The Netherlands Press
Journal of Airline Operations and Aviation Management

Article

When do Airlines Price Match? A Review of Factors Affecting Parallel Pricing

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DOI: https://doi.org/10.56801/jaoam.v3i1.2

Abstract.

Parallel pricing refers to the practice of firms making independent pricing decisions to match each other' prices. This paper provides plausible economic intuitions about the market characteristics that affect the emergence and persistence of airline parallel pricing behavior by reviewing and synthesizing the relevant factors identified in the industrial organization literature as influencing cooperative outcomes or tacit collusion. One of the key findings of this paper is that the combination of high price transparency, quick price response, and repeated interactions among competing airlines can make parallel pricing as a self-evident outcome, even in the presence of information asymmetries, cost discrepancies, variations in capacity and service quality, as well as fierce market competition. Another finding is that as personalized pricing becomes more prevalent, the likelihood of success of parallel pricing may decrease. It remains unclear what other forms of cooperative outcomes will emerge as the industry continues to adapt to changing technological and market landscapes. With these findings, this paper contributes to the groundwork for developing a comprehensive model of parallel pricing in the airline industry.

Keywords: airline competition, cheap talk, parallel pricing, personalized pricing, tacit collusion.

Journal of Airline Operations and Aviation Management Volume 3 Issue 1

Received Date 23 December 2023
Revised Date 18 March 2024
Accepted Date 27 March 2024

1. Introduction

At 16:00 on Friday, Airline X increased its fare by 5% on the city-pair in direct competition with Airline Y. At 20:00, Airline Y responded by increasing its fare by only 3% on the same route. At 17:00 on Saturday, Airline X withdrew the 5% fare increase. The next day at 17:00, Airline Y also rescinded the 3% fare increase. The following Friday, at 16:00, Airline X raised its fare on the route again, this time by 3%, the same percentage increase as Airline Y did in the previous week. Four hours later, Airline Y matched the 3% fare increase. After that, no fare changes were made by Airline X over the weekend[1].

Airline pricing is highly dynamic and competitive. Airfares are constantly adjusted in response to changing market conditions such as demand in general or in specific markets, industry-wide and airline-specific costs, and the pricing actions of competitors. A fare change initiated by one airline prompts other airlines to respond with an identical or similar change, with the expectation that subsequent competitors will also match the price. This reactive pricing behaviour is called parallel pricing, which generally refers to the "practice by which two or more sellers change their prices at or about the same time and by the same or similar amount or proportion" [1].

A frequently asked question in this context is what motivates airlines to engage in parallel pricing. According to the industry literature [2-4], matching a competitor's fare is consistent with the cost structure of the capital- and asset-intensive airline industry, where the marginal cost of an additional passenger is so low that the immediate priority is to recover high fixed costs by protecting market share, regardless of the short-term impact on revenue.

Another question often asked is how to achieve parallel pricing among competing airlines. The answer is usually given from an operational and technical perspective: the airline industry's highly standardized pricing and distribution process [3, 4]. In this regard, the role of third-party intermediaries, acting as clearinghouses or aggregators of airfares, cannot be overemphasized. The Airline Tariff Publishing Company (ATPCO), which is jointly owned by about a dozen major airlines, dominates this role. Airlines around the word use ATPCO's fare filing systems to manage their fare products, including travel/sales rules and ancillary items, and adjust them quickly and automatically through algorithms embedded in these systems. Once an airline files its fare products with ATPCO, any updates or changes become visible to other airlines, resulting in a high level of transparency. Airlines can obtain complete data about competitors' published fares (predetermined fares available to the general public for purchase) and monitor and react to them in real-time at a very small cost. ATPCO also aggregates the fare data into a standard format and distributes it multiple times a day to the global marketplace, including airlines, global distribution systems (GDSs), travel agencies, travel management companies, and metasearch engines.

The opening anecdote illustrates a typical pattern of airline price adjustments using the ATPCO system. Often, several rounds of cascading price changes (initiated, not followed, amended, withdrawn, reinstated, etc.) take place until all the airlines charge the same price. In this iteration, each airline's price change appears to act as a signal that communicates each other's proposal and counterproposal to find a price that is acceptable to all [5-9]. The exchange

[1] This example is hypothetical, but quite realistic, and is based on a case cited in the U.S. Department of Justice, Antitrust Division [5].

of price signals is so fast with multiple price changes being made during low demand periods (off-peak hours and weekends when travel agencies are closed) that little or no actual sales are made at each proposed price[2].

These price signals among competing airlines are essentially cheap talk – costless, non-binding, non-verifiable communication [10]. In theory, cheap talk does not alter the potentially large set of equilibrium prices, nor does it guarantee the transmission of true information. Nevertheless, it may provide an easy, flexible way for firms to increase the chance of achieving a coordinated outcome [11]. This suggests that parallel pricing behaviours of airlines may correspond to a form of "tacit collusion" in that the price leadership and matching are achieved through cheap talk among them.

