# POLITECNICO DI TORINO

Department of Management and Production Engineering

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Politecnico di Torino

Master's Thesis :

## Collusion and Dynamic Pricing : enablers and origins of airlines' cartels

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***ABSTRACT***

In an unprecedented era, consumers' focus has sharpened on the rising prices of everyday commodities. The cost of living has surged across even the southernmost regions of Italy, impacting both families and individuals. While some are willing to accept the extra euro spent on essentials like food and groceries, the substantial hikes in expenses, such as fuel for vehicles and travel, cannot be ignored, leading to widespread discontent.

These price escalations are not driven only by inflation; recent events have triggered spikes in critical raw material costs. Economic sectors, including the airline industry, are dealing with a prolonged period of unprofitability, if not serious losses, brought on by the two years of pandemic. These price increases far exceed recently accumulated variable costs, prompting numerous complaints from consumer protection organizations and regulators.

Furthermore, the economic setbacks endured during the COVID-19 years have left indelible marks, constituting one of the most severe crises in recent memory for certain sectors. Recovering from these losses necessitates a gradual approach, with incremental price adjustments until losses are remarginated, allowing a return to competitive pricing instead of exorbitant increases that burden consumers.

The core objective of this thesis is to scrutinize the incongruity between rising market demand and simultaneous product price hikes, delving into the reasons behind these escalations. The aviation sector, in particular, has always been under scrutiny due to concerns of collusion, both due to its profound societal impact and sector-specific characteristics. As a result, laws and regulations are in place to support market competitiveness controlling and monitoring firms within the market. However, it was a not supportive regulation that exacerbated losses in this sector.

The suspension of the 'use it or lose it' law, mandating airlines to utilize airport slots at least 80% of the time, a valuable but limited resource, has lasted insufficiently. This suspension was initially introduced during the restriction period but later relaxed to require a utilization ratio of 50% (2021) and later 70% (2022). This relief proved inadequate, especially as Italy remained divided into red, orange, and yellow zones, with restricted foreign travel too. Airlines found themselves in dire straits, unable to avoid fixed prices while accommodating passengers affected by Covid-19 or moving goods. Consequently, losses were caused not only from no-sales but were exacerbated by the burden of not necessary fixed costs.

Given these circumstances, current collaborations between airlines appear plausible, almost justifiable, but punishable anyway.

To enhance the thesis, additional factors that have historically facilitated collusion in the airline market, despite algorithm-managed pricing, are explored. The first chapter aims to underscore the cultural, social, and economic significance of the aviation sector, emphasizing its interconnectedness with society's broader fabric. Subsequently, the pricing strategies employed by airlines are defined, supported by real-world cases, including insights from my internship at the tour operator Alpitour. In the next chapter, the concept of collusion, its definition, and its enablers are detailed, drawing a clear connection between this theme and the previous one. While airline ticket prices exhibit high volatility managed by algorithms, these algorithms have evolved beyond optimizing revenue solely based on internal data. Instead, they engage in a form of the Prisoner's Dilemma, maintaining price similarity with competitors regardless of the time remaining before departure, be it seven days or three months.

# Summary

# Tables of Figures

# 1 Airline Industry

## 1.1 Air travel for tourism

The tourism and airline industries are strictly correlated, the first has been shaped by the development of the second. Advances in aircraft technology, lower prices offered by more and more airline companies, improvements in communication and information technology, have doubled the volume of traffic, particularly on longer routes allowing people to move fastly, cheaply and easily. On the negative side, air transport has been a highly regulated industry with controls on routes, capacity and tariffs. Threats and weaknesses explained in the SWOT analysis ( *paragraph 1.3.2* ) could affect negatively even the tourism industry, although there are other way of moving.

Transport by private car dominates especially in two major regions, North America and Europe, using the cars for over 80% of domestic travel (Wheatcroft, 1998, p. 159) and confirmed by Eurostat statistics (2018). Air transport share increases on longer routes for obvious reason of time-saving, while travel by sea nowadays has virtually been eliminated and confined to cruising (WTTC, 1996).

Although the air travel component is relatively small, the tourism industry is strongly affected by airline industry. Moving by planes is necessary for long distance trips, or allows to move fastly reaching the other part of the country within 2 hours, not 2 days. Moreover, airplanes are the safest transportation mode, according to statistics conducted by international Civil Aviation Organization (ICAO). The passenger death rate in commercial air accidents in 2020 was 0.27 per million flights, making it the safest means of transport in the world. (Dimitri & Debbage, 1998)

Individuals become tourists when they voluntarily leave their normal surroundings to visit another environment, regardless of how far this environment is. Definition of who the tourist is has been evolved during years. According to the last definition , given by United Nations World Tourism Organization (1991)

*‘tourism comprises the activities of persons travelling to and staying in places outside of their usual environment for not more than one consecutive year for leisure, business of other purposes’.*

Tourists could be categorized into two types of travelers : those who travel for reasons of business and the others who travel for pleasure.

Basically, tourism comprises four main sectors: transportation, accommodation, ancillary services and sales and distribution. The thesis will focus on the first sector.

## 1.2 Impact of tourism in the economy

Tourism and economic development are linked by the various ways in which tourism can contribute, due to the large of stakeholders involved:  from global hotel chains, cruise lines, seaports, airlines to local and small B&B, individuals teaching cooking class or leading a tour through their local community.

According to WTTC statistics, the Travel&Tourism sector contributed 7,6% to global GDP (2022), just 23% below 2019 levels. Talking about Italy, the WTTC has revealed that this sector will provide a significant boost to the country's economic recovery, contributing 8,7% to national GDP and 2% to national employment. Before pandemic, the contribution was 10,6%, including the direct (expenditure made by tourists) and indirect contribution (other stakeholders involved).

The so called 'Conto Satellite del Turismo' (CST), computed by ISTAT, estimates the percentage of each sector attributable to tourism industry. The table reported the expenses by inbound tourism (stranger's expenditure in Italy), domestic (Italian's expenditure in Italy) and total. The inbound tourism has a weight of 33,5% over the total tourism expenditure. The domestic percentage of accommodation is lower than the inbound because a lot of Italians prefer 1-day trip, without spending a night outside. The total includes the expenses made by public administration

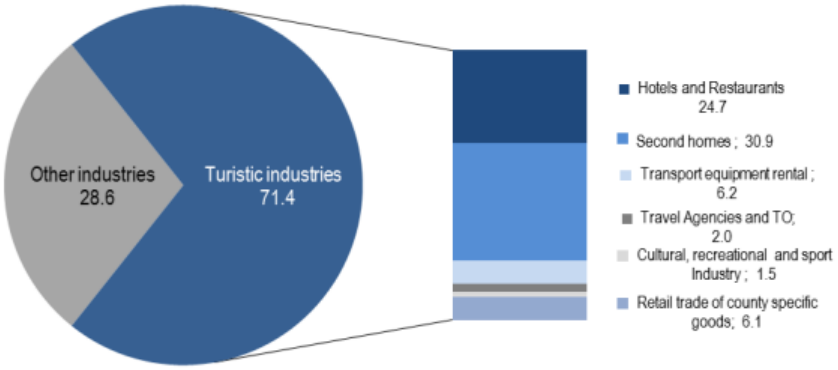
*Table 1 Percentages of total tourism expenditure*

| | Inbound | Domestic | Total |
|---|---|---|---|
| Accomodation | 30,7% | 22,2% | 36,5% |
| Food&Beverage services | 18,6% | 16,0% | 14,6% |
| Railway Transport | 0,8% | 2,9% | 2,0% |
| Road Transport | 1,5% | 3,0% | 2,0% |
| Sea Transport | 0,8% | 3,0% | 1,5% |
| Airline Transport | 3,1% | 5,1% | 5,1% |
| Vehicle Rental | 1,1% | 0,6% | 0,9% |
| Tour Operators | 0,9% | 4,0% | 4,1% |
| Cultural Services | 1,0% | 0,6% | 1,1% |
| Sport Service | 3,2% | 1,9% | 2,6% |
| Shopping | 14,1% | 16,1% | 11,5% |
| Other | 24,3% | 23,7% | 18,1% |

*Source: www.ISTAT.it; the Italian tourism satellite account*

Another goal of CST is determining the value added by tourism. Each industry of the list of table 1 has a value added, expressed as bln euro. Just a percentage of this is attributable to tourism activity. ISTAT estimates these percentages : accommodation and Food & Beverage industry contribute for the 24,7 % of value added of tourism and so on. The value added of tourism respect the total Italian economy is 6%, the third highest contribution, after Greek and Portugal. The figure 1 shows the touristic coefficient : the % of value added that will be attributable to tourism.

*Figure 1 Tourism Value Added by Tourism Industry (2015)*




*Source: www.ISTAT.it; the Italian tourism satellite account*

## 1.3 Airline industry - characteristics

Since the revenue of airline transport are attributable to touristic activities (including both business and leisure travelers), this sector is of considerable significance as an input into a rapidly growing international and global economy, not only passenger air transportation that is vital to many industries, but many other firms rely on a range of air freight services to provide quality service to customers and to operate just-in-time production management.

Features of the airline industry are:

- Costs → airlines have substantial fixed and operating costs: fuel, labor, engines, IT services and networks, airport equipment, airport handling services, training, aviation insurance, and others. Airlines companies is characterized by a low ROCE, earning 6% return on capital employed, lower than the return earned by airports (10%) or aircraft manufacturers (16%).
- Revenue → pricing of airline tickets has become increasingly complicated over years and is now largely determined by computerized yield management systems, using a form of price discrimination, to sell air services at varying prices simultaneously to different segments.
- Assets → airlines are highly leveraged. Not only they lease new airlines bodies and engines regularly, but they must make major long-term fleet decisions with the goal of meeting markets' demand. A second financial issue is that of hedging oil and fuel purchases. A significant tradable asset for many airlines is the ownership of slots at certain airports, especially in view of the congestion apparent at many international airports.
- State support → air travel has survived largely through state support, in the form of equity or subsidies, due to the positive externalities. The higher growth due to global mobility outweighs the microeconomic losses and justify continuing government intervention.
- Regulation → ownership has gradually changed from governments to private organizations. Countries with a deregulated airline industry have more competition and greater pricing freedom, resulting in lower fares or collusion between companies.

- Energy supply → aviation has been a leader in the quest for decarbonization, committed to offsetting CO2 emissions since 2016 and trying to achieve net-zero emissions. This is particularly challenging since the price of SAF (sustainable aviation fuel) is 2 or 4 times higher than that of jet fuel, then airlines depend on conventional jet fuel, although the war in Ukraine caused a sharp increase in fuel prices.

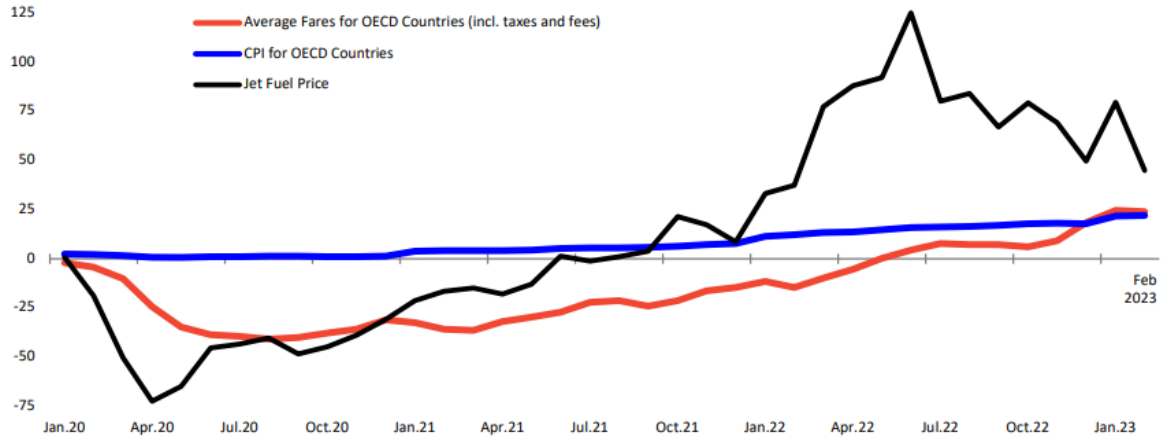
*Table 2 fuel spend, fuel use and fuel price in the worldwide airline industry*

| **Worldwide Airline Industry** | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| Fuel spend, $bn | 190 | 80 | 102 | 214 | 215 |
| % change over year | 6,80% | -58% | 28% | 109,40% | 0,60% |
| Fuel use, bn litres | 359 | 196 | 229 | 281 | 327 |
| % change over year | 1% | -45,30% | 16,50% | 22,80% | 16,50% |
| Fuel price, $/barrel | 79,7 | 46,6 | 77,8 | 135,6 | 98,5 |
| % change over year | -7,40% | 41,50% | 67% | 74,30% | -27,40% |
| % spread over oil price | 22,60% | 11,60% | 10,10% | 34,30% | 23,20% |

*Source: IATA Sustainability and Economics*

- Inflation → covid-related demand for goods and the start of the war in Ukraine pushed inflation at high levels (8,7%). Airlines face an outsized inflation rate because price of jet fuel exceeds that of household energy sources and the share of jet fuel in airlines' operating costs is between 25% and 30%. The level of inflation has an impact of fares. The following chart compares the average fares and the fuel price (CPI = average consumer price inflation) (OECD = organization for economic co-operation and development, including 38 member countries, founded in 1961 to stimulate economic progress and world trade)

*Figure 2 Airfares, jet fuel prices, and CPI*




*Source: IATA Sustainability and Economics, OECD Stat, S&P Global, and DDS*

### 1.3.1 Key success factors

An industry's **key success factors (KSF's)** are those competitive factors that most affect industry members' ability to prosper in the marketplace.

Key success factors could be used as analytical tools for examining the character of the industry and defining a business strategy. In the early growth phases of an industry, the general guidance from Thompson may be sufficient : "*only rarely are there more than five or six key factors for future competitive success*". As an industry approaches maturity, rivalry increases and consolidation proceeds, the number of KSFs is likely to increase.

The key success factors listed in this thesis have been used in a study (McCabe, 2006) to assess the competitiveness of 7 companies of US airline industry.

| | | |
|---|---|---|
| Attracting customers | Attractiveness of airline's service | including the price of tickets, infrastructure convenience and scope of service. |
| | Effectiveness of airline's promotional expenditures | Ticket sales per dollar of promotion expense. |
| Managing the fleet | Airplane utilization (hours per day) | How well the companies' major assets are used as a group |
| | Load factor | How well the average individual airplane is used |
| Managing people | Productivity | How effectively the employees work together in providing the physical service |
| | Morale | |
| Managing finances | Unit revenues | |
| | Unit costs | |
| | Unit margins | |
| | Funding for growth | |
| | Debt-to-assets | |
| | Equity growth | |

### 1.3.2 SWOT Analysis

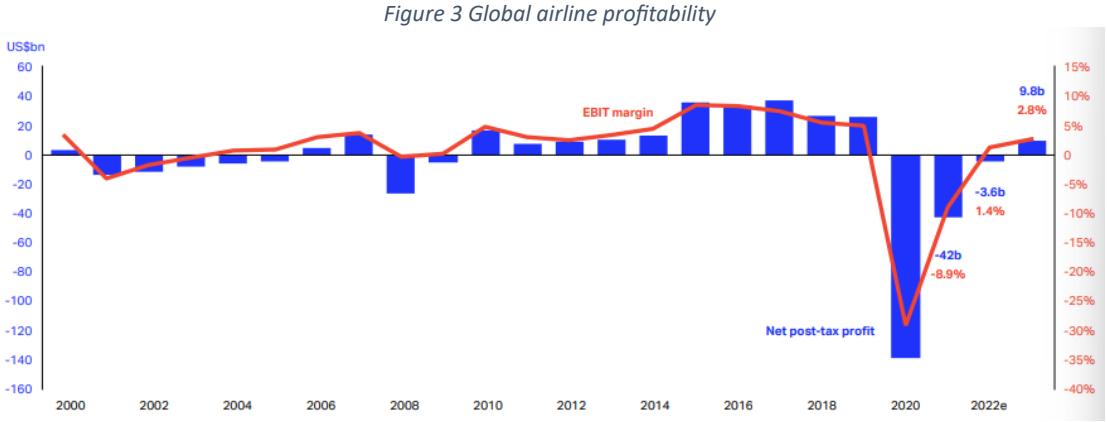
A swot analysis is a core requirement of any organization and essential to understand any industry. There are overall industry similarities that all airlines face, although individual airlines will analyze and make decisions based on their own situations.

| STRENGHTS | WEAKNESSES |
|---|---|
| - the product itself, air travel. This product is seen as a **need** and continues to grow, not only due to population growth but even to propensity to fly.<br>- **safety**, the public acceptance of air travel ad both a fast and safe way to travel.<br>- ability to **segment the market**, even on the same routes, establishing different levels of optional services and pricing decisions. | - **high spoilage rate**, once a flight leaves the gate, an empty seat is lost.<br>- aircraft expensive requiring **high capital** outlays. Return on investment can be different than planned.<br>- continual communication and monitoring within international point. **High risk** of operational irregularities (as bad weather)<br>- difficulty making quick schedule and aircraft changes due to delays, staffing commitments and other factors |
| **OPPORTUNITIES** | **THREATS** |
| - **airline market growth**, opportunities for both leisure and business destinations, especially international ones.<br>- **technology advances** can result in cost savings, more fuel efficient aircraft or more automated processes on the ground.<br>- **value-added products** for which a customer pays extra<br>- link-ups with other carriers can greatly increase passenger volumes | - **global economic downturn** could negatively affect leisure, optional and business travel.<br>- **price of fuel** is the greatest cost for many airlines, an upward spike can destabilize the business model.<br>- events, such as pandemic or terrorist attack anywhere in the world can negatively affect air travel.<br>- **government intervention**. |

### 1.3.3 Financial Performance

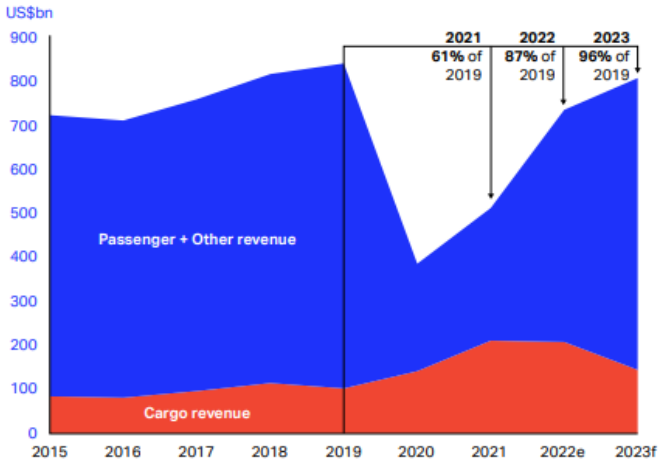
Despite oil price volatility, inflation, geopolitical challenges, the financial performance of the airline industry is expected to recover from the massive loss of USD 140 billion within this year (2023), returning to a net profit position and even global airline revenue is expected to recover to 96% of the pre-pandemic level in 2023. Financial performance depends on regions, remaining divergent and led by North America. The assumptions taken are no more lockdowns or restrictions and a global GDP growth rate of 2,8%.

*Figure 3 Global airline profitability*




*Source: IATA Sustainability and Economics*

*Figure 4 Global airline revenue*




*Source: IATA Sustainability and Economics*

### 1.3.4 Market Demand

Since there are two categories of travelers, there are two levels of demand elasticity and behavior. The business travelers has little influence over the choice of their potential location and departure date. They are forced to book that plane for that day, are not able to choose the most convenient one. For these reasons, their demand is inelastic (Gillen, Morrison & Stewart, 2003) since they need to buy that airplane ticket. The second category, the leisure travelers, has higher degree of elasticity and are characterized by patience. Their demand fluctuates according to the cost, willing to wait until the price rise down (Russo, 2002). If the price is still high and they still want to go on vacation, they will settle for cheaper destinations.

Recently, another category of traveler can be defined. Could students, or people at the beginning of their career, living away from home in search of working opportunities, be defined as business travelers?

Demand elasticity is determined by how much demand for the product changes as the price increases or decreases. It can vary according to the number of close substitutes available, its cost, the amount of time between a price variation and another (Will Kenton, 2021). Two other important

factors are how that good is perceived by the customer, as a luxury or a necessity, and the proportion of income available to be spent on the good (CFI, 2020).

The demand of a good is also affected by other types of elasticity, such as income elasticity, defined as the measure of the percentage change of the quantity demanded of a good in reference to changes in the consumer's income.

There is also an important distinction between short-run and long-run elasticities of demand. In the long run, consumers are better able to adjust to price signals, then tends to be more elastic than short run demand.

The International Air Transport Association (IATA) has conducted an econometric analysis to estimate air travel demand elasticities. The table provides elasticity estimates for the final OLS regression equations. The first column indicates the key travel markets. Higher elasticities were observed in the IntraEurope market, due to the shorter average distances between European cities and use of very low fares that result in significant market stimulation. In the past, European market had high charter carrier share, which today is being converted to very low fare LCCs.

*Table 3 Ordinary Least Squares Regression Results*

| Region | Price Elasticity | Income Elasticity | Population Elasticity | Goodness of Fit |
|---|---|---|---|---|
| U.S. Domestic | -0.83 | 1.00 | 0.45 | 0.95 |
| World | -0.62 | 0.03 | 0.10 | 0.61 |
| UK to Western Europe | -0.82 | 1.45 | N/A | 0.61 |
| Intra-Europe | -1.30 | 0.09 | N/A | 0.71 |
| Intra South and East Asia | -0.86 | -0.08 | N/A | 0.10 |
| Intra Latin America | -1.20 | 0.10 | N/A | 0.22 |
| Intra Sub-Saharan Africa | -0.56 | 0.19 | N/A | 0.60 |
| Transatlantic | -1.06 | 0.32 | N/A | 0.60 |
| Transpacific | -0.36 | 0.19 | N/A | 0.60 |
| Europe-Asia | -0.73 | 0.22 | N/A | 0.40 |

*Source: IATA Sustainability and Economics*

The model used has been :

$$\ln(Traffic) = Constant + a_1 \times \ln(Fare) + a_2 \times \ln(GeometricGDPPerCapita) + a_3 \times \ln(GeometricCountryPopulation) + a_4 \times \ln(RouteDistance) + \sum_{i=5}^{n} a_i \times (TimePeriodDummies)$$

Where :

- Traffic is the dependent variable
- Fare is the average economy or leisure fare
- Var2, Var3 and Var4 are quantifiable explanatory variables that affect traffic levels
- Dummies variables takes the form of 1 or 0 in any observation capturing any remaining structural reasons or traffic differences between routes. For example, a dummy for the month of July would take the value of 1 for any observations from July and 0 during all other months' observations.

Similar values have been obtained by surveys conducted and reported by the Journal of Transport Economics and Policy. The classification is by data types and nature of travel (business or leisure).

*Table 4 Demand Elasticities of Air Passenger Travel*
*(all elasticity estimates are in negative values)*

| | **Time Series** | **Cross-Section** | **Others** |
|---|---|---|---|
| **Leisure travel** | 0.40-1.98, 1.92 | 1.52 | 1.40-3.30, 2.20-4.60 |
| **Business travel** | 0.65 | 1.15 | 0.90 |
| **Mixed or unknown** | 0.82, 0.91, 0.36-1.81, 1.12-1.28, 1.48 | 0.76-0.84, 1.39, 1.63, 1.85, 2.83-4.51 | 0.53-1.00, 1.80-1.90 |

*Source: from 13 studies. They are: Abrahams (1983); Agarwal and Talley (1985); Andrikopoulos and Terovitis (1983); Doganis (1985); Fridstroom and Thune-Larsen (1989); Haitovsky, Solomon and Silman (1987); Ippolito (1981); Oum and Gillen (1983); Oum, Gillen and Noble (1986); Straszheim (1978); Talley and Eckroade (1984); Talley and Schwarz-Miller (1988); and Taplin (1980)*

The demand sensitiveness to price is higher (negatively) respect to income, then the increase of income could be useless in a situation where also prices increase. but students perceive the flight tickets as a necessity. Especially, in Italy, where the culture of spending holidays such as Christmas or Easter Day with the family is strongly felt, but unlucky it is one of the country with the highest rate of outgoing student or researchers (ISTAT, 2018) and with a relevant flow of young people from south to north of Italy. Within 2012-2021, the South had losen 525 thousand of people, migrated to the North. Although the migration balance is negative between Italy – rest of the Europe, the North is able to compensate the loss filling the outflow with the incomes from the South (116 thousand in ten years)

Time periods in which they can move from the study-town are limited by working days, and their first preference is towards air transport, since the other way of transport would take even 24h. Moreover, it is not obvious that bus or trains are cheaper than airplanes, especially for routes involving north-south Italy, or it is not feasible moving from North Europe to south of Italy by bus, or at least, it is a trip that a person could bear once in a year. Then their price elasticity is lower than leisure travelers

due to their dependence of the air travel mode, but less rigid respect to business travelers, due to the higher income elasticity.

