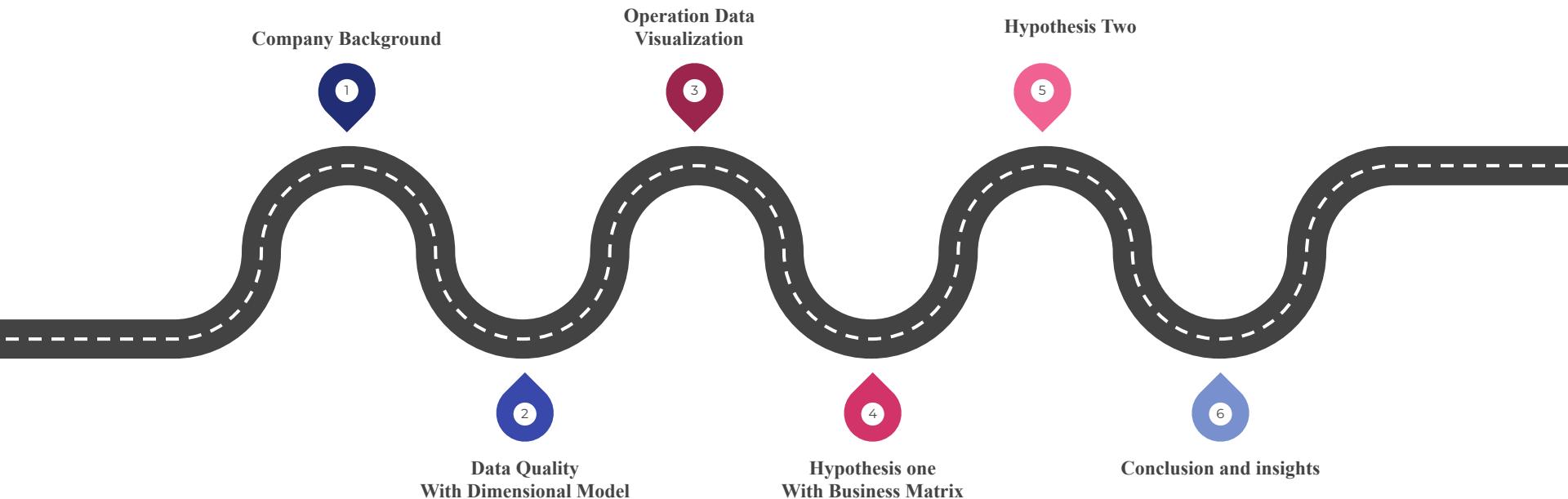


U.S. Commercial Airline Industry Analysis

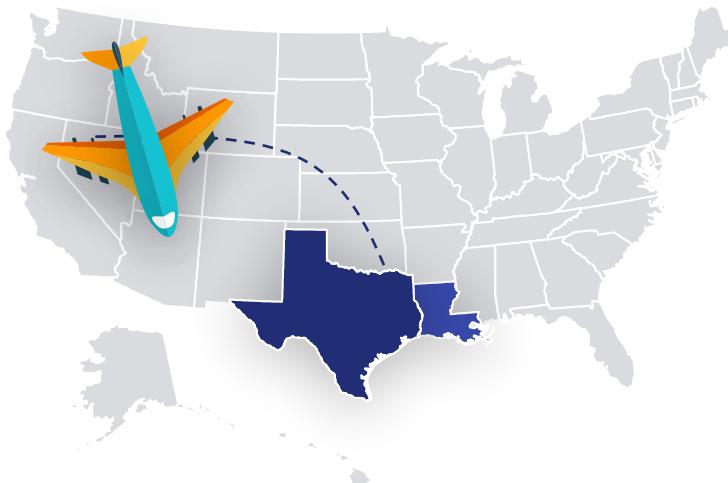
BUS256A - Team1
Shengjie Xia, Ziyue Wang,
Angie Chen, Tianyi Zhang,
Zihan Xu

