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Pricing with flexibility as vertical product differentiation and peak-load pricing

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Abstract

Introducing flexibility as a factor that determines prices is something that is possible by giving different types of contracts different levels of flexibility. This is in particular very apparent when one starts to analyze domestic flight tickets.

The flight ticket is today a good that is vertically differentiated and this thesis will address the problem of pricing with flexibility as vertical product differentiation. It is found that the tickets are vertically differentiated with flexibility and that the level of flexibility is a significant factor pricing flight tickets.

Peak load pricing is a theory that suggests the airline to increase the prices when they are facing an increasing demand for a group of tickets. These tickets are found in the peak hours where the demand for tickets is higher than usual. This thesis will define these hours and find that such a pricing strategy is more significant the closer the departure date.

Keywords: Flexibility, Peak load pricing, Vertical product differentiation

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1 Introduction

In this section the background of this paper is presented along with the main question of this paper. The approach, purpose and method are described and finally a brief delimitation of the material used in this paper is presented.

1.1 Background

The Swedish domestic airlines today offer tickets with different levels of flexibility of being able to reschedule your flight. The paradox is that the more flexible the ticket becomes the less flexible the holder has to be. These flexible tickets are offered in particular to businessmen and women that are willing to pay more for a ticket than the common commuter or tourist. The main reason for this is the possibility of being as inflexible as possible but always be able to catch your flight. But is it possible to price tickets on the level of flexibility?

As the ticket only takes you from A to B with the same people that bought a less flexible ticket it seems as an occurrence of vertical product differentiation and this will therefore be one of the topics of this paper.

Finding a seat in the rush hour is usually not a problem in public transportation but when it comes to flights there is a peak load problem linked to the level of flexibility. As tickets become more demanded at certain hours in the day the price goes up, not only as an effect to the demand but the fact that there are fewer tickets available makes it profitable to charge a higher price at these peak hours. To solve this problem for the consumer, one does simply buy the ticket with the highest possible flexibility at the highest possible price, the last ticket sold will be the most expensive as shown in the monopoly model 2.2. Using peak load pricing will also solve the problem of efficiency for the airline as the consumer with the highest willingness to pay will self select into the full flex ticket, enhancing the profit. Does the airline use peak load pricing in order to enhance profit, forcing consumers to buy the most expensive ticket to catch their flight? Peak load pricing is a social welfare problem from the beginning but will in this paper be treated as a monopoly profit maximization problem.

1.2 Problem/Question

Does flexibility as vertical product differentiation affect prices and is peak load pricing a significant strategy for the airlines to enhance profits?

1.3 Approach

Firstly an analysis of domestic flight tickets to find if the demand for flexibility drives the price and to apply this theoretically. Secondly an analysis of domestic flight tickets to find if there are different prices on tickets depending on peak hours.

1.4 Purpose

To find out what decides prices on flight tickets and to test it flexibility can be viewed upon as vertical product differentiation. It is also the purpose to find if prices are governed by peak load pricing.

1.5 Method

Create data with prices, ticket types and hours to build a spreadsheet that can be analyzed by linear regression with OLS. Studying of economic literature relevant to find the theory applicable on the question at hand.

1.6 Delimitation

All flights will be Swedish domestic flights. The data will be collected from three airlines on-line booking system on one single day with one specific departure date. Using Stockholm as a hub, Malmö, Gothenburg and Umeå will be destinations, back and forth and only one-way tickets to avoid any discount offers or bundles. All flights will be non-stop. To see differences in different hours during the day, the two peak hour periods will be 06.00 to 09.00 and 15.00 to 18.00. The full flex ticket will be the ticket where there are no limits on rescheduling, limits on cancelling tickets will not be discussed.

2 Economic theory

In this chapter two models will be described to make it possible to answer the question at hand.

The first model is the one described by Pepall in *Industrial Organization* that covers vertical product differentiation in the context of a market that is run by a monopolist. The model will be modified to the extent that quality in the model will be made equal to flexibility to fit the purpose and problem of this paper. More specifically, quality is equal to flexibility and the level of flexibility is the variable that prices depend on. The model is divided in two parts. The first part describes how prices are dependent on the quality of the good offered and the second will describe how the monopolist can enhance profit by offering different levels of quality. This model will make it possible to explain how different levels of flexibility drive prices.