### 1.3.5 Competitors

The natural consequence of the constant rapid growth of air transport sector has been the initial increasing of competition and the rapid change of competition parameters of the aviation sector. The industry's market structure is dependent on the historical event of liberalization and Deregulation Act (1978) for air transport market. Deregulation is the process of removing government imposed entry and price restriction on airlines. Liberalization is less stringent and is related to the reduction – not disappearance – in applied restrictions of the government on international trade and capital. These two events also significantly altered market structure, giving rise to mergers of flag airline carriers and diverse forms of collaboration, often anti-competitive.

In June 2014, the OECD Competition Committee held a discussion on Airline Competition to examine the main competition issues and how enforcement authorities have been dealing with them.

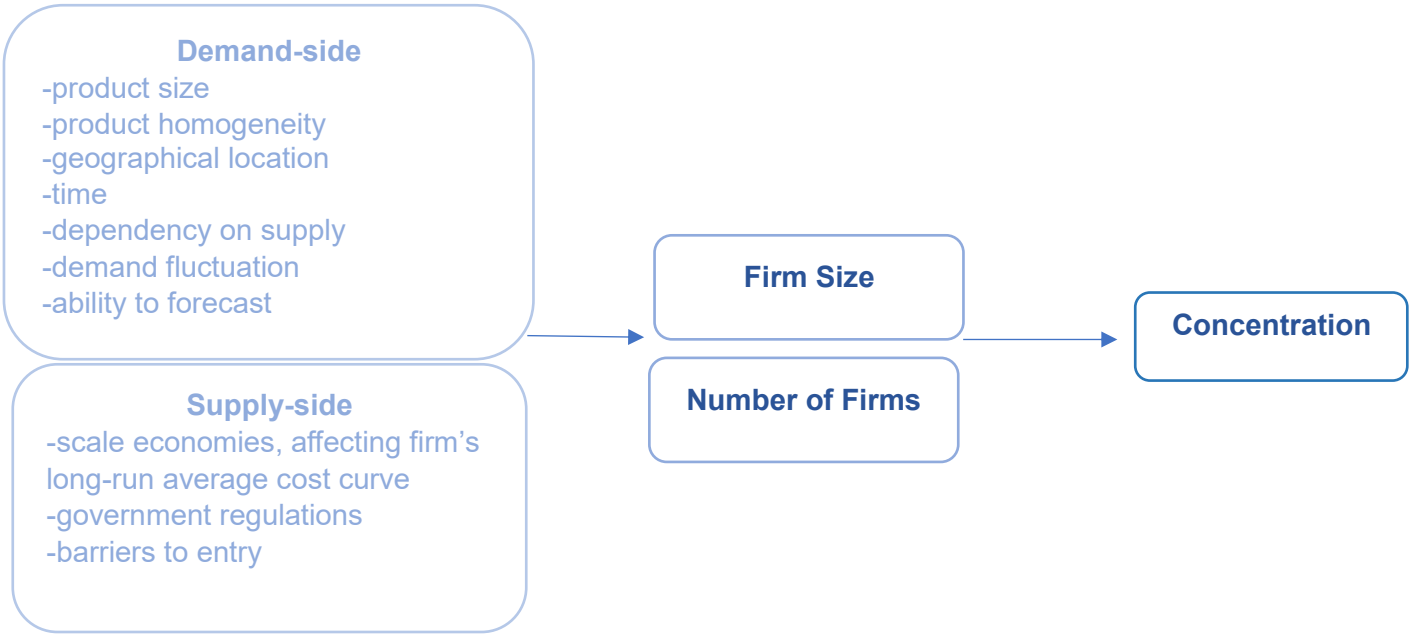
The key fundings from the discussion has been:

- Air transportation is a vital sector for the global economy and heavily regulated at national and international levels;
- Industry is characterized by three driving trends : (1) a hybridization of business models, between full service and LCCs; (2) a consolidation of the industry through airline alliances; (3) a recurrent exposure to financial distress, due to internal (mismanagement) or exogenous (oil prices) factors;
- There are three types of barriers to entry but expansion in air transport markets have recently attracted attention: (1) access to airport slots ( = structural), (2) airlines' loyalty schemes and (3) drip pricing strategies ( = strategic). Such barriers call in certain circumstances for antitrust enforcement or regulatory responses.

The key aspects of competition in the airline industry are:

Concentration : *large percentage of total economic resources and activities (lavor, sales, income generated, assets) controlled by a small percentage of the units that own or control this collection* (Polat 2007)

Concentration is related to the number of firms and firm size. These factors are affected by the absolute size of the product, the product homogeneity (or degree of variance), geographical location, time, dependency on supply and demand conditions in other markets, demand fluctuation and ability to forecast. In addition, businesses' demand size benefits from scale economies, greater efficiency, resilience to environmental change and profitability.




Since concentration means that a small number of firms dominate a large part of the market, there is a negative relationship between market concentration and level of competition. Market concentration indexes provide insight into how competitive the market is. If the number of firms operating in the market is high, with equally high levels of influence then the concentration will reduce and competition increase.

Empirical fundings (Lijsen, 2004) showed that the Herfindahl-Hirschmann Index gives the best result among other indicators (such as CR4)). Many studies have been done in literature regarding on market concentration, although the difficulty of finding data in aviation and the lack of adequate sectoral data. Study conducted by Yasar and Kiraci examines the market structure of airline sector in the world. the worldwide analysis was carried out on 7 different geographies. Data were obtained from annual reports of the industry's leading organizations and analyzed using with N-firm concentration ratio and HHI.

The N-Firm Concentration Rate is calculated as follows, where Si indicates the market share of the first, second, third … n firm.

$$C_n = \sum_{i:1}^{n} Si \quad \text{i: 1,2,3,...n}$$

- $CR_4 < 30$ → Low level concentration,
- $30 < CR_4 < 50$ → Medium level concentration,
- $50 < CR_4 < 70$ → High concentration,
- $70 < CR_4$ → Very high concentration.

The Herfindahl-Hirschman Index consists of the resulting values from the sum of squares of the market shares of all firms in the industry obtained from the concentration analysis of N-firms (Yayla, 2005). As the number gets smaller, the market can be considered more competitive. The maximum reflects a monopoly market.

HHI: $\sum_{i:1}^{n} Si^2$

- 0 ≤ HHI < 2000 → Low Concentration,
- 2000 ≤ HHI < 4000 → Medium Concentration,
- 4000 ≤ HHI ≤ 10000 → High Concentration,

the study has been conducted within a time frame of 9 years, in order to show not only the concentration of the 7 airline markets, but even the transformation of them.

Table 5 shows the results using CRn (=CR8, including the world) method.

*Table 5 Analysis of CR8 Concentration ratio (2006-2015)*

| | REGIONS / YEARS | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Asia Pacific** | 37,1 | 37,1 | 38,4 | 38,4 | 40,2 | 41,3 | 40,6 | 38,9 | 38,3 | 37,1 |
| 2 | **Australasia** | 72,7 | 74,8 | 70,6 | 68,3 | 72,5 | 67 | 71,2 | 72,5 | 69,9 | 67,8 |
| 3 | **Eastern Europe** | 42 | 40,2 | 43,4 | 43,4 | 46,5 | 49,3 | 59,1 | 61 | 59,8 | 56,2 |
| 4 | **Latin America** | 45,3 | 47,3 | 50,9 | 47,5 | 51,2 | 54,7 | 56,8 | 58,7 | 60,8 | 57 |
| 5 | **Middle East and Africa** | 40,8 | 39,3 | 39,5 | 39,9 | 41,9 | 44 | 46,1 | 46,1 | 47,7 | 46,7 |
| 6 | **North America** | 69 | 68,4 | 71,1 | 70,5 | 70,8 | 72,7 | 73,2 | 74,7 | 74,9 | 74,5 |
| 7 | **Western Europe** | 42,7 | 42,8 | 44,7 | 44,7 | 48 | 51,6 | 52,1 | 51,7 | 52 | 54,4 |
| 8 | **World** | 28,5 | 27,3 | 29,2 | 28,1 | 29,4 | 30,8 | 30,3 | 32,3 | 32,3 | 33,1 |

*Source: Empirical fundings Yasar and Kiraci (2007)*

North America and Australasia markets were determined to have the highest market concentration from 2006, with an increasing trend through years, hence market competition level in these markets followed a declining trend. Evolution of level of competition can be visualized by a graphical representation of the concentration ratios. Remember that high concentration means few competitors and a situation which tends to oligopoly (few firms control the market)

*Figure 5 Analysis of CR8 Concentration ratio (2006-2015)*

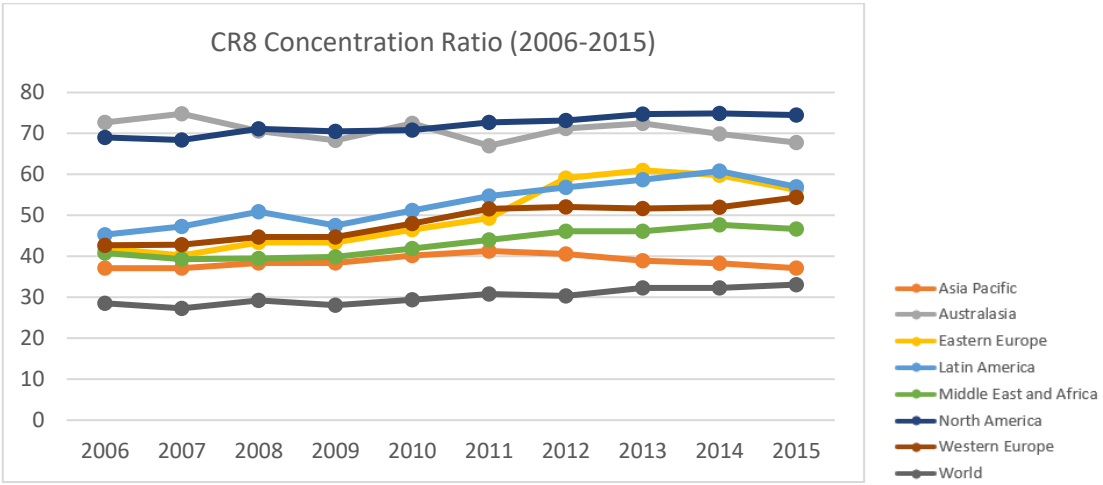


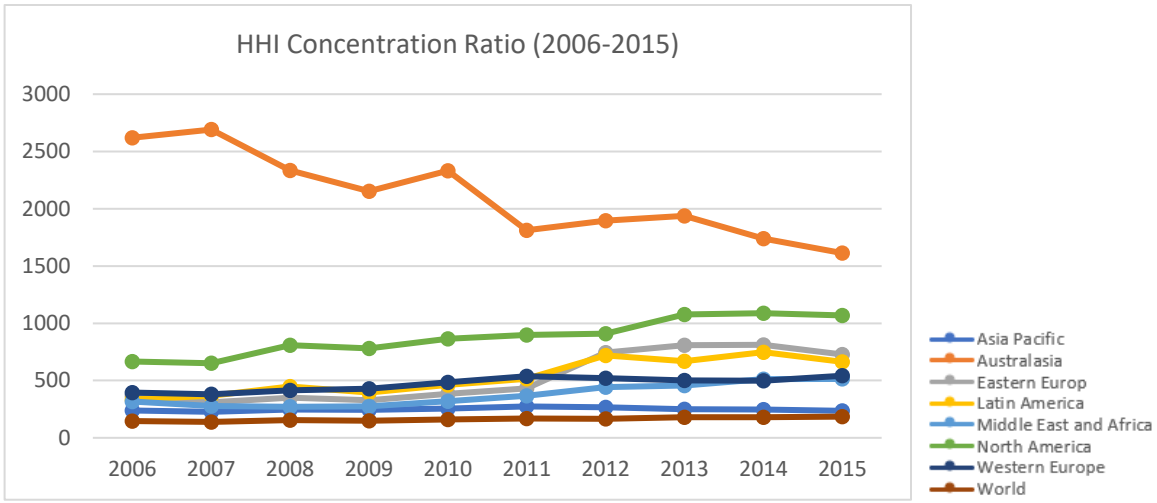

Table 6 shows the results using the HHI method. It is seen that in a significant part of this ratio is below the 1000 critical level, then all the markets could be identified as low concentrated and then highly competitive. The north American market have seen an increasing trend, hence a diminishing competition level. Differently from CRn method, Australasian market has become increasingly competitive.

*Table 6 Analysis of HHI Concentration ratio (2006-2015)*

| | REGIONS / YEARS | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Asia Pacific** | 238,8 | 227,3 | 247,7 | 243,5 | 256,3 | 274,9 | 267,97 | 250,9 | 246 | 235,7 |
| 2 | **Australasia** | 2620,1 | 2691,9 | 2334,8 | 2152,2 | 2332,8 | 1811,5 | 1897,5 | 1939,9 | 1740,8 | 1613,1 |
| 3 | **Eastern Europe** | 367,1 | 310,2 | 350,3 | 327,1 | 385,7 | 431,7 | 745,1 | 809,85 | 812,98 | 729,5 |
| 4 | **Latin America** | 335,1 | 367,1 | 447,7 | 395,8 | 462,9 | 516,8 | 719,24 | 669,44 | 748,9 | 664,45 |
| 5 | **Middle East and Africa** | 317,1 | 278,9 | 271,9 | 275,1 | 320,6 | 368,06 | 442,8 | 458,44 | 513,4 | 514,73 |
| 6 | **North America** | 666,0 | 651,6 | 808,2 | 781,0 | 865,1 | 898,97 | 910,5 | 1078,3 | 1088,07 | 1068,9 |
| 7 | **Western Europe** | 394,8 | 380,4 | 416,7 | 430,5 | 485 | 537,14 | 520,2 | 501,56 | 498,49 | 542,4 |
| 8 | **Word** | 147,8 | 139,8 | 154,2 | 149,4 | 160,5 | 169,8 | 167,55 | 179,44 | 179,9 | 185,4 |

*Source: Empirical fundings Yasar and Kiraci (2007)*

*Figure 6 Analysis of HHI Concentration ratio (2006-2015)*




Both the CRM analysis and the Herfindahl-Hirschman Index method generally show that the airline market has competitive features, although in some markets competitive characteristics are weaker and is gradually approaching oligopolistic market characteristics.

Results confirmed that although the deregulation act in 1978 and the high growth rate of airline market, the number of competitors tend to be diminishing and the market power is divided among few companies, or among airline companies that create alliances, mergers and collusion.

In the case of US airline industry, the major airlines - Delta, American, United, US Airways, Continental and North-west – developed a strategy to eliminate the discount and smaller airlines companies. In fact, after the deregulation act, a number of new discount airlines did come into existence since they faced lower operating costs and then could offer lower fares. Some of the strategies were:

- Mergers of major airlines
- Control of most of the landing slots at large hub airports
- Computer reservation systems
- Premiums paid to travel agents
- Frequent-flyer programs (incentive for business travelers)

Since competition and concentration are topics related to collusion and collaboration, they will be discussed in the third chapter.

## 2 RM and Pricing

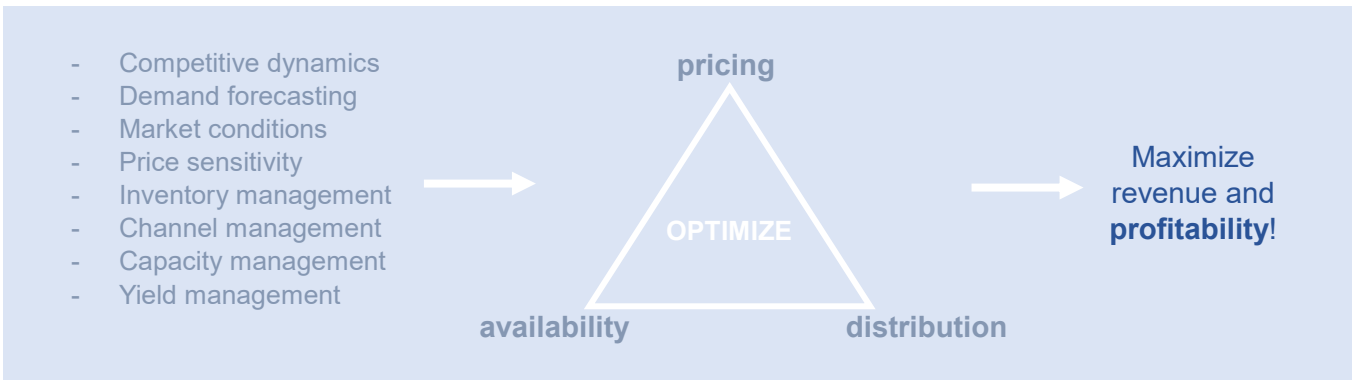
Scope of seller is getting the maximum benefit available by the sale of products or services. Profit is made up of two components, price and quantity. The combination of these two dimensions must be in equilibrium with the demand curve. Increasing price could rise profit but less people will be willing to buy that product at that price, while moving toward the other dimension could rise the variable costs and then profit growth could turn into a loss. Anyone who has ever faced such decisions knows the uncertainty involved. Setting the right price in a time when market conditions are most favorable, but who knows if the price could be higher for that particular moment? Moreover, there are several variables to consider: seasonal factors, customer segments, then price differentiation, cannibalization across segments, allocation decisions for complements (seats on two connecting airline flights) or substitutes (different car categories for rentals).

RM is a business strategy and set of techniques to maximize revenues by making joint decisions about prices and demand controls (Chiang, Chen and Xu, 2007). sales decision, such where, when to sell, to whom, at what price; and demand-management decisions, estimating demand and managing it through price and capacity control.

> *'Revenue Management is the art and science of predicting real-time customer demand at the micromarket level and optimizing the price and availability of products' (Robert Cross, 1997)*

Or, in other words : selling the right product to the right customer at the right time to the right price (smith, Leimkuhler, Darrow, 1992). This practice is also known as yield management. Whist yield management focused on inventory controls, revenue management takes into account all profit centers holistically. The RM scope is broader: maximizing the revenue through optimizing pricing, product availability and distribution; yield management focuses solely on the sale of fixed and time-limited inventory. Today, the two terms indicates the revenue maximization.

The essence of RM is selling the right amount of products to prices based on your customers willingness to pay. Traditionally, the price is set looking at the manufacturing cost and then what margin is wished. Revenue management flips that concept and looks at what the customer is willing to pay and based on that decide what the product can cost. Operating in a market where customers could be differentiated according to different willingness to pay, revenue management is essential.



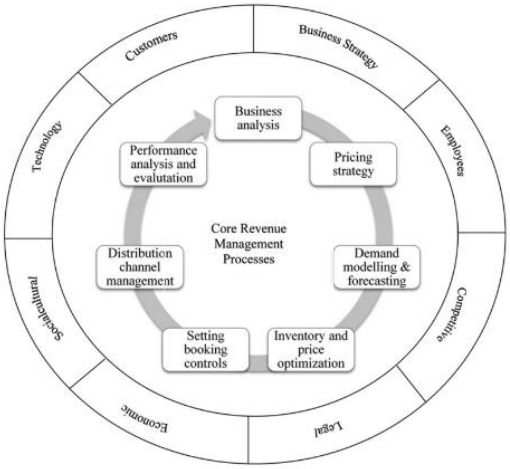
Yield management : varying prices based on demand fluctuations, such as offering discounts during low-demand periods or charging premium prices during high-demand ones;

Channel management : inventory allocation across different distribution channels, such as direct sales, online platforms or third-party distributors.

Capacity management : resource allocation by accepting more bookings than the available capacity, considering historical cancellations or no-show rates (overbooking).

Chiang et al(2007) examined 221 articles on RM and noted that dominant area of RM research is pricing, inventory control, overbooking control, forecasting but there were articles also about customer behavior and perception, performance evaluation, and techniques for solving RM problems.

*Figure 7 Extended framework for hospitality revenue management*




*Source: Adapted and expanded from Noone et al. (2011, p.295)*

## 2.1 RM in Airline Industry

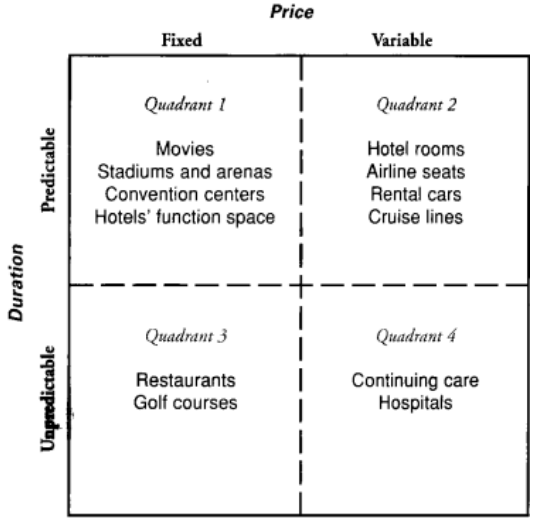
Revenue management is commonly used in industries with perishable inventory or time-limited services, or in sectors where demand and pricing dynamics play a significant role in business success. RM has been practiced in the airline (smith et al, 1992), hotel (Hanks et al. , 1992) and car rental industries (Carroll and Grimes, 1995) for over 20 years, but has recently attracted attention in other industries as restaurants (Kimes et al, 1998), golf (Kimes, 2000), health care (Born et al, 2004) due to the revenue increases that RM could generate, typically of 2,5% (Hanks et al, 1992)

Examples of these industries are airlines, hotels, car rentals, restaurants, entertainment venues, and even in sports.

Revenue management could be implemented in similar markets that respect certain conditions : fixed capacity, appropriate cost structure, variable demand, perishable inventory, revervations made in advance. The appropriate techniques to use depend on the industry, especially looking at two

dimensions : duration control and pricing management. The first refers to the prediction of customer arrivals and length of customer use. The second includes the development of the best set of prices and the perceived fairness of them.

*Figure 8 Typical pricing and duration positioning of selected service industries*




*Source: S.E. Kimes and R.B. Chase, ''Thre Strategic Levers of Yield Manageemnt'' Journal of Service Research, 1(2) 156-166, 1998*

Quadrant 1 revenue management programs consist of pricing tools since duration is already controlled. These industries offer only few prices but exercise control over duration of use while quadrant 4, typically health care, offer many prices but have little control over duration. The quadrant 2 includes the industries where RM application is more effective (variable pricing and products with a specified duration).

There are few business practices whose origins are connected to a single industry, and this is the case. The origin of RM practices is attributable to the airline industry. Starting point was the Airline Deregulation Act (1978), dismantling a comprehensive system of government controls (Kahn, 1988). before deregulation, airline's environment was regulated by the US Civil Aviation Board (CAB) and the International Air Transport Association (IATA). A powerful voice in favor of deregulation was Alfred Kahn, chairman of CAB. New low-cost carriers entered the market and established carriers were free to charge any price they needed. Due to the no-frill service, or lower operating costs, the new entrants were able to charge prices much lower (50-70%) than the major airlines (not casually are called low cost) serving different customer segment, such as students, couples getting away for few days, big families.

The first yield management system (Cummings, 2007) was developed by American airlines' research group, under commitment of Robert Crandall. The strategy was exploiting the higher willingness to pay of business travelers, while charging lower cost to reach the leisure traveler segment. Solution

had been a combination of purchase restrictions and capacity-controlled fares: discounts that had to be purchased 30 days in advance of departure, nonrefundable, with a seven-day minimum stay (prevent business travelers from utilizing the new low fares) and limitation on the number of discount seats sold.

Secondly, they developed a more sophisticated model, DINAMO (dynamic inventory allocation modeling optimizer). The seat availability was based on the net nesting method (Vinod, 2009) with segment limits. By the yield management development, AA led the largest low cost airline company PEOPLExpress to failure.

*'we had been profitable from the day we started until American came at us with Ultimate Super Savers. That was the end of our run because they were able to underprice us at will .. we did a lot of things right, but we didn't get .. Yield Management and automation issues'*

*(Donal Burr, CEO of PEOPLExpress, 1986)*

The practice of RM in the airline industry is then necessary and critical to running a modern airline profitably. In the case of AA, RM practices generated 1,4$ billion in additional incremental revenue over a three-year period around 1988 (Smith et al) and it is widely acknowledged that RM contributes between 3-8 % in incremental revenues based on the sophistication of the tools. (Donovan, 2005). The impact of RM can be seen also in other industries: Hertz car rental reported a 5% increase in average revenue per rental (Carrol & Grimes 1995); Chevy's Mexican Restaurant experienced a similar increase in revenue (Kimes & Thompson, 2004).