Agenda



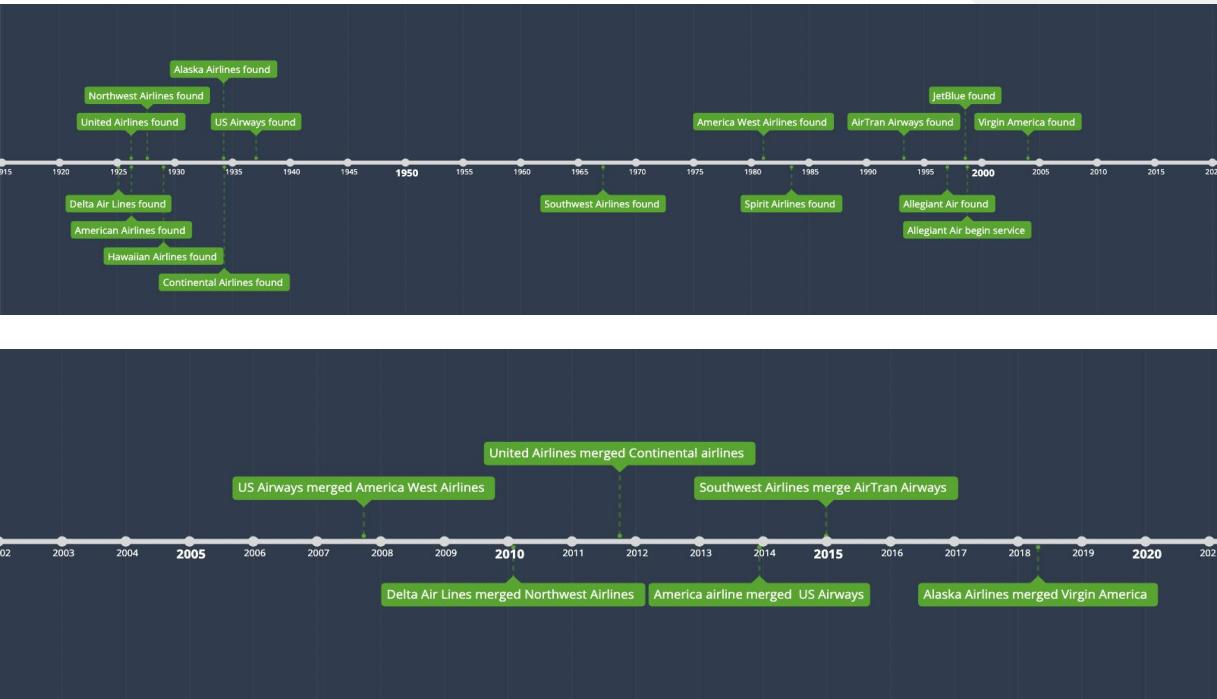
Background

- U.S is the largest air travel market in the world, with more than 900 million passengers each year
- A dilemma brought by the pandemic as well as financial success and failures
- With U.S. airline industry dataset to analyze its operating environment and make recommendations
- Analysis from operating region, revenue, costs and productivity



[View Details](#)

Industry History



- Most stable and extensive airlines were established between 1925-1940
- The steadily growing companies had M&A activity in 2010-2020
- Changes in the company structure have an impact on the company's revenue, costs and business distribution



Missing parts of data and business shifts are consistent with timelines

Airplane Company	Domestic	Atlantic	Pacific	Latin America
American airlines	1995-2020	1995-2020	1995-2020	1995-2020
United Airlines	1995-2020	1995-2020	1995-2020	1995-2020
continental airlines	1995-2011	1995-2011	1998-2011	1995-2011
Delta Air Lines	1995-2020	1995-2020	1995-2020	1995-2020
Northwest Airlines	1995-2009	1995-2009	1995-2009	2009
US Airways	1995-2015	1995-2015	/	2015
America West Airlines	1995-2007	/	/	1995-2007
Spirit Airlines	1995-2020	/	/	2005-2020
Allegiant Air	2000-2020	/	/	2012,1016-2018
Hawaiian Airlines	2007-2018	/	1995-2020	/
Virgin America	2007-2018	/	/	2010-2018
Alaska Airlines	1995-2020	/	/	1995-2020
JetBlue	2000-2020	/	/	2004,2005,2008-2020
AirTran Airways	1995-2014	/	/	2005-2014
Southwest Airlines	2000-2020	/	/	2014-2020
America West Airlines	1995-2005	/	/	1995-2005



Data Quality

Data source

Column introduction

Variables explanation

Data wrangling

Data Source

Elements	Scope
Sources	U.S. Department of Transportation and Securities & Exchange Commission
Companies	American Airlines, United Airlines, Continental airlines, Delta Air Lines, Northwest Airlines, US Airways, America West Airlines, Southwest Airlines, AirTran Airways, JetBlue, Alaska Airlines, Virgin America, Hawaiian Airlines, Allegiant Air, Spirit Airlines
Geography	US domestic, Atlantic, Latin America, Pacific
Time Period	1995-2020
Hotwords	U.S. Airlines, Cost, Revenue, Region

The coverage from our data used in the analysis will include the following content

- Expenses
- Revenue
- Employees compensation
- Employees productivity
- Traffic and capacity by operating region

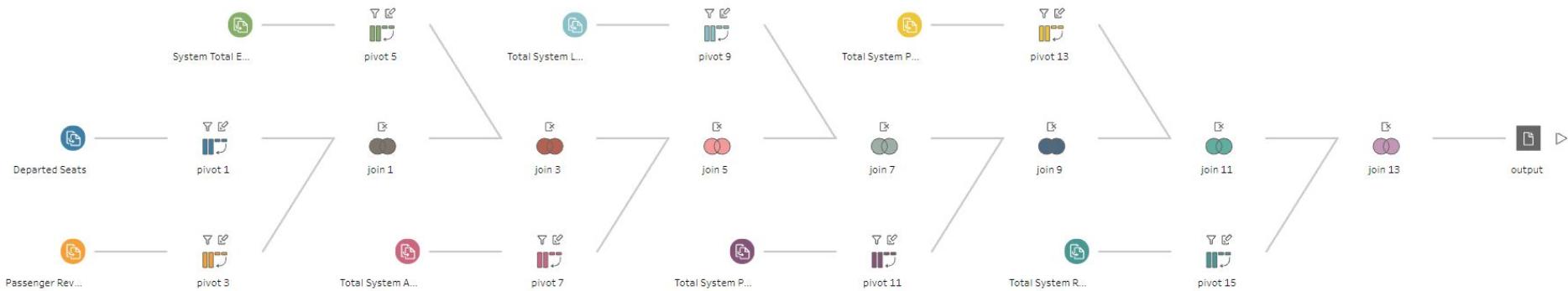
Data Wrangling

- **Imputation** - Imputing Missing Values using Mean and KNN Method
- **Normalization** - Eliminating redundancy and inconsistent dependency.
- **Transformation** - Converting data to different format or type

