Welfare Consequences of Upgrades: Evidence from the Airline Industry

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Abstract

Using upgrades—fees that customers pay to access a premium quality product after the purchase of a regular one—can significantly affect consumer welfare. With them, regular consumers benefit from discounted access to higher-quality goods, but monopolists adjust price menus to capture surplus. Whether consumer welfare rises or falls when a firm introduces upgrades depends on the relative magnitudes of these two effects. The aim of this research is to disentangle the two effects by analyzing the data of an international airline that offers economy class passengers the option to pay an additional fee to upgrade to business class. I develop and estimate a model of airline pricing to assess the effects of such upgrades via counterfactual simulations. I show that the upgrade option improves the allocation of passengers across cabins, which leads to an increase in consumer and producer welfare of 1.5% and 2%, respectively.

Keywords: price discrimination, ancillary revenue management, airlines

Track: Pricing & Promotions

1 Motivation, Research Question and Plan of the Paper

Offering upgrades is a popular practice in industries characterized by multiproduct offerings and limited capacity. Airlines, freight transport providers, car rental companies and hotels offer products of various quality and allow customers to access premium-quality products through either retail sales or upgrades. Upgrades can generate up to 10% and 8% of revenues in the car rental (AllianzTravel) and the airline (OAG) industries; however, they have received little attention in the literature in empirical economics, marketing and operations, because of lack of accessible data.

Firms complement the retail sales channel with upgrades to sequentially price discriminate and manage limited inventory. However, the effects on total welfare of the introduction of this new sales channel are ambiguous. On the one hand, the availability of an upgrade option provides the seller with extra flexibility in selling products, increasing producer surplus. In particular, through upgrades, firms can find customers who value premium products below the listed price among those who already hold a regular product. According to theoretical research, this may alleviate allocative inefficiencies by reducing mismatch between supply and demand (Gallego and Stefanescu, 2009; Cui, 2017). Moreover, existing evidence suggests that airlines' revenues could increase after the introduction of upgrade options (Cui, Orhun, and Duenyas, 2019). On the other hand, the effect on customers is less straightforward. Upgrades increase the welfare of consumers who can enjoy premium products at discounted prices. However, introducing an upgrade option modifies the seller's pricing problem, influencing prices for retail sales, with ambiguous effects on consumer welfare. Existing theoretical studies (Varian, 1985; Aguirre, Cowan, and Vickers, 2010; Bergemann, Brooks, and Morris, 2015) do not consider sequential price discrimination strategies featuring a dynamic multiproduct offering and limited inventory, thus leaving open the question of what the effects of upgrade options are on consumers.

This paper studies how introducing upgrades affects welfare in the context of the airline industry. First, I analyze new proprietary data from an international airline[1] that allows travelers in lower cabin to upgrade to premium cabin. I find both that upgrades are a relevant sales channel for premium products and that the airline employs them for price discrimination. I then estimate a structural model to quantify the effect of the upgrade option on welfare via counter-

[1] The identity of the airline is confidential. In terms of size, in 2018, the airline studied in this paper had revenues between $10 and $20B. As a benchmark, American Airlines made $43B (macrotrends).

factual simulations. My results indicate that, on average, both consumers and the monopolist benefit from the upgrade option.

2 Empirical Evidence

This project uses a new transaction-level dataset from an international airline that allows lower-cabin ticket holders to upgrade to premium cabin in the last two days departure. The dataset contains information on both upgrades and retail sales. Analysis of the data reveals three facts: firstly, upgrades are a relevant sales channel to generate revenues, secondly, the airline uses upgrades to allocate a large share of premium cabin travelers (and this is particularly evident when considering sales over time) and, lastly, the airline employs upgrades to sell premium-cabin seats at a discounted price.

2.1 Upgrades are a Relevant Sales channel to generate Revenues

The airline sells a large fraction of seats by means of upgrades in the last two days before departure. This practice generates substantial revenues.