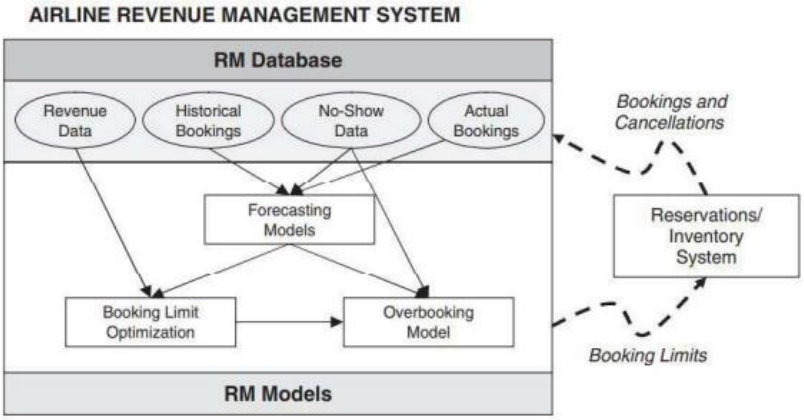
The RM in the airline context must take into consideration all the following elements. Such estimations have provided airlines (and other businesses) with significant financial gains.

| *Elements of Airline Revenue Management* | |
|---|---|
| **Customer Behaviour and Demand Forecasting** | **Revenue Factors** |
| Demand volatility | Fare values |
| Seasonality, day-of-week variation | Uncertainty of fare value |
| Special events | Frequent flyer redemptions |
| Sensitivity to pricing actions | Company or travel agent special vouchers |
| Demand dependencies between booking classes | *Cancellation* penalties or *restrictions* |
| Return itineraries | **Variable Cost Factors** |
| *Batch bookings* | Marginal costs per passenger |
| *Cancellations* | *Denied boarding* penalties |
| *Censorship* of historical demand data | *Goodwill costs* |
| *Defections* from delayed flights | **Fare Products** |
| *Diversions* | Number of products |
| *Go-Shows* | *Fences* (restrictions) |
| *Group bookings* | **Problem Scale** |
| *Interspersed arrivals* | Large airline or airline alliance |
| *No-shows* | **Problem Interfaces** |
| *Recapture* | Market strategy |
| *Upgrades* | *Code-sharing* alliances |
| **Control System** | Routing |
| Booking lead time | Gate acquisition and schedule planning |
| Number of *controllable booking classes* | *Fleet assignment* |
| *Leg-based, segment-based*, or full *ODF* control | |
| Distinct *buckets, parallel nesting*, or *full nesting* | |
| Reservations systems *connectivity* | |
| Frequency of control updates | |
| *Overbooking* | |

*Source: McGill and Van Ryzin, 1999*

The study on revenue management is comprised of forecasting and demand management, capacity, overbooking, seat inventory control and pricing.

*Figure 9 Component of typical RM system*




*Source: Belobaba et al, 2015*

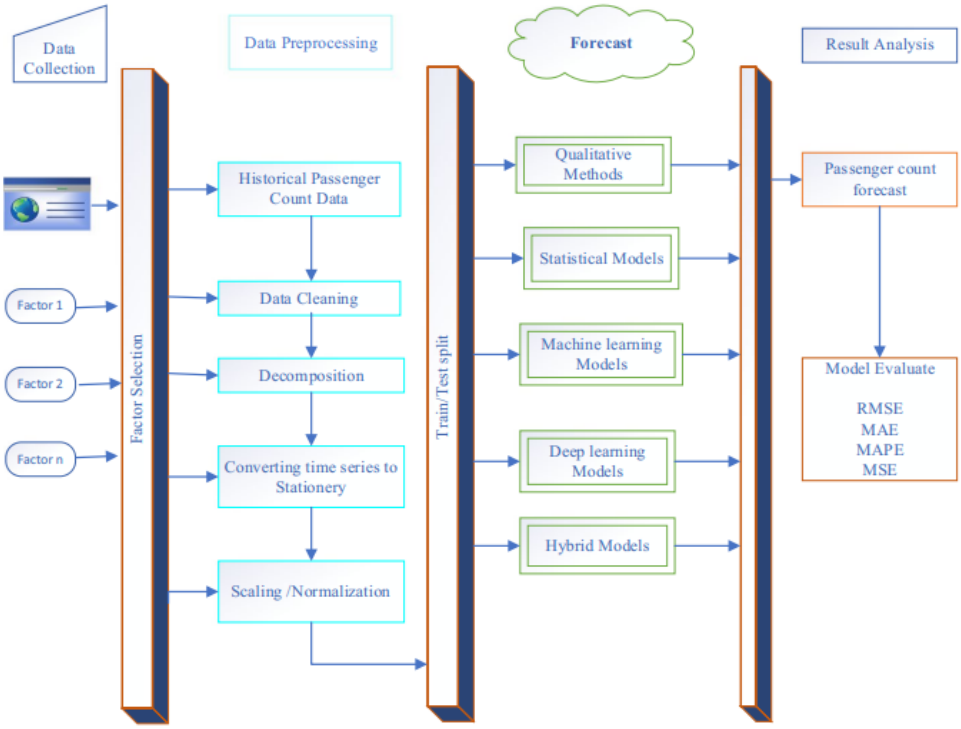
### 2.1.1 Forecasting

The entire revenue management is based on historical and present data in order to know more about market demand and allow the business to discriminate the price within all market segments. How does an airline choose which forecast method will wok best for it? Evaluation of different forecasts is generally made on forecast accuracy. More forecast diverges from true demand, more seats are

sold to the wrong customer, or not sold at all. Demand forecasting predicts number of passengers expected to fly on each combination of itinerary and fare category (Colville, 1996).

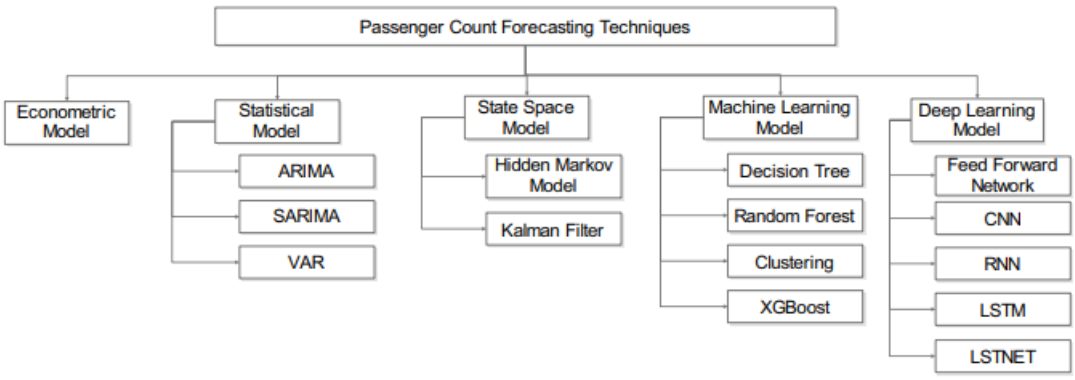
There are multiple techniques but the general framework is :

*Figure 10 General framework of passenger demand forecasting*




Influencing factors can range from social causes to economic reasons, such as GDP, inflation or travel restrictions. Moreover, the historical demand must take into account (data collection). Then, noise and outliers must be removed and time series (seasonality) must satisfy tests such as stationarity tests (data pre-processing). Using the normalized panel of data, there are different techniques to forecast demand, from qualitative to statistical, to Artificial Neural Networks.

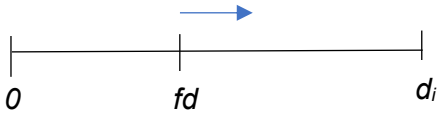
*Figure 11 Aviation Demand Forecasting Techniques*




*Econometric models* : based on discovering relationships between economic variables, such as GDP, interest rate, standard of living, population size, etc. there are three models in econometric

modeling: cross-sectional, time series and panel data. Number of passengers is the dependent variable, the other are independent ones. Different study case have been conducted to develop a functional regression model. Suryan in Indonesia, avoiding to take into account economic considerations; Bastola in Nepal, using the number of visiting tourists as independent variable, Carmona-Benitez et al. in Mexico, using the Arellano-Bover method

*Statistical models* : based on historical data, observed at regular intervals called time-series data. Data's stationarity must be checked because statistical variables such as mean, variance and autocorrelation should not change over time. Bermudez et al presented a formulation for an additive forecasting technique by obtaining the maximum likelihood estimates of smoothing parameters. The time frame of 50 weeks (350 days prior to flight departure) is divided into set of control time intervals (d day). Days left to departure (DL) is then d – fd where fd is the date when forecast is made.




For example, let set the forecast date fd in Oct 16, Monday, for a flight departing in 14 days on Oct 30. DL could be split in two intervals : 14-7 and 7-0. If N=8 is chosen (smoothing parameters), historical bookings from eight most recent flights (Oct 16$^{th}$ , Oct 9$^{th}$ , …, Aug 28$^{th}$ ) will be used for 7-0 incremental forecast and same for 14-7 incremental forecasts, but including Oct 23$^{rd}$ .

However, time-series-based forecasting is difficult due to the increased uncertainty of air passenger movement.

*Machine learning models* : capable of handling big data applied in time series data for prediction accuracy. The leading causes of forecasting errors are uncertain economic conditions and planners' bias.

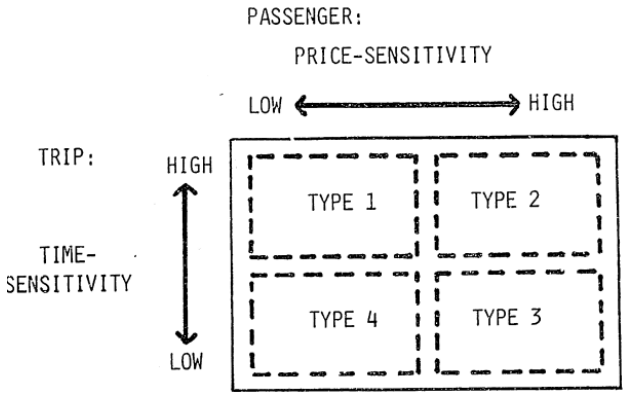
Forecasting in the airline industry is difficult due to its vulnerability to external shocks and its volatility at the leg/class/departure-date level. In Beckmann and Bobkoski (1958), forecasting models for passenger reservations are described for the first time while Lyle (1970) created a demand model, where the overall demand was represented by a negative binomial distribution.

### 2.1.2 Demand Management

*'art and science of dynamically managing demand to optimize distribution and maximize client relationships' (Larry Hall)*

Demand management offers the potential to provide value by producing and guiding demand, not just controlling it. Characteristics of most of the travelers could fall into one of these segments.

*Figure 12 Market Demand Segmentation Model*




Then different fares must be applied to each of them. Type 1 and type 4 could be aggregated since both are willing to purchase high-priced fare regardless of their trip purpose.

### 2.1.3 Capacity

The characteristic of industries where RM is most suitable is the perishable income potential from capacity utilization, in fact output cannot be inventoried for subsequent sale. A comprehensive overview of mathematical models and methods is provided by Talluri and van Ryzin (2004). After assigning aircrafts to flights, airlines offer ticket reservations from almost one year prior to departure. Throughout this booking horizon, aircraft assignments can change several times. Empirical data se from a major European network carrier has been analyzed to verify this observation (Busing, Kadatz and Cleophas). For 40% of 5867 observed flights, aircraft changes lead to capacity updates of at least 10% of the previous value. For 35% of flights, capacity updates of at least 50%. Updates made more than 8 weeks prior to departure (71%) are caused primarily by fleet assignment, whereas the ones made from 2 weeks prior to departure(19%), are driven by operational difficulties. In an extreme case, one day before departure, the economy compartment for a flight from Munich to NY shrank from 270 to 161 seats, likely caused by operational difficulties.

Moreover, capacity is not only related to seats. There are four types of capacity, also called the ‘four Ps’ (Huefner et al., 2013). These are: (1) physical, crucial to most of the RM literature; (2) personnel, or the degree of people required to operate but quickly modifiable in the near term; (3) processes, related to resources which take management decisions; (4) purchases, which supplies the products and services required for the organization’s outputs.

### 2.1.4 Overbooking

There always happen guests with the late cancelations and even no-shows on the arrival rate and since seats are perishable goods, the canceled bookings are unsold. Most of the time, airline company does not offer the refund, but empty seats mean that the company could still have exploit and sold it, reaching consistent financial gains (Bailey, 2007). Klophaus and Polt (2007) reported a contribution of 105 $ million in 2005 thanks to the right management of nearly 5 million passengers

who did not show up. It is the first RM technique currently utilized extensively in the airlines to increase profits. It is commonly accepted that 10-15% of passengers with confirmed bookings will not show up without giving advance warning, then airlines may still have about 15% of seats available in the actual trip if overbooking is not practiced (Smith et al., 1992). Airlines could fill these empty seats by selling more seats than their physical capacity (Amaruchkul et al. , 2011). Overbooking is strongly affected by demand uncertainty: excessive overbooking and underestimation of demand could cause denied boarding and loss of customers' fidelity (Belobaba and Farkas, 1999).

### 2.1.5 Seat Inventory Control

Seat inventory management is the process of limiting the number of seats available to each fare class, maximizing the total revenues generated by the mix of fare products sold for a flight. The term 'surplus seats', from which the revenue management's concept started (Crandall wanted to sell the seats with zero marginal costs at lower fares), may no longer be appropriate in the new context of seat inventory control. The surplus seats were considered a by-product of the airline's operation, traditionally devoted to serving the full-fare passenger. Instead, airlines must provide capacity for low-fare as well as full-fare passengers. In fact, although an airline can seldom impose price changes without taking competitors' reaction into account, seat inventory control is entirely under the control of each individual airline, and potentially increases total revenues on departure-by-departure basis (P. Belobaba,1988). The Expected Marginal Seat Revenue Model (EMSR) has been developed by Belobaba and consider the expected demand for each fare category to be normally distributed and customers booking lower fare classes are assumed to book earlier than those booking higher fare classes finding the optimal limits on the number of booking accepted in a particular fare class requires estimates of both the expected demand for each fare class and the average revenue associated with each class. These estimates are based entirely on historical patterns or derived from a forecasting model. The process also involves setting initial booking limits on each fare class that must share a common inventory of seats, monitoring actual bookings relative to these initial limits and then adjusting fare class limits as bookings are accepted.

### 2.1.6 Pricing

Price is one of the '4Ps' of marketing mix, including product, place and promotion too. Each P is a variable driven by the company and used by her to reach strategic goals but pricing is the only element of the marketing mix that produces revenues for the firm, while all the others are related to expenses (Marn and Rosiello, 1992, Simon, 1992, Lovelock, 1996). Dynamics of marketing mix take into account that only price is the leverage that generates direct revenues, and for this reason it is essential that companies focus on the setting procedure of prices. The other marketing mix components contribute to change customers' price elasticity and then enable price increases to drive greater profits. Price has a central role for clients, for which represents the value of a certain product

and its willingness to pay in order to get it, and for the seller, for which it is the direct source of revenue and profit. Due to its importance, the next chapter is dedicated to pricing.

## 2.2 Pricing

Pricing decisions have a direct effect on operations and vice versa (Fleischmann et al., 2004). Initially, revenue management techniques have focused mostly on optimal inventory allocation decisions, treating price and demand as exogenous. In reality , price is a key determinant of demand and one of the most important levers of profits.

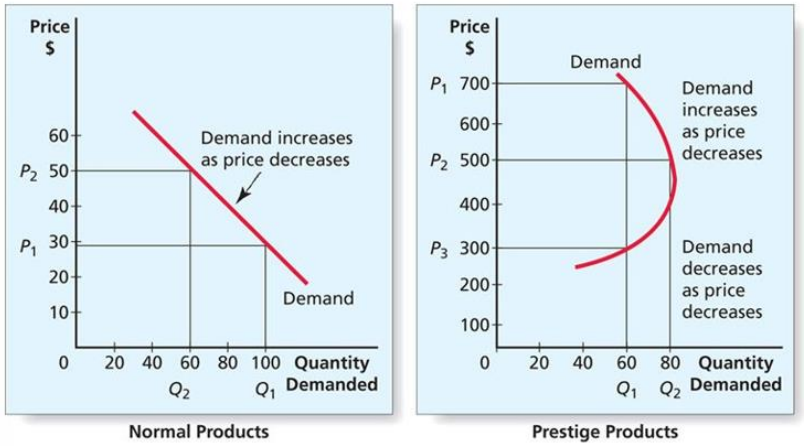
This separation between the functions of marketing (pricing) and operations (revenue management) is partly explained by rigid organizational structures and also by technical and operational difficulties inherent in implementing an integrated price-availability decision support system.

'*Departmental differences in personnel, expertise and decision-support systems make it difficult to coordinate … pricing and yield management decisions'* (Jacob et al., 2000)

Mc Kinsey & Co estimated that 'for the average S&P 1500 company, a price increase of 1% would generate an increase in profits of 8-12%, that is an impact 50% greater than a 1% cut in variable costs and 300% greater than a 1% increase in volumes' (McKinsey Quarterly, 2003).

The general rule is that price is inversely linked to the demand; as the prices rise, the quality demanded would usually go down. There are exceptions depending on the type of the product or on other factors. For prestige products, from a certain level of prices, the demand curve slopes upwards. The higher price is perceived as being an indication of a high quality good and so the product acquires a higher marginal utility ( = degree of satisfaction given to the consumer). The price is set by reaching the equilibrium between demand and supply, for which the slope and intercepts depends on costs ( P = MC(q) ).

*Figure 13 Demand function - Normal products and Prestige products*



From a historical perspective, the interest in revenue management practices started with the pioneering research of Rothstein (1971) but it was after the work of Belobaba and the success of American Airlines (Smith et al, 1992) that the field really took off. In fact, the airline context provides a concrete example of how the revenue management could impact on the overall life of the company (smith et al, 1992). Prices in the original models were assumed to be fixed and managers were in charge of opening and closing fare classes as demand evolved. Especially in airline industry, differentiation is considered a challenge and difficult due to the oligopolistic nature of the market. Since the 21st century, airline companies shifted gears and developed innovative strategies to create differentiation (Serio et al, 2016). For example, Etihad offers Belgian chocolate gift boxes; Thai Air offers a Royal Orchid Spa (John, 2021), Southwest created a distinctive image, offering no-fee for changes in itinerary or for two pieces of checked-in luggage. These strategies are designed in the direction of cost reduction.

During 1990s, models became industry-specific and more complex and sophisticated. After the long period where the principal strategy was cost reduction and increasing the market share, more and more researchers try deal with the problem of adjustment of the prices to the state of the market, and this area is called pricing.

### 2.2.1 Pricing Methods

Revenue management is increasingly marketing-led for the reasons explained in the previous paragraph: integration between operations and marketing – as well as strategy and tactics . is key for successful revenue management, not based anymore on just capacity control.

Since the amount of data, the most critical aspect is capturing, analyzing and interpreting these data in real time (Buhalis and Sinarta, 2019) using artificial intelligence (Buhalis, 2019). In the last decades, four emerging issues :

1- Organizational cultural
   Removing organizational barriers to automation and artificial intelligence (Aubke et al, 2014). RM is complex and requires the use of big data and skills about how to manage them. Organization support is crucial to keep a collaborative workplace climate (Li et al, 2019) and trained managers and appropriate IT infrastructure are essential (Selmi and Dornier, 2011)
2- Dynamic pricing
   Managing strategic and tactical performance target. DP occurs for two reasons, (1) intertemporal price discrimination, where company proposes real time price adjustments segmenting different groups of customers based on their urgency and flexibility; and (2) inventory controls, where company has already divided capacity into chunks and assigned a

price tag to each chunk (Melis and Piga,2017). The risk of dynamic pricing is about price fairness (Abrate et al, 2019).

3- Personalized pricing

   React to strategic consumers and anticipate their needs. Personalized pricing transforms each individual to a market segment of one, charging a behavior-based price discrimination according to their past purchase history, location, and other data (Caillaud and De Nijs, 2014). Automated revenue management is crucial for the accurate knowledge of the individual and to anticipate customer needs, such us make preliminary bookings that will be just finally approved by the end consumer.

4- Distribution channel

   Managing different distribution channels simultaneously. Multi-channel approaches are worthwhile to capture different segments, for example similar companies have a differential impact across channel used (Yang and Leung, 2018). An omni-channel strategy is essential (Gallino et al, 2017)

**Pricing strategies**

A pricing strategy has as goal to establish an optimum price with current profit maximization (Dolgui, Proth). As explained above, the price parameter influences strongly profit margin as well as market share; moreover, changing a price is easier and faster than developing a process to reduce production costs. There are several price strategies; here some examples:

- *High and low price strategies*

  High price is accepted if it agrees with the value of the product perceived by customers, such as Apple products (basing its strategy on quality and aesthetics, promoting them with a good marketing strategy) or Mercedes-Benz class A vehicles. A low price strategy may lead to a commercial success depending on the number of clients attracted, since low margin should be compensated by higher number of items sold. Examples are specially in the food retailing sector, such as Lidl, Aldi or Amazon.com, who gained a significant share of the book market.

- *Price discrimination strategy*

  Applicable to a type of item in the case of a monopoly market. It consists on segmenting the market and charging a different price for each segment, depending on their willingness to

pay. Goal is to anticipate customers' behavior in order to maximize revenue. Companies adjust their pricing decisions using historical data and other events

- *Discount strategy*
  It consists in selling a given set of items at a reduced price for a limited period. The reduction should generate enough supplementary sales to compensate the price reduction.
- *Price skimming*
  A high price is set at first, and then lowered over time, to reimburse huge investments made for research and development. It is similar to price discrimination strategy but with the time factor, because high price can not be maintained for long time, unless the company is in a monopolistic situation. This strategy is suitable when customers are less price sensitive or attracted by innovation, such as cosmetic industry or electronic industry.
- *Penetration pricing*
  The lowest price in the market is set initially, breaking down the purchasing habits of the customers and obtaining a larger market share. Similar to the low price strategy but with the time factor, since the price will increase over time.

Then, the pricing strategies could be summarized into cost-based, competition-based and demand-based.

Pricing strategy used by airlines is a demand-based pricing model which discriminate market segments, also called dynamic pricing. Is it the most suitable strategy for this industry?

Advantages of cost-based pricing are that it is easy to calculate because the price is computed by adding the desired profit margin starting from the operative costs. It will cover company's costs at least, but it does not take into account customer demand and their sensitiveness, so there is not certainty that the product will be sold (Oxenfeldt, 1961). Moreover, 'cost-plus pricing leads to overpricing in weak markets and underpricing in strong ones – the opposite direction of a prudent strategy' (Baker, 2006). Although this process was criticized for its 'arbitrariness', or a 'formula for mediocrity' (Morris and Morris, 1990; Gregson 2008), surveys conducted in Europe, Asia and America found that more than half of surveyed firms used cost-based pricing, more than competition or demand-based.

Competition-based strategy is also called follower pricing or parity pricing. It consists on setting prices slightly above or below the average market price. It is a step below demand-based pricing but above cost-based pricing (Liozu, 2015) since its process requires more skills and discipline. However, neither this strategy is aimed to profit maximization. Such as cost-based, even this approach has been criticized as a form of 'laziness'(Bouter 2013), the 'sign of a weak management

that does not know how to go about pricing' (Symonds, 1982) or a process that makes a 'dangerous assumption' that the firms being copied know what they are doing (Kennedy and Marrs, 2011).

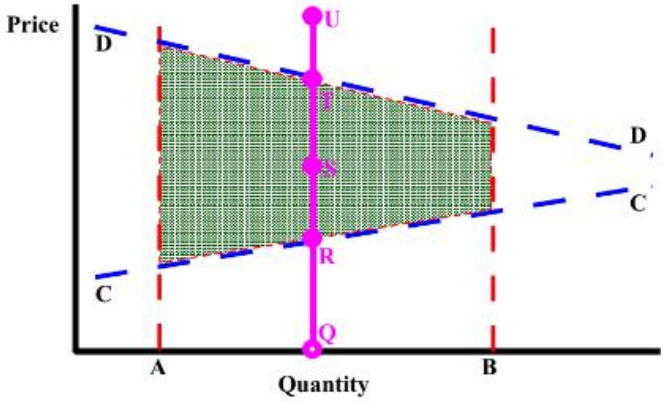
Finally, demand-based pricing considers fluctuations in customer demand and adjusts prices to fit the changes in perceived value. Methodologies can vary based on company's business goals, or on how and when a company enters its market (original innovators will not apply the same methodology as those that make a budget-friendly alternative. Demand-based pricing includes penetration pricing, price skimming, value-based pricing, yield management, …

Airline industry is an example of demand-based pricing, since yield management is particularly suitable for businesses that sell fixed-inventory resources within limited windows of time (perishable) and a demand strongly affected by time. The disadvantage of this method is the requirement of quality data and an intensive research, so it is labor-intensive process since the demand estimation is crucial. Another characteristic in favor of cost-based pricing, is that this one has a great public relations benefit, people tend to perceive external cost increases as fair justifications for price increases (Urbany et al, 1989). 'People who feel that a price is unfair are highly motivated to punish the seller whom they hold responsible' (Maxwell, 2008) But the advantage is the lower risk to have remaining units, because the firm could still adjust the price for last-second buyers however getting higher margin with the units sold before.

In conclusion, several authors have tried to explain which strategy is more efficient (Brooks, 1975; Urbany, 2001, Johansson et al, 2012) and the answer is obviously dependent on each case. Lack of data or ability forces firm to choose cost-based pricing, but must have the ability to allocate costs at least. A survey found that about of 70% of managers would choose demand-based pricing if they had better demand elasticity measures (Morris and Joyce, 1988) but only 12% of them conduct researches to improve them (Clancy and Shulman, 1993). The figure shows a simple graphic that could be used to encourage firms to consider demand when choosing their price. Every firm has a minimum quantity goal, based on a break-even analysis, and a maximum capacity, represented by vertical lines A and B (constraints). Line CC is the average costs, fixed or variable (not horizontal); line DD is the buyer willingness to pay, it could be nonlinear due to pricing psychology (Larson 2014). Using cost-based pricing process, the firm would choose Q, costing R and the price would be set by adding a margin. The demand-based approach implies the consideration of the demand when setting the margin. The key is staying inside the feasible area constrained by the demand. moreover, the feasible area could be affected also by other goals (using a balanced scorecard or triple bottom line).

Demand-based approach rises attention on demand function since small errors in demand forecasts could produce poor prices (Urbany, 2001).

