6.4%	-5.9%	-0.3%	-8.8%	-2.5%
Continental Airlines, Inc.	2.0%	2.5%	1.0%	-5.4%	-8.4%	-13.7%	-38.9%	-5.6%	-2.3%	-7.6%

3.2. Relative Closeness of Evolutionary Paths

The closeness of the evolutionary paths of other airline firms relative to an anchor representative firm in the industry (American or Hawaiian Airlines) is examined over the 1978- 92 time periods. Table 6 presents the longitudinal relative movements of stock returns of airline firms from the perspective of American Airlines. The coefficients in the table or points in the graph represent summary correlation coefficients between a firm and American Airlines over that

year. For example, 0.0887 in the first cell of the table is the correlation coefficient of stock returns between American Airlines and Alaska Airlines in 1978 (50 weeks). The coefficient is regarded as a measurement which summarizes closeness of stock return movements over 50 weeks or one year. The last column in the table represents the average of the 15 annual coefficients. It can be interpreted as a grand summary statistic which summarizes stock movements between a firm and American Airlines over the period of 1978 through 1992 or 15 years.

Table 6. Summary Correlation Coefficients for Relative Closeness from the perspective of American Airlines (15 years).

	1978	1979	1980	1981	1982	1983	1984	1985
AIRCAL								
ALASKA	0.0887			0.4717	0.0866	0.4142	0.3264	0.1792
ALOHA			-0.1513	0.2155	0.2477	0.1759	0.1512	-0.1374
BRITISH								
CONT	0.4832	0.3758	0.5362	0.2583	-0.1736	0.3686	0.2931	0.2355
DELTA	0.4207	0.4271	0.4443	0.4776	0.6623	0.6626	0.7050	0.6329
EASTERN	0.5031		0.5330	0.6949	0.4034	0.3688	0.2276	0.3918
FRONTIER	0.4158	0.2462	0.3213	0.4737	0.2671	0.2550	0.2764	
HAWAIIAN	0.4490		0.2462	0.0296	0.0175	0.2004	-0.0962	-0.2272
KLM		0.3244		0.1804	0.2791	0.1944	0.1118	0.3551
NW	0.4542	0.435	0.4813	0.5921	0.5076	0.7233	0.6475	0.2647
PAN AM	0.3094		0.3345	0.3531	0.2819	0.3941	0.4471	0.2115
PIEDMONT		0.1757	0.1174	0.3848	0.2353	0.3308	0.4387	0.4542
EPUBLIC	0.2103	0.5812	0.3014	0.4302	0.0583	0.2906	0.4450	0.5276
SOUTHWEST	0.1020	0.0225	0.1807	0.2860	0.3930	0.4867	0.5196	0.3710
TIGER	0.1813	0.3327	0.4025	0.2580	0.0506	0.3243	0.2176	0.2546
TWC	0.5379	0.2251	0.5178	0.5821	0.5950	0.5481	0.5570	0.1541
UNITED	0.5062	0.5459	0.7400	0.7084	0.3909	0.7853	0.6644	0.6405
US AIR	0.2290	0.3845	0.5804	0.5929	0.5471	0.7977	0.5616	0.0879
WORLDCORP	0.3710		0.2975	0.3367	0.1224	0.2913	0.1026	0.1661
MAX	0.5379	0.5812	0.7400	0.7084	0.6623	0.7977	0.7050	0.6405
MIN	0.0887	0.0225	-0.1513	0.0296	-0.1736	0.1759	-0.0962	-0.2272
MEAN	0.3508	0.3422	0.3677	0.4070	0.2763	0.4218	0.3665	0.2684
STD	0.1473	0.1485	0.2056	0.1803	0.2713	0.1966	0.2172	0.2282

Table 6. Continued.