Compared to retail sales of premium cabin seats (premium economy and business class), upgrades serve as a relevant sales channel in terms of both transactions and revenues. According to Table 1, a large group of travelers chooses to fly in premium cabins because of the availability of the upgrade option, and the fees associated with these upgrades contribute significantly to the overall revenues of the airline. Over all premium cabin transactions, 29% of the seats in premium economy and 10% of those in business class are sold by means of an upgrade. Considering revenues, upgrading fees account for 10% of premium economy and 6% of business class revenues. In aggregate, 16% of travelers fly in premium cabins by means of upgrade purchases. The associated upgrade fees account for 6% of premium-cabin revenues and nearly 2% of total revenues.

Table 1: Distribution of transactions and revenues across products and sales channels

	Economy	Premium Economy	Business
Transactions	239,771	7,820	21,288
Retail	239,771 (100%)	5,542 (71%)	19,030 (90%)
Upgrades		2,278 (29%)	2,258 (10%)
Revenues (000)	66,491$	4,315$	23,664$
Retail (000)	66,491$ (100%)	3,841$ (89%)	22,366$ (95%)
Upgrades (000)		474$ (11%)	1,298$ (5%)

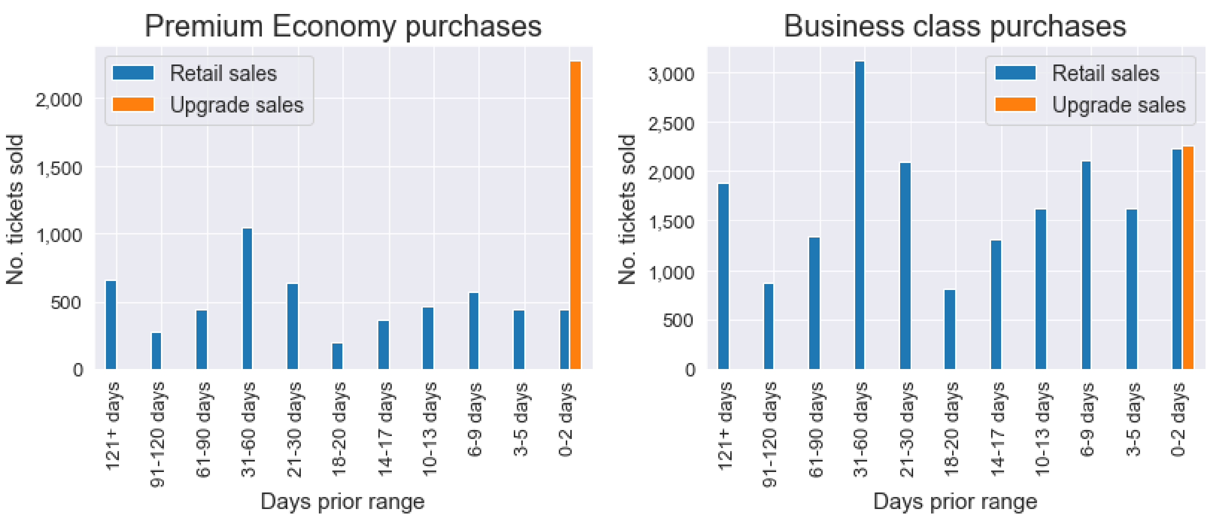
Notes: Revenues are expressed in thousand \$. Percentages are with respect to total transactions (or revenues) of the corresponding class. Upgrade revenues correspond to upgrade fees. When considering upgrades, I include also auction upgrades.

2.2 Sales over time

A large number of travelers flying in premium cabin are there because of an upgrade. This practice allows the airline to "extend" the booking horizon.

Figure 1 shows how the airline sells seats in premium cabins over time, distinguishing between retail and upgrade sales. In the last two days before departure, the number of seats allocated in premium economy through upgrades is five times the number of seats allocated by means of retail sales in the same period. We observe a similar trend for business class, where as many upgrades as retail sales take place in the last two days before departure.