Given the highly standardized pricing and distribution process and the potential for signaling in the form of cheap talk, an open question is the extent and stability of parallel pricing as a distinct outcome, i.e., do the characteristics of the airline market encourage or discourage parallel pricing? There are numerous theoretical and empirical economic studies analyzing the relationship between the degree of competition and the level and structure of airfares by focusing on one or a few market characteristics. However, these studies have not examined the parallel pricing behavior of airlines by holistically reviewing the relevant factors identified in the industrial organization and regulatory economics literature as influencing cooperative outcomes or specifically tacit collusion. The contribution of this paper is to fill that research gap by reviewing these factors and drawing broader economic intuitions or plausible, albeit non-mathematical, accounts for the critical market characteristics that give rise to parallel pricing and enable its persistence over time.

Note that this paper focuses specifically on the conditions for the emergence and persistence of parallel pricing in the oligopolistic setting, but not on whether the equilibrium price exactly maximizes the profits of airlines, nor on whether parallel pricing constitutes anticompetitive behavior. That is, the paper does not address policy implications and legal concerns regarding potentially anticompetitive aspects of parallel pricing. For this reason, it deliberately avoids the use of terms such as tacit collusion, tacit coordination, conscious parallelism and concerted action. Note also that the analysis in the following sections synthesizes the theoretical and empirical results of three strands of relevant literature. The first group of literature is theoretical studies of tacit collusion in the fields of industrial organization and regulatory economics to provide theoretical underpinnings. The second group is empirical economic analysis of the effects of competition on airfares. The third group is various gray literature, supplemented by academic work in operations research and antitrust law (law and economics), to add perspectives from the airline industry, governments, and the judiciary.

The paper is organized as follows: Section 2 presents an illustrative benchmark model to assess industry characteristics resulting from the highly standardized pricing and distribution process – price transparency, rapid response and repeated interactions. In Section 3, key relevant factors that would affect parallel pricing are reviewed by relaxing assumptions of the benchmark model with respect to symmetries in information, costs and capacity between

[2] Instead of making fares effective immediately, airlines could send less expensive, non-binding signals by posting a fare that will take effect at a later date (or that has no seats available for sale), so that no sales actually take place at that price. If competitors do not follow suit, the posted fare will be withdrawn or modified before it goes into effect, or the effective date will be postponed. Some jurisdictions including the Unites States and Brazil prohibit certain forms of such preannouncements on fares using footnotes about future sales dates etc. [5, 7].

the airlines, and by introducing a more dynamic competitive landscape. Section 4 considers the potential impact of the dynamic/personalized pricing feature, currently under development, on parallel pricing. Conclusions are presented in Section 5.

2. Benchmark Model

In an oligopolistic market like the airline industry, firms are interdependent in their pricing decisions and tend to influence their competitors, who in turn react against them. Initiating price changes carries the risk of losing profits if the new price is above competitors' level, or triggering a spiral of price drop if it is below competitors' level. The industrial organization and regulatory economics literature [12-17] has consistently identified relevant market characteristics or factors that may influence the emergence and sustainability of coordinated outcomes in a given market. The most frequently cited are summarized in Table 1.

Among the industry characteristics listed in Table 1, the salient ones in the airline industry are a high degree of price transparency (near perfect monitoring), a high speed of price response (rapid or immediate response), and frequent, repeated interactions by the same set of airlines with no deterministic endpoint. As discussed in the preceding section, airlines use ATPCO's fare filing system to learn instantly about competitors' pricing decisions. Sophisticated pricing algorithms allow airlines to automatically respond to rivals' actions at little or no cost, as well as to signal their intentions, making it easier for competitors to figure out what is going on. In addition, each airline responds to a competitors' fare change faster than many customers can find and book the updated fare. This is effectively the same as exchanging information about near-term prices (but not full preannouncement of future prices).

Table 1: Relevant Factors Influencing the Emergence and Sustainability of Coordinated Outcomes

Type of market characteristics	Relevant factors
Industry characteristics (Structural characteristics)	Market transparency+, immediate response+, frequent interactions among competitors+, market concentration (less competitors)+, barriers to entry+, interaction and linkage with other markets (multimarket contact)+, etc.
Demand-side characteristics	Demand growth+, demand fluctuations and business cycles*, low demand elasticity+, etc.
Supply-side characteristics	Cost asymmetry*, asymmetry in capacity constraints*, product differentiation+*, innovation and disruptive technology*, etc.

Note. + facilitate coordinated outcomes; * hinder coordinated outcome.

Compiled by the author based on [12-17].