*Figure 14 Pricing constraints and cost-based pricing options*




### 2.2.2 Dynamic Pricing

Customers in any given market have different propensities to pay, so segments exist based on different price points. Dynamic pricing is where the 'science of pricing can work for airlines to charge individual travelers the maximum price they are willing to pay, with an eye toward better using capacity' (Kohli and Habibi). To set optimal prices for a given inventory, airlines vary prices every day taking into consideration different factors, such as departure dates, inventory quantity, demand shocks, day of the week, and others. For example, research shows that fares are 5% lower when purchased on weekends, since leisure (and not business) travelers usually book tickets on weekends (Puller & Taylor, 2012).

In literature, dynamic and personalized pricing are sometimes distinguished. Both are differentiation pricing but while personalized approach sets the price based on willingness to pay (Choudhary, 2005), dynamic approach sets the price in order to achieve revenue gains responding to a given market situation with uncertain demand (Aviv and Vulcano, 2012)

Dynamic pricing practices are particularly suited for industry with

- High start-up costs
- Perishable capacity
- Short selling horizons
- Demand that is both stochastic and price sensitive.

Other industries the same 4 characteristics are retailers (Bitran and Mondschein, 1997), car rental agencies (Carol and Grimes, 1995), hotels (Bitran and Mondschein, 1995), Internet providers (Nair and Bapna, 2001), passenger railways (Ciancimino et al. 1999), cruise lines (Ladany and Arbel 1991) and electric power supply (Scweppe et al 1987).

Managers have to face up the trade off between selling the product to customers who have a high valuation, and then, who can bring high profit margin; and selling to low valuation customers. Sellers can not wait for high valuation customers too long because they would risk to end the selling period with unsold units that could have been sold to low valuation ones. Then the conditions of non-perishable goods (possibility to have unsold seats) and stochastic models are needed.

Dynamic pricing could be considered a value-based pricing. Douglas Ivester, CEO of Coca-Cola, in 1999 suggested a temperature-sensitive vending machines that adjusts the price according to the outside temperature (Phillips 2005). Douglas wanted to quench as much as possible customers' thirst and desire for a cold drink during hotter days. reasonably, Coca-Cola faced accusations of gouging and exploitation and this machine remains a rumor (Leonhardt 2005) but this is the basic idea of value-based pricing and its algorithms, and it would be easier to implement in a monopolistic market (the customer needs a cold Coca-Cola, not just a cold drink).

### 2.2.3 Algorithm of Pricing

Literature about methods, approaches and formulations of dynamic pricing models is heterogeneous, complete and even specific cases could be found, for example the multi-product case (Schlosser, 2020) or dynamic pricing model in case of two substitutable flights, using a Hotelling model (Wittman, Fiig, Belobaba, 2018).

Such models use and combine different algorithms such as stochastic approximation algorithms (Robbins and Monro, 1951) and Fibonacci ones (Bitran and Mondschein, 1997), other includes principles of Baynes (green 1963), or different form of learning algorithms, which change parameters with respect to varying external conditions, such as Q-learning, R-learning or SMART algorithms.

Not matter the type of algorithm used, at the center of each scheme stands the principle of profit maximization (BesBes and Zeevi, 2015). The objective function aims at increasing the overall profit by choosing the optimal price for a good / service (Chen and Gallego, 2019). The variables taken into account are broadly categorized according to Bayesian (Gallego and Talebian, 2012) and non-Bayesian methodologies (Ramsey-Boiteux, HJI equations or Taylor model). The demand side of a policy equation is characterized by fluctuation over time or static demand situation. Products are usually time-sensitive, perishables, sold within specific selling periods (Chen and Chen, 2015). Inventory management must be included. Dynamic pricing offers the instrument to manage the inventory and then decreasing costs (the marginal cost of one seat is zero if the flight is almost full).

Airline companies keep their pricing algorithm unknown, but generally there are factors in common that influence price and are the determinants of all of these algorithms. There could be many more, depending on airline needs.

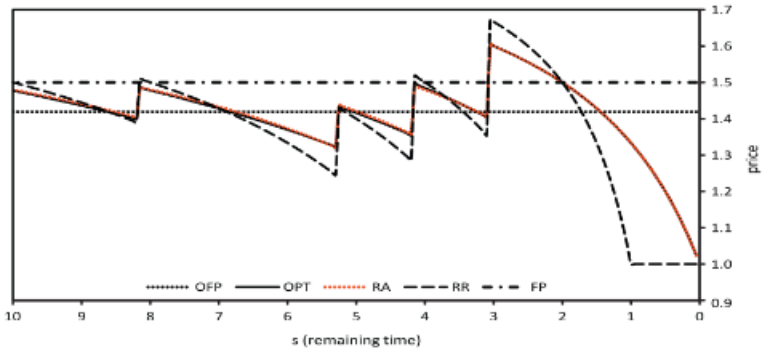
| | |
|---|---|
| Business/leisure passengers profiling | Fares start high on leisure routes and reduces closer to departure; other way around for business routes. For routes both leisure and business, fares based on previous purchases (airlines are starting to do this but there is still a long way to go) |
| Length of advance purchase | Prices can vary significantly over the months leading up to a flight. Prices could be extremely high or low depending on the remaining seats and type of flight (for example, Mi-Pa route is high especially for last-minute bookings ) |
| Current sales volume | Price will be higher if there are only a few seats left. Sales volume can also have a very short-term effect and algorithms increases price if there is a pick-up in demand (sales incur very quickly) |
| Length of trip | Lower fares will usually require a long stay. Low cost airlines usually operate a 'point to point' pricing system, offering attractive one-way fares but return trip really high. |
| Level of competition | Airlines monitor competitor fares on the same or similar routes. A homogeneity among prices offered is common. The MIT International center for Air Transportation in 2013 looked at the effect of LCC moving into new routes showing a significant reduction even from legacy airlines. |
| Peak and 'blackout' dates | Limiting availability of lower booking classes at certain times (peaks). |
| Level of overbooking | Oversell flights, especially on certain routes. Could be turn in expensive practice when regulations demand customers are compensated, if the airline makes mistake on demand forecast. |
| Fuel and oil prices | Fuel is a major part of airline costs. Airlines must consider to cover its cost although the prices are not fixed. A solution implemented by some company is the 'fuel surchages', additional fees added to tickets. |
| New ticket types | Diminishing services offered and comfort |

### 2.2.4 Static vs Dynamic

Real cases could demonstrate the superiority and the necessity of implementing dynamic pricing model, for example the American Airline case discussed before. Suddenly after deregulation, major airline companies were close to bankruptcy thanks to new entrants, the low cost carriers.

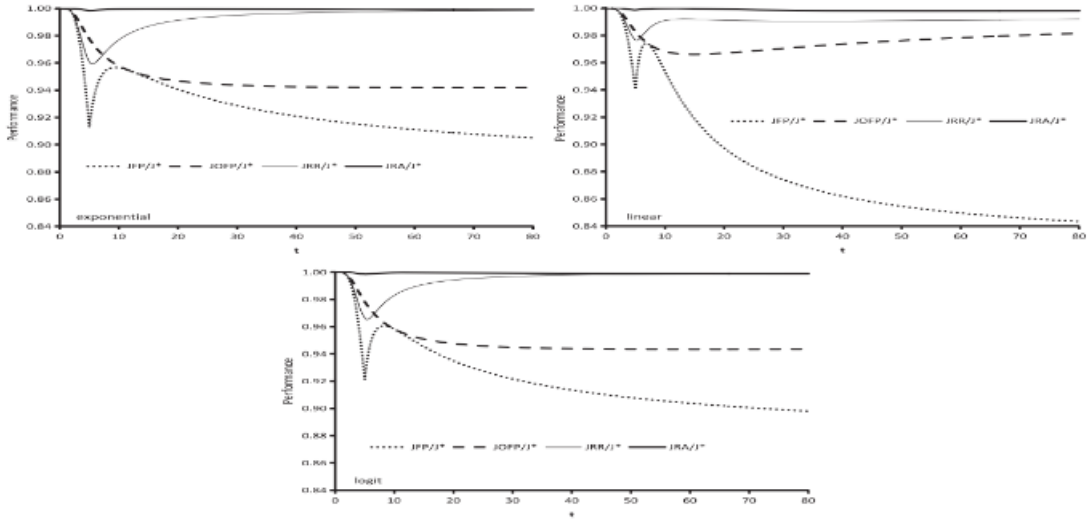
AA has been the first company to implement revenue management practices flipping the outcome of the 'war' against LCCs. From that moment, RM practices are considered the basilar strategy of airline industry. The comparison between static and dynamic pricing has been done even in study cases mathematically (Alper Sen, 2011). Performance of dynamic pricing heuristics (RA, revenue approximation, and RR, run-out rate) and constant price heuristics (FP, fixed price and OFP, optimal fixed price) has been compared and plot in the table. In FP model, the price is the one maximizing revenue for a given remaining time s and inventory x, solving p(λ)=p(min { $\lambda^0$, λ*} where $\lambda^0$ = n/t is the run out rate and λ* is the revenue maximizing rate; RA approximates the optimal expected revenue function with a proper function $\lambda_{RA}(x,s) = argsup\{r(\lambda) - \lambda(j(x,s) - j(x-1,s))\}$ ; RR solves the same problem of FP but iteratively, while FP solves it just once at the beginning of selling period; OFP solves $p = argmax\, pE[min\{n, N\lambda(p)(t)\}]$ where $N_{\lambda(p)}(t)$ is a Poisson random variable. The figure shows the sample price paths for each heuristic.

*Figure 15 Price paths for optimal and heuristic policies, linear demand a=2, b=1, t=10, n=5*




Alper Semn performed the study considering n=5 and λ*=1 and three different demand functions. For all f them, when t is very small, performance of all heuristics are close to optimal but RA heuristic performs better than all heuristics for all demand functions and all values of t. The graphs below show the result with a linear demand function, but the results are the same even for the other two functions (horizontal axes is t)

*Figure 16 Performance of fixed price heuristics, n=5, p=λ=1*




Considering bigger problems, with n=300 and t=360 days, OF and OFP performances are better since expected sales is larger. However, RA offers the best performance.

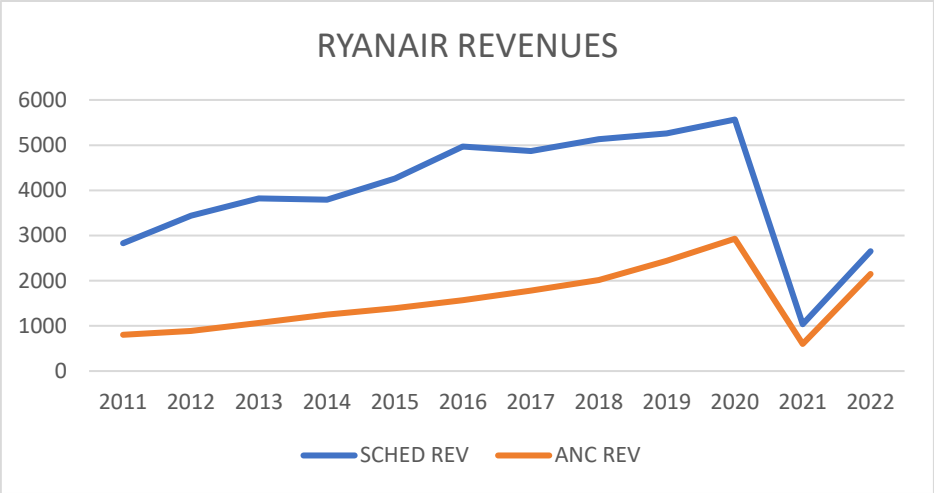
## 2.3 Practical Cases

In this paragraph will be discussed some real cases about how airline companies implements dynamic pricing in their business. In particular, low cost airlines use a simpler dynamic pricing structure than traditional airlines. Full-cost carriers must discriminate price according to different fare classes, customer loyalty schemes and other actors that low-cost carriers may be able to exclude from analysis, basing their price mainly on the time to departure ( D'Alfonso, Redondi, Malighetti, 2011).

**Ryanair**

Ryanair is considered one of the European low cost leaders that has developed a strictly low fare leading strategies due to its no-frill product, as well as other low cost carriers. No-frills means the lack of non-essential features that allows to keep the costs and then the price low. Any additional charge may be designated as a 'frill'. Especially Ryanair became the company with the most rude and extreme interpretation of the low cost idea: non-profitable routes were eliminated, network cut from 19 to 5 routes, leader in carrying the highest number of passengers, reducing size of seats and increasing aircraft's capacity.

*Figure 17 Ryanair Revenues*




*Source: Ryanair Reports*

The graph shows the revenue trends from 2011 to 2022, respect to scheduled and ancillary revenues (beyond the sale of tickets generated by direct sales to passengers or indirectly as part of the travel experience. Although both trends are positive, not considering the pandemic, the difference between the two types of revenue is diminishing: ancillary grew from 25% to 50% within 2020. Passenger numbers are constantly increasing (except the drop in 2020).

Ryanair's pricing strategy could be just supposed using existing literature about price trend influenced by demand. it is quite typical to use an exponential demand curve (Gallego and Van Ryzin, 2004) and customer arrivals with a Poisson distribution. The demand can be expressed as: (Anjos, Russell, Cheng and Currie, 2015) .

$$q_i = Ae^{-\alpha p_i F(i)} \qquad where\ i \in [1, K, T]$$

Where qi is the number of seats booked on the same day, A and α are two constants and F(i) introduces the correlation to the time period (i, days) between purchase and flight date. The maximization problem can be solved through a 'Lagrangian', where the revenue is maximized (since marginal costs are zero, profit = revenue) and μ represents the aircraft limit of capacity.

$$L = \sum_{i=1}^{T} p_i q_i + \mu(Q - \sum_{i=1}^{T} q_i) \qquad \mu(Q - \sum_{i=1}^{T} q_i) = 0$$

The optimal price is then a hyperbola where α is the highest price level that may be reached, and β is a decrease in the fares directly proportional to the advance of booking days : low β means that the price trend is slow (if β = 0,1 buying the ticket 90 days in advance yields a 90% discount on the maximum fares). The hypothesis is that Ryanair tailors a pricing strategy for specific routes, estimating the parameters using data from 90-day period before the flight date.

$$p_i = \mu + \frac{1}{\alpha(1+\beta_i)}$$

The research conducted by Malighetti, Paleari and Redondi is based on database of Ryanair's fares for several routes operated during the year (1st July 2005) estimating the price trends over 3 months (90 days) prior departure.

Figure shows the estimated (calculated by using above formulas) and the average ticket price for the RomeCiampino-LondonStansted route. Moreover, the daily bookings remains steady according to Stokey's (1979) study.

*Figure 18 Comparison between the daily average price and the estimated price on CIA-STN route*


Conclusions are:

- *Positive correlation* between fares and route length, route frequency and percentage of fully booked flights.

*Table 7 Determinants of the average price*

| Variable | Coefficient (std error) | Statistic $T$ |
|---|---|---|
| Length | 0.021 (0.0010) | 19.98*** |
| Route frequency | 0.100 (0.0496) | 2.02*** |
| Ryanair ASK/departure ASK | −9.013 (3.4414) | −2.62*** |
| Ryanair ASK/destination ASK | −8.822 (3.2156) | −2.74*** |
| Overall taxation | 0.298 (0.1119) | 2.67*** |
| Departure GDP | $-0.71 \times 10^{-03}$ (0.0002) | −2.71*** |
| Destination GDP | $-0.46 \times 10^{-03}$ (0.0002) | −1.74*** |
| % Of fully booked flights | 24.116 (7.4912) | 3.22*** |
| Departure population density | $0.43 \times 10^{-03}$ (0.0008) | 0.52*** |
| Destination population density | 0.001 (0.0008) | 1.74*** |
| Total number of competitors | 0.038 (0.5403) | 0.07*** |
| Constant | 1.849 (2.6235) | 0.71*** |
| Adjusted $R^2 = 0.5668$ | | |

- Length and route frequency are *negatively correlated* to dynamic pricing intensity (fewer discounts on long haul / high-frequency routes)

*Table 8 Determinants of the dynamic pricing level (β coefficient).*

| Variable | Coefficient (std error) | Statistic $T$ |
|---|---|---|
| Length | $-0.22 \times 10^{-03}$ ($0.016 \times 10^{-03}$) | $-13.50^{***}$ |
| Route frequency | $-0.15 \times 10^{-03}$ (0.0007) | $-2.04^{***}$ |
| Ryanair ASK/departure ASK | 0.111 (0.0524) | $2.13^{***}$ |
| Ryanair ASK/destination ASK | 0.042 (0.0490) | $0.86^{***}$ |
| Overall taxation | $3.26 \times 10^{-03}$ (0.0017) | $1.91^{***}$ |
| Departure GDP | $1.65 \times 10^{-06}$ ($4.040 \times 10^{-06}$) | $0.41^{***}$ |
| Destination GDP | $2.95 \times 10^{-06}$ ($4.088 \times 10^{-06}$) | $0.72^{***}$ |
| % Of fully booked flights | −0.078 (0.1142) | $-0.69^{***}$ |
| Departure population density | $-0.01 \times 10^{-03}$ ($0.012 \times 10^{-03}$) | $-0.81^{***}$ |
| Destination population density | $-0.01 \times 10^{-03}$ ($0.012 \times 10^{-03}$) | $-0.99^{***}$ |
| Total number of competitors | 0.016 (0.0082) | $2.03^{***}$ |
| Constant | 0.326 (0.0400) | $8.17^{***}$ |
| Adjusted $R^2 = 0.3756$ | | |

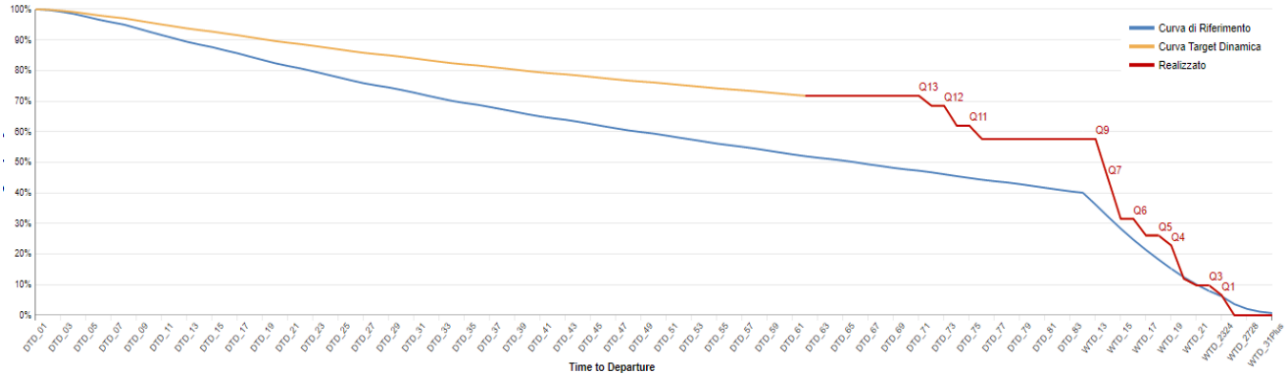
- *Negative correlation* between importance of arrival airport and fares (discounted fares incentive to use secondary airports)
- Presence of competitors *does not seem to have an impact* on the average price. The number of competitors is positively correlated to dynamic pricing intensity.

**Neos Company**

NEO spa is an Italian airline, a subsidiary of Alpitour. Neos was established as a joint venture between two tourism companies, Alpitour and TUI Group (Germany). Since this dependency, the market where Neos operates is more complex and different respect to other airline companies, but the pricing strategy and logic is comparable to other companies' ones. During my traineeship, I had experienced both Neos's and Alpitour's dynamic pricing methodologies. The airline company in fact has some 'own' seats that could be sold as air travel, not associated to the hotel (Alpitour business). Alpitour buys some seats in advance in order to guarantee a certain availability, but its prices are different from Neos' prices, and must be aligned to not create an internal competition.

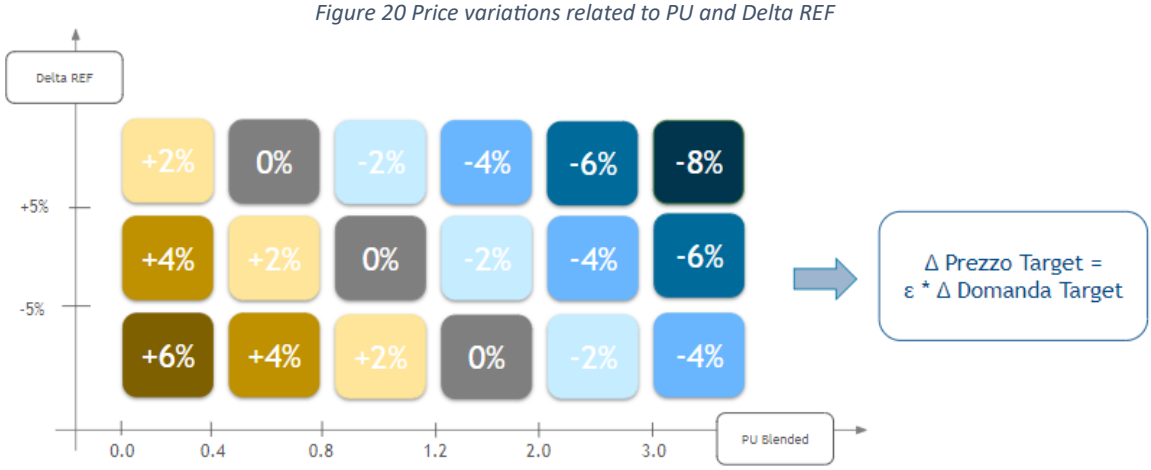
Dynamic pricing algorithm often cooperates with human mind (*importance of both parties is explained in the paragraph 2.4*), and my role during the traineeship was in the team that adjust the price, helped with the algorithm, and using a platform called 'Toolkit'. First of all, two different criteria are applied depending on the type of flight: for the flight with < 30 seats initially available, called 'Nani', the algorithm is activated just in certain moment respect the days to departure (DTD) and the remaining seats, then the dynamic pricing is more 'static' than the other type of flights and their price is changed just in pre-determined periods (when DTD = 45 days, 30 days, 15 days, …). For the others, called 'standard', the algorithm works in the following way. The historical data are visualized in the form of 'REF' curve, how much the company sold in previous year, and these data are used to compute demand elasticity also. The current sales are represented by the 'booking curve' (the blue one). Then, the algorithm computes different scenario distinguished by profit margin/sale volumes and chooses the price that will bring similar results of previous year.

*Figure 19 Booking Curve related to time to departure*



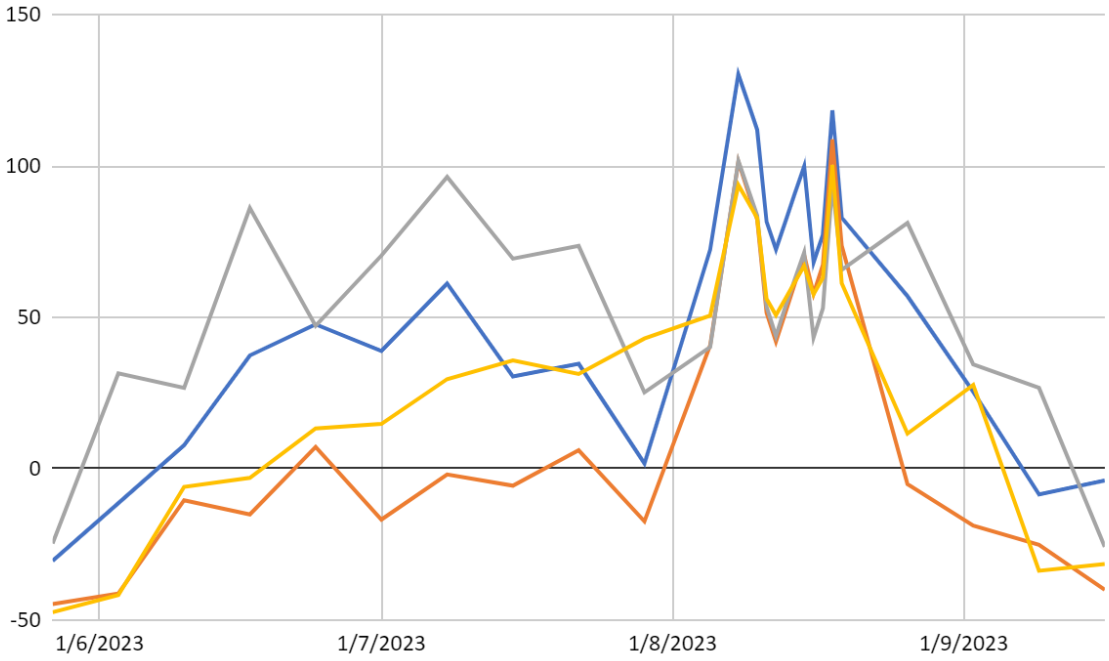

Two metrics used are Delta REF and PU. The first one is the difference in sale volume respect historical data; the second one is referred to the sales of previous weeks, giving an idea of how fast tickets are sold. If the PU and delta REF are both high, this graph suggests the algorithm to increase the price because the sales are incurring too fastly even respect the previous year, so the tickets could bring additional profit margins. (remember demand elasticity is negative! Then Delta Demand (-8%, in our case) x elasticity (-) = Delta Price (+)).

