

Summary

In more and more sectors, businesses use computer-controlled consumer prices. These are prices that are not set 'manually' by a human being but that come about with the help of computers and algorithms. In recent years, both the public sector and the academic sector have given more attention to the use of computer-controlled consumer prices. Computer-controlled consumer prices can offer benefits to both businesses and consumers, yet they also carry risks.

With this market investigation¹, ACM carries out its duty of conducting oversight over the proper functioning of markets, even without a suspicion of a violation of the rules. ACM looks at the impact of computer-controlled pricing on well-functioning markets as well as its effects on those markets. Also, ACM wishes to better understand under what circumstances risks arise. This knowledge is necessary for effective oversight, for identifying potential harm or violations, and for having an informed public debate on the desirability and fairness of computer-controlled pricing.

The market investigation is divided into two parts:

- (1) a broad exploratory market study, with the objective of gathering knowledge about different forms of computer-controlled prices, the use of computer-controlled pricing in various sectors, reasons for sellers to use computer-controlled prices, the potential effects on consumers and on the functioning of markets, and legal frameworks.
- (2) an in-depth case study into the Dutch aviation sector. The objective of this part is to gain real-world knowledge of how computer-controlled prices work in a specific sector, and to get an idea of the effects thereof on consumers. This part is divided into a consumer study² and an investigation into the price-formation process³.

ACM focused its market investigation on two types of pricing: prices are adjusted through (i) **dynamic pricing**, where prices of products change in real time, for example as a result of changes in supply and demand, competitors' prices, and consumer behavior, as well as (ii) **personalized pricing**, where different consumers might see different prices for the same product at the same time, for example, on the basis of purchase history or geographic location. Collectively, ACM refers to these two forms as **computer-controlled pricing**.

Key findings from the broad exploratory market study into computer-controlled consumer prices

In its broad market study, ACM found widespread use of computer-controlled pricing, for example in the e-commerce sector, the travel sector, in prices for fuel and EV charging, the mobility sector (for example ride-hailing), the events sector, and the supermarket sector. It is plausible that, in the coming years, the use of computer-controlled pricing will increase in various sectors, with more-advanced forms and with a greater use of data. For example, it will be possible for supermarkets to automatically adjust prices in their stores, for instance on the basis of the time of day or inventories, using digital price tags.

¹ This market investigation was conducted by the Netherlands Authority for Consumers and Markets (ACM). The consumer study was conducted with the help of Dutch research agency Motivaction. Additionally, ACM thanks Charlotte Kroese, Sofija Pantić, and Grace Appelford for their contributions to the section on legal frameworks.

² This behavioral study, which was conducted by Motivaction, is available on [ACM's website](#) [only in Dutch]. It consists of a series of interviews and a survey among a representative group of consumers with recent experiences in booking airline tickets.

³ The data set concerns transactions for flights carried out over a time period of three years, from July 2022 until July 2025. This data was requested from market participants for 56 routes selected by ACM. In total, the data set contains information on 155,417 flights and over fourteen million transactions.

The exploratory market study shows that the use of computer-controlled pricing can offer benefits, such as:

- Cost savings for businesses through lower sales costs and improved inventory management, resulting in lower average prices for consumers;
- Lower prices for groups of consumers, as consumers that are more price-sensitive are willing to board a plane after all (personalized pricing) or board a plane at a time that is right for them (dynamic pricing).

At the same time, there are risks associated with the use of computer-controlled pricing, such as:

- Amplification of the effects of market power, including pushing up profits, for example by charging higher prices to consumers that are less price-sensitive;
- An increase in consumers' search costs because the comparability and predictability of prices diminish;
- The disruption of consumers' autonomy (perceived or real) to make an informed choice about their purchases;
- Reduced competition, as a result of consumers losing their ability to play their crucial role, and as a result of lower barriers to collusion (tacit or otherwise) among competitors, as well as to other strategies that lead to reduced competition.

There can be significant differences between, on the one hand, the types of algorithms that are used to set dynamic or personalized prices and, on the other hand, the purpose for which they are used. Businesses ultimately use computer-controlled pricing to increase their profitability, but this can be accomplished in different ways. For example, price algorithms are able to respond automatically and faster to changes in the market, contribute to inventory and capacity management⁴, make pricing more competitive, and implement price discrimination⁵ on the basis of the willingness to pay (or the differences therein) between different groups and individuals.