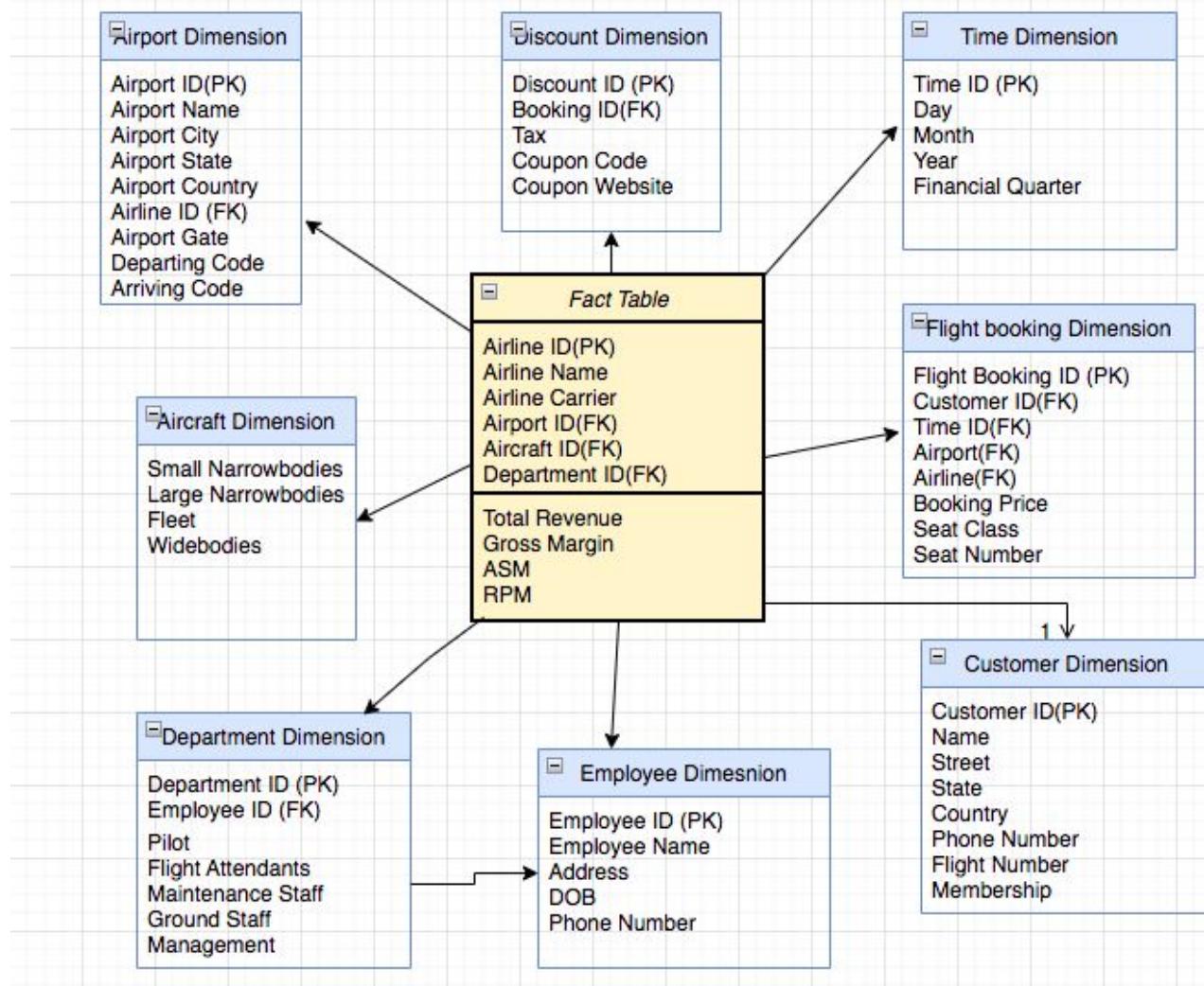
```
15  Total_Management          370 non-null   float64
16  Average_Annual_Wages_Management 370 non-null   float64
17  Total_Flight_Attendant_Average_Block_Hours 370 non-null   float64
18  Percent_of_Maintenance_Expenditures_Outsourced 370 non-null   float64
19  Handing_Employees_per_Aircraft 370 non-null   float64
20  ASM_employee               370 non-null   float64
21  Per_employee_compensation 370 non-null   float64
22  Average_blockhour_month    370 non-null   float64
23  Total_Pilot_Compsesation   370 non-null   float64
dtypes: float64(16), int64(6), object(2)
memory usage: 80.4+ KB
(370, 24)

: Airline           0
Hue_Index         0
Year              0
Total_FTE_Equivalents 0
Average_Annual_Wages 0
Average_Pension_Benefit 0
Total_Pilot_Employee 0
Average_Annual_Wages_PILOT 0
Average_Pension_PILOTS 0
Total_Flight_Attendant 0
Average_Annual_Wages_FLIGHT ATTENDANT 0

