



Price volatility in the airline markets

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ABSTRACT

In this article we examine volatility measures and investigate what factors explain price volatility in different US domestic air routes. We find that volatility remains reasonably stable up to 2 weeks prior to the flight, at which point it increases significantly. The type, LCC or legacy carrier, and identity of the airlines appears to have a major impact on the volatility measures, and that these effects are different for 2 weeks out and 1 day out, even after controlling for market differences.

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1. Introduction

The airline industry has employed dynamic pricing and revenue management (RM) systems for more than the past two decades. These systems provide the airlines with the schedule of prices and the number of seats in any price category (sometimes referred to as buckets) for each flight. By considering the interconnected network of flight segments and routes and the stream of future demand arrivals, the systems set fares and booking limits, usually based on a method known as expected marginal seat revenue, EMSR; a concept introduced by Belobaba (1989). At each point in time prior to the flight the systems propose a structure of prices to maximize the total revenue of the flight and adjust these prices according to whether bookings are above or below expected values. These early systems treated demand in a relatively simple way using econometric forecasting models such as ARIMA.¹

Recently, it has been recognized that modeling consumer behavior should be a major element of consideration for the dynamic pricing and revenue systems. Such recommendations were given by, e.g., the reviews by Bitran and Caldentey (2003), Elmaghraby and Keskinocak (2003), Chan et al. (2004), and Shen and Su (2007). These reviews, which provide an excellent summary of the dynamic pricing literature for revenue-managed goods, have concluded that incorporating different aspects of consumer behavior, such as consumer choice or consumer rationality, is an important research direction.

Consumers' heterogeneity and familiarity with products can substantially affect their purchasing decisions from certain product categories. While some consumers are completely insensitive to prices, others pay more or less attention to prices, how they compare with other similar products, and the fluctuations of these prices over time. These price watchers usually possess a reference price, based on an accumulation of the consumer's knowledge about the appropriate price for the good based on past prices. This price reference assists consumers in determining whether the current price is high or low, fair or unfair, and so on. Thus, consumers may have different perceptions about prices they encounter, and these perceptions can

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¹ ARIMA stands for arithmetic moving average.

influence their purchasing decisions or the timing of those purchases; this is important in industries which rely heavily on cash flow for operating capital such as airlines.

When dynamic pricing mechanisms are used by vendors such as airlines this notion of price perception should not be ignored, as it plays an important role in influencing consumers' purchasing behavior. In fact, it may be that airlines are already employing volatile pricing, at least partly, to mitigate strategic consumer behavior and optimal timing of purchase. Consumers who are exposed to highly fluctuating prices become less sensitive to changes in prices, as suggested by Range Theory (Volkman, 1951). Furthermore, the introduction of randomness in the observed prices obscures consumers' ability to understand the pattern and predict future prices, as suggested by literature concerned with consumers search for information (see, e.g., Mellers, 1980).

In this work we investigate the volatility of prices set by airlines using US domestic market information. We first construct different price volatility measures using daily airfares over 90 days periods. Next, these volatility values become the dependent variable as we look for the drivers of these price volatilities. Using airfare data histories on 113 different routes, we fit several models to explain price volatility. We distinguish a number of sources of volatility including route market structure, route characteristics, and competition specifics such as the presence of low cost carriers. Competition specifics also refer to the identity of the carriers competing in the market, which is measured either through their presence on the non-stop service for the origin-destination pair or their market share on the route (in term of enplanements both non-stop and one or multi-stop flights).

Our main findings can be summarized as follows: We find evidence that price volatility tends to decrease from 90 days out and as time progresses up to 2 weeks prior to the scheduled departure time. At this point, measured volatility spikes upwards and increases substantially and while market structure and route characteristics alone have little explanatory power, adding information identifying carriers competing on the routes substantially improves the explanatory power of the models. In general, higher market concentration is correlated with lower volatility levels, while dominance by one carrier on the route increases the volatility level. However, we also find that the closer it is to the departure, competitive and dominance effects diminish. Across time and over routes we find that distance consistently is a moderating influence on price volatility, and as departure time approaches this effect is larger. That is, an even higher volatility is observed for short-haul routes than for long-haul routes at 1 day out than at 2 weeks out. We find that the airlines contribute in different ways to the volatility of prices and this behavior is different for 2 weeks out and 1 day out. We further observe some distinction between legacy carriers and low cost carriers.

The remainder of the paper is organized as follows: In Section 2 we review the relevant literature on both airline pricing, price volatility in different areas, and consumer behavior. Section 3 describes our research, data collection, and volatility measures employed. In Section 4 we look at the behavior of the volatility over time, and in Section 5 we investigate the drivers of the price volatility, while Section 6 contains concluding remarks.

2. Relevant literature

Our work touches upon three related streams of literature. As the major focus of the work considers prices posted by air carriers, we first review the literature that deals with airline pricing. Next, we review aspects of volatility in other areas, such as finance and operations, and, lastly, we examine aspects of consumer behavior when facing decisions in volatile pricing environments.

2.1. Airline pricing

The literature on airline pricing can be segmented into two main streams. One stream investigates the actual pricing and rationing mechanism over time, i.e., this line of research develops the relevant revenue management practices. The second stream finds its home in the economics literature and examines how price levels and structures, including price discrimination, are affected by different market structures.

Revenue management is concerned with the setting of the appropriate set of controls over time to maximize the expected revenue from the network of flights operated by the carrier. While in real life revenue management systems need to face, among others, an enormous amount of concurrent transactions, different constraints (capacity, scheduling, routing, regulation, etc.), competitive forces, different distribution channels, and heterogeneity of consumers, the literature usually takes a more stylized approach by investigating a small subset of issues at a time. The literature concerned with dynamic pricing and revenue management is best summarized by the recent books by Talluri and van Ryzin (2004), Phillips (2005), Boyd (2007), the book chapter by McAfee and te Velde (2007), and the reviews by Bitran and Caldentey (2003), Elmaghraby and Keskinocak (2003), Chan et al. (2004), and Shen and Su (2007).

While the practice of revenue management seems to be conducted at the operational level, pricing is a key strategic variable which can effect and be affected by market structure and which airlines compete in the market. The economic stream, which is mostly occupied with the understanding of implications stemming from market structures (a review of related empirical studies is to be found in Tretheway and Kincaid, 2005), by and large makes use of the US Department of Transportation databases, such as the T-100 and the Origin and Destination Survey Data Bank 1, also referred to as DB1B. While the former database contains monthly statistics of carriers' activities, the latter records 10% of all itineraries sold within the USA.

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