

An Introduction to DOT Form 41 Web Resources for Airline Financial Analysis

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An Introduction to DOT Form 41 Web Resources for Airline Financial Analysis

U.S. federal law requires American passenger and cargo airlines to report financial and operating information to the U.S. Department of Transportation; the resulting “Form 41” data is widely used in airline analysis and financial research but was previously not easy to obtain. Now available on the Web, DOT’s TranStats Intermodal Transportation Database is a wonderful data resource for teaching financial ratio analysis, benchmarking, and airline industry analysis. This paper teaches the reader to “speak airline” by using DOT data to replicate a government study on airline bankruptcy.

INTRODUCTION

U.S. federal law requires that most American passenger and cargo airlines, whether publicly traded or privately owned, report financial and operating information to the U.S. Department of Transportation (DOT) on a monthly, quarterly, or semi-annual basis.¹ Often referred to by the name of one of its required reports, the “Form 41” system includes balance sheets, income statements and other financials as well as operating or “traffic” statistics. Financial reports submitted to DOT are generally unaudited, but they must tie to the airlines’ GAAP reporting.

The system is a holdover from the days of complete government regulation of the airline industry under the Civil Aeronautics Board (CAB), which mandated an industry-wide standard for accounts and reports. With airline deregulation and modernization of enterprise-wide accounting systems, carriers now have a diverse array of accounting system choices. They either must have their accounting system approved by DOT, and let DOT do the translation of their reports into Form 41 format, or they must translate their own accounting system output into DOT format before reports are submitted. The resulting comparability across carriers makes Form 41 data widely used in finance, economics, and industry analysis and for competitive benchmarking.

Airlines typically fulfill the statutory Form 41 requirements by forwarding electronic versions of several reports to the Bureau of Transportation Statistics (BTS.) Some months after airline reports are submitted, DOT makes the non-confidential components available to the public as raw data and as published summary reports. Formerly, the raw data files were

available for modem download in text file format from BTS for the price of a long distance phone call or from third party vendors in a more user-friendly format. Industry insiders who don't need the raw data often read McGraw-Hill's *Aviation Daily* which regularly summarizes newly-released Form 41 data. Analysts also scrutinize DOT's quarterly release of the *Airline Quarterly Financial Review*, available online at http://ostpxweb.dot.gov/aviation/X-50%20Role_files/airlinefinancialreview.htm; this report, produced by the Competition and Policy Analysis Division at the Office of Aviation Analysis, offers comparisons of the largest passenger and cargo carriers.

Despite the richness of detail available from the Form 41 system, academics outside of the transportation and logistics fields seldom used this data due to the time required to obtain it, the level of industry knowledge required to use it, and/or the expense of subscribing to more user-friendly third-party vendors' products. Now, DOT has made the airlines' Form 41 data available on the Internet through TranStats, the "Intermodal Transportation Database" which can be found at <http://www.transtats.bts.gov/>. This paper provides the new user of Form 41 data with an introduction to airline analysis as well as a guided tour through the TranStats data resources. The user is then guided through obtaining enough data to replicate the calculations from a published government analysis of airlines on the verge of bankruptcy in the post 9/11 period; after this exercise, the diligent reader should be ready to use TranStats to obtain Form 41 data for their own research purposes.

FORM 41 DATA USE IN FINANCE

The student of finance studying airlines for the first time is learning a foreign language; the most widely-used aviation benchmarks are different from those used in other industries and the source of the information used to calculate those ratios is seldom identified. For example, O'Connor's (2001) *An Introduction to Airline Economics* defines airline ratios but does not specifically discuss Form 41 data or how to get it. This is pretty typical of the literature; those who are in the field use Form 41 data for many purposes but seldom identify its origins.

Vasigh and Fleming (2005) use Form 41 data from 1996-2001 in a Total Factor Productivity Analysis of airline efficiency. Their input and output factors, shown in Figure 1,² include the most frequently used Form 41 data elements and ratios based upon them. Their cited Form 41 source is Data Base Products Inc., whose (2006) website listed the one time purchase

cost of Form 41 annual data DVDs (with educational discount) as \$3500. Many of the aviation-related cost function studies reviewed in Oum and Waters (1996) are based on Form 41 data. Finally, Gudmundsson's (2002) study on distressed airlines names as its sources publications by the International Air Transport Association (IATA) and the UN's International Civil Aviation Organization (ICAO) which contain data originally derived from carriers' Form 41 reporting systems.³

Input Variables	Output Variables
Available Seat Miles (ASM)	Revenue Passenger Miles (RPM)
Total expense	Total Revenue
Cost per available seat mile (CASM)	Yield (or Revenue / RPM)
Average number of employees	Revenue per available seat mile (RASM)
Fuel cost	Load Factor

Figure 1: Form 41 Variables Used by Vasigh and Fleming (2005)

Airlines report Form 41 facts to their shareholders; references to Available Seat Miles, Load Factor, or Revenue Passenger Miles can be found in every carrier's annual reports, usually listed with Consolidated Highlights on the inside cover or in a five- or ten-year summary of selected data. Airline industry analysts on Wall Street also use Form 41 data. A PowerPoint presentation made by Lehman Brothers analysts Chase and Clark (2004) is typical. The slides refer to Revenue per Available Seat Mile (RASM), city pairs, frequency, yield, and stage-length; raw Form 41 numbers have been transformed to tell a sophisticated story about airline competition in specific markets. No data source is cited, but many analysts subscribe to Form 41 products from third-party vendors such as BACK Aviation Solutions or Data Base Products, Inc. Wall Street Journal articles covering the airline industry also cite Form 41 elements. Airline industry benchmarking ratios all rely upon Form 41 data.

GETTING STARTED WITH TRANSTATS

Preliminary Advice

Using TranStats requires a fast and reliable Internet connection. Beginners may prefer to use the interactive Analysis Tools discussed below but more detailed research will require downloading data tables. The data download interface is very user-friendly and TranStats

provides a Downloading Instructions link on every download page. The data tables are offered as read-only, comma-delimited .csv files, usually packaged in WinZip format. When extracted and reformatted, the files are suitable for use in spreadsheets, databases, or statistical packages. In cases where fast Internet access and/or computing experience are limited, the reader may wish to download the data into a database or statistical package to make available locally to other users.