```



Dimensional Model



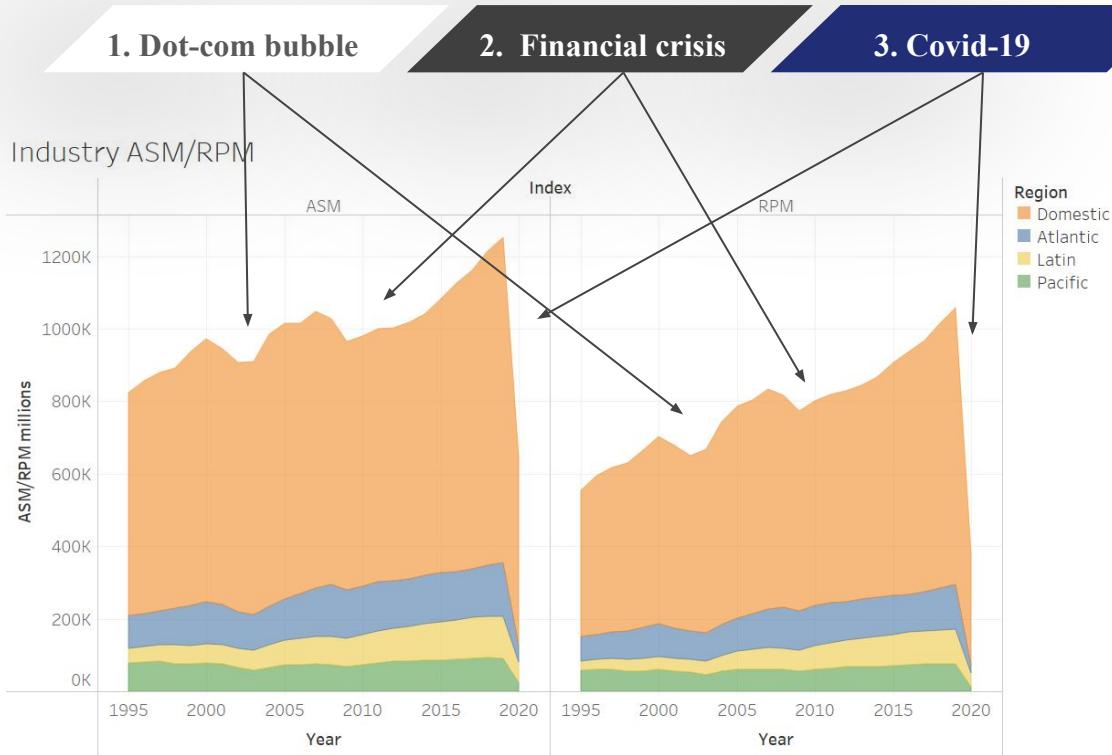
Operation Data Visualization

Display some main descriptions or trends



Overall Industry Trend

- sensitive to situations



ASM: available seat miles, measures capacity.

$\sum(\# \text{ of Available seats} \times \text{distance})$

RPM: revenue passenger miles, measures traffic

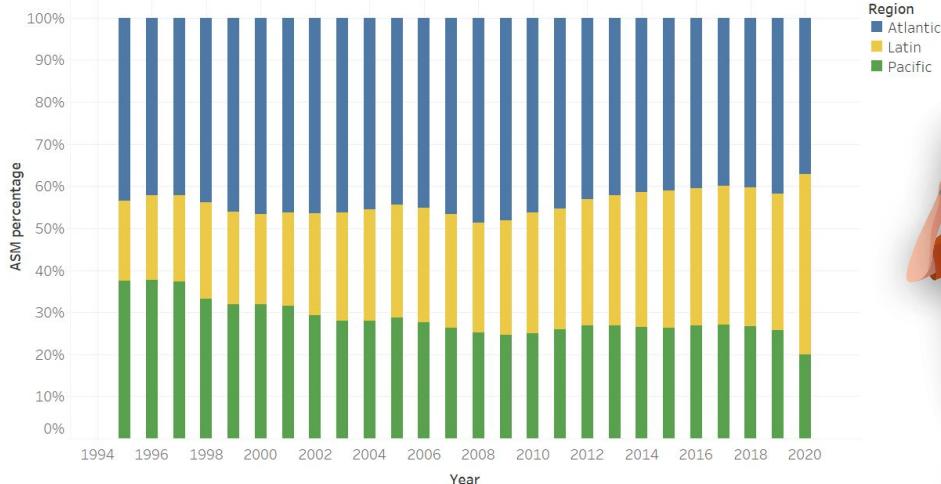
$\sum(\# \text{ of Revenue passengers} \times \text{distance})$

ASM and RPM have similar trends.