*Figure 20 Price variations related to PU and Delta REF*




Price chosen by toolkit or by human is the result of adjustments of the so called ‘entry level price’, decided by pricing team. During the year, the team sets the entry level price for each day of the season on the basis of historical data and evaluation of the current year. The entry level price brings negative profits during the off-season, and really high profit margin during peak periods: day by day profits are adjusted using these prices as starting point, trying to increase these margins as much as possible. The following chart shows the profit margin brought by different travel packages in Calabria. Overall margin, considering also other destinations, are calculated in a way to compensate the negative margin periods and getting an overall positive profit for the company.

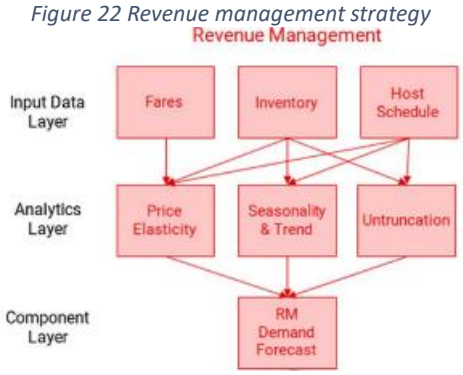
*Figure 21 Profit margin of different travel packages in Calabria*




## 2.4 Algorithm and Humans

The use of artificial intelligence is not just an accessory. As explained in previous chapter, travel industry, travel suppliers, Online Travel Agencies (OTAs), rely on the dynamic pricing strategy to survive. This strategy is based on the use of an extensive amount of data since forecasting demand (these data provide unique insights into consumer preferences and behavior patterns) and benchmark between competitors is essential.

*Figure 22 Revenue management strategy*



Literature suggests that Revenue Management system (RMS) of airline industry can use different models to approach the revenue maximization problem, classified according to the type of learning employed:

- Passive learning

  The traditional approach (Talluri and van Ryzin, 2004) is to estimate the unknown demand model parameters from a database of historical observations using classic techniques as ordinary least squares (OLS) or maximum likelihood estimation (MLE) and then produce the set of price recommendations (myopic policy). RMS periodically re-estimates the demand model parameters and updates its myopic policy. it is called passive learning because RMS never validates its demand model parameter estimates

- Active learning

  With active learning, airline trades-off the benefits and costs of exploiting the myopic policy that it believes to be optimal, versus exploring new policies that could improve the accuracy of the estimated demand model parameters (Balvers and Cosimano, 1990). Exploration implies setting sub-optimal prices, representing a short-term cost, but also a future revenue benefits by increasing the speed at which RMS can learn about true customer behavior.

- Reinforcement Learning

  RL is model-free, learning the optimal policy directly through repeated interactions with the environment instead of relying on a demand model and explores prices that deviate from the perceived revenue-maximizing prices (active learning). RM optimization problem can be seen as a 'game' : positions correspond to a state s = (x,t), where x denotes the number of bookings and t the time to departure, and 'moves' are the different pricing actions taken by the airline company. RL is implemented in practice by Q-Learning and Deep Q-Learning approaches.

The entire department of revenue management is still necessary? Particularly in scenarios where large-scale and real-time adjustments are required, smarter auto-learning systems will monitor and alert early enough to maximize as possible revenue and minimize opportunities' losses. Experts predict that AI usage will add as much as 15,7$ trillion to the global economy by 2030.

However, humans will remain a necessary component in revenue management, despite advancements in technology. Machines lack of contextual understanding, ignoring external events or specific market dynamics, like applicable laws and regulations or even ethical considerations, and there could be exceptional cases to be handled where human intervention may be required. Airline, or even the entire tourism industry, is highly dynamic and revenue management must be flexible to accommodate changes in the market, requiring strategy, not just software. On the other hand, to enjoy the full benefit of dynamic pricing, the prices will have to be adjusted in real time, possibly after each transaction, then human brain processing capacity is limited. For this reason, the two intelligences have to work in collaboration.

The artificial intelligence must be a tool and supervised by humans. Software can provide an immediate response and reset the selling price at optimal intervals whereas human agents provide a deep knowledge and readily adapt as circumstances or objectives of the problem to be solved evolve and change, offering a good initial solutions that software can use ad basis for further improvement.

## 2.5 Price Fairness

Price fairness is defines as

*'a consumer's assessment and associated emotions of whether the difference between a seller's price and the price of a comparative other party is reasonable, acceptable or justifiable'*

(Xia et al, 2004)

Maxwell (2008) states that 'fair' has two separate meanings : (1) acceptable, implying that a fair price is satisfactory; (2) just, implying that the price is judged as justified and free of favoritism. The difference is the same between the personal and the social fairness. The personally fair price is low enough to meet one's expectations; the socially fair price is the same for everyone, not giving unreasonably high profits to seller.

Through one lens differential pricing can be seen as a form of 'covert' marketing activity that damages consumer trust (Milne et al,2009). The price is set in the view of profit maximization, not cost cover, then the company goal is exploiting the willingness to pay of the consumer in order to get more and more profit. Potentially two passengers could have paid the same flight a price with a difference of hundreds of euros potentially, and are now sitting next to each other.

Researchers have been requested to pay more attention to the problem of price fairness (Kung et al, 2002) since it could bring deterioration of the reputation or trust of the company. Marketing and psychology studies conducted to investigate consumers' respond to dynamic pricing are based on :

- Distributive justice theory (Thibaut and Walker, 1975) : 'allocation of rewards on the basis of individual contributions' (Cox, 2001). A consumer perceives price fairness when they paid the same price with other consumers for purchasing the same product or service (Martins and Monroe, 1994);
- Equity theory (Adams, 1965) : consumers perceive the fairness (equity) of transactions by comparing the ratios of their contributions versus the resulting outcomes;
- Dual entitlement principle (Kahneman et al, 1986) : perceived fairness is governed by the reference transaction , exchange parties' outcomes and exchange context. If either party does not get its entitlement, the relationship is perceived as unfair, even by the party that might get a discount (perceived that they did not receive their entitlement).

Although in his study, Da Silva (2012) shows that customers are still loyal to the airline even when they believe the price to be unfair, due to other factors affecting loyalty (competition, types of destinations, …) , Chung and Petrich (2012) suggest the importance of dealing with customers who perceive prices to be unfair, since this leads to unfavorable behavioral intentions. Depending on the type of market and the 'degree' of product / service, consequences of price unfairness could vary from a lower perceived value to dissatisfaction. In the case of airline market, unfair pricing leads to claiming financial compensation (Xia et al, 2004), searching for alternatives (Okun 1981) or spreading negative word-of-mouth (Kahneman et al,1986) although customers are familiar with varying prices. In fact, Kimes and Wirtz (2003) assert that dynamic pricing in this sector has been so popular and common that it is generally accepted by customers and 'unreasonably high' prices have becoming the normality.

# 3 Collusion

## 3.1 Collusion vs Competition

Competition and collusion concepts are exactly one the opposite of the other. Competition is the activity or condition of striving to gain something ( = profit ) by defeating or establishing superiority over others: economic firms are in contention to obtain limited goods by varying the elements of the marketing mix. Theoretically, competition can be distinguished into four types :

1- perfect competition, where sellers provide homogeneous products at fixed price, set by equilibrium between demand and supply. No one takes profit, since the number of sellers is adjusted according to the possibility of earning profit. The assumption is that price is set equal to the marginal cost of the firm.
2- monopoly market, where a single seller providing a product with no close substitutes. Monopolist is a price maker, then price discrimination is possible (charge different consumers different prices for same product)
3- oligopoly markets, with few but large firms mutually dependent on one another in taking pricing decisions. selling homogenous or differentiated goods. Simplest form of oligopoly is duopoly (example : Boeing and Airbus)
4- monopsony, where market systems are differentiated according to the number of buyers. There is one big buyer per type of market system, which has the power in determining the price.

The described model are ideal model, the reality presents imperfection since the assumptions are easily violated, such as the absence of entry or exit barriers. In all of the cases, competition occurs naturally between organisms co-existing in the same environment. On the other side, while competition brings the concept of positive ‘rivalry’, collusion brings the notion of ‘cooperation’, but negatively.

Collusion is a deceitful agreement between rival companies which cooperate limiting open competition and misleading or defrauding others outside from their deal. It is the enemy of competition since it is an anticompetitive business practice n order to obtain benefits at the expenses of consumer welfare. For this reason collusion is addressed to negative terms : disadvantages the consumers and firms outside the tacit agreement.

## 3.2 Oligopolistic equilibrium

Oligopoly is a type of market characterized by relatively undifferentiated goods, and a relatively small number of firms operating. Oligopoly and collusion are two concepts strictly correlated. Firms see an economic benefit in collaborating rather than competing with their competitors. Cooperation allows to control prices and raise barriers to entry, keeping a profit surplus (the absence of entry barrier is the main assumption for perfect competition ,characterized by a zero profit for all the firms). But the

two concepts are distinct: oligopoly is a the market structure where firms can influence price and market conditions, then a degree of interdependence exists between them; collusion is the secret deal and implies the violation of antitrust laws.

Oligopoly does not imply collusion, indeed collusion is not a state of equilibrium. Behavior of firms enjoying an oligopoly could vary from an aggressive approach to a collaborative way to act.

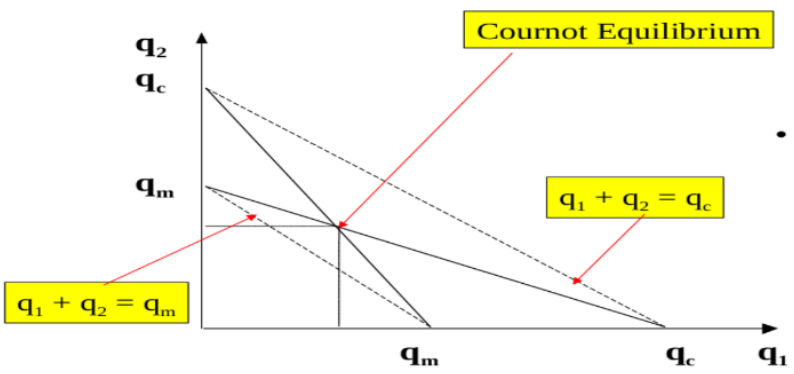
*Collusive oligopoly* - competing in an oligopoly means deciding if being focused on price or quantity instead. If price sensitiveness is rigid, firms have little incentive to change prices and then there will be a non-price competition, where firms could gain market share by marketing or quality investments to improve market sales.

*Non Collusive oligopoly* - In the other side, when the approach is collaborative, the oligopoly turns into a collusive oligopoly, where firms cooperate following a common price policy creating an explicit or tacit cartel. Generally, there is a leading firm which acts as a price leader and its price policy is accepted by other firms in the cartel. Even a formal agreement is illegal. In certain case, it could be legal if there is an agreement signed between countries, not individual firms, such as the case of OPEC (organization of the Petroleum Exporting Countries).

**Cournot Model**

A model expressing the oligopoly market is the Cournot model. This model is based on the quantity competition (instead of the Bertrand model, basing on price competition) and takes into account the interdependence between firms, leading to a game where firms must respect a tacit deal and cut out a potential third rival. The basic concept of the model is the so-called 'Cournot Conjecture' – rivals do not modify their quantity; given rival's quantity, the other firm acts as a monopolist on its residual demand. Then, both firms draw a reaction curve. If the other firm does not produce (q2 = 0), the rival produces a monopolistic quantity ( $q_1 = q_m$ ); if the other firm produces at a competitive level ( $q_2 = q_c$), the other can not produce ( $q_1 = 0$). Cournot outcome is in the mid way between perfect competition and monopolistic outcomes, $q_m < (q_1^* + q_2^*) < q_c$ ,order respected even for prices.

*Figure 23 Cournot Equilibrium*



Being in the halfway between the two 'perfect' models, means that the losses of welfare (WL) is less than the monopoly case but still relevant. The WL depends on the specific case: it increases as product differentiation increases, or number and relative size of firms can be a factor influencing the WL.

## 3.3 Enablers of collusion

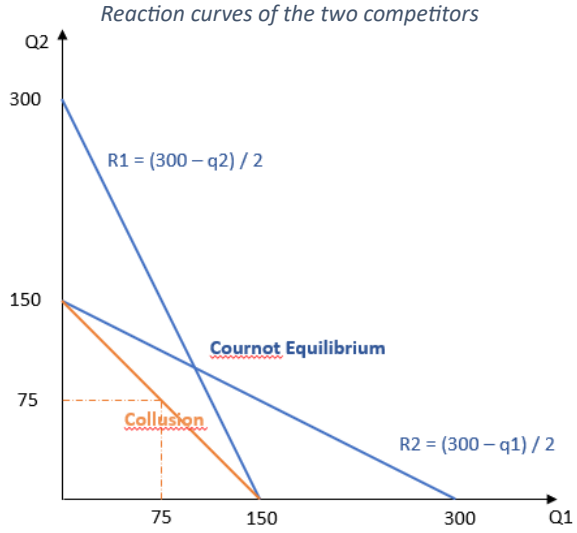
Collusion is not a Nash equilibrium, while the Nash-Cournot equilibrium is a non-collusive but stable equilibrium.

In Nash-Cournot equilibrium firms compete by choosing their quantities simultaneously and maximizing independently their own profits, producing a quantity higher than the monopolistic one, and a price lower than the monopolistic one. The equilibrium is ensured since firms' profit is already maximized and no player can improve its payoff but each participant adopts the strategy best for him, regardless of which strategy the other participant chooses.

On the other hand, colluding firms coordinate their actions to achieve joint profit maximization. The total quantity is less than Cournot equilibrium quantity but the profit is higher. Let give an example.

| Market demand curve | P = 300 – ( Q1 + Q2 ) | |
|---|---|---|
| | **Cournot Equilibrium** | **Collusive Equilibrium** |
| Total Revenue | $TR = (300 - Q_1) \times Q_1$ | $TR = (300 - Q_{tot})\ Q_{tot}$ |
| Profit maximization function | $0 = 300 - 2Q_1 - Q_2$ | $0 = 300 - 2Q_{tot}$ |
| Quantities | $Q_1 = Q_2 = 100$ | $Q_1 = Q_2 = 75$ |
| Price | P = 100€ | P = 150€ |
| Individual Profit | $\Pi_1 = P \times (100) = 10.000€$ | $\Pi_1 = P \times (75) = 11.250€$ |
| Total profit | Π = 20.000€ | Π = 22.500€ |

*Figure 24 Cournot Equilibrium price and Collusion Price; Reaction curves of the two competitors*



Collusion is not stable, since that quantity is not the best response of the firm. As the graph suggests, if firm 1 produces Q1 = 75, the best response of firm 2 is Q2 = 150 – 37,5 = 112,5.

The resulting output is

P = 112,5 €

$$\pi_1 = 75 \times 112{,}5\ € = 8437{,}5\ € \left(= \frac{\pi^m}{2} = \frac{6\times(\alpha-c)^2}{64}\right)$$

$$\pi_2 = 112{,}5 \times 112{,}5\ € = 12656{,}5\ € \left(= \pi^m = \frac{9\times(\alpha-c)^2}{64}\right)$$

The resulting profit of firm 2 is higher than the collusive one, then the firm has the incentive to deviate if we consider a timeframe T finite due to the immediate profit consequent to the deviation.

Whereas considering an infinite timeframe and applying the *folk theorem (any individually rational outcome can arise as a Nash Equilibrium in infinitely repeated games with sufficiently little discounting,* suggesting that if players are patient enough, the repeated interaction can result in a wide range of efficient equilibria, not achievable in a one-shot game*),* the collusive interaction could lead to an equilibrium, particularly when the following condition is achieved :

$$\frac{1}{1-\delta}\frac{\pi^M}{2} \geq \pi^D + \frac{\delta}{1-\delta}\pi^c \qquad where\ \delta \geq \frac{9}{17}$$

Meaning that the firm has the incentive to produce $\frac{q_m}{2}$ (collusive quantity) because future profits have a heavier weight respect the immediate profit that would come after deviation ($\pi^d$ plus the future $\pi^c$).

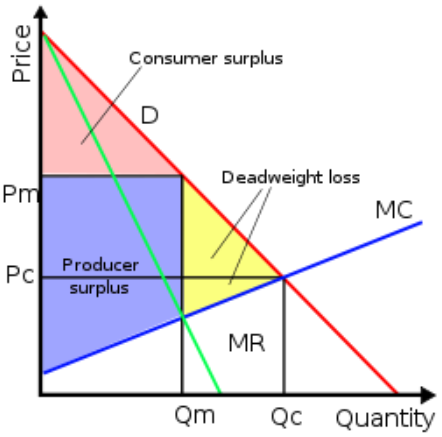
## 3.4 Collusion illegality

Collusion seem to be a natural consequence of oligopoly from firms' point of view. Oligopolists wish to collude to maximize joint profits, and effectiveness of collusion is much more effective in some circumstances than in other (Stigler). Why would it be illegal? Oligopoly, such as monopoly, reduces consumer welfare and social efficiency by creating an outcome similar to the monopoly one, then lower than the competitive level (Chad H.).

Consumer welfare is defined as the difference of the maximum amount that consumers are willing to pay and the actual amount they pay. Social efficiency is the situation where the total surplus (consumers + producers) is maximized.

The monopoly, such as the oligopoly, since the individual firms forming the cartel could act as a single firm, does not produce an efficient output level and moreover, creates a deadweight loss (no social efficiency).

*Figure 25 Producer surplus, consumer surplus and deadweight loss*




In his studies, Gaurab Aryal (et al., 2018) demonstrates empirically that when all legacy airlines in a market communicate concurrently, the result is a reduction of offered seats by 1,13 / 1,45 % (result is confined just to the legacy airlines, not the LCC).

Beyond the inefficiency of the model, collaborative oligopoly is not illegal in itself. Illegality borns as a consequence of antitrust law violation, stating that firms can not form a cartel for that particular market, because it could harm the whole economy system and create a waterfall deteriorating effect due to negative externalities. For example, a disincentive to travel damages not only the airline or tourism industry, but all the society under an economic (importance of tourism industry in PIL has been explained in the first chapter), social and cultural perspective, involving a huge number of other sectors.

Cooperation between companies is allowed, but the problem is when these firms want to deploy this cooperation and superiority and make unfair the competition with other firms. A strategy commonly used is to set really low prices temporarily, and then increase price when the other firms get out from the market, because the too low prices were not sustainable for their survival.

Collusion leads to an unfair advantage for those ones who win. In many contexts and jurisdictions, collusion is considered unlawful and subject to penalties, depending on the specific circumstances of course. Especially in the context of business and competition law, collusion between companies implies some practices such as fixing prices, rigging bids, allocating markets, leading to an unfair competition.

A potentially collusive pattern of prices is a violation of the first section of the Sherman Act although demonstrating evidence of agreement among competitors is not so easy. Awaya and Krishna (2016) and Spector (2018) have shown that airline companies can use cheap talk (unverifiable and non-binding communication) to sustain collusion, signaling to others about their residual demand.

*'in some circumstances, competing sellers might be able to coordinate their pricing without any detectable acts of communication. This is the phenomenon called 'conscious parallelism' or 'tacit collusion'* (Posner, 2001)

## 3.5 Organizations in the airline industry

The airline industry influences the overall economy and even the relationship between countries around the world. due to its nature, the high startup costs and infrastructure constraints, the airline industry could be considered an oligopoly today, although it has not always been so.

The life stages of airline industry is summarized in the following five steps:

1- **Start**
The use of airplanes for tourism purposes began in the first years of the XX century. There were just small companies flying short-haul routes.

2- **Regulated Era**
During the years 1930-1940, many countries established national regulated air carriers, which enjoyed a dominant - monopolistic position on certain routes even thanks to the government support.

3- **Deregulation**
The Airline Deregulation Act of 1978 removes government-imposed entry and price restrictions on airline market and new carriers started to enjoy the market. These new companies were able to sell the air ticket at really low price due to the low quality of their service (no frills).

4- **Expansion**
During the late years of XX century, the business models of the traditional airlines have adapted to the new low cost carriers and learned to share the market with LCCs and live together.

5- **Consolidation**
Last stage is the wave of mergers, acquisitions and alliances among airlines started and consolidate the structure of the market in certain regions.

As explained in the previous paragraphs, oligopoly is a market structure where the competition could be focused on price or on quantities, or alternatively, there could not be competition at all but a collaborative and unstable approach.

Airline industry is a striking example of market oligopolies. The US airline market is dominated by just 4 big companies : American Airlines, Delta AirLines, Southwest Airline and United Airlines Holdings, carrying the 67% of total national passengers ( = US market share). In Italy, the passengers usually fly with airplanes of Alitalia (the historical one, it is going through a business and

organizational change), Ryanair, EasyJet, Volotea, Neos and Wizz air. In the fourth chapter, their competitive behavior will be investigated.

Some partnership and organization have been formalized under official agreements.

### 3.5.1 Airline Partnership

The three main airline alliances are OneWorld, Star Alliance, and Skyteam, each of them including airline companies from different part of the world and they are the largest global airline alliances in terms of passengers carried, Star Alliance (762M) followed by SkyTeam (676M) and OneWorld (490M).

The extent and importance of airline partnerships differ across the markets. Especially on long haul routes, membership of international alliances has become a key component of business strategy. Infact the service quality levels must be assessed through the analysis of the airline alliances as a group rather than individual airlines (Tiernan).

Partnerships are not oligopolies themselves. They are alliances of multiple member airlines from the world (not just national or continental). Some of the members within alliances might operate in markets considered oligopolistic and others not, although the airline industry is suitable industry for an oligopolistic consolidation.

The key policy-relevant forms of airline partnerships are :

- *Codesharing* :
  Contracts between two carriers in which the airline acting as Marketing Carrier (MC) is allowed to sell seats on a flight operated by the other airline, acting as Operating Carrier (OC). In Europe, article 101 of the European Treaty, similar to the first section of the Sherman Act, accepts codesharing agreements only if they are in favor of consumers, meaning when the agreement would not increase fares or reduce competition.

- *Antitrust immunity*
  Partner airlines obtain the explicit right to set the fares jointly for the interline itineraries. All groups of carriers that are covered by antitrust immunity are parts of one of the three airline alliances (OneWorld, Star Alliance, and Skyteam).

- *Revenue-sharing joint ventures*
  Joint ventures can be seen as an add-on to multi-carrier partnerships that operate under antitrust immunity. It is an agreement between airlines to share revenues on a route and coordinate on route planning and scheduling.

- *Parallel partnership* (the partner covers the overlapping parts of the partner's network)

- *Complementary partnerships* (journeys where the passenger needs to change the airplane)

The parallel or complementary distinction plays a crucial role in earlier deliberations related to antitrust immunity requests by British Airways/American Airlines partnership.

Alliances could bring advantages to traveler, such as variety of times that can be chosen, more travel options, fast track access on all alliance members (frequent flier program), relatively low price for flying over the world, smoother connections. On the other side, the disadvantages could be the potential higher prices when competition is erased on less frequent flights and the risk of turning the collaboration into a cartel is high.

Airline alliances are not prohibited, in fact there are three main alliances, cited above, and other smaller alliances. But their behavior and freedom of acting is regulated by law to guarantee the welfare of customers for first.

Some airline alliances' practices are limited or directly prohibited by antitrust organization these practices include: price cartelization, excessive control of the market (the alliances obtain the full market segment), limitation on alternatives given to travelers (as prohibiting the access to airlines not in the alliance), creation of entry barrier.

### 3.5.2 Organization

The rapid growth of the industry has required the development of organizations aimed to implement standardized safety and process measures. Passengers interface with individual companies, but behind them worldwide structures are needed to coordinate their mutual relationship. Some of these organizations include:

- IATA – International Air Transport Association
  it is a business association, focused on airlines, founded in 1945 and it consists of 300 airlines among 117 countries, meaning the 83% of total available seat miles air traffic.
  Role of IATA is then the promotion of safe, reliable and economic air transports through a standardized service regarding booking methods, professional training, operative practices) offered by the parties belonged to IATA, cooperating with ICAO.

- ICAO – International Civil Aviation Organization
  It suggests some standards concerning safety, efficiency and sustainability of the air transport. Each member guarantees if they are following rule and normative suggested by ICAO.

- ACI – Airport Council International
  It is an international organization representing airports at a global level and promoting efficiency, safety and cooperation within the airline industry.

- IATA Clearing House
  It provides settlement services in multiple currencies and dispute mechanism of billings and protection in case of default or bankruptcy.

- Airlines for America – A4A
  It is an American trade association and lobbying group representing the major north American arlines. It promotes the air transport as safe and efficient and improves the economic and

operational environment for its members, such as establishment of air traffic control systems or streamline regulations.

- ERA – European Regions Airline Association
  It is a trade association of European regional airlines representing more than 55 airlines. It encourages long-term and sustainable growth for the sector.

- CAPA – Centre for Aviation
  It helps to identify new business opportunities and provide up-to-date on airports, airlines, suppliers, countries, offering in-depth insights on the news and trends that are shaping our industry.

- EASA – European Union Aviation Safety Agency
  It carries out certification, regulation, standardization, monitoring processes regarding civil aviation safety.

IATA in particular has been defined as 'the world aviation cartel' (John Hannigan, 1982) since one of services of IATA is organizing tariff conferences that served as a forum for price fixing. Price fixing is an agreement between participants to buy or sell a product only at a fixed price, controlling both supply and demand. The final purpose is the mutual benefit of the traders, pushing the price of a product as high as possible.