Some of the downloadable files are too large to open using spreadsheet software. To get around this problem, either import the downloaded .csv file directly into a database or statistics package or use the TranStats tools to limit the download by date to generate smaller files. Writing an Import Specification the first time a particular Form 41 file type is imported into database software will make it very easy to import the .csv data efficiently with each quarter's new data release.⁴

Be wary of using Excel to open and save those .csv files that will be exported into other software. Critical leading zeroes in some table fields could be lost. Numbers formatted as scientific notation in too-narrow columns may not export well into other software. To prevent these problems, use Excel's Data Import wizard on tables.⁵ Alternatively, for examining a smaller data table before exporting it into other software programs, use a text editor such as WordPad to open the downloaded .csv file.

Aviation Support Tables

To get started, look on the TranStats home page at www.transtats.bts.gov. On the left hand side of the page, just under the *Resources* section is the *Data Finder*. Click on the *Aviation* link to find a long list of relevant databases in the Aviation Data Library. Each database listed is briefly described and has links to a more detailed profile and a download link. Start with the database called **Aviation Support Tables**; click on its name to see the tables it contains. While the web pages for each of the Form 41-related databases contain links to specific field name definitions and code lookup tables, these three **Aviation Support** tables discussed next are the files on which many lookup tables are based and are crucial to understanding Form 41 data. Rather than downloading bits and pieces, go ahead and download these tables and have them handy. Anyone who anticipates downloading quarterly data regularly would be prudent to check

TranStats for updates to the Aviation Support tables at the same time. Technical questions about tables and their content can be directed to answers@bts.gov.

Aircraft Types

Begin with the **Aircraft Types** table; click on its name and you will get a list of field names and descriptions. Notice that the second field name listed is *AircraftGroup*, which is hyperlinked to a lookup table. The Description tells you “Aircraft Type Group - This Number Gives The Group Or Classification Of Aircraft Engine And Type Of Aircraft.” Click on *AircraftGroup* and then on *Download Lookup Table*; open it (or save to your computer as a .csv file and open it) and you get the results shown in Figure 2. A “6” here indicates a two-engine jet. Notice a code of “9” for is used in records containing financial or traffic data that is summed across aircraft types. The **AircraftTypes** table itself should have no records containing “9” in this field.⁶

Code	Description
0	Piston, 1-Engine/Combined Single Engine (Piston/Turbine)
1	Piston, 2-Engine
2	Piston, 3-Engine/4-Engine
3	Helicopter/Stol
4	Turbo-Prop, 1-Engine/2-Engine
5	Turbo-Prop, 4-Engine
6	Jet, 2-Engine
7	Jet, 3-Engine
8	Jet, 4-Engine/6-Engine
9	Used for capturing expenses not attributed to specific aircraft types

Figure 2: Aircraft Group Lookup Table⁷

Now download the actual **Aircraft Type** table; be sure to check *Select All Fields* before you begin. Note that if you check “Documentation” on the download choices you will only get the field definitions, not the table itself. If you are interested in studying individual aircraft types with Form 41 or in learning what aircraft a particular carrier operates, you need the *Aircraft Type ID*. Figure 3 below contains an **Aircraft Type** table extract showing details for the Boeing 767-400. Notice its *AC_TYPEID*, 624. This number indicates that the aircraft is a 767-400. The first digit “6” is the *Aircraft Group* code for two-engine jets that you just looked at in Figure 2. The Begin Date shows when DOT added 767-400s to the system. A Null or blank End Date means that aircraft of this type are still in service. For more information on specific aircraft

types, consult a good general aviation reference such as any recent edition of Jane’s All the World’s Aircraft or Montgomery’s Field Guide to Airplanes of North America.

Field Name	767-400 Example:
AC_TYPEID	624
AC_GROUP	6
SSD_NAME	BOEING 767-400
MANUFACTURER	BOEING
LONG_NAME	BOEING 767-400
SHORT_NAME	B767-4
BEGIN_DATE	1/1/1998
END_DATE	

Figure 3: Extract from Aircraft Types Table

Carrier Decode Table

Now that you have the aircraft identified, who is flying them? The **Carrier Decode** Table provides a guide through the tangled thicket of air carrier identity changes since 1960 and is therefore crucial for understanding any carrier’s traffic statistics or financials through time. Air carriers are commonly referred to by *Carrier* codes, such as “FX” for Federal Express Corporation, which are not unique and can change over time. DOT’s *AIRLINE ID* field is a unique code which allows the data user to more easily follow the same airline through its history of changes in name, carrier code, and ownership structure. The **Carrier Decode** Table is therefore the best place to start the analysis of any airline by identifying when and where it has operated.

Figure 4 below contains an extract from the **Carrier Decode** table showing the history of Federal Express Corporation. From June of 1981 through the end of 1985, FedEx’s *CARRIER* code was FED. IATA assigns all international carriers a two digit *Carrier* code; with growing international operations, Federal Express was assigned *Carrier* code FM and used it from January 1986 until 1996. At the carrier’s request, IATA then changed the Federal Express carrier code to FX, and the Carrier Decode table reflects this change as of August 1996. Note that Federal Express can be identified across its history in this table by its *AIRLINE ID* code 20107 as well as its *UNIQUE CARRIER* code of FX. If different carriers had previously used the carrier code FX over time, they would show up in the *Unique Carrier* field with a trailing number in parentheses.

Air carriers providing scheduled services are required to make separate financial and traffic reports by the world regions in which they operate: Domestic, Atlantic (for Europe), Pacific (for Asia), and Latin America (for Central and South America); carriers providing non-scheduled service report Domestic and International regions. Besides identifying these regions by name in the *Region* field, the **Carrier Decode** table includes a five-character *Carrier Entity* code for each *Region* in which a specific carrier operates. In the rare instance where these entity codes are not unique, the *Unique Carrier Entity* field adds trailing numbers to distinguish different carriers. Thus, the use of region and/or entity codes allows one to study the Asian or Latin American business of American carriers.