Key findings from the case study into the aviation sector

ACM decided to take a deeper look at pricing in the aviation sector. The reason for choosing this sector is that, for quite some time already, airlines have used ticket prices that fluctuate over time (dynamic pricing). The exploratory market study uncovered developments in the sector that pave the way for price personalization. Another reason for this decision is that different theories circulate among consumers about how prices for airline tickets are formed.

This is what ACM found:

The prices for airline tickets are determined on the basis of flight characteristics, supply and demand, elasticities, taxes and surcharges, and fees for additional services and upgrades. Prices are composed of different elements:

- A base price, which is determined on the basis of **flight characteristics** and other product characteristics. This leads to a price curve in which this price component changes as the departure date approaches, with sharp price increases occurring particularly in the final two months prior to departure. Deviations from the **estimated load factor** in the time period up until departure result in continuous price changes.
- **A fixed price component**, such as airport taxes, service costs, and fuel surcharges.

⁴ This is particularly the case in sectors with time-based capacity, such as hotels, travel, and events.

⁵ Differentiating the price of identical products or services on the basis of information that a business has on potential customers.

- **Prices for add-ons and upgrades**, such as extra luggage and seat selection (such fees are minimally included in this investigation).

The base price of airline tickets is determined dynamically, price personalization is still very limited.

ACM sees that the aviation sector sets the base price⁶ by applying dynamic pricing. ACM has requested data from airlines, and used it to conduct price analyses in order to investigate what factors influence the base price of airline tickets. These are flight characteristics, such as destinations, flight periods, departure date, departure time, as well as the trends in supply, demand, and elasticities during a flight's selling period.

Personalized pricing is used to a very limited extent in the sector. The instances where it is used are through loyalty programs, incidental discounts, such as on birthdays, and sometimes on the fees for add-ons and upgrades. On the basis of the investigation, ACM expects the frequency of experiments with personalization of airline ticket prices to increase in the near future.

Prices change frequently and price variation is substantial: one in three tickets is priced 40 percent or more above the average price.

Price changes for the base prices of airline tickets are frequent. ACM's price analysis shows that, on average, between 30 and 35 unique prices are paid for the same base ticket during a flight's selling period. The height of the prices, too, varies significantly: for one-third of the tickets, the price deviates more than 40 percent from the average during the selling period. For two-thirds of the tickets⁷, the price deviates up to 40 percent from the average. This spread over time underlines the fact that prices for airline tickets on the same flight under the same conditions can vary considerably.

Pricing is on the basis of expected demand, supply, and willingness to pay (derived from historical data), as well as on the basis of current deviations from expected supply and demand.

Airlines adjust the prices for airline tickets on the basis of changes in demand over time. From the perspective of profit maximization, the goal of airlines is to show consumers the price that matches their willingness to pay at the right moment in time. In order to achieve this, they estimate the willingness to pay among consumers (or groups thereof) from the start of sales through the day of departure. This generally results in price increases as the flight fills up and the departure date approaches. ACM observes that, as the departure date approaches, the average price trend for flights (aggregated across all flights within Europe) gradually drops at first, and then significantly rises from two months before departure until the departure date. The magnitude of the price change may depend on a typically predetermined threshold value, such as reaching a certain number of seats sold or reaching a certain time period (for example remaining time period) until departure.

Whenever the number of seats sold (the load factor) deviates from the *expected* number of seats sold at that time (the *target* load-factor curve), the price is adjusted mid-period to influence demand. Figure 1 shows this relationship between the expected and actual load factor in the days leading up to departure. If the load factor is higher than expected, the price is raised (further). If it is lower than expected, the price will rise less quickly or be lowered.

⁶ The base price for airline tickets consists of the price of the ticket including the fixed price component, excluding add-ons and upgrades, with the cheapest available options for add-ons and upgrades. This is often an economy-class ticket.

⁷ For this calculation, ACM used the price of basic tickets. The values were calculated by taking the average of the standard deviation and the average price of a ticket per flight. The percentage was calculated on the basis of these averages.

