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A Real Time Application for Dynamic Pricing Model in the Passenger Air Transport

Dr. G Vijay Kumar

Abstract— **Our planet is more connected than at any time in its history. Especially in air travel industry we can see that 2011, some 2,8 billion people traveled on 35,000 routes connecting 3,800 commercial airports. Together they flew 5.1 trillion km. Tariff structure is a tool of a carrier to influence his profit and to react on competitors respectively. It is a strategically planned sophisticated system of offered seat capacity for specific prices depending on many variables. The tariff structure has considerably changed in last years, above all as a consequence of the entry of low cost carriers.**

***Index Terms*— passenger air transport, demand, fare structure, forecasting, GDP, pricing model.**

I. Introduction

As seen historically, air transport is a growth industry as proved by its resilience to external shocks. The several exogenous events it has faced recent years had an impact in the short-term, but did not prevent air traffic from recovering its long-term growth trend.

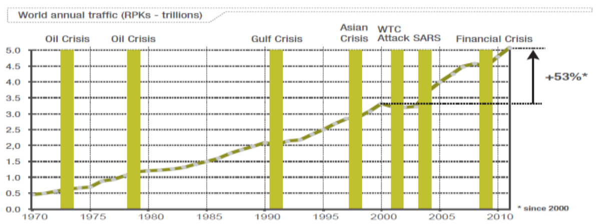

Fig. 1: Air travel has proved to be resilient to external shocks (source: IATA,ICAO,Airbus)

For example, the 1990 – 1991 Gulf war provoked a -2,9% decrease in world traffic, expressed in RPKs (Revenue Passenger Kilometers). The 1998 Asian crisis slowed the world traffic growth down to 1.8%. Last decade (2000-2011) had several very pronounced exogenous shocks: the 2001 terrorist attacks in the US (-2.9% RPKs in 2001, -0.5% in 2002), the 2003 SARS respiratory disease (+1.3% RPK in 2003), and finally the 2008-2009 Financial crisis (+2% RPK in 2008 and -2% RPK in 2009). All these events did not prevent passenger traffic from increasing by 53% over the period of 2000-2011. People definitely want and need to fly. [1]

A. Air traffic growth factors

Growth over the last 40 years was enabled by various factors:

- **Demographic evolution,** with both greater population and especially greater urban populations.
- **Increased wealth,** in parallel with the development of a middle-class in many countries
- **Progressive liberalization of air transport,** which permitted the creation of the low-cost business model. This in turn provoked the reaction of traditional airlines, which improved the efficiency of their operations. The overall effect was decrease of the airlines unit cost (average cost per RPK), which itself has translated into a decrease in the average ticket price over time.
- **Globalization:** Allowing increased world connectivity of people as well as their overall increased need and ability to travel [4][5].

From a forecast perspective, passenger air traffic is driven by two main factors:

- **Global economic activity.** Considering only the GDP at a worldwide level, an increase of this indicator translates into an increase of global wealth, which increases people's propensity to travel. Among the other macroeconomic activity data, we also look at Exports, Imports, Disposable Income, Private Consumption, Unemployment Rate, Consumer Price Index, Oil Prices, etc.
- **The price of travel.** Everything else being equal, a decrease in the average price relaxes the consumers' budget constraints and makes more people economically able to fly. It is estimated that the price elasticity of passenger air traffic is around -0.6 at world level, meaning that if the average price decreases by 1% then the air traffic is expected to increase by 0.6%. [1] [4]

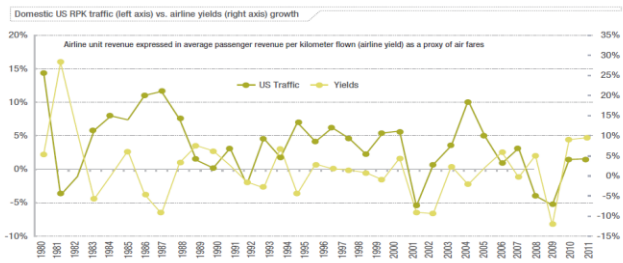

Fig. 2: Air traffic is correlated to air fares (source: IATA,ICAO,Airbus)