Returning to Figure 4, look at the *Carrier Entity*, *Region*, *Start Date Source* and *Thru Date Source* rows. From 1981 through 1985, Federal Express has only a Domestic entity. They began scheduled service flights to Europe in 1985. In 1986, there are now two Federal Express entities, Domestic (06200) and Atlantic (16196). According to FedEx’s Corporate History (2006a), flights to Japan started in 1988; the Pacific (16197) entity appears as of January 1988. FedEx Mexico (2006b) reports that flights to Latin America began with their acquisition of Flying Tigers in 1989; the Latin America entity (16195) has a start date of August 1989.

AIRLINE_ID	20107	20107	20107	20107	20107	20107	20107	20107	20107
CARRIER	FED	FM				FX			
UNIQUE_CARRIER	FX	FX	FX	FX	FX	FX	FX	FX	FX
CARRIER_ENTITY	80029	06200	16196	16197	16195	06200	16196	16197	16195
UNIQUE_CARRIER_ENTITY	80029	06200	16196	16197	16195	06200	16196	16197	16195
REGION	Domestic	Domestic	Atlantic	Pacific	Latin America	Domestic	Atlantic	Pacific	Latin America
WAC	10	10	10	10	10	10	10	10	10
CARRIER_GROUP	7	3	3	3	3	3	3	3	3
CARRIER_GROUP_NEW	7	3	3	3	3	3	3	3	3
START_DATE_SOURCE	6/1/1981	1/1/1986	1/1/1986	1/1/1988	8/1/1989	8/1/1996	8/1/1996	8/1/1996	8/1/1996
THRU_DATE_SOURCE	12/31/1985	7/31/1996	7/31/1996	7/31/1996	7/31/1996				

Figure 4: Extract of Federal Express Corporation Data from Carrier Decode Table, Aviation Support Database ⁸

When you download the data from the **Carrier Decode** Table, you should also download these three associated Lookup Tables: *WAC* or World Area Code, *CarrierGroup*, and *CarrierGroupNew*. The WAC for FedEx in Figure 4 is “10”, indicating from the WAC Lookup Table “U.S.A. (including Territories and Possessions)”. The *CarrierGroup* for FedEx changed from a “7” for “Domestic Only - All Cargo Carriers” to a “3” for “Major Carriers” at the same time that the entity codes show FedEx’s internationalization. The *CarrierGroupNew* of “7” also

changes to a “3”, indicating its shift from the category of “All Cargo Carriers” to “Major Carriers”. The carrier groups for reporting purposes have changed, but both fields are needed in order to correctly interpret both older reports and newer ones.

Master Coordinate Table

The shortest distance between two airports is not a straight line but the arc of a great circle that follows the planet’s surface. (Pilot’s Web 2006) Revenue ton miles and available seat miles, important benchmarks for air carriers, are measured in great circle miles; latitude and longitude of origin and destination (O&D) airports are entered in website or software tools in order to calculate these distances.⁹ But ...are location coordinates measured at the air traffic control tower, at the air carriers’ ramp, or at the center of the runway? Which runway? DOT provides the **Master Coordinate Table** of airport locations so that all carriers can use the same coordinates for reporting purposes; otherwise, DOT’s summaries of a carrier’s traffic statistics could differ from the carrier’s own reports for the same flight. This table also contains the official three-letter IATA Airport codes (as well as their cities and countries) for most commercial airports in the world, making it a useful file for any traveler’s laptop computer or PDA. Adding longitude and latitude coordinates from this table to an airline dataset enables spatial analysis of the carriers. Some data cleanup is required, including care with formatting when importing this table for use in spreadsheet, database or geographic information system (GIS) software.

FORM 41 FINANCIAL REPORTS

Having absorbed the first lesson in “speaking airline” from exploring the **Aviation Support Tables**, it is time to actually look at the financials. Go back to the Aviation Data Library page and click on the **Air Carrier Financial Reports (Form 41 Financial Data)** database name. Each table in this database contains a different type of financial report or “schedule” which is explained in some detail in the TranStats list of tables. Since October 2006, the financial reports listed here follow the conventions for number signs found in company financial statements; descriptions of some tables include a warning to re-download older data for consistency with this change.¹⁰

In general, the financial reports presented in TranStats as Form 41 Schedules are all organized along the same lines; however, because reporting requirements differ between airlines of different sizes, not all airlines will be found in every schedule. The Balance Sheet serves as an example. Two versions are listed: **Schedule B-1** represents quarterly reports from carriers with annual operating revenues of \$20 million or more while **Schedule B-11** provides semiannual reports from smaller carriers. **Schedule B-1** is examined in more detail below.

Each Schedule listing includes a brief descriptive paragraph as well as four clickable items: 1) **Schedule name**, 2) **Table Profile**, 3) **Release Info** and 4) **Download**. The reader is encouraged to explore these options before continuing. **Table Profile** provides a description of the schedule including numbers of records and fields as well as the latest date of available information. **Release Info** provides a color-coded graphic showing whether each carrier's reports for the six most recent reporting periods are filed, revised, missing, or deleted.

Click on **Schedule B-1**'s name to see all the data fields for large carriers' balance sheets. The list of fields is categorized by Account type in balance sheet order, beginning with Current Assets, and concludes with carrier information and reporting period fields. Notice that the Carrier Information category items are the same ones previously seen in the **Carrier Decode** Table. Each record, when downloaded, will contain all of these fields, representing one airline's balance sheet for a particular region of the world for a particular reporting quarter. Typically, carriers report all balance sheet items in the domestic entity.¹¹ The Uniform System of Accounts required for this report is spelled out in Part 241 of Title 14: Aeronautics and Space of the Code of Federal Regulations, which can be found by typing 14CFR241 in the search box at <http://www.gpoaccess.gov/cfr/index.html>.