Figure 1: Distribution of sales over time



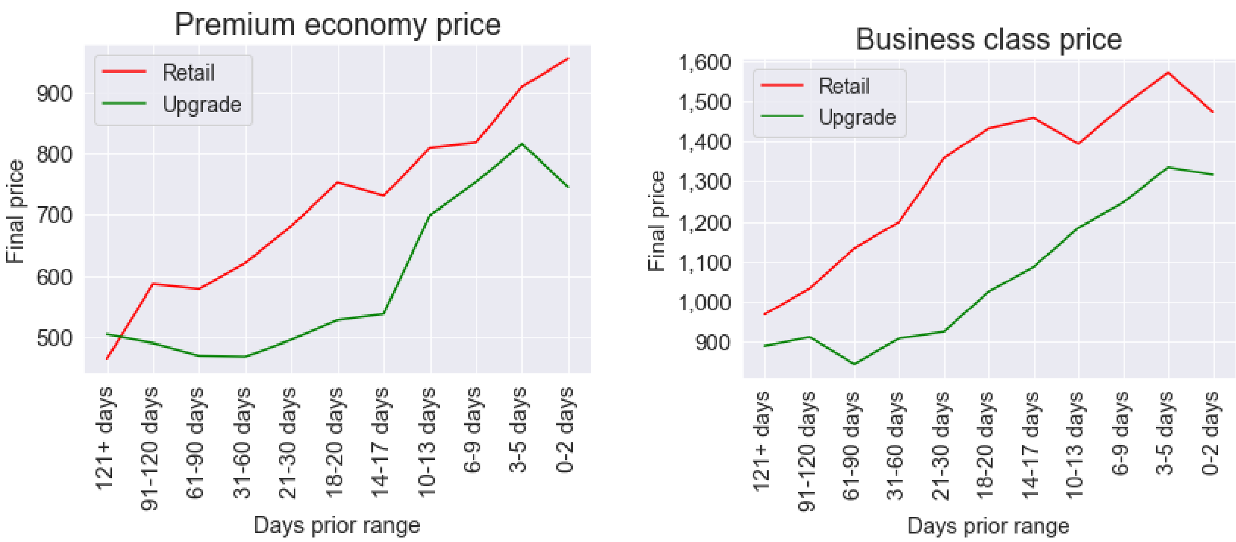
Notes: The horizontal axis shows the booking horizon by period before departure. The vertical axis displays the total number of tickets purchased over all flights in the dataset.

2.3 Price Discrimination with Upgrades

Accessing premium cabin is cheaper via an upgrade than via a retail purchase. I support this claim by looking at the time series of prices associated with accessing premium cabins.

Figure 2 provides visual evidence of the discount offered through upgrades. It compares the average final price paid to access premium cabins by the time of initial ticket purchase, so that the final upgrade price is the summation of the lower-cabin ticket and the upgrade fee. Customers flying in premium economy and business class by means of an upgrade consistently enjoy discounts from the retail price.

Figure 2: Discount over time



Notes: The horizontal axis shows the booking horizon split by period before departure. The vertical axis displays the final paid price paid to access premium cabins. I exclude travelers belonging to frequent flyer programs.

3 Structural Model and Estimation

In this part of the paper I describe the structural model and its estimation. This step allows me to analyze counterfactual simulations in the last section.

The structural model captures the supply and demand dynamics of the airline industry. On the supply side, I consider a capacity-constrained monopolistic airline that optimally chooses prices over time. In particular, in any day t of the booking horizon the airline chooses the optimal prices for two products: economy and business class. For simplicity, $t \in \{0,1\}$, with $t = 0$ being the initial period of the booking horizon and $t = 1$ the departure day. Additionally, in $t = 1$, the airline sells upgrades, allowing those who bought an economy class ticket in $t = 0$ to pay a fee and access business class. The firm solves a dynamic programming problem that considers multiple cabins and upgrades simultaneously. This supply model reproduces relevant features of the airline's price discrimination strategies, including intertemporal, intratemporal and sequential price discrimination. On the demand side, customers randomly enter the market for airline tickets and, upon arrival, make a decision regarding whether to purchase an economy or a business class ticket or, alternatively, not to fly at all. I assume that customers do not expect the possibility of an upgrade when making their initial purchase decision. In $t = 1$, when the airline offers the upgrade possibility, only a fraction of customers pay attention to the offer and then consider whether to upgrade. This demand specification embeds uncertainty in the number of travelers shopping for a ticket, heterogeneity in preferences and inattention to the upgrade option.

I estimate the model with a simulated method of moments as in Aryal et al. (2023). First, I specify the demand model as a random coefficient model. Then by simulating demand shocks and airline optimal decisions, I match prices and ticket sales along both the retail and upgrades channel. Demand estimates are in line with previous estimates in the literature.