Illustration of the price adjustments for the expected and actual load factors

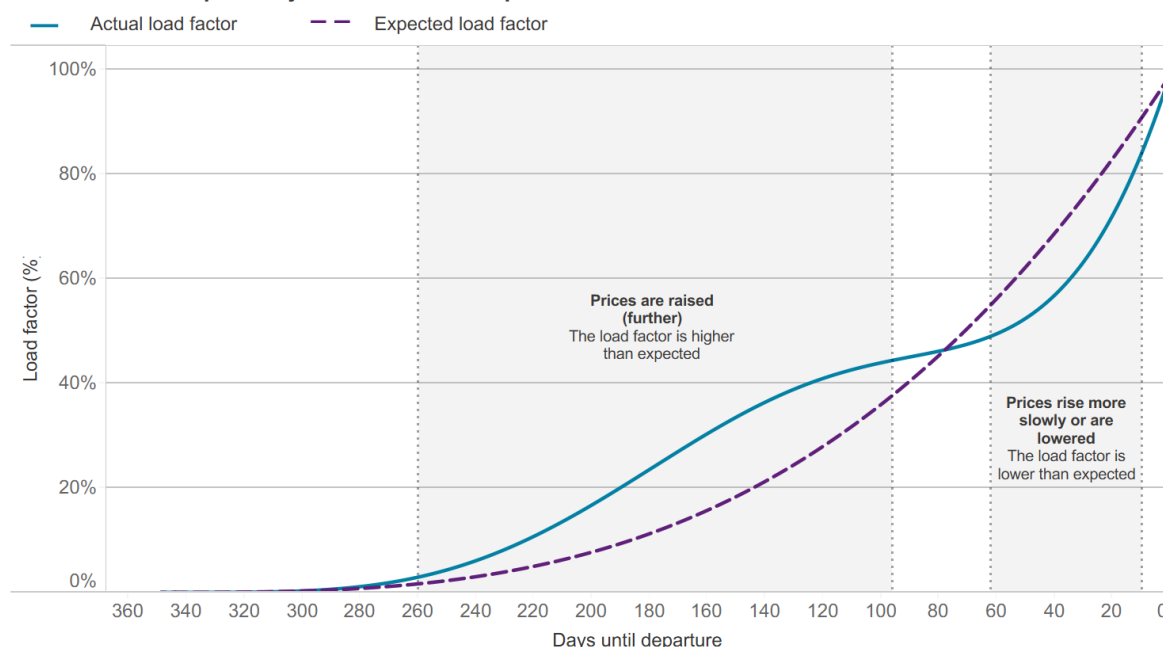


Figure 1: Illustration of the price adjustments for the expected and actual load factor, the second cause of price changes

Developments in the systems used by airlines make advanced computer-controlled pricing possible.

At the moment, the Global Distribution System (GDS) is a widely used system for distributing airline tickets among sales channels in the aviation sector. This system serves as the foundation upon which information exchange in the aviation sector is built. It facilitates the exchange of ticket price information and ticket sales among different airlines and other airline ticket sellers (such as online travel agencies). The system works with a set number of price buckets per flight: a set number of tickets per flight that can be sold at a certain price before it increases. This technical limitation means that it is not possible to charge a separate price for each seat on a flight: airlines cannot price their flights entirely dynamically. A new standard system does exist that makes this possible, and the adoption of this system has increased in the past few years. This development suggests that the use of dynamic pricing will continue to increase, and it offers the opportunity to personalize ticket prices.

The effects of computer-controlled pricing in the aviation sector

ACM describes the effects of computer-controlled pricing in the aviation sector on the basis of the results of its price analyses, literature review, and consumer surveys. These effects are summarized in table 1 below.

	Undetermined	Negative	Positive
Effects of computer-controlled consumer prices in the aviation sector	1. Redistribution of wealth between consumer groups, and between airlines and consumers	2A. Increased search costs, especially for consumers under financial pressure 2B. Negative consumer perceptions: trust and fairness	3. Higher load factor on aircraft, in other words, better capacity utilization

Table 1: Key effects of computer-controlled consumer prices in the aviation sector

1. Dynamic pricing leads to an invisible redistribution of wealth between consumers (or groups thereof)

The findings from the airline study, supported by the literature review, show that dynamic pricing makes it possible to charge higher prices to consumers with a higher willingness to pay or lower price sensitivity, resulting in the possibility that consumers with a lower willingness to pay or higher price sensitivity are offered a lower price and still purchase a ticket. Consumers with a different willingness to pay or price sensitivity can be distinguished on the basis of the time of booking. As a result, a redistribution of wealth occurs between different groups of consumers. Even without explicitly taking into account consumers' willingness to pay or price sensitivity, while only basing oneself on supply and demand, a redistribution between consumers takes place as a result of dynamic pricing. That is because consumers (or groups thereof) pay different prices for the same product depending on when they purchase their tickets.