The second model is described by Andreas Bergh and Niklas Jakobsson in *Modern Mikroekonomi* and will cover the simple profit maximization problem of the monopolist with the addition that the monopolist will face two different levels of demand. The simple profit maximization problem will be used to explain the theory and the two levels of demand will explain the peak and off-peak demand to make it possible to analyze the effects of peak load pricing.

2.1 Vertical product differentiation - Differences in prices are dependent on flexibility

The first part will focus on the fact that prices are dependent on the level of flexibility and how to find the optimal level of flexibility. The monopolist will try to find the optimal level of flexibility through a profit maximization problem, differentiating the profit function. The monopolist will only offer one good of one level of flexibility and the model will state that a higher level of flexibility will generate a higher price.

The second part will focus on the case where the monopolist offers one good of two levels of flexibility, one good of high and one good of low level of flexibility. The model will show that there is an advantage in the strategy of offering more than on level of flexibility. The consumer sensitivity for flexibility and the preferred level of flexibility will be analyzed to find the optimal levels of flexibility for the good (Pepall et al. 2008).

2.1.1 One good, on level of flexibility

This is the model where we have only one product and the firm tries to optimize price and flexibility to enhance profits.

We find the inverse demand function as $P = P(Q,z)$ where P the price when the whole market is served no longer only depends on the quantity Q, but also on the level of flexibility of each and every contract z. If we add the consumer sensitivity for flexibility θ into the demand function and the cost for producing flexibility into the cost function α we will get:

$$P = z(\theta - Q) \text{ and } C(Q,z) = \alpha z^2$$

Where $C = C(Q,z)$ is the cost function. This model is based on that the level of flexibility is the variable that the price and cost and depends on. Though the cost depending on flexibility is not to be tested it will be assumed that with a more refined product comes higher costs. The hypothesis that price is dependent on the level of flexibility will be tested in 5.1 to see if this can be substantiated.

The profit function $\pi(Q,z)$ is given by:

$$\pi(Q,z) = PQ - C(Q,z) = z(\theta - Q)Q - \alpha z^2$$

Where the profit π is dependent on the quantity sold Q and the level of flexibility z. Differentiating with respect to Q will give us get the first order condition to find the optimal quantity for monopolist:

$$\frac{\partial \pi(Q,z)}{\partial Q} = z(\theta - 2Q) = 0$$

Solve for Q and we find Q^*, the optimal quantity:

$$Q^* = \theta / 2$$

In the same manner we find z^*, the optimal flexibility:

$$z^* = \frac{\theta^2}{8\alpha}$$

The model will not be extended to a numeric analysis. The monopolist will try to find the optimal level of flexibility using profit maximization as shown above (Pepall et al. 2008).

2.1.2 One good in a vertically differentiated market, two levels of flexibility

If the airline wants to sell the same contract but with different levels of flexibility one have to study the effect on consumer surplus based on the flexibility of the product. The model describes the case where we have two types of consumers, one of high flexibility preferences and one of low flexibility preferences.

This is described with two consumers and the monopoly is offering more than one product vertically differentiated. The consumer decides on the level of flexibility that gives the highest consumer surplus. Therefore we analyze the indirect utility V for consumer i obtained from consuming the product of the flexibility z and at the price p (Pepall et al. 2008). This gives us:

$$V_i = \theta_i (z - \underline{z}_i) - p \qquad (i = 1,2)$$

We assume two types of consumers, one of higher sensitivity for flexibility and one of lower sensitivity. Important note is that $\underline{z}_i$ is the lower bound of flexibility accepted by consumer i. If flexibility falls under this level $\underline{z}_i$ consumer i will not buy the contract, because of negative the negative consumer surplus that occurs. The two types of consumers are type 1 and type 2 and we will assume that type 1 have a higher sensitivity of flexibility than type 2, $\theta_1 > \theta_2$, and that type 1 will not accept a flexibility at least as high as the one offered to type 2, $\underline{z}_1 > \underline{z}_2 = 0$. Type 1 is what one should call the business traveller and that his sensitivity for flexibility and the level of flexibility accepted is much higher than the common commuter or tourist, the type 2 consumer. Type 1 wants to be able to pick any flight at any time and would therefore go for the high flexibility full flex ticket. Type 2 would settle with the flex ticket or the economy ticket (Pepall et al. 2008).

The airline would like to price discriminate between the two types and as in second-degree price discrimination consumer type 2 will be charged the price that is equal this its willingness to pay for the preferred level of flexibility. At the same time the airline will try to get the most out of type 1 consumers surplus charging a higher price for the high flexibility contract (Pepall et al. 2008).