4 Counterfactual

In this section, I describe how the upgrade option affects airline pricing decisions and welfare. First, I describe the role of the upgrade option as a sequential price discrimination tool and its role in managing limited inventory. Second, I analyze the aggregate welfare consequences arising from the introduction of upgrades. Finally, I focus on the distributional welfare effects of upgrades between travelers and the firm.

4.1 The economics of upgrades

To understand the two complementary roles of upgrades as price discrimination and inventory management tools, I compare the airline's pricing decisions with and without upgrades under scenarios with and without capacity constraints. On one hand, the difference in prices between the scenarios with and the scenario without upgrades, in the absence of capacity constraints, illustrates the role of upgrades as a sequential price discrimination tool. On the other hand, comparing these differences with those observed when the airline faces capacity constraints shows how the airline uses upgrades as a way to manage inventory.

Table 2: Counterfactual in levels, role of capacity constraints

	WITH capacity constraints		WITHOUT capacity constraints	
	With upgrades (1)	Without upgrades (2)	With upgrades (3)	Without upgrades (4)
$p_{EC,0}$	303	308	313	317
	(3.33)	(2.95)	(2.95)	(2.49)
$p_{EC,1}$	418	422	430	430
	(5.29)	(5.64)	(5.28)	(5.28)
$p_{BC,0}$	1,305	1,268	1,152	1,134
	(12.77)	(11.32)	(14.23)	(11.96)
$p_{BC,1}$	996	983	848	848
	(13.92)	(24.15)	(15.61)	(15.61)
p_{UP}	297		268	
	(134)		(115)	
$passengers_{EC}$	164.5	167.2	145.69	150.27
	(2.85)	(3.24)	(2.25)	(2.82)
$passengers_{BC}$	29.3	23.82	42.36	35.13
	(0.86)	(0.83)	(1.73)	(1.61)
upgrades	7.11		7.78	
	(0.19)		(0.25)	

Notes: I simulate the estimates and bootstrap standard errors for large aircraft on the international route. I use 10 bootstrap samples, each simulating 500 aircraft. The scenario with capacity constraints considers $c_{EC} = 247$ and in business class $c_{BC} = 51$. The variable $passengers_k$ indicates the number of passengers flying in cabin k.

By comparing columns (4) and (3) of Table 2, we learn about the role of upgrades as a sequential price discrimination tool. In scenario (3), when setting prices in $t = 0$, the airline anticipates that some economy class ticket holders may choose to upgrade to business class if given the possibility of accessing this cabin at a reduced price. Introducing the upgrade option, then, leads to two effects. On one hand, the average opportunity cost of decreasing economy class ticket prices diminishes: lower prices for economy class incentivize more customers to purchase tickets in this cabin, thus increasing the number of potentially upgrading travelers. Introducing upgrades results in a 1.3% average decrease in economy class prices (from 317 to 313). On the other hand, the average opportunity cost of increasing business class ticket prices decreases since customers who did not purchase business class retail initially can still upgrade in $t = 1$. The introduction of upgrades leads to an average increase of 1.6% in business class prices in $t = 0$ (from 1,134 to 1,152). There is no effect of the upgrade option on $t = 1$ prices: the pricing problems

Table 2 also shows how capacity constraints (with total capacity in economy class set at

$c_{EC} = 247$ and in business class set at $c_{BC} = 51$) affect the airline's pricing decisions on average across flights. By comparing column (4) and (2), we see the role of capacity constraints absent upgrades. With capacity constraints (column (2)) the opportunity cost of selling business class in the initial period increases (with respect to column (4)): this induces the airline to increase $t = 0$ business class prices (from 1,134 to 1,268) to reduce early sellouts in premium cabin and leave room for last minute sales. Due to high $t = 0$ premium cabin prices, those passengers with low WTP and relatively high value for comfort not only no longer want to purchase a premium cabin seat, but also would prefer not fly at all when economy class $t = 0$ prices are as in column (4). To make these passengers fly, the airline decreases $t = 0$ prices in economy (from 317 to 308). Due to scarcity, the price of business class in $t = 1$ (983) increases with respect to the price without capacity constraints (848); then, to compensate for these high prices and not to lose revenues from low WTP travelers and relatively high value for comfort, the airline decreases economy prices (from 430 to 422).