As a first step, consider a duopoly market of airlines analogous to the hypothetical, non-mathematical model of [18-20], which illustrates two gas stations located across the street from each other in a small town. In this model, hereafter referred to as the benchmark model, Airline X and Airline Y repeatedly compete on price in a given city-pair and can easily monitor each other's prices at very low cost and react to changes almost immediately. To eliminate the possible influences of other industry, demand and supply-side characteristics, the following assumptions are made:

A. both airlines have access to the same information about market conditions which are relatively stable;
B. their operating costs are identical;
C. their capacities are at the same level in terms of frequencies and seats;
D. their services are very close substitutes in the sense of a full-service carrier (FSC);
E. there are no new entrants, resulting in duopoly of the two airlines;
F. they compete in only one specific market;
G. each of them sets only one fare without price discrimination; and
H. existing technologies continue to be used by the two airlines.

Assumptions D and G imply that there is no brand loyalty: if the two airlines offer the comparable service at the same price, customers will be indifferent and the market shares of the two airlines will be equal; otherwise, customers will purchase the flight with the lower fare. All of these assumptions lay the groundwork for understanding how parallel pricing can occur in a market with perfect monitoring, rapid response and repeated interactions, and serve as a starting point for more complex situations where some or all of these assumptions are relaxed.

In this benchmark model, Bertrand competition, i.e., a race to undercut each other's prices until they reach marginal cost (competitive price), is highly unlikely to occur. The two airlines rationally understand that any price cut they make would be immediately matched by the competitor. This is because the protection of market share by matching the competitor's fare is more profitable than losing market share by not matching it. Obviously, the new lower fare leaves both airlines' market shares unchanged but reduces their overall profits. Thus, a price cut only makes sense if it can stimulate demand and improve profits for both airlines. A likely outcome is that each airline individually sets the same supracompetitive price, below which neither airline has an incentive to go.

Likewise, a fare increase is considered rational when market conditions suggest that the two airlines can benefit from a higher price. Suppose Airline X is the first to raise a fare. If Airline Y did not follow suit, Airline X would immediately revert to its original lower fare, preventing Airline Y from gaining market share simply by maintaining its current fare. Therefore, there is common knowledge among the airlines that a price increase will at least be matched by others, and failure to do so will result in a return to the original, lower price [21]. Given this mutual understanding and the favorable market conditions, the rational response for Airline Y is to match Airline X's action and maintain its market share at a higher price, thereby increasing profitability for both airlines.

The economic intuition from the above is straightforward – both Airlines X and Y collectively have a degree of market power and a common interest in charging a higher price rather than a lower, competitive price. Unless the two airlines have good reason to believe that changing the current price up or down will benefit them both, the existing price is maintained. As the opening anecdote illustrates, the initiation of a price change by one airline spurs a very rapid iterative change in prices between the two airlines, eventually converging on a focal point, i.e., a price level that is so compelling that a firm would expect all other firms to set their prices at that level. As such, parallel price changes occur without explicit communication between the airlines as "the outcome of an appreciation by the industry that the interests of each member of the group might be best secured by the coordinated pursuit of the interests of the group as a whole" [22].

Moreover, once the focal point of the parallel price was established, there would be no temptation for either airline to unilaterally deviate from it even if it were above the competitive price. The reason is that, with the ability to perfectly monitor and quickly respond to each other's prices, any deviation is easily detected and countered. A tougher punishment not only eliminates the price advantage immediately, but would also trigger a price war, resulting in a long-term loss of profits that may outweigh the short-term benefits of the deviation. In general, the higher the discount factor, the greater the long-term gain from cooperation over the short-term gain from deviation [16, 23]. Thus, as long as each airline is patient, it is in its best interest to retaliate against deviations rather than lose market share.

The caveat is that the focal point may not necessarily represent a price that maximizes the joint profits of the two airlines, i.e., a price that would be charged if they could merge into one airline. According to the "folk" theorem, proved by [24] among others, if firms expect to interact indefinitely and have a sufficiently high discount factor, any price between the monopoly price and marginal cost can be maintained as an equilibrium. Therefore, there is no guarantee that the joint profit-maximizing price is in equilibrium just because parallel price changes appear to be the most likely outcome. The equilibrium might be somewhere above the marginal cost or competitive price, and possibly closer to the joint profit-maximizing price.

3. Review of Factors Affecting Parallel Pricing

It is obvious that the assumptions A through H underlying the benchmark model are too restrictive and do not reflect the reality of the market. On the contrary, each airline often faces asymmetric and more dynamic conditions, and may therefore have different preferences as to what prices are desirable to set in the market. The next step of the analysis is to review the relevant factors that may facilitate or hinder tacit collusion cited in the industrial organization literature and apply them to the parallel pricing behavior of airlines. Specifically, each of the assumptions A through G is relaxed sequentially to see how the results of the benchmark model would change (assumption H is relaxed in Section 4). The focus is on whether the structural and supply-side characteristics of the market would discourage or encourage the emergence and sustainability of parallel pricing.