The first balance sheet account listed for **Schedule B-1** is **10100 Cash (000)**, with the zeroes indicating the account is reported in thousands of dollars. In the same row, to the right, is an **Analysis** link; click it once and be patient. TranStats is preparing a cross-tabulation of the newest year's reported Cash account amounts by Unique Carrier by Quarter. As of December 2007, the first three quarters of data are available. Scroll down to carrier code FX and you will see the cash amounts reported by Federal Express Corporation for the periods displayed.

Filter options at the top of the **Analysis** page let you quickly change to other accounts or other reporting periods and then recalculate. Change the Variables filter to show *Accounts Pay Trade* and hit recalculation; you will get the balances of **20210 Trade Accounts Payable (000)**.

With the crosstabulation showing each carrier's amounts, you also get a Chart link at the end of each row that will show that account's balances for that particular carrier for all reported quarters going back as far as possible. If you only need a few values, Analysis tools can give you quick access to data; it is easy to highlight and copy one airline's row of data from the crosstabulations for pasting into a spreadsheet. To get the entire table or a large subset of it, return to the Schedule listing for **Schedule B-1** and click **Download**. The interface offers options to select all or only a subset of fields and to limit the data to a particular year or quarter.

The Form 41 Profit and Loss (P&L) Statements include **Schedule P-12** for large carriers and **Schedule P-11** for smaller ones. Click on the **Schedule P-12** name to get the field list of accounts; this list begins with bottom line accounts **98990 - Net Income, Profit or Loss (-) (000)** and **79990 - Operating Profit or Loss (-) (000)** then reverts to typical P&L category order from Operating Revenue onward. Now find account **71990 Total Operating Expenses (000)** and click on Analysis. The Analysis Tools offered for **Schedule P-12** include more filtering options. On the left of the screen, click on Analysis Type: Crosstabs. After the screen refreshes, the Filter Rows default setting is Quarters. Change this to Unique Carrier and click on Recalculate to refresh the screen again. Now set Filter Columns on Quarter, and Filter Years on 2005, then click on Recalculate again to get a crosstabulation showing the OpExpense account by Unique Carrier by Quarter for 2005. Scroll down the listing to find carrier FX. The Federal Express total for this account for the first quarter of 2005 appears as \$4,523,388 which is their total operating expense for all four operating regions, or \$4.5 billion. What fraction of these operating expenses is devoted to preparing to fly or actually flying? Find out by setting Filter Variables on FlyingOps and click Recalculate. For Federal Express, Account **51000 Flying Operations Expenses** appears as \$935,022 in the table, or \$935 million. The reader is encouraged to explore the Table Profile for **Schedule P-12** to find definitions of all the accounts included in this P&L. To get P&L listings by individual reporting regions of the world for each carrier, download the entire data table for the period of interest or at least download the identification fields including carrier and unique entity and the account fields of interest.

Even more detailed expense information can be found in a report that is unique to the airline industry and DOT: **Schedule P-52 Aircraft Operating Expenses**. Each carrier provides expenses for each aircraft type for each region of the world. These reports are useful for understanding the cost structures of particular carriers or their particular aircraft fleets. For

example, analysts wanting to study the impact of jet fuel prices on a particular carrier or type of aircraft would find fuel expenses in account **51451 - Aircraft Fuels (000)** and the number of gallons actually used in account **Z9210 - Aircraft Fuels Issued in gallons (000)**. Downloading these accounts from the table would allow more detailed examination of fuel usage patterns. Analysis Tool options in **Schedule P-52** offer many more choices. Experiment with settings until you get a crosstab analysis of Total Expenses by Unique Carrier by Quarter. Look at **P-52 Account 51990 Flying Operations – Total Expenses (000)** for Federal Express for Q1 2005 and you see that its total \$935,022 ties back to account **51000 Flying Operations Expenses** from **Schedule P-12** for the same period. Downloading the full data set for a period of interest allows exploration of expenses by aircraft type and world region for each carrier.

Comparisons of non-aircraft related expenses, such as salaries and advertising, are best done with the **Schedule P-6 Expenses by Objective** grouping and **Schedule P-7 Expenses by Operating Group**, which break down the same total expenses from the P-12 into other categories. **Schedule P-6** account **00360 Total Operating Expenses** and **Schedule P-7** account **00380 Total Operating Expenses** both tie back to **71990 Total Operating Expenses** from the **P-12**; Q1 2005 balances for Federal Express total \$4,523,388(000). Annual numbers of employees for some airlines, found in **Schedule P-10 Annual Employees Statistics by Labor Category**, can be used to calculate per capita benchmarks.

FORM 41 TRAFFIC STATISTICS

The TranStats Aviation Data Library also includes Form 41 traffic databases that summarize operational details about flights, passengers, and cargo summarized by *markets* and *segments*. Passengers or cargo traveling from a first departure airport to their ultimate destination airport on a single flight number make up the *on-flight market* for that origin-destination pair of airports. The same flight number can include one or more stops between the market origin and destination, with each of those nonstop intermediate flights being a flight *segment* (also called a flight *stage*.) Because one flight segment can serve many markets, the Form 41 reporting system includes both market and segment information.

For example, passengers traveling from Louisville International Airport in Kentucky (Airport code SDF) to Phoenix Sky Harbor International Airport in Arizona (Airport code PHX)

have many choices. Passenger A chooses Southwest Airlines Flight 963 for nonstop service between SDF and PHX. Southwest reports Passenger A in the SDF-PHX on-flight market and the SDF-PHX nonstop segment. Passenger B chooses Southwest Flight 1592, which makes an intermediate stop at Midway International Airport (Airport code MDW) in Chicago before flying on to Phoenix. Passenger B is reported in the SDF-PHX on-flight market and the SDF-MDW and MDW-PHX nonstop segments of Flight 1592. This flight actually has many segments along its itinerary (BWI-SDF-MDW-PHX-ONT-OAK), but only some of its passengers and cargo would be part of the SDF-PHX market. Across the aisle on Flight 1592 is Passenger C who boarded at Baltimore-Washington International Airport (Airport code BWI) and gets reported in the Southwest BWI-PHX market and the BWI-SDF, SDF-MDW, and MDW-PHX nonstop segments. Passenger D buys a ticket combining passage on American Airlines Flight 4485 nonstop from SDF to Chicago O'Hare International Airport (Airport Code ORD) and American Flight 2487 nonstop from ORD to PHX. Passenger D's travel is reported in American's SDF-ORD market and segment as well as its ORD-PHX market and segment. Finally, some passengers might choose to travel between Louisville and Phoenix on an itinerary comprised of separate flights operated by two or more carriers.