International ASM percentage

- increase in Latin America

International ASM percentage



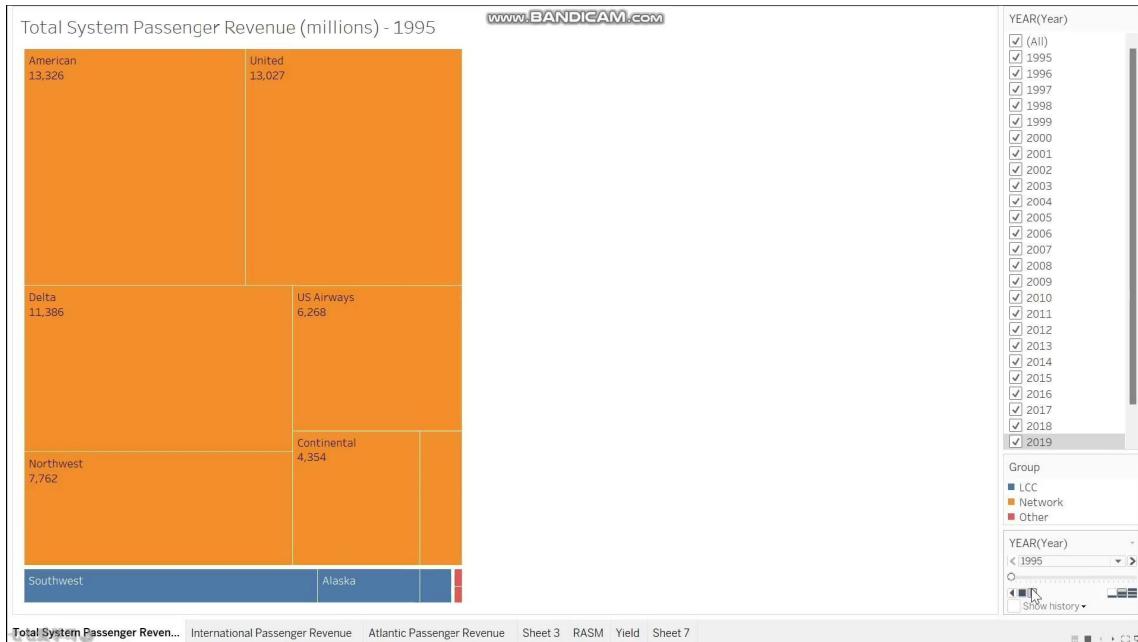
The percentage of Latin America ASM is increasing(yellow), even during the pandemic.

Reason: The LCC(low cost carrier) and ULCC(ultra-low cost carrier) are all increasing Latin America business.



Passenger Revenue

- the increasing participation of LCC and ULCC



The proportions of LCC (Blue) and ULCC(Red) are **increasing**.

Passenger Revenue per ASM

- Network and LCC airlines have similar Passenger Revenue per ASM.
- The ULCC(other) group has smaller Passenger Revenue per ASM.
- Even except 2020, Passenger Revenue per ASM is not always increasing.
- The airlines could take some measures to increase it.

RASM Cents per ASM

Group	Airplane	Year																										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Network	American	8.59	8.92	9.28	9.46	9.01	10.17	9.19	8.37	8.62	8.61	9.41	10.25	10.65	11.14	9.90	10.93	11.62	12.27	12.67	12.89	11.99	11.53	11.98	12.33	12.64	8.46	
	Continental	8.02	8.88	9.18	9.04	8.78	9.62	8.81	8.53	8.62	8.75	9.27	9.94	10.45	11.05	9.39	10.62	11.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Delta	8.74	8.96	9.20	9.27	9.12	9.60	8.40	8.15	10.11	9.12	8.48	9.30	9.99	10.67	9.14	10.57	11.50	12.16	12.63	13.17	12.80	12.15	12.36	12.94	13.08	7.93	
	Northwest	8.85	9.15	8.98	8.22	8.62	9.20	8.34	8.28	8.55	9.21	9.62	10.56	10.77	11.11	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	United	8.22	8.75	8.91	8.74	8.74	9.46	8.17	7.74	7.78	8.22	8.88	9.71	10.46	10.84	9.18	11.03	11.90	11.87	12.14	12.43	11.89	11.23	11.25	11.75	11.95	7.86	
	US Airways	10.68	11.86	12.16	12.34	11.56	11.34	9.85	9.26	9.55	9.35	9.44	10.61	10.96	10.75	9.27	10.44	11.52	11.91	12.21	12.46	12.84	0.00	0.00	0.00	0.00	0.00	
	America West	7.43	7.52	7.44	7.62	7.81	8.02	7.28	7.11	7.56	7.27	8.23	9.30	9.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
LCC	Southwest	7.49	7.99	8.14	8.32	8.51	9.00	8.07	7.58	7.80	7.94	8.31	9.21	9.19	9.88	9.74	11.28	12.11	13.95	14.84	14.38	13.01	12.51	12.43	12.34	12.66	6.96	
	AirTran	0.00	0.00	7.18	7.48	8.37	10.22	9.83	8.49	8.78	8.35	9.03	9.51	9.66	10.06	8.92	9.75	10.54	2.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	jetBlue	0.00	0.00	0.00	0.00	0.00	7.41	7.29	7.47	7.05	6.43	6.81	7.78	8.19	9.41	8.99	9.81	10.95	11.35	11.60	11.87	11.94	11.20	11.22	11.35	11.25	7.55	
	Alaska	6.90	7.42	8.14	8.16	8.53	9.11	8.73	8.39	8.58	8.80	9.50	10.20	10.22	10.52	9.98	10.64	11.36	11.67	11.50	11.67	11.00	10.39	10.56	10.91	10.55	6.86	
	Virgin America	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.51	7.76	7.35	8.60	9.67	9.76	10.49	10.71	10.56	9.96	9.60	0.00	0.00	0.00	0.00	
	Hawaiian	6.36	6.40	6.11	6.35	6.33	6.39	6.16	8.29	8.69	9.69	9.67	9.90	9.64	11.62	10.72	11.38	12.31	12.03	11.53	11.94	11.36	11.61	12.38	12.07	11.82	8.02	
Other	Allegiant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.94	5.69	6.46	6.94	7.73	7.10	7.59	8.64	8.65	8.85	9.10	7.95	7.09	7.04	7.16	7.57	5.47
	Frontier	7.48	8.04	7.21	8.38	8.66	10.72	9.16	8.58	8.43	8.17	8.77	9.07	8.84	9.91	8.75	9.84	12.32	9.81	10.48	10.09	7.71	5.91	5.23	4.92	4.86	3.73	
	Spirit	7.26	6.26	5.87	7.46	6.98	7.08	7.14	6.79	7.54	7.46	8.29	9.30	8.08	8.02	7.42	7.03	7.82	7.36	7.55	7.45	5.93	5.12	5.06	5.21	5.08	3.17	