3.1 Information asymmetry

Assumption A of the benchmark model ensures that competing airlines have access to the same salient information. For example, if the two airlines know that the market is growing and tomorrow's profits will thus be higher than today's, and if there is no prospect of new entry, parallel pricing could easily be maintained. The real world is different, though. There is often information asymmetry, whereby one airline in the market may have more or better information than its competitor. Of particular interest here is what would happen if competing airlines were not equally informed about the latest change in industry-wide market demand.

Consider the following scenario. The economy is bottoming out and can support a higher fare, but only Airline X is aware of this latest market condition. Suppose that Airline X raised its fare based on this information but Airline Y did not react to it. Although the higher fare benefits both airlines, Airline X would be forced to reverse the fare increase before losing market share in the absence of concerted action by Airline Y. To induce Airline Y to do the same, Airline X's fare increase must serve to reinforce Airline Y's belief in the likelihood of a demand recovery. In other words, Airline X's pricing action must be a credible signal that makes a price increase a more rational option for Airline Y.

One problem with these price signals is that they are cheap talk. Airline Y may ignore the signal, suspecting that Airline X is trying to cheat, or may misunderstand the rationale for Airline X's action. Building the credibility of the price signals requires repeated interactions, or a stable market environment in which a firm gets to know its competitor well [18, 25-27]. Typically, through heuristic trial and error, Airline Y can learn about Airline X's price patterns and behaviours. If Airline X cheats, its reputation is immediately ruined and it will be punished by Airline Y. Knowing the future negative consequences of cheating, Airline X is willing to maintain its reputation and continue to send signals containing trustworthy information to Airline Y. In this way, Airline X can adjust its fare when the market condition changes while Airline Y waits for Airline X to move. In other words, Airline X becomes a barometric price leader in a sequence of prices, in which the uninformed firm always matches the informed firm's previous price, while the informed firm sets different prices for different states [28].

3.2 Cost asymmetry

Contrary to assumption B of the benchmark model, when the two airlines do not have identical costs, their profit-maximizing prices differ and therefore no simple focal point would exist. Suppose that Airline X has publicly announced a commitment to restructuring its business. This announcement, which is difficult to reverse, could act as a credible signal to Airline Y that it is rational for Airline X to lower the current fare. Airline Y might respond with a compromise signal to set the new fare at the midpoint of their respective profit-maximizing prices[3]. However, Airline X, which could increase its profit by undercutting, is unlikely to accept this compromise. Even if Airline Y threatened to retaliate against Airline X, it would be less effective and less credible because of the greater loss of its own profit. Presumably, all other things being equal, Airline Y would be forced to match Airline X's lower fare. The market share would remain the same, with Airline X's revenue increasing and Airline Y's revenue decreasing.

Nevertheless, parallel pricing could occur at the higher focal point if the cost difference between them is not extreme and unequal market shares are allowed. For example, if Airline Y allows Airline X to gain a sufficiently high market share in exchange for Airline X setting a fare above its profit-maximizing level, then Airline X might accept the price closer to Airline Y's desired level. Mouraviev & Rey [29] suggests that the coordinate outcome could be achieved if the high-cost firm acts as a price leader and the more efficient, low-cost firm acts as a follower to gain a sufficiently high market share. In contrast, if there is a significant cost difference between the two airlines, a more complex price iteration is necessary. As discussed in the later subsection, by relaxing assumptions C (symmetric capacity constraint) and G (no

[3] From a strategic perspective, Airline X's commitment to reducing operating costs may induce Airline Y to behave more aggressively than Airline X expects because Airline Y has no way of knowing exactly what Airline X's new profit maximization level will be (information asymmetry). Given this risk, Airline X may be better off acting like a puppy dog. That is, it takes a less threatening action to prevent a price spiral below the supracompetitive level [33].

price discrimination), and by allowing for heterogeneity in the price elasticity of demand across customers, there may still be plenty of room for partial matching between these two airlines.

3.3 Asymmetric capacity constraint

The benchmark model (assumption C) did not account for capacity constraints, which, if present, would reduce both the incentives of the firm to deviate and its ability to punish such deviations [15, 16]. In the context of airline competition, on the one hand, a capacity-constrained airline has less to gain from undercutting its competitor's price because its flights can accommodate only a fraction of the additional demand attracted by a fare cut. On the other hand, its retaliation power to prevent the competitor from deviating from the parallel price is limited because it cannot fully satisfy the additional demand from a retaliatory fare war.