### 3.4.3 Competitive Effects

Alliances are authorized to coordinate various aspects of joint operation, from pricing and scheduling decision to creation of revenue-sharing joint ventures. Although the significant consumer benefits generated, the alliances raise antitrust concerns.

For example, joint ventures can be a mechanism for effective risk sharing and cost saving, due to economies of scale/scope or complementary nature of the products (Shapiro and Willig) but they can be used as a vehicle to tacit collusion (Barney).

Alliances in their modern form started appearing in the 1990s, starting with agreements of various forms, like code-sharing or blocked-space arrangements (part of seats on the flight are sold directly by the partner airline).

The most imminent effect of airline alliances is the effect on market price. Cooperation removes double marginalization, reducing price for the interline trips (alliance partners jointly set the price). The effects depend on the degree of cooperation and the types of airline network.

Moving from no cooperation to full cooperation benefits both firms and consumers. Suppose there is no available flight from A to B. then airlines A and B offer complementary services.

Each airline bears the cost of *c* and demand for the joint product is q = Q - p. Without cooperation each airline sets the sub-fare at $\frac{(Q+c)}{3}$, then the total fare paid by customers is twice that amount. With cooperation, the total fare is $\frac{(Q+c)}{2}$, and even firms benefits from higher profit. An empirical study by Wan, Zou and Dresner find that OneWorld business class fares are lower than comparable fares between non-alliance hubs. Although one world did not have antitrust immunity to coordinate fares, this result implies that alliances without immunity produce greatest consumer benefits.

The evidence in the economics literature supports the claim that alliances (with or without antitrust immunity) benefit customers relative to interline arrangements. Park (1997) shows how alliances may enhance flight options and customer welfare by facilitating the interline trips. Bamberger, Carlton and Neumann (2004) and Ito and Lee (2007) demonstrate that prices are lower in routes served by domestic alliances between US carriers, while looking at international level, Park and Zhang (2000) show that alliance fares for connecting travel itineraries were lower than interline fares.

In the case of non-stop flights, the situation is the opposite. Peters (2006) computes actual fare increases of 7%-29% due to the loss of competition after alliance's formation. Gillespie and Richard (2011) used a panel data of 115 routes over the period 2005-2010 and a cross-section approach to analyze fares, estimating how average economy fares (economy-class tickets represent 90% of ticket sold) for non-stop travel vary across routes as a function of the number of independent non-stop competitors, presence of antitrust immunized carriers, route characteristics (distance, population) and year-quarter fixed effects.

In 2010, the 52% of the trans-Atlantic routes have just one independent non-stop competitor and only the 23% have at least three independent non-stop competitors. For this reason, single-competitor routes are the reference group for the econometric analysis.

Variables in the model include competitive variables - equal the number of non-stop competitors and the variable ATI - equal to the number of additional ATI carrier in a route above the number of independent competitors. ATI carriers are immunized members of the same alliance.

The model explains 84% of the variation in average fares across routes ($R^2$=0,84). Average one-way non-stop fares in routes served by a single independent non-stop competitor are 31 £ higher than in routes served by two independent non-stop carriers, 62 £ higher than in routes served by three and 86 £ higher than in routes with four independent non-stop carriers. Then, there is an average fare increase of about 7% for each reduction by one in the number of competitors.

These results, summarized in the table 9 are consistent with the theoretical conclusions provided by literature (such as Peters, 2006): loss of competition significantly increases concentration levels in the market and results support the normal antitrust presumption that eliminating competition through alliances enhances the market power of remaining suppliers, harming consumers.

*Table 9 Descriptive sample statistics for Data on Non-Stop Overlaps*

| | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| One-way fare | $438 | $96 | $184 | $720 |
| Number of sampled passengers | 958 | 992 | 88 | 7,682 |
| Mileage of route | 4,180 | 563 | 2,885 | 5,788 |
| Population | 0.06 | 0.02 | 0.02 | 0.15 |
| Number of independent non-stop competitors | 1.78 | 0.92 | 1 | 6 |
| Number of additional ATI carriers | 0.10 | 0.31 | 0 | 2 |

| Average one-way fare when # of independent nonstop competitors is: | Mean | Standard deviation | Minimum | Maximum | Number of observations |
|---|---|---|---|---|---|
| 1 | $465 | $94 | $243 | $720 | 944 |
| 2 | $423 | $92 | $184 | $705 | 650 |
| 3 | $403 | $88 | $230 | $655 | 268 |
| 4 | $370 | $76 | $236 | $579 | 76 |
| 5 or mote | $415 | $78 | $275 | $578 | 27 |

*Source: DOT DB1B data for 2005-2010 quarterly;*
*1965 route-year-quarter observations between twenty largest cities in US and EU*

## Antitrust immunity Effect

The results presented by Gillespie and Richard (2011) using a panel data over the period 2005-2010, showed in the table 10, demonstrate that the differences in fares between ATI or non-ATI, immunized airlines or not, are not statistically significant. Immunized arrangements then do not reduce fares below those sold under non-immunized arrangements in the same alliances. This evidence is consistent with other published works (for example, by Bilotkach) claiming that antitrust immunity does not influence or it is not relevant to pricing efficiencies.

*Table 10 Price differences across connecting tickets based upon the type of ticket.*
*The dependent variable is log (individual ticket fare)*

| **Explanatory Effects:** Alliance | Ticket type | Estimate | Standard error | Estimated fare differences relative to interline[1] | Within each alliance, estimated fare differences relative to non-ATI[2] |
|---|---|---|---|---|---|
| *oneworld alliance* | Online | -0.034 | 0.006* | -3.3%* | -2.1%* |
| | non-ATI | -0.013 | 0.005* | -1.3%* | --- |
| | ATI[3] | 0.017 | 0.015 | +1.7%* | +3.0% |
| *SkyTeam alliance* | Online | -0.053 | 0.004* | -5.2%* | -3.1%* |
| | non-ATI | -0.021 | 0.006* | -2.1%* | --- |
| | ATI | -0.018 | 0.004* | -1.8%* | +0.3% |
| *Star alliance* | Online | -0.079 | 0.004* | -7.6%* | -6.4%* |
| | non-ATI | -0.013 | 0.005* | -1.3%* | --- |
| | ATI | -0.005 | 0.005 | -0.5% | +0.8% |
| *Interline ticket* | | --- | --- | --- | |
| **Other Controls** | | | | | |
| Log( Mileage of ticket ) | | 0.052 | 0.018* | | |
| # of coupons in ticket | | -0.011 | 0.002* | | |
| Route-year-quarter fixed effects | | | Yes | | |
| Carrier effects | | | Yes | | |

$R^2 = 0.42$. The data include 1,933,166 individual round-trip economy tickets.
Descriptive statistics: Mean round-trip ticket fare is $941 (standard deviation is $349). Mean itinerary mileage is 10,248 (1,685). Mean number of coupons per ticket is 4.35 (0.83).
Ticket breakdown: Oneworld: 85,829 non-ATI, 6,250 ATI, 142,485 online. SkyTeam: 88,771 non-ATI, 196,208 ATI, 617,543 online. Star: 88,422 non-ATI, 212,566 ATI, 315,693 online. Interline:179,399.

*Source: DOT DB1B, 2005-2010 quarterly.*

Another effect is on non-price parameters, for example better scheduling coordination implies more benefits for the interline passengers via shorter total travel time. Lederman provides empirical evidence on demand effects of international frequent flier program partnerships, which is positive and then airlines are able to increase average fares for flying into some important airports.

# 4. Cartel and Dynamic pricing

The current industry framework is an oligopoly regulated by international organizations, suggesting that reality is mirroring the collusive model, rather than Cournot, Bertrand or another competitive model.

During last year, particularly after the Covid-19 pandemic that causes the price increases of the only resource – variable cost – that airline companies have to sustain : the fuel cost. Events lead to incredibly high ticket prices and airline alliances, but even organization such as IATA, have been accused of having created a cartel disadvantaging travelers and exploiting their high willingness to pay, that came from two years of restrictions, not from the product itself.

What are the real reason of the price increases?

The concepts of ‘cartel’ and ‘collusion’ should be distinguished.

Cartel is a group of independent firms who collude with each other in order to dominate the market. Like the collusion, being part of a cartel is illegal since it limits the competition by creating artificial shortages. Differently from collusion, cartel is a more structured and official way of cooperating: firms establish rules and detailed agreements about price fixing or segmentation of the routes between them, and there could be even a ‘leader’. Collusion is a secret agreement less explicit and less formalized. Then, cartel could be seen as a formalization of collusive behavior, and it is unstable in the same way.

## 4.1 Antitrust Laws

Differing from one jurisdiction to another, antitrust – or competition – law is a legal framework to protect the market from abuses of power and development of predominant positions, which do not lead to a state of maximum total efficiency and diminish free competition through unfair practices.

Antitrust law have a focus on mergers and acquisitions too, ensuring they do not lead to a significant reduction in competition or in consumer choice.

**Europe**

In the European Union, antitrust law includes:

*Treaty of the Functioning of the European Union (TFUE)*

The treaty integrates the principles of the original treaty establishing the European Economic Community (EEC Treaty) ,1957. The TFUE consists of 358 articles organized in 7 parts: principles, Non-discrimination and citizenship of the Union, Union internal actions and policies, overseas countries’ associations, external actions by the Union, institutional and financial provisions, general and final provisions.

Articles concerning competition and antitrust provisions are:

- Article 101 : prohibits agreements between companies such as price-fixing or market allocation;
- Article 102 : prohibits abusive behavior by companies, such as predatory pricing that leads to a dominant position in the market;
- Article 107 : defines the 'State aid' as 'any aid granted by a member state in any form whatsoever which distorts competition (…), affects trade between member states'. The state aid brings a selective advantage by the use of state resources and has an negative impact on competition. The article 107 prohibits states from granting this type of benefits such as grants, loans, guarantees.

*Council Regulation (EC) No 139/2004*

It is a regulation on the control of concentrations and of mergers and acquisitions which meet specific size and impact criteria within the EU's single market. In fact it is commonly known as 'merger regulation' and sets out the criteria for the analysis and approval of concentration operations.

The purpose is ensuring that a merger will not result in a significant deterioration of competition within a market. If the concentration operation is considered impactful, the commission requires the involved parties to adopt corrective measures.

**United States**

The antitrust law, especially the Sherman Act, has been a model and example for the antitrust regulations in other countries. It includes:

*Sherman Antitrust Act* (1890)

It was the first to address the problem of anticompetitive practices that could be arise spontaneously in certain type of markets. Sherman act prohibits 'every contract, combination in the form of trust (…) or conspiracy, in restraint of trade' and unilateral conduct aimed to monopolize the market. 'The purpose of the Act is not to protect businesses from the working of the market, it is to protect the public ( consumers ) from the failure of the market' by restriction of trade or supply to prevent artificial raising of prices and other actions.

*Clayton Antitrust Act* (1914)

It integrates the Sherman act: while the Sherman act only declared monopoly illegal, the clayton act includes even certain business practices conducive to monopolies, such as price-fixing.

*Federal Trade Commission Act* (1914)

It establishes the Federal Trade Commission (FTC) which is a government agency that protects consumers from unfair business practices.

*Hart-Scott-Rodino Antitrust Improvements Act* (1976)

The act requires the compilation of a 'notification and report form' by both parties involved in a merger or acquisition process and wait until the FTC assess whether the proposed transaction violates the antitrust laws.

## 4.2 Algorithms and Collusion

In airline industry is common to use dynamic pricing as pricing strategy, due to the factors and reasons explained in the second chapter, and the economic model that could reflect this industry is the collusive oligopoly. Dynamic pricing strategy could be pursued by cooperation between humans and artificial intelligence, since the amount of data required to estimate demand is not manageable just by human mind. The literature demonstrates that algorithms are capable – or have become – of following the collusive model although the price they have to set is extremely volatile and changes on a daily basis. Moreover, cartels are often more durable than standard economic theory predicts since humans engagement in pricing decision. 'Collusion is more likely if the competitors know each other well through social connections, trade associations, ..(…)' (US Department of Justice), while algorithms are engaged in cold calculations.

Calvano, Calzolari, Denicolò and Pastorello conducted an experiment to show whether algorithms may autonomously learn to collude and charge supracompetitive prices, without communicating with one another.

The algorithms, since they are similarly programmed, may better predict rival's response and can uniformly punish a rival's deviations. The AI pricing agents, constructed for the experiment purpose, have been let to interact repeatedly in computer-simulated marketplaces. The main challenges have been choosing realistic economic environments and trying to go beyond the 'apparent thesis' validation', remembering that collusion is not simply a synonym of high prices but involves 'a reward-punishments scheme designed to provide the incentives for firms to consistently price above the competitive level' (Harrington 2018).

Results of experiment show that Q-learning pricing algorithm learn to play by trial and error and collusive behavior is caused by a reaction similar to punishment strategy in case of deviation. Punishment is of finite duration and there is a gradual return to pre-deviation prices after a while.

The link between algorithm pricing and collusive behavior is then existing and provable. The collusive equilibrium leads to higher prices but it is not always the case that higher prices are caused from collusive equilibrium. Algorithmic pricing can lead to higher prices for consumers both in competitive

and collusive markets. High prices could arise from the automated nature of algorithms independently from the current market model, even when firms do not collude.

For this reason antitrust law cannot solve the problem, which is beyond the current reach of antitrust law Antitrust enforcement against collusion can not find agreements if they do not exist Pricing algorithms facilitate supracompetitive pricing in markets by two enabler to collusion:

(1) **Speed**: allowing some firms to update prices faster than other firms, re-pricing products every day instead of one a week for example, discouraging any possible deviation. The slower firm perceives the other firm's ability to quickly reduce prices as a threat and then charges a price above the competitive level, while the faster firm chooses a price below its rival's price but yet above the competitive level, taking the share of its rival. The result is that firm with a faster algorithm will have a competitive advantage by undercutting the price of the rival.

(2) Through a **commitment** to pre-specified pricing strategies, and the increased pricing transparency, setting prices in a predictable manner.

Key characteristics distinguish collusive regimes from algorithmic competition. The first, the firms are required to make short-run sacrifices for long-run gains and expected to charge similar prices and to engage in a reward-punishment regime to discipline price-cutters. The punishment is extended to a infinite period of time, reducing the profits of all firms: it is not a flexible game. In algorithmic competition, firms may be charging quite different prices and the individual can initiate a cycle of consumer harm simply by employing a superior algorithm.

The use of pricing algorithms provides firms with two mechanisms for changing the competitive game (Brown and MacKay): they allow firms to vary the frequency with which they price and to signal commitment to a pricing strategy. This thesis is in opposition with the predatory pricing theory of Lina Khan, who has argued that amazon's pricing algorithm allows it to undercut its rivals' prices while Brown and MacKay also found evidence of effects of algorithms on Amazon Marketplace, resulting in prices higher than competitive one.

They compiled data on the hourly prices five online retailers charged for seven brands, over the period April 2018 and October 2019. By observing how their products' prices change, they supposed that two retailers (A and B) have the fastest algorithm, allowing to change price hourly, the retailer C could update price once per day, and D and E just on Sundays. These disparities affect retailers' prices. Firm A has the lowest price of the five retailers but gains the highest profits (22%), firms D and E have prices higher than 25% than A, and firm C has prices 10% higher than A. simulating Bertrand-Nash equilibrium, the final prices are more than 5% higher than if firms had symmetric technologies.

## 4.3 Real Cases

To enforce the thesis of a link or a 'cause-effect' relationship between pricing strategy used and possibility to collusion or even a cartel, some real cases, relating to different industry – not only the airline one – have been reported in the literature. Detecting collusion is a central theme of research (Jacquemin and Slade, 1989; Porter, 2005; Harrington, 2008). Collusive behavior has been identified by using variation in costs (Rosse, 1970; Panzar and Rosse, 1987; Baker and Bresnahan, 1988; Weyl, 2009), rotation of demand (Bresnahan, 1982; Lau, 1982), taxes (Ashenfelter and Sullivan, 1987), product entry and exit (Bresnahan, 1987; Nevo, 2001).

### 4.3.1 Spanish gasoline market

Such as airline market, the petrol market is now a liberal and private market, after liberalization happened during the last years of XX century. In Spain, the Repsol Group become easily the 'national champion' : a huge, vertically integrated company with a high market share. One important aspect to emphasized of vertical integration is that it allowed the big oil companies to either directly or indirectly fix the final price in almost every service station, meaning a reduced number of agents and then easier collusive agreements.

Jordi Perdiguero Garcìa has found a tacit collusion equilibrium within the Spanish gasoline market after the liberalization, usually aimed to increase competition rather than reduce it.

The analysis in fact demonstrates that the restructuration process has effectively culminated in over pricing due to tacit collusion, instead in competitive – an lower – prices. The market of gasoline does not facilitate collusive agreements thanks to the presence of cycles in the demand and some horizontal differentiation, although this last has an ambiguous effect on the ease of achieving collusion (Ivaldi et al, 2003).

The first step of the study has been to demonstrate theoretically and then empirically the relationship between demand and profit margin. The model considered is Haltiwanger and Harrington (1991)' model: demand is strongly seasonal and no shocks are observed (volume rises from January to August and then falls until December); penalty after deviation will last infinitely. The model shows that companies will maintain the collusion price only if profits expected from collusion are greater than profits obtained if firms left the agreement.

$$p_t(t) = \sum_{\tau=t+1}^{\infty} \delta^{\tau-t} \left[ (p_t(\tau) - c)\left(\frac{Q_t(p_t(\tau);\tau}{n}\right) \geq (n-1)(p_t(t) - c)\left(\frac{Q_t(p_t(t);t)}{n}\right) \right]$$

Assuming that the penalty for leaving occurs only in the next period (t+1) and marginal costs vary over time, the equilibrium equation takes on the following form:

$$p_t(t) \equiv \delta\left[\left(p_t(t+1) - c(t+1)\right)\left(\frac{Q_t(p_t(t+1);t+1}{n}\right)\right] \geq (n-1)(p_t(t) - c(t))(\frac{Q_t(p_t(t);t}{n})$$

If we expect a growing demand, $\frac{Q_t(p_t(t+1);t+1}{n}$ to be greater than $\frac{Q_t(p_t(t);t}{n}$, the $p_t(t)$ could be increased without breaking the equation. In the same way, expecting a higher cost $c(t+1)$ respect $c(t)$, the price could be reduced. There is a positive relationship between current margin and demand expectations and a negative relationship between current margin and cost expectations.

The regression model used is the one proposed even by Borenstein and Shepard (1996), including the temporary asymmetries in the change in retail prices:

$$\begin{gathered} margin_{it} = \alpha_1 q_{it} + \alpha_2 q_{it+1} + \alpha_3 pricespot_{t+1} + \beta_1 \Delta preciospot_t^+ \\ + \beta_2 \Delta preciospot_t^- + \beta_3 \Delta preciospot_{t-1}^+ + \beta_4 \Delta preciospot_{t-1}^- + \beta_5 \Delta preciospot_{t-2}^+ \\ + \beta_6 \Delta preciospot_{t-2}^- + \beta_7 \Delta price_{t-1}^+ + \beta_8 \Delta price_{t-1}^- + \beta_9 \Delta price_{t-2}^+ \\ + \beta_{10} \Delta price_{t-2}^- + \beta_{11} price_{t-1} + \beta_{12} pricespot_{t-1} + \gamma_{it} \end{gathered}$$

Where demand variable is defined by the variable $p_{it-1}$,representing the public sale price at services stations at time t-1, the dummy variable ciclej, assuming 1 within January and august, and $time_j$ growing evey period. The $pricespot$ is quoted for spot price of gasoline in the period t. $crudeUSA$ is the Texan crude oil rate at time t-1, t-2 and t-3.

$$q_{it} = a_0 + a_1 q_{it-1} + a_2 p_{it-1} + a_3 cicle_j + a_4 time_j + \xi_{it}$$

$$pricespot_t = b_0 + b_1 crudeUSA_{t-1} + b_2 crudeUSA_{t-2} + b_3 crudeUSA_{t-3} + b_4 cicle_j + \eta_{it}$$

The signs predicted by the theory have been obtained empirically and are significant at 1%. The relationship between profit margin and demand or cost confirms the behavior compatible with tacit collusion strategy. While, as noted in Borenstein and Shepard (1996), if firms compete in Cournot or Bertrand, there would be no significant relationship between profit margin and demand or cost expectations.

*Table 11 Econometric results by two steps least squares (2LS)*
*(dependent variable: margin; num of observations = 1920)*

| | Equation 12 | | | Equation 13 | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) |
| $q_{it}$ | −0.594*** | −1.053*** | −0.121*** | −0.397*** | −0.447*** | -0.104*** |
| | (0.136) | (0.345) | (0.026) | (0.100) | (0.162) | (0.028) |
| $q_{it+1}$ | **0.597*** ** | **1.056*** ** | **0.123*** ** | **0.397*** ** | **0.447*** ** | **0.140*** ** |
| | **(0.136)** | **(0.344)** | **(0.026)** | **(0.100)** | **(0.161)** | **(0.028)** |
| $pricespot_t$ | 0.480*** | 0.725*** | 0.168*** | | | |
| | (0.096) | (0.211) | (0.051) | | | |
| $pricespot_{t+1}$ | **−0.401*** ** | **−0.620*** ** | **−0.083*** | **−0.540*** ** | **−0.565*** ** | **-0.572*** ** |
| | **(0.098)** | **(0.205)** | **(0.051)** | **(0.088)** | **(0.115)** | **(0.058)** |
| $\Delta pricespot_t$ | −0.972*** | −1.203*** | −0.657*** | | | |
| | (0.093) | (0.200) | (0.021) | | | |
| $\Delta pricespot_t^+$ | | | | −0.534*** | −0.549*** | -0.508*** |
| | | | | (0.036) | (0.038) | (0.032) |
| $\Delta pricespot_{t-1}^+$ | | | | 0.367*** | 0.364*** | 0.372*** |
| | | | | (0.078) | (0.084) | (0.047) |
| $\Delta pricespot_{t-2}^+$ | | | | 0.163** | 0.164** | 0.076 |
| | | | | (0.067) | (0.078) | (0.052) |
| $\Delta pricespot_t^-$ | | | | −0.387*** | −0.372*** | -0.364*** |
| | | | | (0.040) | (0.044) | (0.037) |
| $\Delta pricespot_{t-1}^-$ | | | | 0.719*** | 0.727*** | 0.683*** |
| | | | | (0.071) | (0.082) | (0.044) |
| $\Delta pricespot_{t-2}^-$ | | | | 0.143*** | 0.144** | 0.190*** |
| | | | | (0.053) | (0.058) | (0.047) |
| $\Delta price_{t-1}^+$ | | | | −0.011 | 0.003 | 0.012 |
| | | | | (0.082) | (0.089) | (0.070) |
| $\Delta price_{t-2}^+$ | | | | −0.298*** | −0.371*** | -0.267*** |
| | | | | (0.069) | (0.082) | (0.056) |
| $\Delta price_{t-1}^-$ | | | | −0.339*** | −0.349*** | -0.323*** |
| | | | | (0.086) | (0.094) | (0.075) |
| $\Delta price_{t-2}^-$ | | | | −0.032 | −0.025 | -0.044 |
| | | | | (0.038) | (0.043) | (0.028) |
| $price_{t-1}$ | | | | 1.080*** | 1.103*** | 1.096*** |
| | | | | (0.074) | (0.090) | (0.020) |
| $pricespot_{t-1}$ | | | | −0.548*** | −0.530*** | -0.531*** |
| | | | | (0.054) | (0.063) | (0.044) |
| Hansen J Statistic | 25.600 | 15.441 | 84.731*** | 17.587 | 16.444 | 15.427 |
| | (0.109) | (0.632) | (0.000) | (0.4153) | (0.4926) | (0.5648) |

*Source: Jordi Perdiguero Garcìa research*

### 4.3.2 US airline industry

The next case provided to confirm the thesis of existence of collusion within airline industry although dynamic pricing strategy, is the test made by Ciliberto, Watkins and Williams in 2018.

The first test – based on theoretical researches of Werden and Froeb (1994) - expects that colluding firms reduce pair-wise differences in price if demand has certain properties; the second confirms the theoretical insight of Athey, Bagwell and Sanchirico (2004) – colluding firms will sacrifice efficiency in production (offer less seats) by increasing price rigidity.

Panel data used are the fare paid and other information on itinerary of 10% of domestic tickets, from Airline Origin and destination Survey (DB1B) over the period 1993-2016.

Carriers considered are 20: American (AA), Alaska (AS), JetBlue (B6), Continental (CO), Delta (DL), Frontier (F9), AirTran (FL), Allegiant (G4), Hawaiian Airlines (HA), American West (HP), Midway Airlines (JI), Spirit (NK), Northwest (NW), Sun Country (SY), Trans World (TW), ATA (TZ), United (UA), USAir (US), Southwest (WN), and Midwest (YX).

The multimarket contact is expressed by the variable $MMC_{hk,t}^{EK}$ or by $MMC_{h\to k,t}^{CW}$ , which is the $MMC_{hk,t}^{EK}$ divided by the total number of markets served by h, the firs firm in the pair. The table 12 shows the

$MMC_{hk,t}^{EK}$ , the number of markets served concomitantly by the carrier in the row and the carrier in the column. The diagonal is the total number of markets served by a carrier.