Analysts studying traffic carried and available capacity in particular markets or flight segments will be most interested in the **Air Carrier Statistics (Form 41 Traffic)** databases derived from the carriers' **Schedule T-100 -- U.S. Air Carrier Traffic and Capacity Data By Nonstop Segment and On-flight Market** and **Schedule T-100f -- Foreign Air Carrier Traffic and Capacity Data By Nonstop Segment and On-flight Market** reports. Foreign carriers only report those flights having an origin or destination in the United States or its territories and this information is published three months later than that of domestic carriers; as a result, two versions of this database are offered.

The **Air Carrier Statistics (Form 41 Traffic)- All Carriers** database contains data on US and foreign carriers while the **Air Carrier Statistics (Form 41 Traffic)- U.S. Carriers** database excludes the foreign carriers; the six tables in each databases are otherwise identical. The **T-100 Domestic Market** table reports on all markets with both origin and destination in the US while the **T-100 Domestic Segment** table reports on non-stop segments operated between US airports. The **T-100 International Market** and **T-100 International Segment** tables report the same data for markets and nonstop segments with either the origin or destination outside the

US. The last two tables are the **T-100 Market** and **T-100 Segment** tables which summarize the domestic and international market and segment data from the other four tables. All three **Market** tables report *enplaned* traffic, or the passengers, freight and mail actually flown; the three **Segment** tables report available capacity and the *transported* passengers, freight, and mail. (BTS 2006). The Segment tables also include aircraft type. These tables can be used to study competition in specific markets or segments, regional carrier operations, hub and spoke patterns and carrier networks.

For most financial analysts, the tables found in the **Air Carrier Summary Data (Form 41 and 298C Summary Data)** database are of greater interest. **Schedule T-1** gives monthly summaries of T-100s by carrier entity and service class. **Schedule T-2** provides quarterly totals by carrier, aircraft type, service class and region for the most common operating statistics, which are discussed in the next section; this table can be used for competitive benchmarking of the airline industry, as described in the next section. **Schedule T-3** summarizes by carrier, region and service class the quarterly operations for each origin airport from which that carrier operates. The fourth table, **RAA: Commuter and Small Certificated Air Carrier Traffic and Capacity Statistics**, summarizes T-100 data on commuter and charter flights from the smallest carriers which are members of the Regional Airline Association.

The TranStats Aviation Data Library also contains other aviation traffic-related databases that may be of interest to analysts but are too specialized for the scope of this paper, such as **Airline On-Time Performance Data**, **Air Carrier Employees**, and the **U.S. International Air Traveler Statistics (I-92)**. **The Airline Origin and Destination Survey (DB1B)** offers a 10% sample of passenger tickets. Other offerings are related to safety, accidents, greenhouse gases, and foreign trade; the reader is encouraged to explore the wealth of information in the TranStats Aviation Data Library.

AIRLINE INDUSTRY BENCHMARKING

An airline's inventory of seats for sale to passengers (or space available for cargo) disappears the moment the plane pushes back from the jet way; the seats (or cargo space) are still being flown whether empty or full. Say one aircraft with ten seats flies one great circle mile; in airline industry terms, that aircraft has just produced ten *available seat-miles* or ASMs. Fly the

same ten-seat plane for one hundred miles and you have produced 1000 ASMs. If five of those seats are filled with passengers who paid for their tickets, the aircraft has just produced five *revenue passenger-miles* (RPMs) for the one mile flight, or 500 RPMs for the one hundred mile flight. What percentage of the available seats that were flown were actually filled with paying passengers? Divide RPMs by ASMs to learn that our ten-seater has achieved a passenger load factor of 50% on either flight.¹² For freight and mail, equivalent measures are *available ton-miles* (ATMs) and *revenue ton-miles* (RTMs), based on transporting one ton of cargo for one mile.¹³ ASMs, RPMs, ATMs and RTMs are all found in **Schedule T-2** of the **Air Carrier Summary Data (Form 41 and 298C Summary Data)** database, along with other statistics such as gallons of aircraft fuel consumed and hours flown. Since total RTMs on passenger flights include the weight of revenue passengers and their luggage as well as any revenue freight or mail carried, **Schedule T-2** also includes fields for Freight RTMs and Mail RTMs.

While load factor considers physical capacity actually used, airline owners and analysts also want to know about revenues and expenses. On the revenue side, seats filled by paying customers matter; **Passenger Yield** divides passenger revenues by RPMs. Since the marginal cost of filling an empty seat with a paying passenger is small, expenses are customarily expressed in terms of capacity flown whether a particular seat is sold or not; the benchmark ratio is **Unit Cost** in cents per mile, obtained by dividing operating expenses by ASMs. Financial information needed to calculate these and other revenue- and expense-related ratios are all found in **Schedule P-12** (for large carriers) of the **Air Carrier Financial Reports (Form 41 Financial Data)** database. For the interested reader, a more comprehensive explanation of airline cost structures, industry production functions and the impact of management decisions on airline profitability can be found in (O'Connor 2001).