The airline will try to charge the type 2 consumer a price that is low enough for him to be willing to buy the contract with the low flexibility. The expression for the price for type 2 is found using the assumption $\underline{z}_2 = 0$, that the lowest accepted level of flexibility is zero. Substitute this into the utility function $V_i = \theta_i(z - \underline{z}_i) - p$ and one will find that type 2 will buy z_2 if:

$$p_2 = \theta_2 z_2 .$$

Type 1 consumers have a higher sensitivity for flexibility and we can therefore describe with an *incentive compatibility constraint* (Pepall et al. 2008) as in second-degree price discrimination. If type 1 is going to buy the high flexibility contract the consumer surplus must be, as written above, non-negative and greater or equal to the surplus obtained purchasing the low flexibility contract (Pepall et al. 2008). We then get:

$$\theta_1(z_1 - \underline{z}_1) - p_1 \geq \theta_1(z_2 - \underline{z}_1) - p_2$$
$$\theta_1(z_1 - \underline{z}_1) - p_1 \geq 0$$

Using the expression for p_2, we can find that flexibility is priced higher if flexibility is valued higher by both types of consumers. Considering a bigger difference between z_1 and z_2 the more differentiated will the contracts be. This will lead to less competition between the contracts and the price of the high flexibility contract can increase (Pepall et al. 2008). Described by:

$$p_1 \le \theta_1 z_1 - (\theta_1 - \theta_2) z_2$$

We can see how type 1 consumers receive non-negative surplus when they buy the high flexibility good by rewrite $\theta_1(z_1 - \underline{z}_1) - p_1 \ge 0 \Rightarrow (\theta_1 - \theta_2)z_2 - \theta_1 \underline{z}_1 \ge 0$ by using the state where $p_1 = \theta_1 z_1 - (\theta_1 - \theta_2) z_2$. If we assume that the highest level of flexibility available $\bar{z}$, in this case the full flex contract, is given as:

$$\bar{z} > \frac{\theta_1 \underline{z}_1}{(\theta_1 - \theta_2)}$$

The condition of non-negative surplus will then always be satisfied by some $z_2 \le \bar{z}$ (Pepall et al. 2008).

This constraint is always satisfied for the type 2 consumer, assuming that he does not want to buy the high flexibility product. It must then be the case that $\theta_2 \underline{z}_1 - p_1 < 0$ and given that $p_1 = \theta_1 z_1 - (\theta_1 - \theta_2) z_2$ will imply that $-(\theta_1 - \theta_2) z_1 + (\theta_1 - \theta_2) z_2 < 0$. This will hold as we have $z_1 > z_2$ and $\theta_1 > \theta_2$. Therefore $p_1 \le \theta_1 z_1 - (\theta_1 - \theta_2) z_2$ and $p_2 = \theta_2 z_2$ will make sure that type 1 will buy the high flexibility product and type 2 will buy the low flexibility product (Pepall et al. 2008).

If we assume the number of N_i consumers of each type and we suppose that if the production cost for each level of flexibility of the product is the same, $c_1 = c_2 = 0$. To make the analysis more simple we will assume that there are no fixed costs and given that $p_1 \le \theta_1 z_1 - (\theta_1 - \theta_2) z_2$ and $p_2 = \theta_2 z_2$ the total profit of the firm will be:

$$\Pi = N_1 p_1 + N_2 p_2 = N_1 \theta_1 z_1 - (N_1 \theta_1 - (N_1 + N_2)\theta_2) z_2$$

We now have to find the level of flexibility for z_1 and z_2 that will maximize the profit. It is clear that z_1 is positive and that profit will rise when z_1 rises. Firm should then consider setting z_1 as high as possible

$$z_1{*} = \bar{z}.$$

The airline will set the level of flexibility of the high flexibility product at the highest flexibility level possible (Pepall et al. 2008). Then the highest level of flexibility $\bar{z}$ is equal to the full flex ticket and this will also be the strategy for the airline to maximize profit.

For z_2 it takes more analysis, as z_2 is positive, the profit decreases when z_2 increases. We analyze the two cases where the first case has more consumers of high flexibility preferences and the second case where we have more consumers of low flexibility preferences (Pepall et al. 2008).