*Table 12 Pair-wise number of common markets ($MMC_{hk,t}^{EK}$) in 2008-Q3*

| | AA | AS | B6 | CO | DL | F9 | FL | G4 | HA | NK | NW | SY | UA | US | WN | YX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AA | 2202 | | | | | | | | | | | | | | | |
| AS | 56 | 258 | | | | | | | | | | | | | | |
| B6 | 96 | 6 | 242 | | | | | | | | | | | | | |
| CO | 1124 | 29 | 113 | 1589 | | | | | | | | | | | | |
| DL | 1598 | 131 | 201 | 1235 | 2989 | | | | | | | | | | | |
| F9 | 253 | 29 | 0 | 153 | 280 | 404 | | | | | | | | | | |
| FL | 357 | 2 | 75 | 250 | 675 | 43 | 706 | | | | | | | | | |
| G4 | 9 | 6 | 0 | 5 | 18 | 5 | 0 | 87 | | | | | | | | |
| HA | 17 | 6 | 0 | 1 | 16 | 0 | 0 | 0 | 52 | | | | | | | |
| NK | 34 | 0 | 10 | 13 | 50 | 3 | 21 | 0 | 0 | 66 | | | | | | |
| NW | 994 | 46 | 61 | 750 | 1336 | 195 | 302 | 10 | 12 | 11 | 1665 | | | | | |
| SY | 7 | 1 | 0 | 0 | 12 | 2 | 2 | 0 | 0 | 0 | 12 | 13 | | | | |
| UA | 1375 | 137 | 139 | 1011 | 1637 | 356 | 299 | 24 | 37 | 17 | 1104 | 5 | 2264 | | | |
| US | 1062 | 64 | 158 | 937 | 1853 | 203 | 476 | 12 | 9 | 36 | 854 | 6 | 1276 | 2297 | | |
| WN | 795 | 65 | 46 | 657 | 882 | 193 | 160 | 0 | 0 | 10 | 490 | 0 | 752 | 734 | 1434 | |
| YX | 105 | 0 | 0 | 51 | 102 | 12 | 31 | 2 | 0 | 0 | 135 | 0 | 112 | 24 | 21 | 146 |

*Note:* The off-diagonal numbers represent the number of markets served concomitantly by the carrier in the row and the carrier in the column. The numbers on the diagonal are the total number of markets served by a carrier.

*First test*

The theory of Warden and Froeb explains that mergers will alter the difference between prices in a market characterized by differentiated products. Specifically, differences decrease depending on the degree of how much the firms internalize the effect change. To test this theory, it must be found the link between (1) the amount of multimarket contact or existence of a code-share agreement and (2) difference and rigidity of prices of each pair of carriers.

Two single-product firms that merge increase the price of the product, resulting in more similar prices although the initial prices were different. This pattern arises because the firm fully internalizes the effect of its price increases on goods. Similarly to a merger, collusion allows the firms to internalize effect of their behavior. Smaller prices differences could be observed with greater levels of multimarket contact and between partners within a code-share agreement.

The Multi-Market Contact (MMC) is linked to the price difference through the following regression:

$$\log \Delta p_{hk,mt} = \beta_{diff} \cdot \log \left( MMC_{hk,t}^{EK} \right) + \gamma_{diff} \mathbb{1}_{hk,t}^{code-share} + \alpha X_{mt} + \epsilon_{hk,mt}.$$

H and k stands for the two firms considered. For example, if firm h is a legacy carrier and k is a low-cost carrier, the difference in prices is likely to be larger than if k is another legacy carrier. Moreover, to test the thesis that multimarket contact leads to more collusive behavior, the coefficient β must be

negative. In the same way, to test that code-share agreements leads to collusive behavior, γ will be negative.

Results are summarized in the table 13 using $MMC_{hk,t}^{EK}$ as measure of multi market contact. It is estimated that β equals -0,035 statistically significant, confirming the already cited relationship. For instance, a 10% increase in multimarket contact is associated with a 3,5% decrease in difference in prices. Column (2) includes market-carrier pair fixed effect instead of market, carrier-pair and year-quarter fixed effect, resulting in a larger estimate of β but a insignificant code-share indicator.

*Table 13 Price differences and potential facilitators of collusion*

| | (1) | (2) |
|---|---|---|
| *Pair-wise covariates* | | |
| $\log(MMC^{EK})$ | $-0.035^{***}$ | $-0.051^{***}$ |
| | (0.0059) | (0.0047) |
| $\mathbb{1}^{code-share}$ | −0.0055 | 0.0016 |
| | (0.0047) | (0.0051) |
| *Fixed effects* | | |
| Market-carrier pair | No | Yes |
| Year-quarter | Yes | Yes |
| Market | Yes | No |
| Carrier pair | Yes | No |
| *Market-level controls* | | |
| HHI | Yes | Yes |
| LCC Indicator | Yes | Yes |
| *Sample & fit* | | |
| # Markets | 4,311 | 4,311 |
| # Carrier pairs | 175 | 175 |
| # Market-carrier pairs | 129,080 | 129,080 |
| # Observations | 4,165,567 | 4,165,567 |
| Within $R$-squared | 0.049 | 0.027 |

*Second test*

Theory developed in Athey et al (2004) explains that colluding firms will sacrifice efficiency in production by increasing fare rigidity, then not responding to firm-specific shocks to avoid informational costs associated to price wars. Collusive firms do not adjust their prices after shocks in cost or demand because they do not want to violate oligopolistic discipline. According to Athey et al (2004), this price rigidity is the result of a trade-off between efficiency benefit of adjusting price to demand and saving informational cost.

For the second test, the following regression is used :

$$\log CV_{hk,m} = \beta_{std} \cdot \log\left(MMC_{hk}^{EK}\right) + \gamma_{std} \cdot \mathbb{1}_{hk}^{code-share} + \alpha X_m + \epsilon_{hk,m}.$$

Where CV is the market-carrier pair coefficient of variation, reflecting the degree of rigidity in prices. Estimation resulting are β equals to -0,073 statistically significant and the coefficient of code-share agreement is lower, -0,015.

*Table 14 Price rigidity and potential facilitators of collusion*

| | (1) | (2) | (3) |
|---|---|---|---|
| *Pair-wise Covariates* | | | |
| $\log(MMC^{EK})$ | $-0.073^{***}$ | | |
| | (0.0046) | | |
| $\log(MMC^{CW})$ | | $-0.034^{***}$ | |
| | | (0.0045) | |
| $\log$ (Rev-Wgt $MMC^{CW}$) | | | $-0.024^{***}$ |
| | | | (0.0033) |
| $\mathbb{1}^{code-share}$ | $-0.015^{***}$ | $-0.032^{***}$ | $-0.034^{***}$ |
| | (0.0054) | (0.0042) | (0.0042) |
| *Fixed effects* | | | |
| Market | Yes | Yes | Yes |
| Carrier pair | Yes | Yes | Yes |
| *Market-level controls* | | | |
| HHI | Yes | Yes | Yes |
| LCC indicator | Yes | Yes | Yes |
| *Sample & fit* | | | |
| # Markets | 4311 | 4311 | 4311 |
| # Observations | 124,670 | 249,340 | 249,340 |
| Within $R$-squared | 0.183 | 0.182 | 0.182 |

### 4.3.3 Airfreight Cartel Case

*'it is deplorable that so many major airlines coordinated their pricing to the detriment of European businesses and European consumers (..) with today's decision, the commission is sending a clear message that it will not tolerate cartel behavior'*

Joaquìn Almunia, Vice President for Competition

The air cargo industry is a concentrated market with a relatively limited number of providers for international shipments. In this kind of market, the potentially collusive conduct often emerge without any overt communication between competitors. For this reason, authorities have historically struggled to determine what level of conduct constitutes a violation of existing antitrust laws. From December 1999 to February 2006, major airline carriers, have been subject to EU Commission investigation for their involvement in an international airfreight cartel.

During the investigation, it has been discovered that these airline companies had organized secret and illicit meetings to exchange information and make agreements on fuel prices and cost management strategies. These agreements have been defined as cartel since the purpose and the effect was limiting competition and increasing profits at the expense of consumers, violating antitrust laws in several jurisdictions, including United States, European Union and Australia. The carriers

coordinated their action on surcharges for fuel and security without discounts over a six year period (1999-2006). In particular, the carriers contacted each other so as to ensure that worldwide airfreight carriers imposed a flat rate surcharge per kilo for all shipments. Later, they extended their cooperation by introducing a security surcharge and refusing to pay a commission on surcharges to their clients. The aim of these contacts was to ensure that increases or decreases of surcharge levels were applied in full without exception and even ensure that surcharges did not become subject to competition through the granting of discounts to customers.

On November 2010, the European commission decided to give penalties against the carriers which had participated in the pricing cartel within the period 1999-2006, imposing a fine on eleven carriers in a total amount of 799.445.000 €. The eleven undertakings fined are Air Canada, Air France, British Airways, Cathay Pacific, Cargolux, Japan Airlines, LAN Chile, Martinair, SAS, Singapore Airlines and Qantas.

The European commission decision's concluded that the airlines conduct constituted a single complex and continuous infringement prohibited by the Treaty on the functioning of the European union, in particular article 101 (TFEU), the agreement between European community and the swiss confederation on air transport, article 8 (EC-Switzerland) and European economic area agreement, article 53 (EEA). Lufthansa and two of its subsidiaries received full immunity from fines under the commission's leniency program, as it was the first to provide valuable information about the cartel. Some carriers obtained concessions by cooperating and the fines were reduced by different proportion, from 50% of reduction obtained by Martinair, to 10% of reduction obtained by British Airways. Five carriers tried to get a reduction claiming their inability to pay the fine but they have been ignored by the commission.

# 5. Conclusive Analysis

## 5.1 Covid Impact on Airlines' profitability

In Italy, the number of students living far from original home is beyond 591 thousand, according to the document 'Per la partecipazione dei cittadini: come ridurre l'astensionismo e agevolare il voto', published in April 2022 by the Department for Institutional Reforms of the Presidency of the Council of Ministers. Adding all the citizens who works in a city different from the own hometown, the number increases to almost 5 million of citizens, workers or not.

As explained in the first chapter, this category of travelers is characterized by low budget but high necessity to buy the product, especially during the peak seasons, such as Easter or Christmas.

In addition, Covid-19 pandemic increases not only the desire of people to travel, but even the need for people to travel. Hospitality industry is one of the market sectors most impacted by pandemic from a double side: thanks to travel restrictions from a country to another (losses from lack of international tourists) and thanks to the prohibition to attend external places (no people going to restaurants, museums, and other attractions). Study from the University of Aberdeen Rowett Institute and Scotland's Rural College (SRUC) found a loss of 85% of output and a 23% loss in the number of jobs between February and May 2020, and similarly had happened in all European countries.

*Il Corriere della Sera* conducted an analysis on ticket prices, using a panel data of all the prices of flights sold in march 2023 in Economy class, excluding extras such as luggage or seat choices. The average price of flight within Europe has increased by 68% respect the past year, from 34 euros (march 2022, despite the outbreak of Ukraine War) to 57 euros, translated into an increase of 6% every month.

Looking at 2022 ISTAT's data, the fares of flights in Europe are 91% higher than fares in 2021, the fares of intercontinental flights are 35,7% higher and those of domestic flights have become more expensive by 15,2%. Especially the most common holiday-destinations, such as Campania, Sardinia, Sicily, have experienced peaks of 918 euros for a round trip in August. This price is totally disproportionate to the kilometers effectively traveled and fuel used, despite the increase in unit fuel cost.

By contrast, according to ISTAT's reports, train tickets prices fell by 9,9% on annual basis, in conjunction with the easing of restrictions on trains, which for several months were reserved only for vaccinated and recovered from covid.

The reason of air travel fares' hike is not only driven by the 7,6% increase in inflation rate.

According to Corriere della Sera, the real drivers of this increase are the disproportion between demand and offer and the increase of the only variable cost that airline companies must face to - the fuel cost.

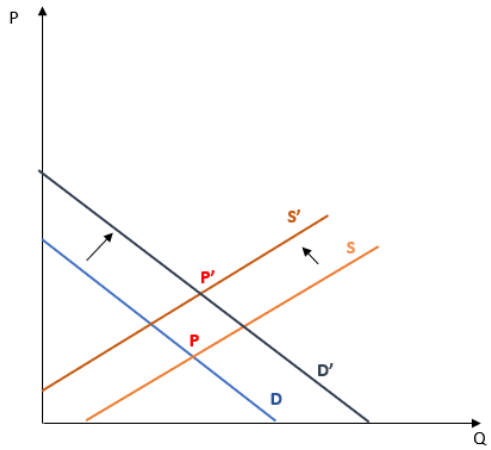
### 5.1.1 Fares increases as natural response

Demand for airline tickets has always been high but the lifting of restrictions has increased the need and the desire to travel even more. In the other side, the supply has decreased. Travel restrictions have caused serious financial crises. Some airline companies were forced to declare bankruptcy; others were forced to adapt their business to the current level of demand, reducing at the minimum their aircrafts.

Fuel cost has increased by 57%, with a price beyond one hundred for a barrel of fuel.

The increase of demand due to the ‘’end’’ of pandemic era, and the increase of variable cost of firms, the result is spontaneously an increase of price.

*Figure 26 Demand and Supply curve shifting*




### 5.1.2 Slot rules

Rightward shift of the supply curve has been contained by the regulation 95/93.

In 1993, Regulation 95/93 on common rules for the allocation of slots at EU airports was introduced in order to ensure that airlines have access to the busiest EU airports *‘based on the principles governing the system of slot allocation’* (IATA Worldwide Scheduling Guidelines). Also know as ‘use it or lose it’ or 80/20, slots are allocated by independent coordinators and airlines must use the 80 per cent of their allocated slots, or will lose them for the rest of the years following. Slot Rule was necessary: the scarcity of slots, especially in busiest airports like London Heathrow, makes the slots-market very furious and difficult for airlines to obtain a place where landing.

In the first months of Covid era, the President of UE Ursula Von der Leyen, suspended the rule of 80/20 from March 2020 to October 2020, a period of time shorter than the one requested by IATA. After this period, the market was not ready to allow a profitable use of 80% of the slots for airlines companies. Then the council of the European Union submitted a new proposal amending regulation 95/93 for the year 2021, which provides air carriers should operate the slots allocated to them for at

least 50% (instead of 80%) of the time. Gradually, the regulation will return to the usual 80/20 in 2023.

Although these regulation lightening, the utilization rate of slots is still lower than the mandatory one (64% in 2022, according to IATA). Airlines have been operating several ghost flights to prevent the loss of their slot allocations from 2020. The necessity to maintain own slots has been converted into a cost that companies were not able to cover until current year, when the demand is finally increasing. Industries like the airline one, with perishable goods, high fixed cost and few variable costs, must reach the break-even point for which the fixed cost are covered: exceeding this point, the marginal cost of other seats is near to zero and next ticket sales are just profits. During 2020-2022, demand did not allow to reach the break-even point and airplanes were forced to fly anyway due to the slot rules, making the fixed cost unavoidable.

## 5.2 Airline Reaction to Covid pandemic

How airline has reacted to consequence of Covid-19 ages?

The following data and strategies are taken from annual reports of two different but similar airline companies, Ryanair and Wizz air. Both of them are popular to offer no frills flights and very low prices. The services included in the fare are the minimum – literally, it is offered just the seat, often uncomfortable – and the rest of comforts are optional and subject to a fee. The common issue experienced by every airline company is the fuel price risk exposure, that it is amortized by call options or other financial instruments.

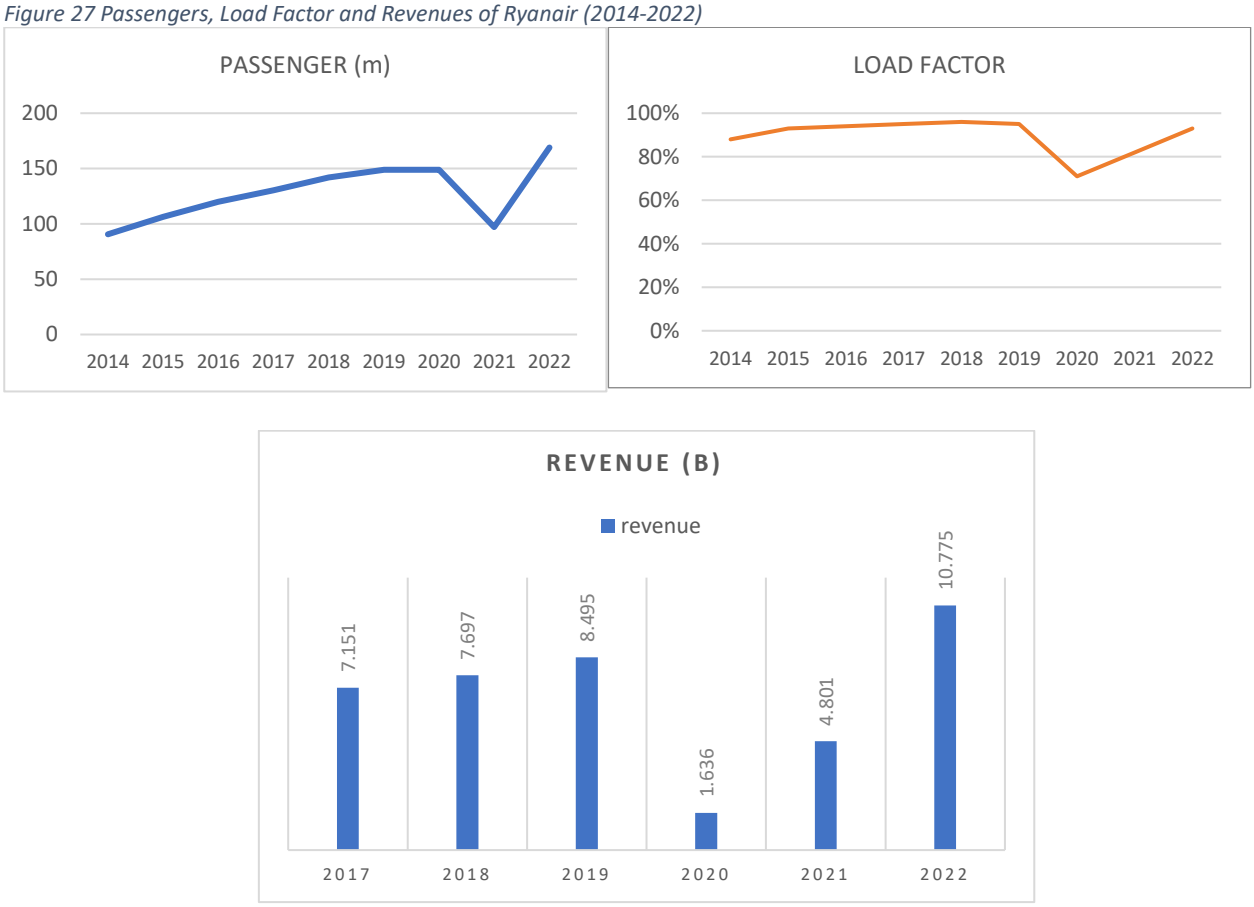
### 5.2.1 Ryanair reaction

‘*we’ve survived the 9/11 attacks, SARS, foot&mouth, 2007/08 financial crisis, volcanic ash cloud disruption, …, but none of these events have had such a sudden, far-reaching and devasting effect on our industry and on people’s daily live …* ‘

Stan McCarthy, chairman of Ryanair

During 2020, airlines have set lower fares to give price incentives and stimulate the return of intra-EU tourism and travel. In order to allow the lower fares, Ryanair’s strategy has been focused on rigorous cost reduction program. Numbers of guests reached in 2020 drops in 2021 again due to the Omicron variant and the Russia’s invasion of Ukraine, which has effect on fuel prices but even on skies-traffic (closed skies over Ukraine, caused a collapse in traffic into Central and Eastern European markets). The main challenge of 2022 has been the short haul capacity constraints in Europe and the fuel cost. The fuel bill is expected to grow by 1bl in 2024 but Ryanair is ordering new aircrafts to offer more competition, more choice and lower fares by 2033. New aircrafts mean huge expenses that is translated to higher fares to compensate even this outflow.

*Figure 27 Passengers, Load Factor and Revenues of Ryanair (2014-2022)*




*Source: Ryanair Reports*

### 5.2.2 Wizz air reaction

Similarly to other airline companies, decline in passenger ticket revenue in 2020 was driven by the decline in passenger, 74,6% in Wizz air's case and leading to a loss of €642 million and a revenue down 40% respect 2019.

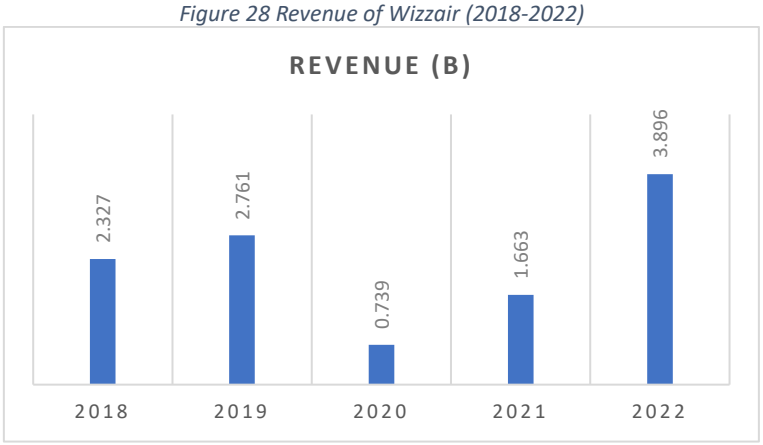
As Ryanair, the company implemented a cost-reduction program, starting from a reduction in salaries, workforce, and capacity (21% in November 2020), parking a lot of aircrafts to re-use them once it would operate higher capacity levels. Following the continuous and increasing refund requests, Wizz air was the first mover to introduce an automated refund process, which offered customers the 120% credit value within five minutes and by one click.

The recovery of 2021 was enabled by diversification brought by the expanded network and the new operating basis opened during previous years, even in 2020, but the second Covid-19 outbreak and the war started in Ukraine have impacted their whole business, deploying capacity and staff from Ukraine elsewhere in the Wizz air network.

In 2023, the demand was expected to return at normal levels and company placed all its efforts in maximization the passenger load factors and trying to keep unit cost as low as possible. Although

the higher fuel cost (by 45%) , the unit revenue increased by 33% supported by the higher ticket price. The year was closed with a loss of 535 million despite the significant revenue growth.

*Figure 28 Revenue of Wizzair (2018-2022)*




*Source: Wizzair Report*

Strategies and issues are the same for all the airline companies. During the Covid year, airlines were forced to operate ghost flights to maintain airport slots. The breath taken by the decrease in infections did not last long and soon replaced by the ban on flying over Russian territory.

Every business sector has been impacted heavily by restrictions and even consumers expected an increase in prices. Not only due to the raw material cost increase, but even to recover losses.

According to ISTAT reports, Covid caused a drop of Italian PIL by 8,8% (more than the average drop in Europe, 6,2%). Italian salaries are lower but the life cost is higher than pre-Covid period. The national consumer price index for the whole community (NIC) has increased by 11,3% on annual basis or 0,3% on monthly basis. Beyond the most relevant and usable products, such as the car fuel or electricity, Italians do not notice anymore that they are paying 1,20 for a coffee, instead of one euro, or they are paying some cents more for a lighter food package.

But how much is the extent of justifiability of this price increases?

The importance of airline industry and its influence over the whole economy has been fully explained and for this reason antitrust regulations exist.

## 5.2 Codacons Complaints

On 7 December 2020, Codacons' complaint about price of air and rail transport has been presented to Antitrust and the Ministry of Transport. Italian Antitrust Authority is represented by the AGCM, 'Autorità Garante della Concorrenza e del Mercato' (competition and market authority). The specific complaint was about the trips in the days around December 20$^{th}$ ,after the Italian government banned travel from December 21$^{st}$ : this specific price peak violated the Consumer Code.

The complaint has been presented even next years, with a particular focus on routes including Sicily and addressing to the four main airline companies that cover these routes: Ryanair, EasyJet, Wizz air and ITA Airways.

In July 2023, the Minister of Enterprise, Adolfo Urso, summoned airlines to provide explanations about the high prices offered and proposed a regulatory intervention to control unfair business practices and related AI programs, using automated algorithms, that process airfares (*ilMessaggero.it*). Travelers have been left without alternatives and forced to renounce to their holiday or to come back to hometown, if they do not want to buy a flight Rome-Catania as if they were going to New York.

The four airline companies have the oligopoly over the routes from the North to the South of Italy, and vice versa, when the working season starts again. The complaint of consumers and Codacons is the violation of the article 101 TFUE (*Paragraph 4.1*) ,which prohibits agreements that could affect negatively competition.

Antitrust authority is working to prove that airline companies are forming a cartel or are colluding, in order to regulate their behavior and protect consumers. Proving the formation of a cartel is easier since the cartel is an explicit agreement, then there are evident documents certifying the cartel existence. instead, collusion is implicit and often involves subtle and secret activities. Some fundamental investigation steps are:

- *Monitoring routes and capacity* : airlines may coordinate to reduce the number of flight on certain routes to allocate number of travellers among their airplanes and reach a 100% load factor, or to avoid entering each other's market (allocation agreements);

- *Comparing pricing to costs* : the profit margin could suggest collusion if prices are consistently set above cost levels and this trend persists.