Finally by comparing price differences between columns (1) and (2) with respect to those between columns (3) and (4), we detect the role of upgrades as a tool to manage limited inventory. In particular, the sequential price discrimination nature of upgrades lead to price differences between (3) and (4). The extra difference in prices between (1) and (2) with respect to the difference between columns (3) and (4) suggests the role of upgrades as an inventory management tool. These two forces are complementary, since they work in the same direction.

4.2 The role of demand shocks

Upgrades help airlines to hedge against the typical revenue management problems of early sellouts and empty seats in business class[2]. In case of low initial demand shocks, upgrades reduce the *spoilage* of empty business class by allowing economy class ticket holders to fill the premium cabin, whereas in the case of large demand shocks, upgrades reduce the *spillage* problem of early sellouts.

When the airline faces low initial demand shocks, the probability of selling out in either cabin is negligible. This implies that capacity constraints have little effect on the pricing problem of the airline and, thus, the airline uses upgrades mainly to sequentially price discrim-

[2] This problem is very well described by the former former Alaska Airlines CFO: "Empty flights and early sellouts are widely recognized problems in the airline industry: "Hold inventory (high) for too long, and they could risk having a plane depart with empty seats (spoilage). The stakes are incredibly high—sell too much too early at a lower price, and airlines might sell out too early missing out on high yielding last-minute sales (spillage)"

inate among $t = 0$ travelers. On unpopular flights, characterized by low initial demand shocks, upgrades work as a sequential price discrimination tool and mitigate spoilage issues in the premium cabin.

Conversely, in cases with a large demand shock, the airline, beyond using the upgrade option to sequentially price discriminate among $t = 0$ customers, uses it to manage limited inventory. Specifically, in the case of a large initial-period demand shock, the probability of business class selling out in $t = 0$ is large. To avoid the risk of it selling out and the airline then missing out on high-value sales in the last period, the airline exploits the upgrade option to increase business class prices in $t = 0$. With respect to the situation without capacity constraints, the increase in $t = 0$ business class prices due to the introduction of the upgrade option is larger when there are capacity constraints. This is due to upgrades serving as a tool to manage inventory. Furthermore, in $t = 1$, upgrading customers compete with retail purchasers for the same business class seats. This induces the airline to increase $t = 1$ business class retail prices. Indeed, in case of a large demand shock, many economy class ticket holders upgrade: with respect to the scenario without upgrades; this leads to more business class sellouts and fewer economy class sellouts at the end of $t = 1$. In general, on popular flights, characterized by large demand shocks, upgrades, beyond serving as a sequential price discrimination tool, work as an inventory management tool and mitigate spillage issues in the premium cabin.

4.3 Welfare effects of the upgrade option

The upgrade option increases the surplus of both travelers and the airline, thereby increasing efficiency. In particular, consumer surplus increases by an average of 1.5% per flight, proving that the welfare gains enjoyed by upgrading customers outweigh the consumer welfare losses arising from higher business class prices. By looking at the average number of passengers boarding the plane when the airline does not implement upgrades, such an increase in consumer surplus is equivalent to a \$6.5 subsidy to all boarding travelers. On the firm side, the airline's surplus increases by 2% per flight, primarily because of the substantial revenues generated by upgrade fees. As a benchmark, the global profit margin in the airline industry in 2023 averages around 1.2% (IATA). Moreover, Cui et al. (2019) find a 4% increase in revenues when an airline introduced add-on products[3].

[3] Cui et al. (2019) study an airline that allowed economy class ticket holders to upgrade to premium economy. There is no retail channel for premium economy. Their framework misses the interaction between capacity constraints and the upgrade option for the premium product.

5 Conclusions

This paper investigates the welfare implications of introducing upgrades within the airline industry. To achieve this, I analyze proprietary data from an international airline that employs upgrades to allocate premium-cabin seats. After estimating a structural model that captures key aspects of airline pricing decisions, including multiproduct offering, dynamic pricing, and capacity constraints, I quantify the effect of upgrades on welfare through counterfactual simulations. My results indicate that, on average, both consumers and the firm benefit from the upgrade option.

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