Case I: $N_1\theta_1 > (N_1 + N_2)\theta_2$

The airline will then set $z_1{*} = \bar{z}$ and try to keep z_2 as low as possible, but not to $\underline{z}$. The type 1 consumer still has to get at least a non-negative surplus from buying the good $\bar{z}$ and we know this is satisfied by the constraint, $\theta_1(z_1 - \underline{z}_1) - p_1 \geq 0 \Rightarrow (\theta_1 - \theta_2)z_2 - \theta_1\underline{z}_1 \geq 0 \Rightarrow z_2 \geq \frac{\theta_1\underline{z}_1}{\theta_1 - \theta_2}$. The monopolist will then choose:

$$z_2{*} = \frac{\theta_1\underline{z}_1}{\theta_1 - \theta_2}$$

It is not possible for the monopolist to distinguish between the two consumer types and even though he wants to set z_2 even lower than optimized it is not possible he offer products that make the consumers select on their own into their true type (Pepall et al. 2008).

We can now find the profit-maximizing prices for good one and two. We will find $p_2* = \frac{\theta_2 \theta_1 \underline{z}_1}{\theta_1 - \theta_2}$ and $p_1* = \theta_1(\bar{z} - \underline{z}_1)$, as the type 1 consumer is charged his maximum willingness to pay for the highest flexibility possible, $\bar{z}$, and type 2 are charged their maximum willingness to pay for the lower flexibility $\frac{\theta_1 \underline{z}_1}{\theta_1 - \theta_2}$. We can see that the aggregate profit is (Pepall et al. 2008):

$$\Pi = N_1(\bar{z} - \underline{z}_1)\theta_1 + N_2 \frac{\theta_2 \theta_1 \underline{z}_1}{\theta_1 - \theta_2}$$

Case II: $N_1\theta_1 < (N_1 + N_2)\theta_2$

We can see from the profit function that profit now is increasing in z_2 and the firm should set $z_2* = z_1* = \bar{z}$. We say that the firm should only offer one product and that it should be of the highest possible flexibility (Pepall et al. 2008).

2.1.3 Comments on model of vertical product differentiation

The sensitivity θ in 2.1.1 is not a subject to be tested but it will be assumed that if consumers are more sensitive for flexibility, the optimal level of flexibility will be higher. In the case where there is only one product, the firm tries to optimize the price through an optimal level of flexibility to enhance profits.

In the case where there are different levels of flexibility of the same product the model is verified for the analysis of prices, as there are different contracts with different levels of flexibility. The model is built upon the assumption that prices depend on the level of flexibility, which is also what will be tested in section 5.1.

2.2 Profit maximization under monopoly

The model is simple but will describe the pricing of tickets due to peaks in the demand in a satisfying way. One big company dominates the monopoly market and we will consider this the airlines operating the flights that are analyzed to make the model applicable. To motivate the monopoly model in a assumed oligopoly market it is considered that every airline has got the monopoly on every departure time. It is then possible for each and every airline to price as a monopolist at each time of departure. The profit is dependent on quantity and monopolist wants to maximize his profit by setting the marginal revenue equal to marginal cost and through this find a optimal quantity and price. Adding a higher level of demand under 2.2.2 one can see what happens to the price, and the profit, when the quantity increases to face a higher demand.

The assumption will be made that the price for a full flex ticket is higher or at least the same as the peak load ticket price if there is not to occur an arbitrage. $Pfullflex = Ppeak$ is enough for the model of peak load pricing to hold. In the analysis of peak load pricing no full flex prices will be included because they will not change and buying a full flex ticket is buying at $Ppeak$. Instead it is assumed that flex and economy ticket prices goes toward the full flex price that then will be equal to peak load price $Ppeak$.

2.2.1 One level of demand

According to Bergh and Jakobsson the revenue is $R = R(Q) = P \cdot Q$, where the price $P = P(Q)$ is the inverse demand function $P = a - bQ$ and Q is the quantity offered. The revenue can then be written as $R = R(Q) = (a - bQ)Q = aQ - bQ^2$ and the marginal revenue MR is found by differentiate with respect to Q:

$$MR = \frac{\partial R}{\partial Q} = a - b2Q.$$

Bergh and Jakobsson define the cost as $C = C(Q) = c + dQ^2$ and the marginal cost MC is also found by differentiate with respect to Q:

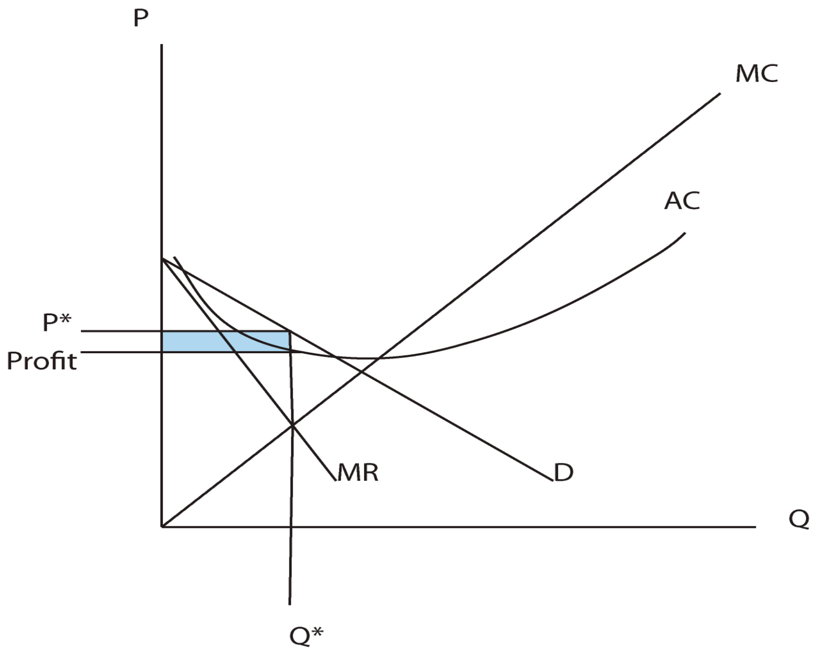
$$MC = \frac{\partial C}{\partial Q} = d2Q.$$

Bergh and Jakobsson set up the profit function $\pi = \pi(Q) = R(Q) - C(Q)$ and maximizing this function by differentiating with respect to Q, finding the optimal quantity, the result is that the optimal quantity is found when marginal revenue is equal to marginal cost:

$$\pi'(Q) = R'(Q) - C'(Q) = 0$$
$$R'(Q) = C'(Q) \Leftrightarrow MR = MC.$$

This is illustrated in figure 1 that is the classic illustration of the profit maximization problem of the monopolist. This is also the case where the monopolist does not or cannot respond to peaks in demand. The profit is the shaded area.

Figure 1. Monopoly profit maximization, one constant level of demand



Source: Bergh & Jakobsson, 2010, own illustration

To this model there will be added a second level of demand illustrated in figure 2 and described in section 2.2.2.

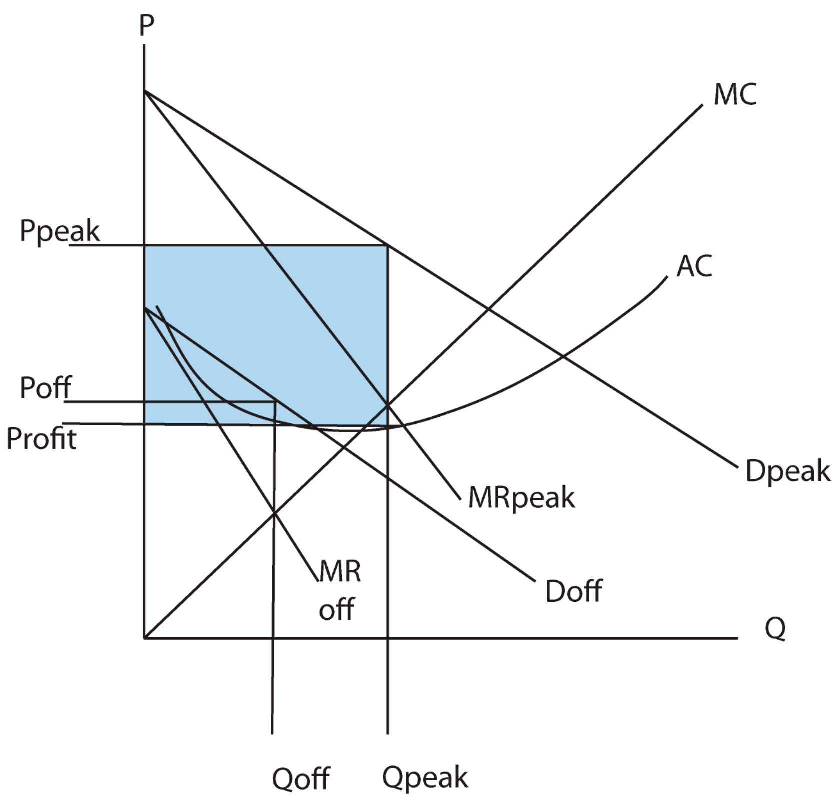
2.2.2 Two different demand levels

The original model only consider the case where there is only one demand level, but adding a higher level of demand it is easy to see what happens with prices as tickets become a more sacred resource.