Responding to consumers' willingness to pay through dynamic pricing, which is a form of price discrimination, is not necessarily undesirable, let alone prohibited. For example, business travelers generally book later than holidaymakers, and pay a higher price because they value flexibility more. However, there are also situations in which late bookers do not gain a clear advantage from booking later, for example, when a consumer must travel at the last minute due to an emergency or when consumers must rebook their trip at the last minute due to cancellations. The risk of dynamic pricing is that the pricing algorithm does not take into account the consumer's specific circumstances.

On the basis of this investigation, it is not possible to determine how responding to consumers' willingness to pay through dynamic pricing affects the group of consumers as a whole on average, or how it affects the profitability of providers. It is plausible that the use of pricing algorithms increases profitability due to the greater flexibility and price variation that this enables. Also, offering additional services (such as extra luggage, travel class upgrades, or seat selection) and the price differences therein allow airlines to better respond to the willingness to pay among different consumers (or groups thereof).

2A. Computer-controlled pricing increases search costs for airline tickets

The consumer study reveals that the greater unpredictability of computer-controlled pricing in the aviation sector raises search costs. This is even more so the case for consumers that are under relatively high financial pressure. As a result of dynamic pricing, they spend relatively more time and energy searching for a good price for airline tickets.

2B. Price changes create uncertainty and distrust among consumers

Additionally, the consumer study shows that price changes also create uncertainty and a sense of unfairness among consumers, which negatively affects their trust in the market. Consumers understand that prices fluctuate, but there are also misconceptions about how that works. See figure 2 below. As a result, the distrust among consumers may be greater than necessary. For example, consumers expect that their previous searches and the device with which they search and book tickets will affect the price of a ticket. ACM does not find this to be the case in its price analysis of airline tickets.

Knowledge about price algorithms among consumers

Flight variables

Season/period in which the flight takes place



Day of the flight



Dynamic pricing

Time remaining until the flight departs



Number of seats still available on the flight



Number of other people who have already searched for this ticket



Price personalization

Previous search queries you have made or that have been made on your device



The device you use to book the flight



Accurate perception among consumers



Inaccurate perception among consumers

Figure 2: Comparison of the results of the consumer study and the case study on consumer perceptions of what factors have the greatest influence on price

The unpredictability and lack of transparency with regard to pricing, the resulting uncertainty, and the misconceptions about computer-controlled prices harm consumers' trust. Furthermore, consumers are more opposed to price personalization than to dynamic pricing. Consumers want to better understand how prices are formed, but more information does not always enable them to make better decisions.

3. Dynamic pricing leads to higher load factors, which can offer price benefits to consumers in a market with effective competition

Dynamic pricing enables airlines to better utilize aircraft capacity, leading to greater efficiency. On the basis of literature reviews and discussions with airlines, ACM expects that computer-controlled pricing will push up demand for airline tickets, because some price-sensitive consumers will be willing to purchase an airline ticket if prices are lower. This helps in selling more tickets and, as a consequence, in raising the load factors of aircraft.

If fixed costs can be spread over more passengers, it can (only in the case of effective competition) benefit consumers in the form of lower prices. ACM did not investigate the degree of competition in the various relevant markets where airline tickets are sold in order to draw a conclusion regarding this question.

ACM concludes that, at the moment, there is no elevated risk of tacit collusion resulting from computer-controlled pricing, because competitors' prices are automated to a limited extent in the pricing process.

General conclusions regarding computer-controlled pricing

ACM has used literature reviews, information from discussions in the exploratory market study, and the comparability of the case in the aviation sector with other markets to draw several general conclusions regarding the functioning, extent of use, and effects of computer-controlled pricing. In that context, ACM concludes the following:

Businesses still seem to be cautious about advanced personalization. What ACM found is largely limited to personal discounts through loyalty programs or incidental discounts, which is true for both the aviation sector and for other markets. This is not the advanced price personalization that can be expected with the advent of advanced AI pricing algorithms, where prices can be personalized on the basis of personal data. Possible explanations for this are consumers' negative perceptions of price personalization, the fact that dynamic pricing or menu pricing already sufficiently enable businesses to respond to consumers' willingness to pay, or that the technology still needs to be developed further first.