Hypothesis One

Increased baggage and cancellation fees will **increase** airline revenue to sustainable levels

Problem: The rise of low-cost carriers puts downward pressure on airfare prices

READ MORE ▶



Overall Trends of Airline B&C Fee and Income

Baggage and Cancellation Fee

Obvious upward trend since year 2014

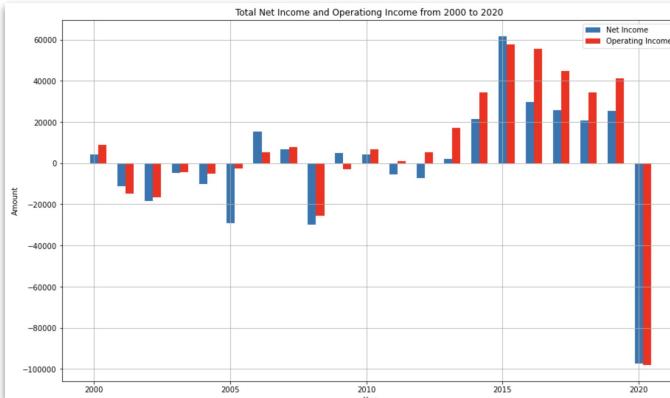
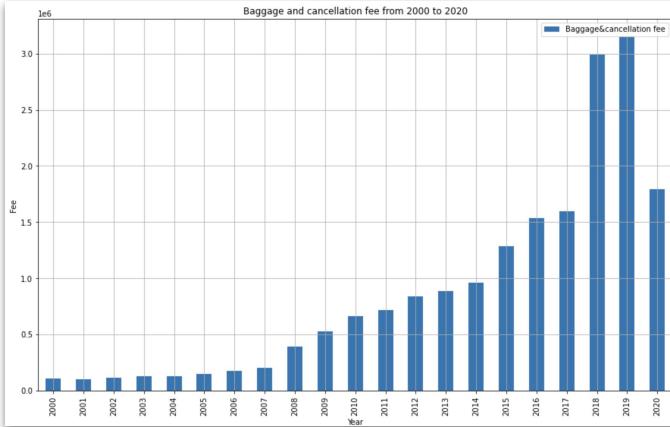
Revenue and Related

The rapid growth of low cost carriers (LCCs) and shifts to Internet distribution channels put downward pressure on airfares and, in turn, airline revenues.

Extreme Loss in 2020



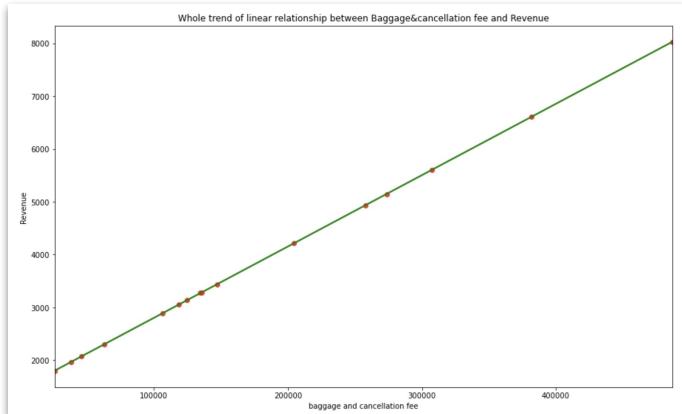
Covid-19 almost shut down the airline industry and bring it to last ditch



Simple Linear Regression

Why linear regression?

Linear model is the most direct model which we could find the relationship between two features through given equation



Model: Revenue=0.0088 B&C Fee + 6164.561

READ MORE ▶

R-squared: 0.3411
Co-efficient: 0.0088
Intercept: 6164.561

How did we get our final model?

Process to create linear model:

01

Data Partitioning

Split dataset into training and testing part (75/25)

03

Model fit

Fit linear regression model to training dataset

02

Data pipeline

Standard scaler and LinearRegression

04

Visualization

Create plot to see the trend

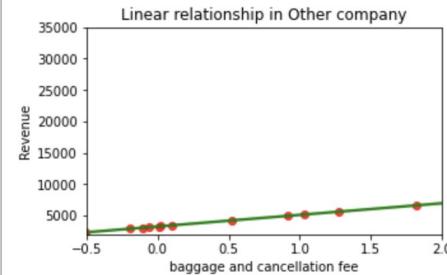
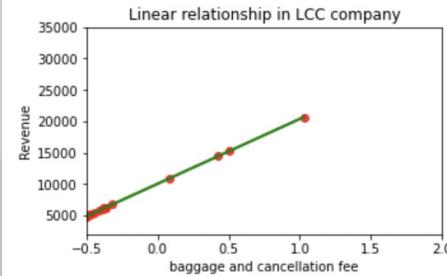
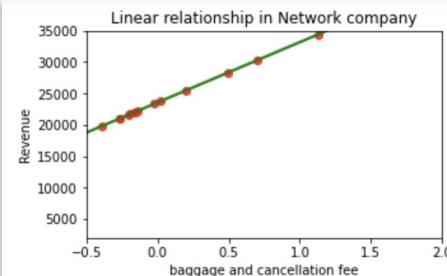
Different group of Company