For every unit increased in demand the linear demand curve shifts as a new equilibrium between the marginal revenue and marginal cost is found. For every unit increased in demand there will be a new optimal quantity and a new optimal price level. At the linear peak-demand curve referred to as $Dpeak$ the airline are offering the last ticket to the price $Ppeak$ at the quantity $Qpeak$. Those are found when $MRpeak = MC$.

With two levels of demand the monopolist will charge a higher price for the peak demand and a lower price for the off-peak demand. The profit is the shaded area in figure 2 and one can observe the difference in profit to the first case where the airline did not respond to the increase in demand. Here the profit and the margins are significantly higher.

Figure 2. Monopoly profit maximization, two levels of demand, peak load pricing



Source: Modification of Bergh & Jakobsson, 2010, own illustration

This model will represent the scenario of peak load pricing. When demand exceeds the level of $Doff$ every ticket becomes more expensive as demand is going towards $Dpeak$ which is the maximum capacity where the last ticket is sold to the price $Ppeak$. The last ticket sold for $Ppeak$ will then be equal to the price of the full flex ticket.

2.2.3 Comments on model of monopoly profit maximization

This model will describe the peak load pricing as long as two different demand levels are analyzed. Considering that the data contains two different samples that will work as a variable demand the analysis will be possible. Assuming that peak load pricing occurs when the airline recognizes the increasing demand for a particular flight and that this happens when the departure date is approaching, the model is verified.

The second level of demand is an addition to the original model and it is assumed that the increased demand does not interfere with the cost function but should be viewed upon as a capacity that is not used during off-peak. We can consider this surplus capacity to be empty seats on off-peak flights.

3 Data

The study of prices of tickets, the ticket types and the study of peak and off-peak hours are described in this section. A total of 380 observations were made containing price, ticket type, flight and peak and off-peak hours.

3.1 Approach

As mentioned in 1.4 the analysis of prices and tickets is made to find if the level of flexibility affect prices. The data is strictly collected from each and every airlines online booking system and registered in an excel spreadsheet. The use of excel spreadsheet is to make it possible to import the data into a program that enables linear regression analysis with OLS to find significant variables. The collection of peak and off-peak hours are subject to the same approach.

3.2 Airlines and flights

The Airlines used are Malmö Aviation, SAS and Norwegian operating between Malmö and Stockholm, Stockholm and Malmö, Gothenburg and Stockholm, Stockholm and Gothenburg, Umeå and Stockholm, Stockholm and Umeå. A major reason for the choice of airlines was the similarities in the structure of the different contracts. As mentioned in 1.6 every flight is Swedish domestic flights, one-way and between predetermined destinations. Every connection is registered with one-way flights back and forth and the one-way delimitation is made to avoid discount offers and bundles.

3.3 Prices

The price is vital to be able to answer the question 1.2 and is therefore collected with the purpose of being the dependent variable in the analysis. The price is used in both purposes but is for the second part considering peak load pricing collected at two intervals. This is made to find if the strategy of peak load pricing is more significant the closer one gets to the departure date because of a higher amount of tickets purchased.

3.4 Tickets

Three different types of contracts are analyzed to be able to find a difference in prices depending on these contracts. The full-flex ticket which is considered the main concern in this paper, the flex ticket and the low flex or economy ticket. The major difference is that Norwegian does not have a flex ticket, and the assumption is made that this will affect prices on the other contracts when the number of different contracts is lowered.

3.5 Peak hours

The time of the day is divided into two groups, the peak hours and the off-peak hours. Peak is assumed to have the largest amount of passengers considering these hours to be rush hours. As mentioned in 1.6 the peak hours during the day are the periods between 06.00 to 09.00 and 15.00 to 18.00. The absolute peak is set to 07.30 with a time-scale of +/- one and a half hour and to 16.30 with the same time-scale.

4 Statistical theory

To be able to explain the results of the test made in this paper some statistical theory have to be described, which is covered in this section. The literature used to explain the theory is Joakim Westerlunds *Introduktion till ekonometri*, where the basic econometric tools are described. To describe the theory of the T-test the *Essential of Econometrics* by Damodar Gujarati and Dawn Porter has been used.