If the capacity constraints of the two airlines are asymmetric, for example, Airline X has less capacity than Airline Y, the likelihood of parallel pricing depends on whether the smaller airline (Airline X) can prevent the larger airline (Airline Y) from deviations. According to Compte et al. [30], asymmetric capacities can contribute to achieving a cooperative outcome when the aggregate capacity of the firms is strictly larger than the market size and thus the focal point is below the joint profit-maximizing price. This is because the existence of excess aggregate capacity, as is often the case for the airline industry [31], makes the smaller firm's retaliation power more effective.

Note that when both cost and capacity asymmetries exist, price matching may be suboptimal [8, 32]. Suppose that Airline X has lower operating costs than Airline Y but has less capacity. In this setting, even if Airline X offers a lower fare than Airline Y, much of the stimulated demand cannot be accommodated by Airline X's flight due to its tight capacity constraints. Since Airline Y's loss of market share is limited, Airline Y would be better off allowing Airline X to fill seats at the lower fare and selling the remaining demand (Airline X's rejected demand or spill) at a higher fare. However, again with the relaxation of assumption G, Airline Y may be willing to partially match Airline X's lower fares, as discussed in a later subsection.

3.4 Differentiated service

Price matching may well occur even without assumption D that the two airlines compete as very close substitutes. For example, if Airline X provides better service than Airline Y but at the same price, then Airline X can provide the same quality of service as Airline Y at a lower cost. The result is therefore similar to the asymmetric cost case. In contrast, when each airline's services are horizontally differentiated, it will appeal to a segment of customers with a particular preference. Once brand loyalty to one airline is established, these customers would be reluctant to switch to the other airline, even if it offered a lower fare. This means that the short-term gains from undercutting the rival's price would be reduced because of the difficulty in attracting the rival's customers. At the same time, each airline's ability to punish deviations would be limited. In such an ambiguous situation, it is necessary to relax assumption G (no price discrimination). By dividing the market and, if required, exchanging signals, both airlines will be more inclined to engage in parallel pricing. Specifically, each airline will play the role of price leader for its own loyal customer segment and will match the competitor's fares for the customers who are loyal to the competitor, with the expectation that the competitor will do the same.

Suppose Airline X launches an advertising campaign to highlight its distinctive service. Some customers perceive the campaign as a commitment by Airline X to improving service quality and become more loyal to it. The increase in brand loyalty enables Airline X to act as a monopolist in that particular segment, and charge a higher price than it would in direct competition. In turn, Airline Y also attempts to lure another segment of customers who are loyal to it. As a result, Airline X's advertising would lead to segregation and allow for a higher price, benefiting not only itself but also Airline Y. This is the so-called fat cat effect [33] – a business strategy whereby if the commitment makes Airline X more accommodating or soft, then Airline Y will become soft as well.

3.5 Less concentrated market

The number of firms has traditionally been identified as one of the critical structural characteristics affecting the cooperative outcome. The U.K. Parliament [22] referred to parallel pricing as "likely to be found in industries where a major share of the industry's market is concentrated in the hands of a few large sellers". According to Ivaldi et al. [16] and the Organisation for Economic Co-operation and Development [34], the more competitors there are in the market and the lower the barriers to entry, the more likely firms are to have different costs and services, the more complex each firm's strategy becomes, and the more difficult it is for each firm to identify a focal point, and effectively penalize deviations. In addition, each firm's share of the pie (joint profit) becomes smaller. As a result, the short-term gains from deviating from parallel pricing increase while the long-term gains from adhering to it decrease.

Indeed, a smaller number of competing airlines may reduce the number of back-and-forth exchanges of signals of intent (i.e., fewer rounds of fare changes) to reach the focal point by all airlines. However, the effect of the number of competing airlines on the emergence of parallel pricing appears to be diminishing as the use of ATPCO and internal systems allows each airline to quickly identify and respond to fare changes by multiple competitors. The OECD [34] made it clear that "in a perfectly transparent market where firms interact repeatedly, when the retaliation lag tends to zero, collusion can always be sustained as an equilibrium strategy", regardless of the number of competitors. This means that assumption E on duopoly may be important but not necessary for parallel pricing to occur because of price transparency, rapid response, and repeated interactions.

3.6 Multimarket contact

Contrary to assumption F of the benchmark model, in the real world, airlines compete against each other at the network level. According to mutual forbearance or multimarket contact hypothesis [35], simultaneous cross-market interactions among competing firms soften asymmetries that arise in individual markets. Many literatures have tested this hypothesis in the air transport market, providing empirical support to it [36-38]. In general, airlines competing in multiple markets are more likely to achieve a coordinated outcome, recognizing that the initiation of a competitive attack in one market may trigger a counterattack by the rival firm in all other contested markets.