Breakeven Load Factor (BLF) is defined as “the percentage of seats that must be occupied by paying passengers in order that the revenues from the operation will just cover the costs.” (O'Connor 2001) A BTS study (2003) calculates it this way:

$$(1) \quad \text{Breakeven Load Factor} = \text{Unit Cost} / \text{Passenger Yield}$$

where

$$(2) \quad \text{Unit Cost} = \text{Operating Expenses} / \text{Available Seat Miles}$$

and

(3)
$$\text{Passenger Yield} = \text{Passenger Revenue} / \text{Revenue Passenger Miles}$$

BLF is expressed as a percentage, while unit cost and passenger yield are expressed in cents per mile. All three ratios are closely monitored by the airline industry.¹⁴

REPLICATING THE BREAKEVEN LOAD FACTOR STUDY

In 2003, BTS used Form 41 data to compare Breakeven Load Factors for the largest US passenger airlines in three categories: *profitable* Southwest (WN), *recently bankrupt* United (UA) and US Airways (US) and *at risk of bankruptcy* American (AA), Alaska (AS), Continental (CO), Delta (DL), America West (HP) and Northwest (NW). The results of the study were published as an Issue Brief (BTS 2003). The analysis (.pdf and spreadsheets) can be downloaded at http://www.bts.gov/publications/issue_briefs/number_08/ and its replication is a suitable assignment for undergraduate and MBA level courses in finance, accounting and economics.

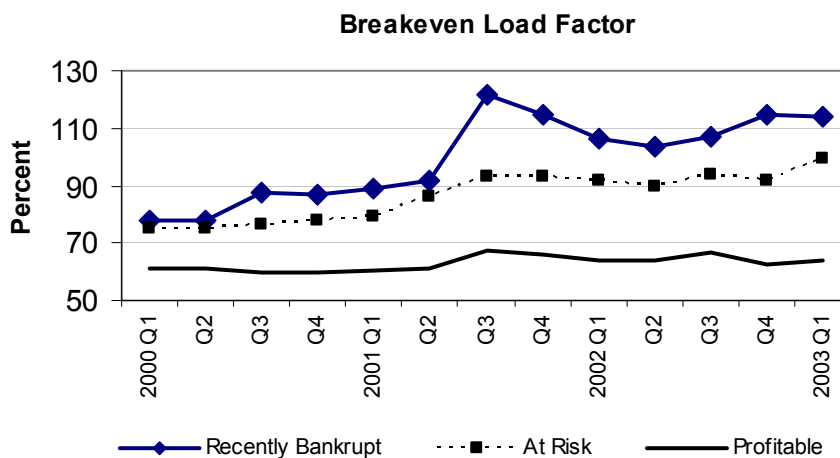


Figure 5: BTS Quarterly Breakeven Load Factor Chart for three airline groups (Figure 1, BTS 2003)

Covering the period from Q1 2000 thru Q1 2003, the BTS study notes the sharp rise (above 100%) in the breakeven load factor for the recently bankrupt group, the control over unit cost maintained by solely profitable Southwest, and the simultaneous decline in passenger yield and increase in unit costs for both at-risk and recently-bankrupt carrier groups (BTS 2003).

Figure 5 reproduces the Breakeven Load Factor chart from the BTS study. The published study

also includes separate charts showing Passenger Yield and Unit Costs. All three BTS charts are readily reproduced from the BTS-calculated results shown here as Figure 6 but none of these precise ratios are published in the TranStats website; where did the BTS analysts get the source numbers from the Form 41 system for these calculations?

Raw Data from BTS (2003) Breakeven Load Factor Study									
Date	Breakeven Load Factor (%)			Passenger Yield (cents per mile)			Unit Cost (cents per mile)		
	Recently Bankrupt	At Risk	Profitable	Recently Bankrupt	At Risk	Profitable	Recently Bankrupt	At Risk	Profitable
2000 Q1	77.70	74.76	61.31	14.39	13.01	12.52	11.18	9.73	7.68
Q2	78.04	74.77	60.86	14.18	13.07	12.77	11.07	9.77	7.77
Q3	87.71	76.78	59.82	13.29	12.83	12.87	11.65	9.85	7.70
Q4	87.08	78.02	59.88	13.80	13.34	12.93	12.02	10.41	7.75
2001 Q1	88.88	79.16	60.21	13.79	13.42	12.76	12.25	10.62	7.68
Q2	92.07	85.87	61.01	12.87	12.33	12.53	11.84	10.59	7.65
Q3	121.68	93.29	67.29	11.32	11.48	11.23	13.77	10.71	7.56
Q4	114.46	92.96	65.90	11.11	11.45	10.89	12.72	10.64	7.18
2002 Q1	106.34	91.78	63.87	11.64	11.68	11.41	12.37	10.72	7.29
Q2	103.51	89.68	64.06	11.68	11.42	11.64	12.09	10.25	7.46
Q3	106.90	94.11	66.79	10.68	10.99	11.03	11.42	10.35	7.37
Q4	114.98	91.55	62.25	10.83	11.56	11.98	12.46	10.58	7.46
2003 Q1	114.02	99.41	64.07	10.71	11.74	11.69	12.21	11.67	7.49

Recently bankrupt: United Airlines, US Airways; At Risk: American Airlines, Alaska Airlines, Continental Airlines, Delta Air Lines, America West Airlines, and Northwest Airlines. Profitable: Southwest Airlines. Form 41 data compiled from BTS (2003) spreadsheets downloadable at http://www.bts.gov/publications/issue_briefs/number_08/

Figure 6: Data from BTS Issue Brief download

Available Seat-Miles (Account 320) and Revenue Passenger-Miles (Account 140) are Traffic Statistics that can be found in the **Schedule T-2 tables in the Air Carrier Summary Data (Form 41 and 298C Summary Data)** database. For the carriers included in the study, Passenger Revenue and Operating Expenses can be found in **Schedule P-12 of the Air Carrier Financial Reports (Form 41 Financial Data)** database: **Account 39010** for *Transportation Revenue – Passenger* and **Account 71990** for *Total Operating Expense*. Remember that financial accounts from Schedule P-12 are expressed in units of 1000s.