The AGCM published the bulletin with the reports against the four airline companies. By observing flight ticket for two different departure days (23/12/2022 and 08/01/2023, the day of observation was 14/12/2022), the AGCM showed a 700% increase in some extreme cases, if the traveller flies on December 23$^{rd}$ instead of January 8$^{th}$ , a not seasonal day. Looking at round trip prices, the alignment between the four companies is evident, especially for MPX-Palermo or Torino-Sicily trips, which are two of the most popular university cities.

*Table 15 Prices of different routes; departure date : 23 dec, 8 jan and 23dec-6jan*

| | MPX- Catania | | | MPX- Palermo | | | LIN-Catania | | | LIN-Palermo | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan |
| **Ryanair** | 174 | 9 | 318 | 255 | 9 | 379 | | | | | | |
| **ITA** | | | | | | | 188 | 67 | 371 | 190 | 59 | 310 |
| **WizzAir** | | 24 | | 247 | 19 | 330 | | | | | | |
| **EasyJet** | 214 | 30 | 375 | 212 | 16 | 379 | | | | | | |
| | **BGY-Catania** | | | **BGY-Palermo** | | | **Torino-Catania** | | | **Torino-Palermo** | | |
| | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan |
| **Ryanair** | 164 | 29 | 292 | 171 | 22 | 279 | 218 | 27 | 389 | 205 | 29 | 392 |
| **ITA** | | | | | | | | 77 | | 253 | 77 | 358 |
| **WizzAir** | | | | | | | 159 | 49 | 259 | | | |
| **EasyJet** | | | | | | | | | | | | |
| | **Bologna-Catania** | | | **Bologna-Palermo** | | | **FCO-Catania** | | | **FCO-Palermo** | | |
| | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan | 23 dec | 8 jan | 23dec-6jan |
| **Ryanair** | 249 | 9 | 336 | 365 | 19 | 463 | 332 | 14 | 400 | 373 | 40 | 438 |
| **ITA** | | 73 | | 123 | 73 | 274 | | 62 | | 206 | 71 | 285 |
| **WizzAir** | 189 | 19 | | | | | | | | | | |
| **EasyJet** | | | | | | | | | | | | |

*Source: AGCM report*

The AGCM decided to investigate more on their behavior because ' the price increase in Christmas season could be the consequence of a collusive behavior, eventually facilitated by pricing algorithm use, instead of rational respect of market conditions. (..) price alignment in certain routes, such as Milan-Catania or Milan-Palermo, is a potential indicator of collusion between operators (…). moreover, there are no initiatives by air carriers to take measures to obtain better adjustment of supply to demand, which would be consistent with a lawful profit maximization strategy.'

The analysis are still in progress but the complaints are increasing, even by politicians such as Renato Schifano, President of the Sicilian Region.

## 5.3 Empirical analysis of the actual route Milan-Palermo

Proving the actual collusion between airlines is difficult and resource-expensive, since a lot of time and resources are required. the fundamental point to be considered are the market structure, the number and size of firms and the relationship/communication between them. As written in previous paragraph, the structure of the airline industry is a breeding ground for the development of oligopolies and the similar dynamic pricing strategy leads to having the same level of price in both high and low season.

The following data have been collected from the 4$^{th}$ of July to the end of August using the search engine *skyscanner.com* and taking the lowest price available on the site, also including non-direct flights and therefore involving even 10 hours of stopover, but managed by the same airline company,

while alternatives involving combination of two companies have been excluded. It must be noted that these kind of options (10 hours stopover, or two companies combined) have been suggested by the search engine just in approximation of the day of departure, for example if time to departure was one week or even less.

I decided to collect prices of the three main airline companies operating in the route Milan-Palermo. The prices of Wizz air have been collected from its official website, not always working. The departure dates are from July 17$^{th}$ to August 15$^{th}$ for the route Mila(MXP)-Palermo, and from August 16$^{th}$ to September 24$^{th}$ for the return trip Palermo-Milan(MXP). This range of departure dates has been decided because represents two period with high demand: it is composed by people looking for a holiday and students or workers going to hometown after university exams or for holidays; the second period starts from August 16th because Italian people use to celebrate the August 15$^{th}$ .

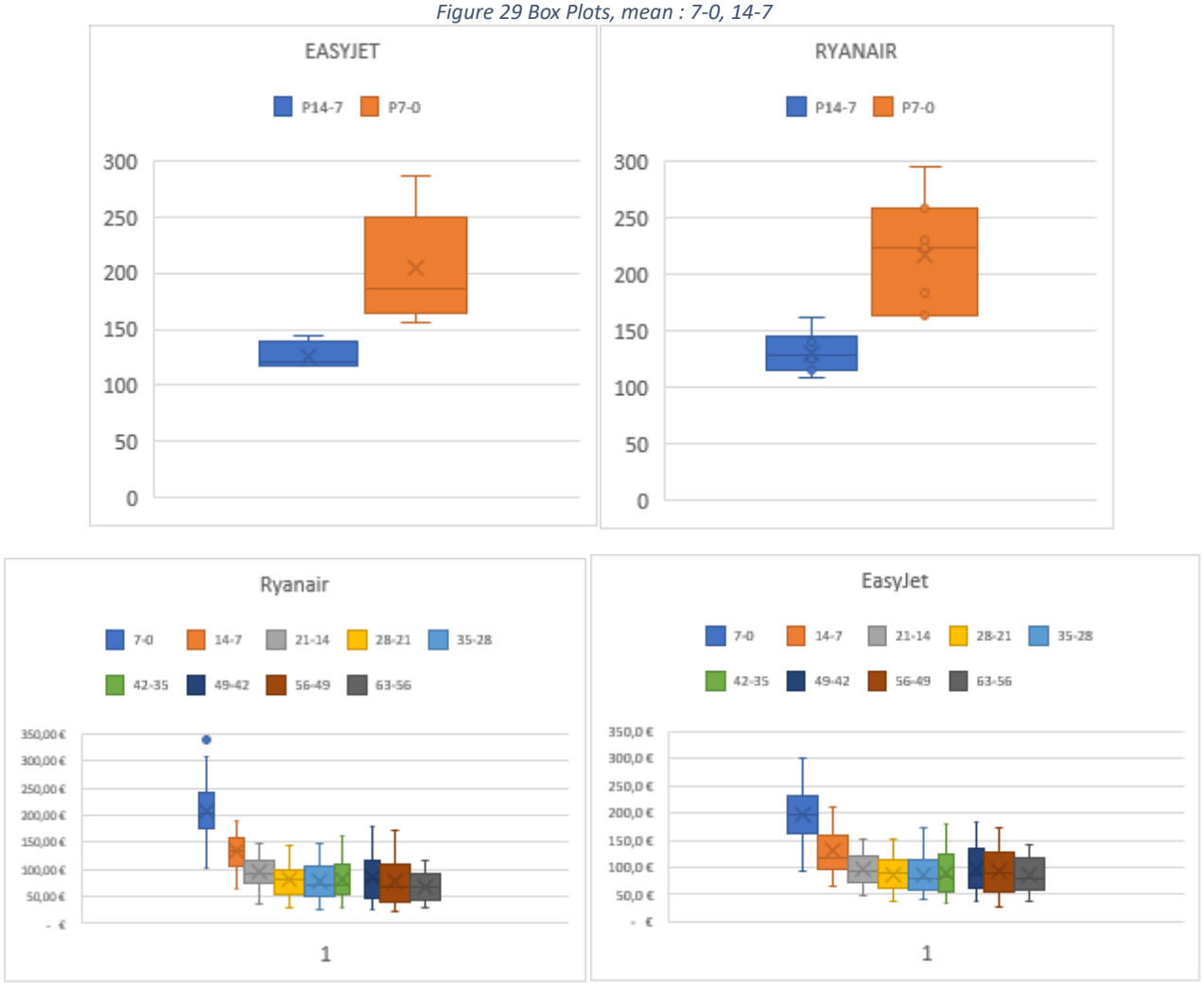
### 5.3.1 Pricing Strategy

Focusing on each airline company individually, its pricing strategy could be studied and identified. an important factor is the so called 'days-to-departure' which is fundamental in the dynamic pricing model. As experienced during my internship in Alpitour, the dynamic price of a flight is mainly defined on the basis of two variables, residual capacity and how many days are left for the departure date (days-to-departure, *dtd*), while seasonality and forecasted demand affect the static price instead. RM department job is adjusting the static price – decided a-priori – on the basis of capacity available and the dtd. Correlation between price and capacity is negative and dtd influences capacity choices too. Less seats are still available, higher will be the price; if the airplane is about to fly (for example, dtd = one week) and residual capacity is still high, the price will be low or the company will substitute the actual aircraft with a smaller one.

Since the aircraft capacity can not be visualized publicly, the only variable that could be monitored is the days-to-departure. Days prior to departure are commonly grouped in time periods of seven days.

The first result of the analysis is the evidence that the average price $P_{7\text{-}0}$ offered over one week prior departure appears higher than the average price $P_{14\text{-}7}$, which is higher than the average price 21-14 and so on. The following figure shows the box plots of $P_{7\text{-}0}$ and $P_{14\text{-}7}$ of the two companies EasyJet and Ryanair. the box plot of $P_{7\text{-}0}$ represents the sample medium when the dtd is one day, two days, three days, … , seven days for all of the departure dates. For example, the price obtained when the dtd is one day is the average of the price of the flight leaving on 16$^{th}$ August and booking on 15$^{th}$ August, the price of the flight leaving on 15$^{th}$ August booking on 14$^{th}$ August and so on. The 3$^{rd}$ and 4$^{th}$ table show how the price fluctuations are flatter when the dtd is one month and more.

*Figure 29 Box Plots, mean : 7-0, 14-7*




The range of prices when the time to departure is less than one week is wider than the range of prices when the time to departure is between 7 and 14 days, but variability is still contained. This results suggest that dynamic pricing algorithm makes more relevant adjustments in proximity of departure; when the dtd is more than 7 days, the differences between adjusted prices are small.

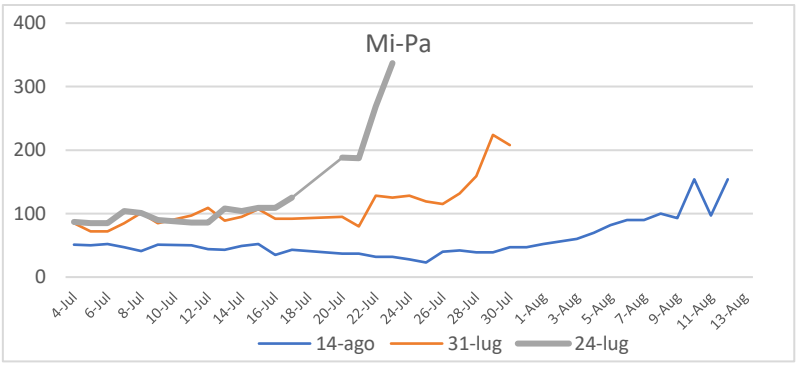
To appreciate more price flow of individual airline company and differences in demand for different days of departure, prices for each day of observation are splitted into a simple graph.

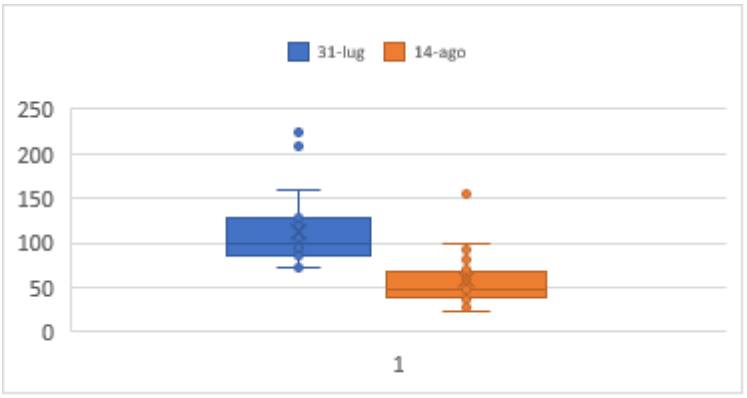
The lower variability of $P_{14\text{-}7}$, $P_{21\text{-}14}$, … respect to $P_{7\text{-}0}$ can be easily visualized, which have are approximately constants.

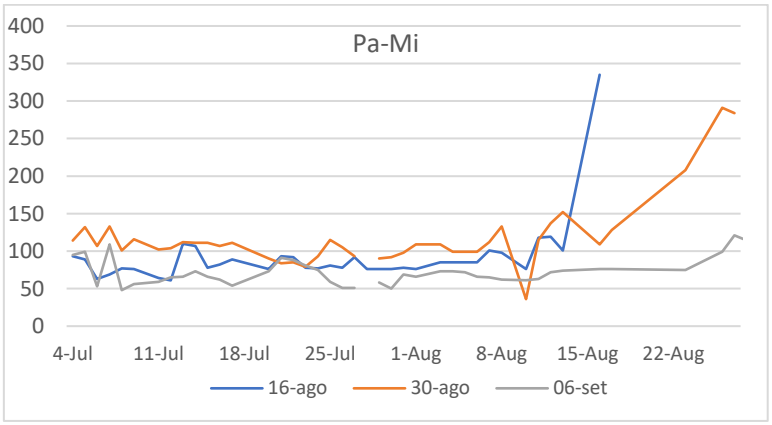
Another interesting behavior is the apparent 'peak' departure day is July 31$^{st}$ instead of August 14$^{th}$ , with a wider range of prices for the peak day. For the return trip, the peak departure day is August 30, with a larger number of outliers.

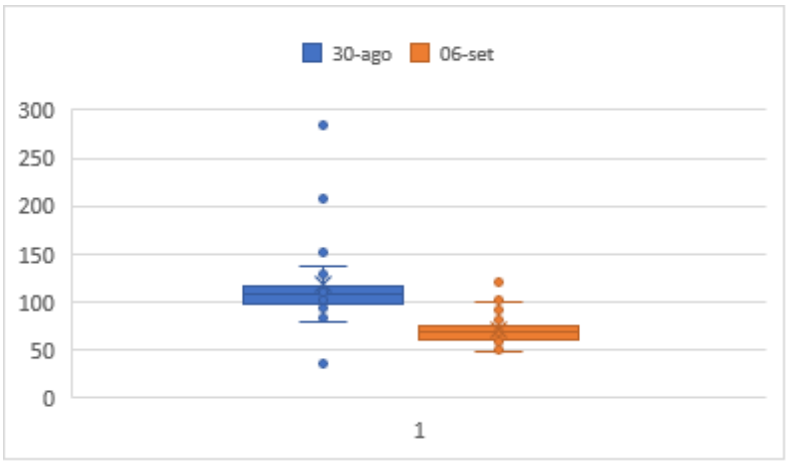
(reference airline company : Ryanair)

*Figures 30 Price trends and boxplot (prices) of different departure dates and routes.*



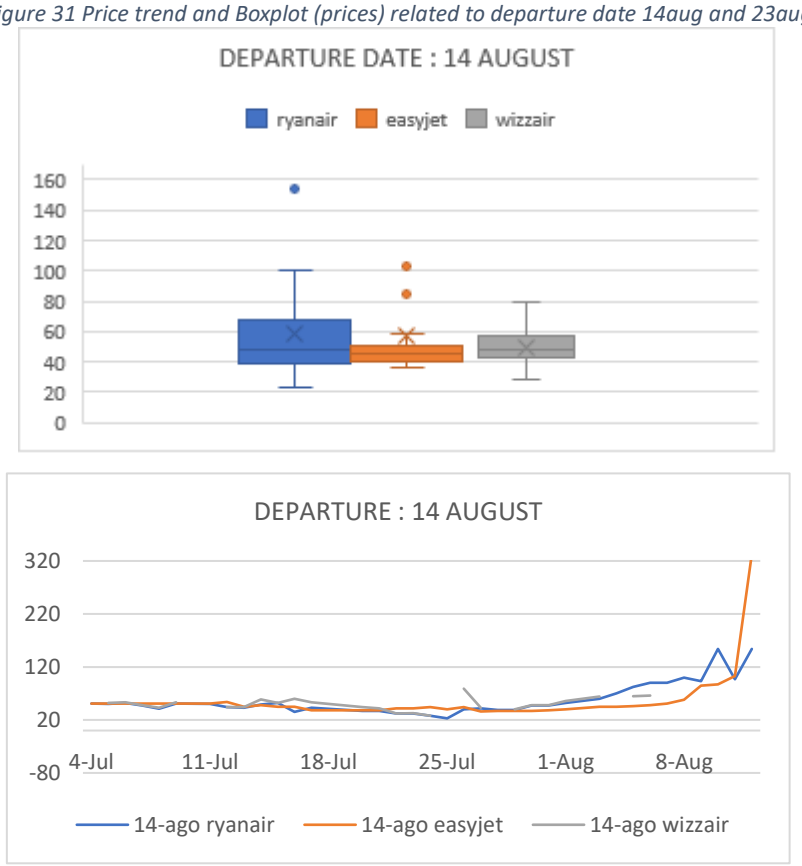



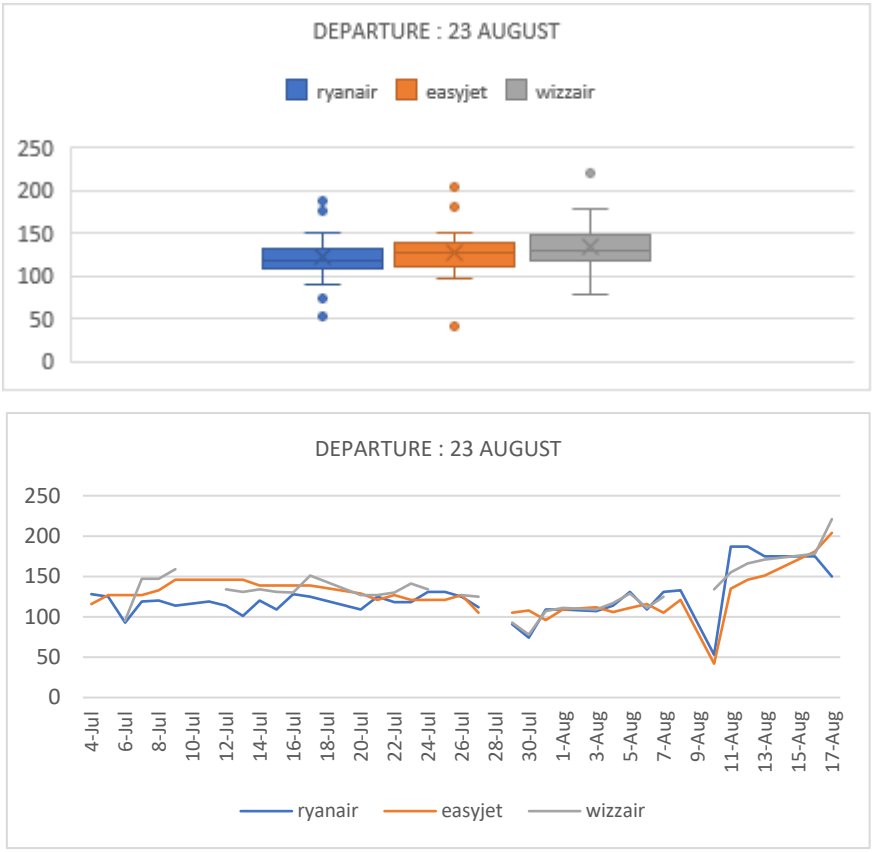



### 5.3.2 Comparison between Airline companies

After evaluating and verifying the dynamic pricing strategy of airlines (all of the three airlines showed similar behavior and results), the collaboration and collusion between the three algorithms. focusing on specific departure dates, although differences of 20 €, irrelevant respect to average prices of even 200 € some observation days, peaks and falls happen in same days.

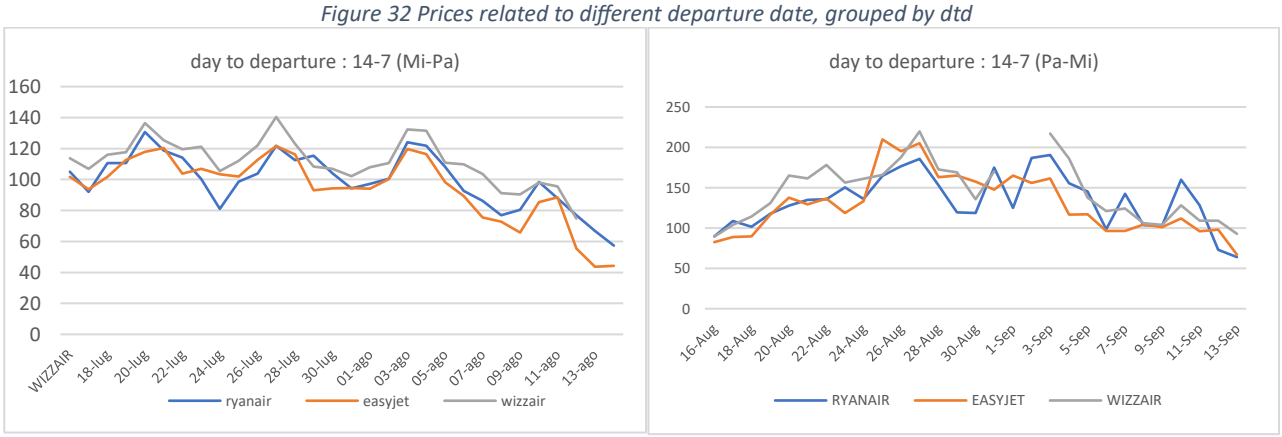
*Figure 31 Price trend and Boxplot (prices) related to departure date 14aug and 23aug*

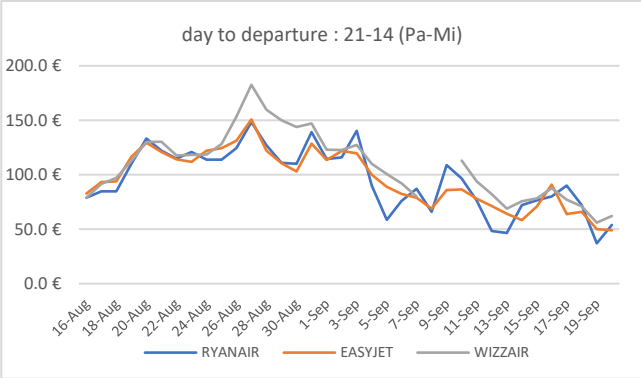


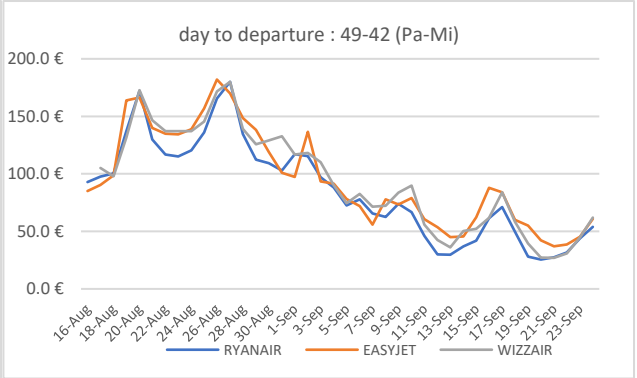



Same conclusion can be achieved by another method. Following graphs show the comparison between the averages of each departure day, differentiated by time intervals. The second way is taking into consideration the price averages of each departure day. It is evident that the airlines set the same prices. The graphs suggest even the demand (late September has a lower demand, in fact average prices are lower, and the peak is reached in late August, as estimated previously). It must be mentioned that these similarities are more notable for the route Palermo-Milan.

*Figure 32 Prices related to different departure date, grouped by dtd*






## 5.4 Conclusion

Demonstrating that airlines are forming a cartel requires investigation and collection of evidence though data that are not easily accessible. the antitrust authorities is still investigating for the Sicilian case, but cartels within airline industry are a common practice since the industry is a fertile soil for the development of collaborations between firms, and beyond economic fines, there are no restrictions thanks to Deregulation Act.

The general steps that could be taken to demonstrate the possible cartel between firms include a constant monitoring of their prices but even testimonies, internal documents, company communications, and the entire database of prices offered by each company.

These goals were not feasible to achieve, due to the lack of resources and time. Then, my efforts were directed to demonstrate why cartels and collusive behavior are so common in airline industry, and why Covid Pandemic should have facilitated them. Also, it had to be pointed out the link between pricing strategy of airlines and the relationship within the market. Prices of industry's product are set by an algorithm not only basing on own demand estimation and own residual capacity, but making comparisons and observing other competitors. These algorithms are able to collaborate and put an eye on external environment.

Also, the formation of a cartel could be considered justifiable to recover from the consequences brought by Covid-19 pandemic. There are two parts involved in price increases. On one hand, customers travel not only for leisure but also for necessity, since, more in Italy than in other countries, there is a relevant outflow of brains or a very frequent movement of them from south to north. Price increase brings negative social impact. On the other hand, tourism industry and all of the related sectors, are the one that suffer from Covid Pandemic the most and from the crisis consequent to Ukraine's war, which not only made rise fuel cost, but also made a big portion of sky impassable. The desperate and unfair attempts to recover the negative profitability of previous years were encouraged by a regulation that lacked solidarity, then the fault is not imputable just to the companies. Leaving customers without alternatives is the only way to sell tickets anyway achieving a positive profitability.

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