Consider two markets, M and N, where Airlines X and Y compete repeatedly and indefinitely. Suppose that Airline X has a larger share in market M and that Airline Y has an advantageous position in market N. With this asymmetry, if Airline X lowers a fare in market N (which is important to Airline Y), Airline Y will not only match the fare reduction in market N but also retaliate with a fare war in market M (which is important to Airline X). This concurrent action across routes acts as a signal that indicates a willingness of Airline Y to stop the fare war in market N in exchange for Airline X eliminating the initial fare reduction in market N[4]. The rational course of action for Airline X is therefore to take a reactive action as a follower in Airline Y's sphere of influence, that is market N, to avoid Airline Y' retaliation in market M, Airline X's own sphere of influence. Consequently, Airline X will match Airline Y's fare in market N and Airline Y will reciprocate by matching Airline X's fare in market M.

3.7 Multiple fares

Some of the situations in which multiple fare setting is required for parallel pricing to emerge have already been considered in the previous subsections by relaxing, where necessary, assumption G and the homogeneity of the price elasticity of demand across customers. Airlines typically offer multiple fares consisting of a stepped series of capacity-controlled published fares on each route. This type of fare structure is called a sell-up tariff and is motivated by the increasing opportunity cost or marginal value of remaining capacity on a flight as departure approaches and the aircraft fills up. In general, the lower the fares, the more restrictive the travel/sales conditions such as advance purchase requirements, fees for changes, cancellation penalties, and minimum and maximum length of stay, and the tighter the inventory controls.

Multiple fare competition leads to intra-firm price dispersion, the pattern of which cannot be explained by cost differences alone [39-43]. Despite such a large price difference between the highest and lowest fares, it is common for each airline to match a full range of fares with each other when there is no significant difference in cost or where both airlines are full-service or network carriers (FSCs) [44]. Table 2 shows an actual example where FSCs systematically match the vast majority of each other's fares, albeit with slight differences, ending up with virtually identical sell-up ladders between them.

Systematic one-to-one matching of individual fares can be achieved as in the case of differentiated services. For example, Airline X matches Airline Y's preferred fares targeted at Airline Y's strong customer segment in exchange for Airline Y's acceptance of Airline X's price leadership in its strong customer segment. Assuming further that Airline X's customers are more price sensitive, they are likely to purchase the lowest fare option more quickly than Airline Y's customers. As a result, Airline X will exhaust the seats allocated to the lowest fare and move to the next tier, while Airline Y is still opening bookings for its equivalent lowest fare. This means that even though both airlines have set identical fares, the actual availability at the time of booking by customers can create the inter-firm price dispersion.

Next, consider the competition between a low-cost or non-frill carrier (LCC) and a high-cost FSC. Again, despite a significant cost difference and vertical differentiation in service, empirical studies have found a pattern of partial or intertemporal matching between them. According to Avogadro et al. [45], the fares of LCCs continue to rise and sometimes even tend to be higher than those of FSCs as the booking date gets closer to the flight date. Ngo & Tsui [46] identified that, when the LCC's fares increase, the FSC lowers its fares to gain more competitive market power, but will start to raise them later. Conversely, when the FSC increases its fares, the LCC initially follows suit but soon reduces its

[4] To make it easier to understand which routes/fares are linked, airlines typically use the similar fare basis codes (a compilation of the fare class or ticketing code and ticketing designators) and the footnotes accompanying the fare changes on all the city-pairs concerned in the ATPCO system, to the extent permitted by law, consent decree, etc. [6, 8].

fares. These two patterns suggest a bounded price response, where fares cannot be too low for the FSC or too high for the LCC to avoid head-to-head price competition between the two airlines.

Levine [47] provided a plausible explanation for the effective market-segmentation strategy of FSCs to compete with LCCs. In essence, FSCs segment the market and can maintain a higher, non-restrictive fare for price-inelastic customers with a high willingness to pay who tend to purchase tickets closer to departure. For price-sensitive customers who would otherwise be attracted to LCCs, a new, lower fare is introduced that matches LCCs' price but has limited seat availability and travel/sales restrictions. Such restrictions can prevent FSCs from overselling seats to price-elastic customers at a low fare far well before departure date due to competition from LCCs and thus underselling seats to price-inelastic customers who would pay at a high fare closer to departure [48].