	1986	1987	1988	1989	1990	1991	1992	Mean
AIRCAL	-0.0420							-0.0210
ALASKA	0.0681	0.2210	0.1913	0.3183	0.1516	0.1245	0.1319	0.2135
ALOHA	0.2764							0.1111
BRITISH			0.2767	-0.3479	0.2477	-0.0060	-0.0072	0.0327
CONT	-0.0745	0.3856	0.2948	0.3337	0.0117	-0.0750		0.2324
DELTA	0.6026	0.5434	0.5996	0.5237	0.7729	0.5010	0.7178	0.5789
EASTERN								0.4461
FRONTIER								0.3222
HAWAIIAN	0.1133					-0.1641		0.0632
KLM	0.1858	0.2796	-0.0133	-0.0555	0.2727	0.0299	0.1752	0.1784
NW	0.6264	0.4355	0.4499					0.5107
PAN AM	0.1709	-0.0079	0.1674	0.2683	-0.0427			0.2406
PIEDMONT	0.4169							0.3192
EPUBLIC								0.3531
SOUTHWEST	0.0636	0.4576	0.3904	0.2533	0.1967	0.4366	0.3682	0.3019
TIGER	0.1232	0.0324	0.0825					0.1830
TWC	0.2624	-0.0315						0.3978
UNITED	0.7280	0.1496	0.4929	0.4710	0.2328	0.7025	0.7296	0.5659
US AIR	0.5038	0.4015	0.2889	0.1796	0.3155	0.4049	0.3937	0.4179
WORLDCORP	0.0940	-0.0076	-0.0327	-0.0379	-0.0179	-0.1066	0.0975	0.1197
MAX	0.7280	0.5334	0.5996	0.5237	0.7729	0.7025	0.7296	0.5789
MIN	-0.1232	-0.0315	-0.0327	-0.3479	-0.0427	-0.1641	-0.0072	0.0327
MEAN	0.2610	0.2374	0.2657	0.1907	0.2141	0.1848	0.3258	0.2941
STD	0.2519	0.1976	0.1982	0.2528	0.2219	0.2860	0.2613	0.1590

From the perspective of American Airlines, as shown in Table 6, there are three firms, namely Delta, United, and Northwest, whose grand correlation coefficients are greater than 0.5, namely 0.5789, 0.5659 and 0.5107, respectively. Considering that it is a summary statistic over the 15 years, their stock returns have co-moved very tightly over the last 15 years. On the other hand, British Airways and KLM have grand correlation coefficients of 0.0327 and 0.1784, respectively. While their sales volumes (see Table 3) and net incomes (Table 4) are near the group of American, Delta, and

United, nonetheless, the two airlines are clearly distinguishable from the large trunk airlines. Furthermore, American Airlines easily differentiates itself from small regional airlines such as Alaska (grand coefficient of 0.2135), Aloha (0.1111), and Hawaiian (0.0632).

Table 7. Summary Correlation Coefficients for Relative Closeness from the perspective of Hawaiian Airlines (7 years).

	1980	1981	1982	1983	1984	1985	1986	Grand Summary
AA	0.2462	0.0296	0.0175	0.2004	-0.0962	-0.2272	0.1133	0.0405
ALASKA		0.1802	-0.0591	0.2081	-0.1344	0.179	-0.2612	0.1058
ALOHA	-0.1172	0.6318	0.3009	0.2966	0.1809	0.1528	-.5328	0.2827
BRANIFF	0.1542	-0.2668						(0.0563)
CONT	0.0483	0.0325	0.0986	0.1221	-0.0605	-0.3218	0.1622	0.0116
DELTA	0.0332	0.1382	0.0928	0.3758	-0.0159	0.1623	-0.0465	0.1057
EASTERN	0.1202	0.2425	0.2595	0.1332	-0.0524	0.3194		0.1704
FRONTIER	0.0338	0.1515	0.1842	-0.0184	-0.0563			0.0590
KLM		0.0911	0.2303	-0.1373	0.0847	0.0278	-0.0541	0.0404
NW	-0.0882	0.1192	0.0328	0.1948	0.0255	-0.1262	0.2544	0.0589
OZARK	0.2239	0.096	0.197	0.1629	0.2299	0.0089		0.1531
PAN AM	-0.1025	-0.0351	0.0057	0.1816	-0.1528	-0.0197	-0.1455	(0.0383)
PIEDMONT	0.2026	0.0056	0.1594	0.3211	0.0052	-0.0158	0.1719	0.1214
REPUBLIC	0.0667	0.066	0.0563	0.3651	0.0376	-0.1237		0.0780
SOUTHWEST	0.1396	0.3176	0.2999	0.2077	0.1648	-0.0039	0.1528	0.1826
TIGER	0.2824	0.1694	-0.0419	-0.027	0.2322	-0.0541	-0.0507	0.0729
TWA	0.1866	-0.0731	-0.0043	0.054	-0.0063	-0.1659	0.1171	0.0154
UNITED	0.1568	0.0985	-0.0089	0.1687	0.007	-0.1119	0.3255	0.0908
US	0.165	0.0128	0.0242	0.3044	0.0948	-0.0414	0.0394	0.0856
WTC	0.0686	-0.0015	-0.023	-0.344	0.1687	-0.0085	-0.0485	(0.0269)
WESTERN	-0.0005	0.006	0.2507	0.3387	-0.0045	-0.0801		0.0851
WORLDCORP	-0.0048	0.098	0.1149	0.6182	0.2846	0.0615	0.1039	0.1823
MAX	0.2824	0.6318	0.3009	0.6182	0.2846	0.1790	0.5328	0.2827
MIN	-0.1172	-0.2668	-0.0591	-0.3440	-0.1528	-0.3218	-0.1455	-0.0563
MEAN	0.0826	0.0959	0.1085	0.1763	0.0516	-0.0378	0.1184	0.0803
STD	0.1104	0.1638	0.1159	0.2024	0.1209	0.1353	0.1730	0.0776