II. New Dynamic Price Model for Standard Airlines

On the basis of the above text, it is clear that price level or tariff structures are one of the main pillars gainful airlines. For determining a right tariff structure is using the Revenue management systems (RMSs). It is tool to micromanage seat availability at different prices: pricing and revenue management have increasingly been used together to

Dr. G Vijay Kumar, Principal & Prof. in CSE VKR, VNB & AGK College of Engineering Gudivada – 521301, Krishna Dist., Andhra Pradesh, India

maximize revenue capture on a departure-by-departure, different market segments with ticket conditions and constrained seat availability in an attempt to prevent price-inelastic customers buying fares set below their willingness to pay.[2]

The basic division of tariff is:

- **Pricing differences between cabins.** The difference based on onboard class (economy, upper economy, business, first class) or we can understood as differential pricing based on production costs associated with cabins services. For example high standards of inflight service and associated ground attributes (priority check-in, baggage allowance, lounge access etc.) for business or first class are so much higher than economy class.
- **Pricing differences within cabins.** It is right place for RMSs which allocate seats within each cabin to different booking classes: the highest booking classes usually contain full, on-demand, unrestricted fares, whilst lower booking classes contain discounted fares which typically been offered subject to progressively tighter restrictions as the depth of the discount increases.

But the main question is whether different fares in the same cabin carrying different booking conditions or usage restrictions do indeed represent different products with different production costs and also how many booking class is really necessary.

A. The basic principle of the New dynamic pricing model for standard airline

Standard traffic structure contains around 20 booking classes for the Economy class with different price level and conditions but based on the Integrated Revenue Management decisions had been made 6 months ago. The fare levels and conditions were primary depend on the price management combine with the route management decisions and respected some airline politics for the zone but did not respect the right demand on real time.

The Real Time Display Pricing (RTDP) model is reducing the traffic structure up to 8 classes and they are conditioned on information in the request as on time as possible. Also a very important change for calculate the fare is the partition for the return tickets for the 2 separated fares. It means you can combine two different price levels and make your fare more interesting for the costumer.

The RTDP use a mathematic model system working with a several variable data, for example place of booking, conjunction flight, inventory situation, competing offer, fare rules, fare adjustment, price level, costs cover etc. Also we can talk about so-called "a seamless request reveals information" system.

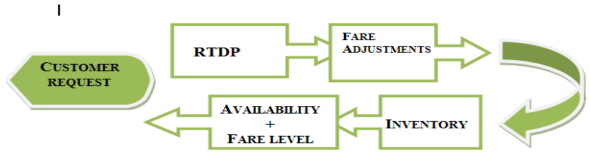

Fig. 3: The RTDP role in the New Dynamic Pricing Model (source: author)

For the using of RTDP i.e. right fare structure determining you need to know the solid market segmentation. You have to know, which fare type or levels are the pillar, and the minimum price level depend on PLF (Passenger Load Factor) for the whole costs cover for the mentioned flight. The perfect segmentation: forecasting independent bookings per class would be sufficient to calculate bid price. How we can calculate right bid price?

FARE – FARE MODIFIER = BID PRICE (fare modifier depends on elasticity)

The price discrimination effected via 3 basic categories:

1. Itinerary and time booking (advance purchase, min stay, season, weekday etc.)
2. Passenger segment (tour operator package, seamen, student etc.)
3. Flexibility, additional services (rebooking, refund, bundling with ancillaries)

Category 1 and 2 can be coded onto availability:

Category 3 implemented according the new fare structure: dynamic price for each offered booking classes. Fare adjustment can be calculated from demand forecast considering choice behavior via the efficient frontier construction, usually a too fine grained segmentation. Need to extract important features: Customer segmentation.