How baggage and cancellation fee impact revenue in different groups

Major airline companies are always splitted into three groups:

- **Network carriers company:** which has the most popular airline that had established interstate routes and highest standard of service
- **Low cost carriers (LCCs):** operated with an especially high emphasis on minimizing operating costs and without some of the traditional services and amenities provided in the fare, resulting in lower fares and fewer comforts
- **Others**

Find their revenue sensitivity towards B&C fee



Result Comparison

Coefficient: 9597.377
Intercept: 23574.3901

Coefficient: 10331.0339
Intercept: 10050.3205

Most sensitive

Coefficient: 1848.6615
Intercept: 3248.9947



Business Matrix

Matrix to measure the performance of revenue related business operations

General Business Matrix

- **Engagement:** daily/weekly/monthly active users who buy service
- **Conversion:** customers who sign up airline website and subscribe news/ total customer
- **Net promoter score:** customers who are likely to recommend our service or hate it
- **Revenue:** sales revenue or return on investment

Not specific for airline industry, but measure basic business operation performance



Airline Industry Key Operating Matrix

- **Revenue passenger miles:** # revenue passenger * their travel distance. Measure the demand of air travel
- **Average seat mile:** # seats available * travel distance. Measure the capacity of flights
- **Passenger revenue per available seat mile:** passenger revenue / average seat mile. Measure “unit revenue”
- **Cost per available seat mile:** operating cost / average seat mile

The airline industry always uses the above unique metrics to measure operating performance

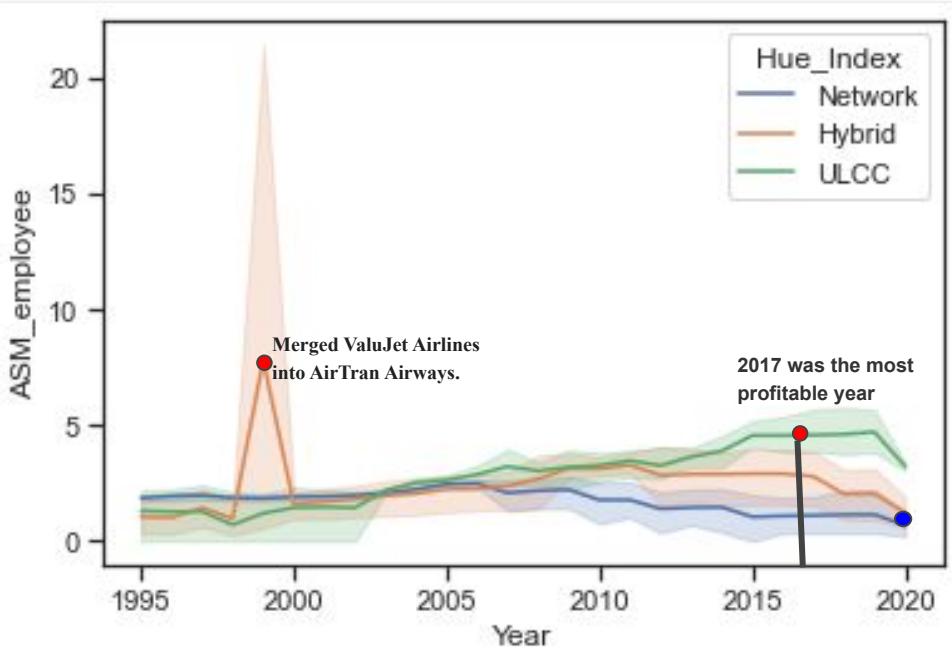
“ Hypothesis Two

There is a positive relationship between increased labor cost and productivity

Problem: Labor costs go up over the year as a part of big expense of each airline, is the productivity goes at the same rate?



Employee Productivity



Network

Highest 2000

Lowest 2020

LLC / Hybrid

Highest ~1998

Lowest 1995

Other / ULCC

Highest 2020

Lowest ~1998

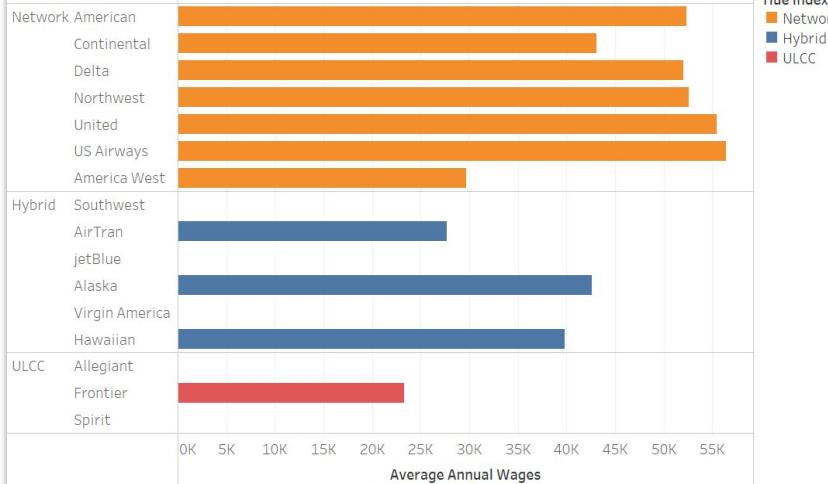
**ULCC tends to have higher ASM per employee compare to Network.