Dynamic pricing is already widespread, but there are differences between what is technically possible and real-world applications. Depending on the purpose for which the algorithm is used, there can be significant differences in how dynamic pricing algorithms work. Discussions with software suppliers in the preliminary market study reveal reluctance among buyers of more complex pricing algorithms due to the black-box nature of these algorithms. However, ACM does expect that the developments in the use of more-complex dynamic pricing algorithms and more personalized discounts will gradually continue.

On the basis of the key conclusions in the aviation sector regarding the economic effects, ACM draws several conclusions, which are also relevant to other sectors.

The positive effect of dynamic pricing depends on, among other factors, the type of product or service that is offered:

- Higher capacity utilization that leads to profitability growth is relevant for all sectors dealing with time-related or perishable goods. This applies to, for example, hotels, package tours, tickets for events or excursions, and fresh produce.
- In markets where there is no fixed capacity but there are time-related goods, such as ride-hailing services like Uber and Bolt, efficiency benefits can also occur by attracting additional supply during periods of higher demand.
- In markets where there are no time-related goods and where capacity is more or less fixed, dynamic pricing can help in managing inventories (such as in e-commerce), yet the efficiency benefits here are less significant.

In any market where computer-controlled pricing is used, redistribution takes place among consumers, and this generally leads to greater profitability for providers. By definition, consumers are faced with different prices as a result of price fluctuations caused by dynamic pricing: depending on when they make a purchase, consumers pay more or less for the same product or service. The increase in profitability depends on the extent of competition in the market.

Higher search costs as a result of computer-controlled pricing is true for all markets. Three explanations can be given for higher search costs: 1) misconceptions about what variables influence the price, 2) price fluctuations during the search process result in consumers spending more time researching, and in making price comparisons across providers as well as over time more difficult, and 3) the uncertainty about how prices will evolve, as a result of which consumers sometimes postpone making purchases.

Negative effects on consumer perception is true for all markets, especially with regard to price personalization (or misconceptions about that). Due to the complexity of computer-controlled pricing and its black-box nature, consumers are not able to fully understand what affects prices and what a good time would be to make a purchase. This uncertainty affects consumer confidence. The perception that price

personalization takes place (or might take place), in particular, affects consumer confidence. This perception can therefore also exist, even if price personalization does not actually take place, yet consumers believe it does.

Recommendations resulting from the market investigation

A call to the Dutch legislature: ACM argues for additional transparency requirements at the EU level to gain greater insight into the factors that play a role in computer-controlled pricing. Transparency regarding the functioning of computer-controlled pricing facilitates investigations by regulators and others, as a result of which the public debate on computer-controlled pricing can be conducted in a more-informed manner. Transparency also helps take away misconceptions among consumers, thereby reducing high search costs and, ultimately, the pressure on consumer confidence. ACM is ready to contribute to the discussions regarding the exact form of the transparency requirements, and is also interested in the opinions of businesses.

A call to businesses: Be transparent and exercise caution when using computer-controlled pricing in order to maintain a good reputation and, by extension, to maintain consumer confidence. Be mindful of unfair redistribution (unintentional or otherwise) among consumer groups resulting from computer-controlled pricing, and do not exploit (unintentionally or otherwise) consumer vulnerabilities.

Next steps after the market investigation: call for a public debate and a first roundtable discussion

With the publication of this market investigation, ACM hopes to kick off efforts to force increased transparency on how pricing algorithms work. Transparency ensures that the legislature, policymakers, interest groups, and researchers have a better understanding of the redistribution effects of computer-controlled pricing. That understanding makes it possible to have a public debate on computer-controlled pricing that focuses on the question of fairness. Such a debate will address topics such as the redistribution of wealth between businesses and consumers as well as among consumers (groups thereof) as a result of computer-controlled pricing, how to use price algorithms responsibly, and whether there are circumstances where computer-controlled pricing is not desirable or only so to a very limited extent. ***ACM will organize a public roundtable discussion on this topic in early 2027.***

Finally, ACM invites businesses, interest groups, consumers, and other market participants to respond to the consultation on this market investigation. Chapter 6 explains how they can do so.

Glossary

Aggregators – websites that show flight information and the prices of sellers.