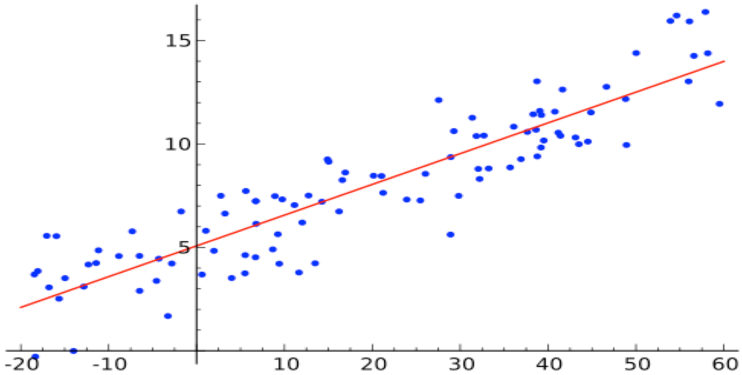
4.1 Linear regression, OLS, dummy, null hypothesis, t-statistic and significance level

The main tools to be able to understand the results of regression analysis are presented in following sections.

4.1.1 Linear regression

Regression analysis is to analyze the relationship between dependent and independent variables in an economic model. In microeconomics it is very common when analyzing the relationship between supply and demand in respect to the price of the good. The econometric model that is often used is the linear regression model. It is a model, part of the regression analysis, which describes the relationship between economic variables. The method is to fit a straight line between the observations. The distance between the observations and the fitted line are the difference between the estimated value and the real value (Westerlund). This is illustrated in figure 3.

Figure 3. Linear regression



Source: http://en.wikipedia.org/wiki/Regression_analysis

4.1.2 OLS

OLS, short for ordinary least squares is the method used to estimate the parameters in the model of linear regression and it will find estimates that represents the amount of change in the dependent variable when the independent variable is changed one unit. The OLS will minimize the distance between the fitted line and the real observations (Westerlund, 2005). For an example if we have different levels of flexibility in a contract, the estimate will tell what happens with the price if there is a change of one unit in the level of flexibility.

4.1.3 Dummy

The data in this paper is represented by intercept-dummy variables. The intercept-dummy is a binary variable that will give 1 for true and 0 for false (Westerlund, 2005). In this data, considered we have a full flex contract the dummy will give 1 for the presence such contract and 0 for all other contract. Same method is used for the peak and off-peak analysis. In the OLS the estimates will then represent the change in the dependent variable when there is a full flex contract.

4.1.4 Null hypothesis

The null hypothesis referred to as H_0 makes it possible to say anything about the significance of the parameters. It is assumed under the null hypothesis that the estimate will take a decided value, often zero. This is true as long as the sample, the data, can't prove the opposite (Westerlund, 2005). If the null hypothesis is true for an estimate, the estimate does not describe differences in the dependent variable. It is called that the estimate is not significant. To test the null hypothesis the t-statistic is a very useful measure.

4.1.5 T-statistic

The t-statistic is the value that summarises the information from the collected data concerning the null hypothesis that is being tested (Westerlund, 2005). If the t-statistic does not depart outside the chosen level of significance the null hypothesis should be considered true and the estimate is not significant, it is not describing differences in the dependent variable. The opposite if the t-statistic is departing outside the chosen level of significance. The estimate is then considered significant and is describing the differences in the dependent variable (Westerlund, 2005).

4.1.6 Level of significance

The level of significance is setting a high and low acceptable value for the t-statistic, an often used value is 95 percent. Using a 95 percent level of significance will give the t-statistic a critical region of 2,5 percent as a measure of probability of finding the t-statistic within the significance level (Westerlund, 2005). If the t-statistic falls inside the significance level, the probability is higher than 2,5 percent null hypothesis will be accepted and the estimate is not significant. The opposite if the probability is lower than 2,5 percent. The 95 percent level of significance is used in this paper.

4.2 T-test

To test if there is a real difference in one group of the population compared to the rest of the population. If there is significant difference, the null hypothesis that the sample is random is rejected and there is a real difference. In other words it is a hypothesis test on one estimate and if the estimate have an effect on the mean of the dependent variable. If the null hypothesis is rejected the estimate have a significant effect on the dependent variable (Gujarati & Porter, 2010). The t-tests in this paper will be of two-sided hypothesis test. This means that the t-statistic can take a value on both sides of the null hypothesis.