Table 2: One-to-One Price Matching of Sell-up Fares between Japan Airlines and All Nippon Airways

(Currency: JPY)	1st booking class	2nd booking class	3rd booking class	4th booking class	5th booking class	Total
Japan Airlines' average lowest fare in each booking class (1st booking class = 100)	97,667 (100)	116,962 (120)	143,000 (146)	162,524 (166)	182,952 (187)	140,621 (144)
All Nippon Airways' average lowest fare in each booking class (1st booking class = 100)	98,362 (100)	117,952 (120)	142,200 (145)	175,063 (178)	181,056 (184)	140,069 (142)
Percentage of routes where the two airlines have exactly the same level of lowest fares	76.2%	66.7%	75.0%	62.5%	55.6%	68.4%

Note. Compiled by the author based on airfare information retrieved from Expertflyer.com (which subscribes to ATPCO's data) on March 15, 2024. The query was made to select the lowest round-trip economy class fares filed by Japan Airlines and All Nippon Airways: a) on 21 international city-pair routes from Japan where both airlines operate at least daily nonstop service; b) for the passenger's itinerary departing on July 3, 2024 and returning on July 10, 2024; and c) from each of the five lowest-valued booking classes in the inventory control hierarchy (both airlines have a nearly identical ladder with a total of 11 booking classes).

4. Potential Impacts of Dynamic and Personalized Pricing

Airline pricing is transitioning to a truly dynamic pricing environment. Although there is no universally-accepted definition of dynamic pricing, it is generally recognized as a method of "adjusting prices to changes in demand and supply, often in real time, not implying any kind of discrimination between consumers" [49]. Specific to the airline pricing context, Wittman & Belobaba [50] defines dynamic pricing as the practice of airlines to "charge different customers different prices for the same product, as a function of an observable state of nature", implying that the prices are adjusted in real time, on a one-time basis, and, in response to each individual shopping request [51].

There has been a growing literature in economics and operations research fields extending dynamic pricing models to intertemporal price discrimination and price dispersion in perishable markets such as air travel with demand uncertainty [45, 48, 52, 53]. However, these studies have analyzed airfares that are adjusted over time using existing technologies (legacy approach), not truly dynamic prices adjusted in real time as envisioned by the airline industry. Of great interest is whether the findings in the previous section that parallel pricing has a high probability of success will change if assumption H of the benchmark model is relaxed so that truly dynamic pricing capabilities will become available in the future.

4.1 Legacy approach vs. optimal dynamic pricing

For the past four decades, pricing and distribution in the airline industry has been relying on published fares and booking classes [3, 4, 51, 54, 55]. Airlines first create a finite number of published fares and file them with ATPCO. Each published fare corresponds to a discrete price point controlled by a specific booking class or reservation booking designator (RBD). The number of seats available for sale in each booking class is adjusted according to the remaining capacity on each flight and demand forecasts. In a nutshell, airlines offer customers a range of published fares with different travel/sales restrictions and induce them to self-select their preferred option. Customers' willingness to pay are screened at a relatively broad group level corresponding to discrete or static price points (second-degree price discrimination), while controlling seat availability for each booking class to incentivize higher-priced choices.

Several technical limitations inherent in this legacy approach, in particular the separate management and distribution of published fares and seat availability, have prevented airlines from achieving optimal dynamic pricing [51, 54, 55]. For example, the fixed number of booking classes does not allow airlines to segment customers more finely by increasing the number of price points, and as a result, airlines cannot offer the price that matches the customer's willingness to pay if the customer falls between two adjacent booking classes. ATPCO [56] describes this problem as fare compression, where multiple fares with similar attributes are forced to share the same RBD. Although recent improvements, including the increase in the number of RBDs, have eased some of the technical constraints [57], these are incremental changes to the existing legacy process.

In addition, there are challenges relate to pricing algorithms, engines and data. Traditionally, airlines have used broad and crude pricing algorithms for fare updates, full matching, partial matching, signaling, and tit-for-tat strategies, among others [32]. The scope of data has also been limited to supply and demand conditions and travel requirements such as seasonality, departure and booking dates, length of stay, and remaining capacity to sell. Optimal dynamic pricing still requires such contextual data, but at a more granular level, as well as more sophisticated dynamic pricing engines.

Industry standards developed separately by ATPCO and the International Air Transport Association (IATA) describe different levels of dynamic pricing methods, the essence of which is summarized in Table 3. As continuous pricing and dynamic bundling become the industry norm, published fares will gradually be replaced by dynamically priced product catalogues [58]. Eventually, fare filing will become obsolete and only a certain category of fares will be filed as private fares (fares that are not publicly displayed and have limited distribution as designated by the fare owner airline).