The reader is encouraged to use TranStats to get the raw data required to replicate the BTS study. The simplest way to get these figures is to use the interactive Analysis tools in each database table mentioned in the previous paragraph to produce crosstabs of each account by unique carrier by quarter. Crosstabulate the data one year at a time, from Quarter 1 of the year 2000 through Quarter 1 of year 2003. Simply highlight and copy the totals for the airlines of interest (AA, AS, CO, DL, HP, NW, UA, US, and WN) into a spreadsheet for further

manipulation. The **Schedule T-2** Analysis crosstab tools will automatically sum an airline's figures for All Service classes to avoid double-counting. For ease of calculation, organize the data in spreadsheet columns arranged as in Figure 7. Depending on the computer skills of the reader or student, an alternative approach would be to download the entire Schedule T-2 and Schedule P-12 for years 2000 through 2003 and then manipulate the raw data with a database or statistical software package to get totals and perform calculations.

Calculations and Data Downloaded from Schedules P-12 and T-2									
Carrier Grouping	YEAR	QTR	Operating Expenses	ASMs	Unit Cost	Passenger Revenue	RPMS	Passenger Yield	BLF
Recently	2000	1	6,440,119	57,584,403,000	11.18	5,568,643	38,690,020,000	14.39	77.70
Recently	2000	2	6,684,409	60,387,545,000	11.07	6,455,139	45,507,936,000	14.18	78.04
Recently	2000	3	7,311,161	62,729,961,000	11.65	6,175,810	46,475,857,000	13.29	87.71
Recently	2000	4	7,380,374	61,421,323,000	12.02	5,959,230	43,185,207,000	13.80	87.08
AtRisk	2000	1	12,750,546	131,104,954,000	9.73	11,825,613	90,909,515,000	13.01	74.76
AtRisk	2000	2	13,219,000	135,321,109,000	9.77	13,644,371	104,430,844,000	13.07	74.77
AtRisk	2000	3	13,820,000	140,280,792,000	9.85	13,851,515	107,952,036,000	12.83	76.78
AtRisk	2000	4	13,875,954	133,273,411,000	10.41	12,525,558	93,863,814,000	13.34	78.02
Profitable	2000	1	1,087,164	14,159,215,000	7.68	1,184,151	9,455,125,000	12.52	61.31
Profitable	2000	2	1,146,067	14,751,461,000	7.77	1,399,062	10,959,328,000	12.77	60.86
Profitable	2000	3	1,178,776	15,317,000,000	7.70	1,411,667	10,972,630,000	12.87	59.82
Profitable	2000	4	1,217,112	15,713,544,000	7.75	1,402,579	10,843,382,000	12.93	59.88

Figure 7: Data Required and Results Calculated to Replicate the BTS Study for Year 2000

Figure 7 shows the downloaded raw data needed to replicate the BTS calculations for the year 2000 as well as the calculated results for Unit Cost, Passenger Yield, and BLF for those quarters. Note that the BTS study's tables and figures show all results by carrier financial status group; to get the same results, each variable used should be added across all carriers in that group before calculating the ratios. For example, Figure 7 shows the Q1 2000 ASMs value of 57,584,403,000 for the Recently bankrupt carriers. This number represents the sum of United's 42,526,128,000 ASMs and US Airways' 15,058,275,000 ASMs reported for the same quarter. In the same row of Figure 7, Operating Expenses represent the sum of those two carriers' expenses. Before proceeding, the reader who is attempting to replicate the BTS study should verify that their Operating Expenses, Passenger Revenue, ASMs and RPMS do indeed sum to match the numbers shown in Figure 7 for the year 2000.

Now it is time to calculate the benchmark ratios. While the BTS study reports Unit Cost and Passenger Yield in cents per mile, Form 41 Operating Expenses and Passenger Revenues account values are recorded in units of thousands of dollars. To get the Unit Cost and Passenger Yield calculation results to match the BTS study results as shown here in Figure 6, a conversion

factor of 100,000 is used in equations (4) and (5) below to convert thousands of dollars to cents. The Breakeven Load Factor is reported as a percentage, so equation (6) includes an adjustment factor of 100 to make results match the BTS study results shown above.

Unit cost should be calculated this way:

$$(4) \quad \text{Unit Cost} = (\text{Operating Expenses} * 100,000) / \text{Available Seat Miles}$$

Passenger Yield is calculated as follows:

$$(5) \quad \text{Passenger Yield} = (\text{Passenger Revenue} * 100,000) / \text{Revenue Passenger Miles}$$

The results of equations (4) and (5) are then combined to calculate the Breakeven Load Factor:

$$(6) \quad \text{Breakeven Load Factor} = (\text{Unit Cost} * 100) / \text{Passenger Yield}$$

These calculations are readily performed in each row of the spreadsheet formatted as suggested above. Once the calculations are completed for all years, verify that the results match the BTS study results found in Figure 6 above. A further challenge would be to produce, from these results, charts similar to those found in the BTS study, as exemplified in Figure 5.

Advice for Instructors

By replicating the BTS study, the reader has explored DOT's Form 41 reporting system while learning to calculate the most common airline industry benchmarks. For classroom use, students' level of proficiency with software and data analysis, speed and reliability of internet access, as well as desired goals for the exercise should govern the choice of method to obtain and manipulate source data from the TranStats databases. For example, students could use pivot tables or data subtotals in spreadsheets to produce the summarized data.

The benchmarks calculated represent weighted averages across each carrier group. A follow-on assignment could require students to calculate the individual airlines' ratios and

compare to the group averages. Alternatively, other carriers than those in the BTS study could be examined for the same benchmark ratios.

Asking students to update the BTS study for more recent quarters adds the complication of US airline industry changes. Both Delta and Northwest filed for bankruptcy; US Airways also filed but then merged with America West. Southwest has remained profitable.¹⁵ In addition, TranStats data can change after initial publication; when airlines restate their previous financial and operating results, DOT then publishes the newest results and flags those affected quarters as revised in database table profiles. Nevertheless, once the student has conquered the basics of replicating the BTS study, the Form 41 world of airline analysis is open to them.