Table 7 presents the longitudinal movements of airline firms from the perspective of Hawaiian Airlines over the period from 1980 through 1986 (stock return data for the Hawaiian Airlines are not available for other years). As shown in Table 7, Aloha Airlines has the highest grand correlation coefficient of 0.2827. The average of the grand correlation coefficients is 0.0803. It is much lower than that of American Airlines or 0.2941 (see Table 6). This fact may imply that Hawaiian Airlines is a niche- -pursuing airline company and that their stock returns would be affected (and move) differently from those of major Airlines companies like American, Delta, and United.

4. Discussion and Conclusion

In order to fulfill the imperative need to develop an objective and replicable method to analyze longitudinal dynamics of categories or SGs in an industry, in this paper, the DSRM is applied to the US airline industry over the period of 1979 to 1992 just after a significant event of industry deregulation in 1978. While the validity of derived categories is checked via the documented industry history, the relative closeness of stock movements between two representative firms (American and Hawaiian Airlines) is further analyzed over the 7- and 15-year time period, respectively.

In our particular sample of US airline industry, the clustering results found show a high level of face validity and confirm the industry's fact-based historical progress. As shown in Table 2, during the period of 1979-1985 the number of firms in the industry increases and the industry leader group does not always include only obvious leading firms such as American, Delta, and United. On the other hand, during the period of 1986-1992, the number of firms in the industry decreases to 10 and the industry substructure become very consistent (see 3rd and 4th 4 columns in Table 2). It appears that the industry liberalization has created lower entry barriers to the industry and thus has caused fierce competition among the firms in the industry (r-type). Consequently, less competitive firms become obsolete, and die out. Competitive firms became more competitive through acquiring less competitive firms (k-type). Niche-specific firms who are efficient survive even in the most competitive environment. In the long run, the firms decrease in number, and the competition has become more intense since deregulation. These facts confirm the paradigm of Industrial Organization of Economics that industrial liberalization is better than restricted industry monopoly from the perspective of social welfare because competition drives firms to be efficient.

As exhibited in Table 6, in the longitudinal analysis of relative closeness from the perspective of American Airlines, the stock returns of the leading firms like American, United, Delta, and Northwest have moved together closely over the 15-year period, their grand correlation coefficients being greater than 0.5. As far as niche players are concerned as

exhibited in Table 7, Hawaiian Airlines has the highest grand correlation coefficient of 0.2827 with Aloha Airlines. Considering that it is a summary statistic over the longer time period like 7 or 15 years (ranging from -1 to 1), it seems a surprising result.

Based upon the findings above, we draw a conclusion from this study. The DSRM can effectively identify industry SGs or categories even over a very longer period, say, even 14 year time span. Since derived SGs are obtained through a stylized method with market data, the DSRM is likely to be a replicable method, which enables us to analyze longitudinal

dynamics in industry categorization. The evidences from the representative airline industry in 1979-1992 appear to confirm that the longitudinal industry categorization can be done reliably and meaningfully through the DSRM.

The major limitation of the DSRM would be that diversified firms across industries may not be suitable for clustering. In order to empirically find industry subgroups, nonaggregate group common effects should be detected, not aggregate effects. Nonetheless, we believe that the DSRM may resolve meaningful issues in the field of strategy. Future research includes applying the DSRM to conduct a longitudinal analysis over a long-term time horizon over various industries. It would be particularly interesting to look into the locus of groups' or group members' structural moves. Some additionally important issues in this avenue of research would include the following; the relationship between SG membership and its profitability over time; the locus of structural changes; the presence of first-mover or competitive advantages; and the sustainability of these advantages over a long-term period. Some of these future issues could be hopefully resolved by using the DSRM.

Acknowledgements

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