Employee Wage - 1998 & 2020

Sheet 1

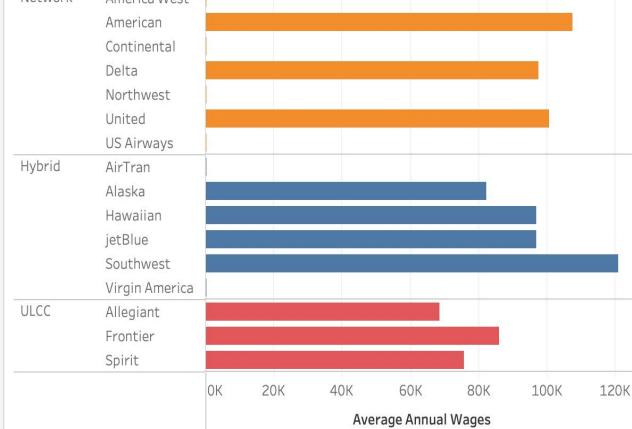
Hue In.. Airline



Sheet 1

Hue Index

Airline



Hue Index

- Network
- Hybrid
- ULCC

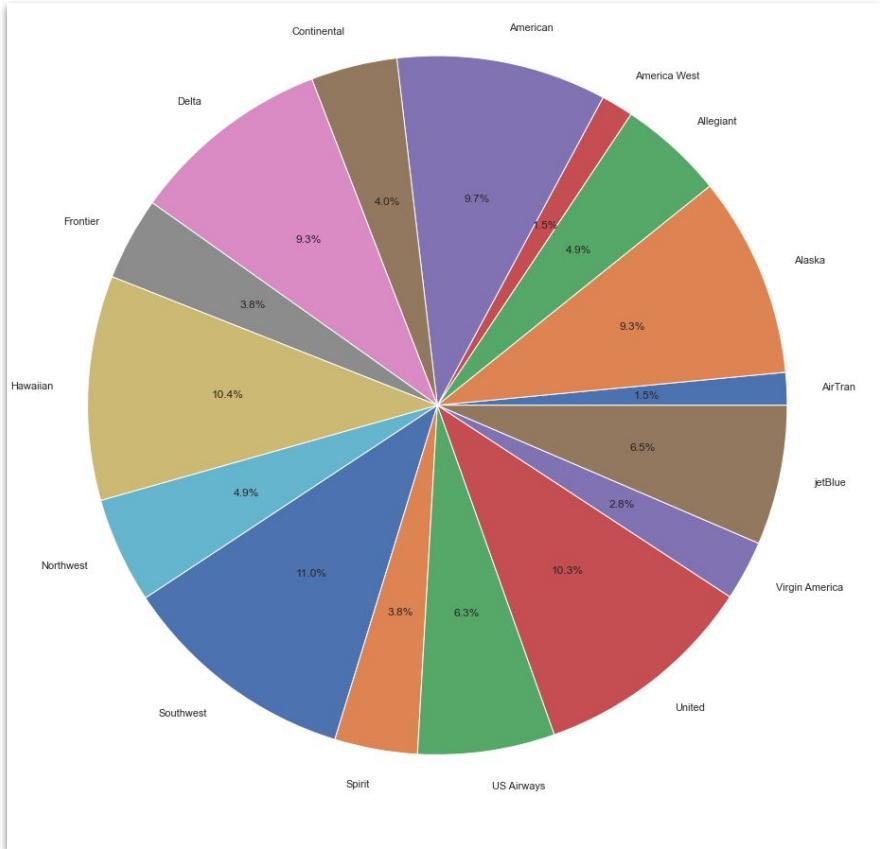
Increased wages not always have a positive relationship with higher productivity.

Network: decreased wage, lower productivity in 2020

Hybrid: increased wage, lower productivity in 2020

ULCC: increased wage, higher productivity in 2020





Employee Benefit

Network

United (10.3%) American(9.7%), Delta(9.3%)

Hybrid

Southwest(11%), Hawaiian(10.4%),Alaska(9.3%)

ULCC

Allegiant(4.9%), Frontier and Spirit(3.8%)



Conclusion and Reflection

- Study operating status, business difficulties, domestic and international business of American airline companies, find self-rescue plan
- Understand the main history of American airline companies, the merger and acquisition relationship
- Understand the business overlap and replacement between companies, and changes in revenue and why

Two approach to predict the airline revenue

- **Hypothesis 1:** Machine Learning algorithms - Linear model is helpful if we need to find direct relationship between two variables (increase baggage fee and cancelation fee can increase revenue)
- **Hypothesis 2:** Time series line graph analyzed a sequence of airline data collected over an interval of time (decrease the labor cost/reduce the wage cannot increase revenue)





Thank You
Open to questions