CONCLUSION

Studying benchmarking and ratio analysis with US airline data from the Form 41 system can foster development of financial analysis skills for all students and can provide aviation-specific analytical skills for researchers and others interested in the US airline industry. This paper makes such airline industry analysis possible for the new user of aviation data. It provides a first lesson in “speaking airline” for the student of financial analysis; at the same time, it directs the reader through the Form 41 reporting system resources found online in the DOT TranStats aviation databases. This paper should convince students and teachers how quickly and easily US carriers’ financial reports and traffic statistics can be downloaded for financial analysis. By using data from DOT’s TranStats databases to replicate the BTS (2003) Breakeven Load Factor study, the reader can learn enough about the Form 41 System to be able to use it correctly for other research projects. Economics students can obtain the raw data needed for input-output studies or to assess the impact of bankruptcies and mergers on competition in the airline industry. Accounting students can download detailed data to perform comparative cost analyses. Students of logistics and transportation planning can use the data resources to study carriers’ networks or to perform supply chain and asset management analysis. Finally, by introducing a wider audience to the world of airline financial analysis, this paper should serve as the reader’s invitation to explore the online wealth of resources provided by DOT’s Research and Innovative Technology Administration, the Bureau of Transportation Statistics and the National Transportation Library.

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¹ US Code Title 49 (Transportation) governs the requirement to report, Title 14 (Aeronautics and Space) of the Code of Federal Regulations spells out the reporting details, and the DOT's Bureau of Transportation Statistics (BTS) Office of Airline Information provides further guidance in the form of Accounting and Reporting Directives.

² To avoid confusion between Form 41 tables and illustrations here, this article's illustrations are all referred to as Figures.

³ Large international carriers who choose to join IATA also make financial and traffic reports to that organization; these reports are generally derived from Form 41 reports to DOT, with metric conversions for distances and weights. DOT also reports on behalf of US carriers to ICAO, the International Civil Aviation Organization arm of the UN, by revising the carriers' Form 41 reports to fit ICAO standards.

⁴ In Access, start by doing File, Get External Data, Import, then browse to the zip file containing the Form 41 data in .csv format. Click Import and you will get an Import Text Wizard dialog box. Click the Advanced button in the lower left corner and you will be in the Import Specification for this file. Using the file documentation for this particular table type from TranStats, adjust each field name and field format so that the data will import correctly. Be sure to save the specification when it works the way you want. For example, the *Unique Carrier Entity* code from the **Carrier Decode** table can resemble either a number field or a text field, depending on which carriers' records are listed first; format that field as a text field in your Import Specification to avoid import errors.

⁵ When you decompress the zipped file, uncheck the "Show Extracted Files" box so the decompressed file does not automatically open in Excel. In Excel, open a blank workbook. Click on Data, Import External Data, Import Data. Now browse to the saved unzipped file containing the Form 41 data in .csv format. The Text Import Wizard will open and should detect that you have a character delimited file. Click Next and make sure the Comma delimiter box is checked. Click Next and you can set the format for each column of data. Use Text format for any column that is not a quantity or dollar figure. For example, Aircraft Type ID in the Aircraft Types table of the Aviation Support Tables Database must be formatted as Text. Date formats can be used for dates; make sure to choose the correct date component order, usually YMD. Click on Finish and tell Excel where to put the data.

⁶ In older Form 41 documentation, it was a DOT convention that 9's in this field indicated a summary line in some traffic and financial reports. It formerly was crucial to remove any total lines containing these 9s to avoid double-counting of reported statistics.

⁷ From DOT TranStats Aviation Support Tables database, downloaded Aircraft Group Lookup Table from within the Aircraft Type Table found at http://www.transtats.bts.gov/Fields.asp?Table_ID=300, on 16 November 2007.

⁸ Downloaded on 30 December 2007.

⁹ See, for example, Karl L. Swartz's great circle mile calculator at <http://gc.kls2.com/>.

¹⁰ The table warning for Schedule B1 viewed on 30 December 2007 states: "**Notice:** Numbers in B1 now follow the format of common public financial documents, such as reports filed with the Securities and Exchange Commission (SEC) or company financial statements. This format reverses signs from the accounting format in which numbers appeared prior to 10/18/2006. For historical comparisons or time series research, please download all historical data again." This change has eliminated one of the mysteries of Form 41 reporting and should have reduced the differences between carriers' Form 41 reports and their financials prepared according to GAAP and SEC requirements.

¹¹ The few exceptions to allocating all balance sheet items to the Domestic region include carriers which serve only an international region without substantial domestic operations, including Continental Micronesia, EOS Airlines and Centurion Cargo, per Schedule B-1 downloaded on 30 December 2007.

¹² The T-100 Segment tables in the Air Carrier Statistics (Form 41 Traffic) databases include a calculated field for passenger load factor calculated as a ratio of Passenger Miles to Available Seat Miles. This field is available in the analysis tools for those tables as well, for quick crosstabulation comparisons.

¹³ O'Connor, W.E. 2001. *An Introduction to Airline Economics*. Westport, Connecticut: Praeger. p. 74-75 advises using an aircraft capacity-based load factor since RTM and ATM fail to capture the volumetric aspect of air cargo; Form 41 reporting does not require volume statistics.

¹⁴ A little algebra can be used to demonstrate the relationship between Breakeven Load Factor discussed here and the calculated Passenger Load Factor found in the T-100 Segment tables of the Air Carrier Statistics (Form 41 Traffic) databases. Breakeven Load Factor weights Passenger Load Factor by the ratio of Operating Expenses to Passenger Revenue.

$$\left(\frac{OpExp / ASMs}{Passenger Rev / RPMs} \right) = \left(\frac{OpExp}{ASMs} \right) \cdot \left(\frac{RPMs}{Passenger Rev} \right) = \left(\frac{RPM}{ASM} \right) \cdot \left(\frac{OpExp}{Passenger Rev} \right)$$

¹⁵ DOT's list of airlines which have gone out of business can be found at <http://airconsumer.ost.dot.gov/cessations.htm>.

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