Table 3: Different Levels of Dynamic Pricing Methods

Concept/method	Definition/description	References
Adjusted pricing or dynamic price adjustment	The system selects a price from a menu of discrete, predetermined price points (such as published fares) and then adjusts it for specific customers or in certain situations, either through a discount or an increment.	[50, 54, 57, 58]
Continuous pricing	The system selects a price that matches real-time seat availability from a continuous range of possible values rather than from discrete, predetermined price points, thereby increasing the number of price points.	[50, 54, 55, 57, 58]
Dynamic bundling or dynamic offer generation (or creation)	The system combines the product creation and price selection processes to flexibly build and price bundles of flight products with flight related ancillary items (such as baggage, seat selection, meals, and flexibility options) and non-flight related ancillary items (third-party content such as parking, insurance, hotel and car rental).	[51, 54, 55, 58]

4.2 Compatibility with parallel pricing

With continuous pricing and dynamic bundling, the more experience the dynamic pricing engines gain and the more customer-level data the airline collects (willingness to pay, loyalty, past purchase history, search behavior, etc.), the better the business logic becomes, and thus the more accurately the airline can sort or segment consumers into smaller groups. At the extreme, each fare offer would be available only to a specific customer and completely invisible to other airlines and customers. This is precisely personalized pricing, which refers to "charging a different price to consumers based on their personal characteristics" [49]. In theory, it is a sophisticated form of third-degree price discrimination, where the firm observes some diversity or variation among consumers and bases the price it charges on that heterogeneity [59, 60]. The results may even be close to first-degree price discrimination, where each customer is offered a unique price equal to her or his maximum willingness to pay.

This perspective raises the question of whether parallel pricing would be more prevalent or sustainable with second-degree price discrimination (legacy approach) or third-degree price discrimination (personalized pricing). Intuitively, the fewer published fares and the more dynamically priced products offered to customers, the less transparent the market becomes and the more difficult it is for airlines to detect competitors' actions[5]. In addition, the bundling of multiple ancillary items with the flight product, which is generated on the fly during the shopping session, will make it even more difficult to identify prices for the air portion only. Like that, there is no single observable focal point that dynamic pricing engines can match, incentivizing deviations from parallel pricing. According to the U.K. CMA [60], sophisticated algorithms could allow each firm to independently derive a focal point at the customer level if there is sufficient

[5] The less transparent nature of personalized pricing appears to be similar to what existed in a traditional brick-and-mortar retail market prior to the air transport liberalization. In a brick-and-mortar environment, airlines had to manually collect competitors' retail prices or actual prices of air tickets paid by customers from each travel agency and consolidator. Changing wholesale prices to travel agents was also a manual and time-consuming process [40]. Despite the similarity in terms of price opacity, personalized pricing is at the other end of the spectrum in that the entire process requires no human intervention, yet allows for instant price changes.

observable information about customers' willingness to pay. However, one-to-one matching of dynamically priced offers may not be easy, simply because the availability of the nearly infinite number of such offers leads to more opportunities for errors and misunderstandings that prevent the accurate capture of each other' intentions.

The above conjecture suggests that parallel price changes by competing airlines may not be the most likely outcome in the context of personalized pricing. Nevertheless, even with imperfect monitoring, it is still one of the possible equilibrium outcomes. Some theoretical models show that parallel price changes and personalized pricing can coexist [59, 61]. For example, each airline uses algorithms to identify high-demand, price-elastic customers (those who tend to prefer the other airline or to shop around for the best deal) and attempts to attract them with a dynamically priced offer. The remaining customers, who are loyal or price-inelastic, are offered a publicly advertised price so that parallel pricing can be maintained at least in these customer segments.

5. Conclusions and Future Perspectives

The paper has drawn a number of economic intuitions about airlines' parallel pricing behaviour by reviewing relevant factors that may affect the achievement of the cooperative outcome, as cited in the industrial organization literature. First, parallel pricing emerges and persists in the airline industry because of the combined effects of price transparency, rapid response to competitors' actions, and repeated interactions by the same airlines with no clear endpoint. Second, parallel pricing stands out as a self-evident cooperative outcome even in the presence of information asymmetries, cost differences, capacity and service quality variations among competing airlines, and in a more competitive market where there are numerous competitors, competing routes, and different fares to be offered.

Third, and looking ahead, the long-standing practice of mirroring each other's fares is being challenged by the ongoing shift from the legacy approach based on published fares and booking classes to dynamic and personalized pricing. Driven by advanced technology that continuously optimizes fares and inventory in real time, airlines will gradually improve their market segmentation capabilities. As the more dynamically priced products can be offered to each individual customer, the sheer volume and velocity of these products will make monitoring competitors' pricing more complex. Therefore, without significant advances in monitoring tools, airlines will find it difficult to effectively detect deviations by competitors. This weakens the expectation that parallel pricing can emerge as the most likely equilibrium.

These non-mathematical insights can contribute to the systematic construction of a general model of airline parallel pricing while facilitating the development of testable hypotheses for empirical analysis. Given the increasing use of personalized pricing and the inclusion of ancillary items, a next step of the research is to further investigate the long-term viability of parallel pricing, and what other possible coordinated outcomes will emerge in the future air transport market.

Disclosure Statement: No potential conflict of interest was reported by the author.

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