Algorithm – a finite set of rules and instructions that a computer executes to analyze and solve problems, as well as to make decisions. See also Price algorithm.

Algorithmic collusion – the situation in which businesses coordinate their behavior through price algorithms in such a way that prices remain high or competition is restricted.

Four forms of algorithmic collusion can be distinguished.

1. **Explicit algorithmic collusion** – pricing algorithms are used to implement and monitor price-fixing agreements that were concluded by humans, between competitors.
2. **Tacit algorithmic collusion** – through repeated interactions, pricing algorithms recognize patterns and avoid price wars.
3. **Autonomous algorithmic collusion** – an advanced pricing algorithm learns on its own through experimentation that it is profitable to implement price increases and keep prices artificially high.
4. **Hub-and-spoke algorithmic collusion** – the hub, which is the software supplier, coordinates prices among the spokes, which are the buyers of the pricing algorithm and are competitors in the markets for the products that they sell. The software supplier uses confidential business information from the “competing” spokes to set prices for individual spokes.

Allocative efficiency – a situation where resources are allocated in such a way that people get what they value most, so that there is no waste and no one can gain without someone else losing out.

Bucket system – a system where airlines sell groups of tickets at a certain price. If a bucket is full, the tickets available at that price are sold out, and the system moves on to the next bucket, which usually has a higher price.

Computer-controlled consumer prices / computer-controlled pricing – prices that are not set ‘manually’ by a human but are determined using computers and algorithms. A distinction can be made between two different types of pricing, which are dynamic pricing and personalized pricing.

- **Dynamic pricing** – a form of pricing where businesses automatically adjust prices on the basis of changing factors, such as supply and demand, competitors’ prices, and consumer behavior, or a combination of these factors.
- **Personalized pricing** – a form of pricing where businesses charge different prices for the same product or service to different consumers (at the same time), on the basis of individual characteristics or behavior related to that consumer⁸.

Consumer surplus – the difference between the maximum amount that consumers are willing to pay (willingness to pay) and the price they actually paid.

Consumer welfare – the collective sum of consumer surpluses.

Deadweight loss – the decline in overall welfare in a market due to goods or services not being traded, even though this would actually be beneficial to buyers and sellers, because, for example, prices are higher than the willingness to pay of consumers that are willing to pay more than the marginal costs of the product.

Demand curve – how much demand exists at different prices.

⁸ In economic literature, this is also referred to as a form of first-degree and/or third-degree price discrimination.

Dynamic efficiency – when businesses in a market invest sufficiently in new or improved products.

Flight variables – when setting prices, pricing algorithms take into account flight-specific characteristics that tell something about the expected popularity of a flight, and thus supply and demand. These variables are fixed in advance, and do not change during the pricing process, but they can have an effect on the price.

Global Distribution System (GDS) – a centralized platform that connects airlines, travel agents, and customers with each other.

Illusion of control – the tendency of people to believe they have influence over events that, in reality, are hard to control (or even impossible to control).

Loss aversion – the tendency of people to avoid losses, because losses weigh more heavily than gains.

Machine-learning models – computer models that learn to recognize patterns in data and make decisions or predictions without being explicitly programmed to do so. They are part of artificial intelligence (AI) and improve their performance as they process more data.

Network pricing – the expected demand, expected load factor, or expected revenue for all of the airline's flights are taken into account when setting the price of a flight.

New Distribution Capability (NDC) – a standard that makes it possible to track prices in real time and to bundle services.

Online Travel Agencies (OTAs) – intermediaries that sell airline tickets.

Price discrimination – differentiating the price of identical products or services on the basis of information that businesses have on potential customers.

Price elasticity – the extent to which demand responds to price changes.

Pricing algorithm – a pricing algorithm is a set of rules and instructions that is used to set a price for a product or service. In that way, sellers are able to combine and analyze large quantities of data to set the optimal price at that moment.

Search costs – the time, effort, and any financial costs that consumers must incur to find information about prices, quality, or the availability of products or providers.

Sunk cost fallacy⁹ – the tendency of people to continue with a process or action, even though it would be more advantageous to stop.

Target load factor curve – an estimate, on the basis of the airlines' demand curve, of the percentage of seats they seek to sell as the departure date approaches.

Willingness to pay – the maximum amount that consumers are willing to pay for a product or service.

⁹ Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, 1(1), 39-60.