B. Review fare adjustment theory

According of *"Revenue Management Under a General Discrete Choice Model" by authors Talluri K., Ryzing G. (2004)* we can define the nature of the problem with using the *REVIEW FARE ADJUSTMENT THEORY* also known as derivation using dynamical programming [3](1):

Fare products $f_j, j = 1, \dots, n$
Fare policy Z ⊆ N {},{1},{3,8},{1,2,6}
Arrival rate α
Prob. of booking $p_j(Z)$
Accumulated dem. $Q(Z) = \sum_{j \in Z} p_j(Z)$

Total Revenue $\mathbf{TR(Z) = \sum_{j \in Z} p_j(Z) f_j}$

Marginal Revenue Transformation using the transformed choice model (primed demand and fares) in an independent demand DP instead of the original choice model DP, the Bellman equation will produce the same bid-price [3] (2):

$$J_{t-1}(x) = \max \begin{Bmatrix} \alpha\big(TR(Z) + Q(Z) \bullet Jt(x-1)\big) + \\ (-\alpha \bullet Q(Z)) \bullet Jt(x) \end{Bmatrix}$$

C. Demand Forecast – Customer Segmentation

The fare structure consists of two basic fare families. Each fare family has the same set of restrictions (within a family price is the only difference). For example "f" family fare as the flex fare and "p" family fare as the economy fare. Both mentioned fare families consists up to 4 booking classes. The main target for model: **max total revenue requires**

Forecasting:

- Demand model that for any policy (p,f) predicts the demand in economy and flex

Optimization:

- Determine the set of efficient policies (p,f)
- The ordering sequence of the policies
- Bidprice for the legs

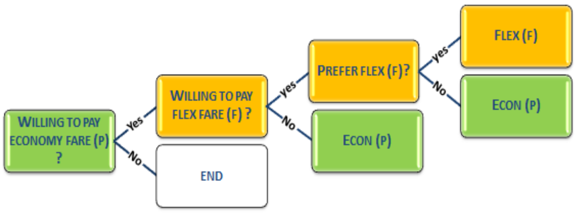

Fig. 4 Forecasting model for determine the fare structure (source: author)

Also you can use for example Bellmann recursion formula or Marginal Revenue Transformation, but will produce same bid-price. Sometime the PODS Simulation setup model is using for his better Hybrid Forecasting possibilities. The PODS Simulations can also count with the PLF (Passenger Load Factors), price and product demand or booking class mix. But the final conclusion in simple is (3):

Total Demand: $Q = dflex(f,p) + decon(f,p)$
Total Revenue: $TR = f \times dflex(f,p) + p \times decon(f,p)$

III. Conclusion

Classic airlines market segmentation consist six types or groups of airlines: Global Network, Major Network, Small Network, Low-Cost, Charter, Regional and Affiliate. Global Network airlines will be the largest in 2031, keeping a share of traffic of 59%, slightly down from 60% in 2011, by the IATA 20-years Passenger Traffic Forecast. Low-cost carriers will gain the most market share, from 15% to 20%, thanks to the dynamics of the American, European and Asian low-cost carriers and as a consequence of ongoing liberalization of air transport all over the world. [1]

So, the standard airline managements still are looking for new tools to be more competitive to the low-cost and fare structure change must be used as the first step on this exhausting way. Fare structure will evolve towards fare families driven customers (changes in corporate travel policies) airline and competitors.

<u>Review of the fare adjustment theory:</u>

- Fare adjustment theory introduces transformation is a tool for the New Dynamic Price Model that allows traditional fare booking class systems change to for fare families.
- Efficient conditions are nested for fare families (price level, availability, inventory etc.)

<u>Application to fare families:</u>

- Closing flex classes while keeping lower economy classes open
- Offer depending on time frame, competition and inventory by local market conditions
- Policies shift in class sets on remaining capacity
- Fare family forecasting achieves gain revenue

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