4.3 For the empiric results

In the results presented in section 5 the estimates will be the value of the coefficients and the standard error is the expected deviation from the coefficient estimated.

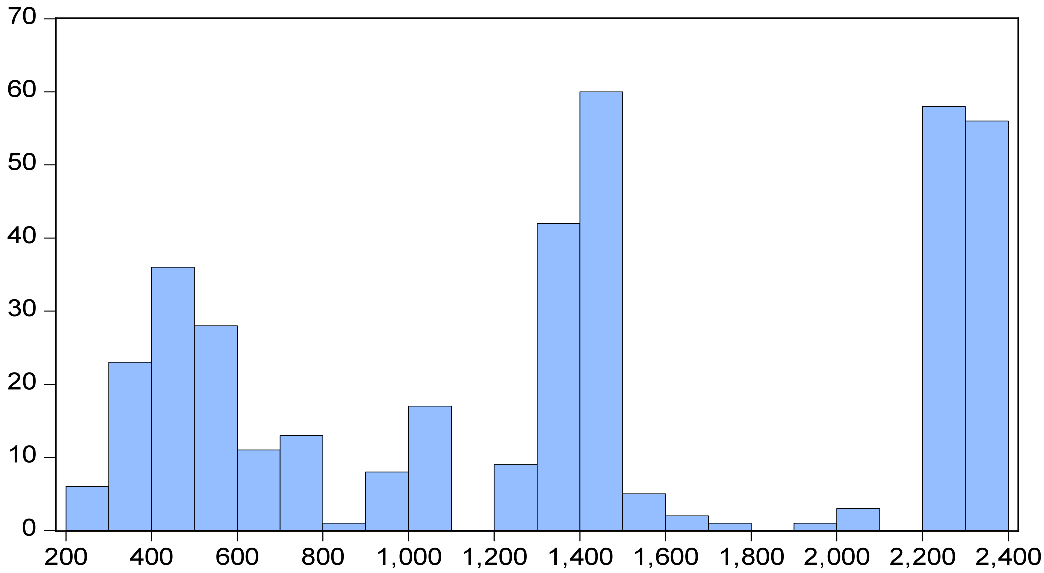
5 Empiric results

In this section the empiric results will be presented. The effect that flexibility has on prices as well as the peak load pricing will be analyzed. The flight distance will be ruled out as a factor that affects prices of domestic one-way flights. Every sub-section is ended with a discussion.

5.1 Pricing with flexibility as vertical product differentiation

The differences in prices depending on tickets are in this section firstly described with a histogram that will show the sample size and the differences within the sample. This is made as an addition to the regression analysis to quantitatively describe the collected data.

Figure 4. Histogram of data concerning prices of tickets. Y =**Number of observations,** X =**Price**



Source: Online booking of SAS, Malmö Aviation and Norwegian. Own work

From this figure 4 it is obvious that there are differences in prices but this is only a presentation of the data that will be analysed. If prices actually depend on the level of flexibility is still a concern of regression analysis.

Table 1. Pricing with flexibilty, dependent variable price, C =base (economy)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Full flex	1544.657	38.06360	40.58094	0.0000
Flex	893.2357	40.14955	22.24772	0.0000
C	566.3000	27.31379	20.73312	0.0000

To be able to substantiate the assumption that the level of flexibility does affect prices a regression analysis using OLS have been made to find significant differences. The model is made to illustrate how the level of flexibility of the different contracts affects prices. C is considered the base, the zero level of flexibility that comes with the economy ticket and upon this the differences in pricing are revealed.

From the test shown in table 1 it is found that the differences in price significantly depend on the level of flexibility attached to the contract. The price difference for the highest level of flexibility is significant and buying the full flex contract will cost you an extra 1544.657 skr with the standard error of 38.06360 skr.

5.1.1 T-test

This will test if differences in prices depending on different levels of flexibility or if the differences are random. The test will be made over the mean of every group compared to the mean of the rest of the group.

Table 2. Test for equality of means for price, T-test, tickets				
Categorized by	Mean price, Full flex	Mean price, Flex	t-value	Prob.
Full flex	2110.957	1459.536	-14.77906	0.0000
	Mean price, Flex	Mean price, Economy	t-value	Prob.
Flex	1459.536	566.3000	-36.11825	0.0000

In table 2 both full flex are significant compared to the mean of flex and flex compared to the mean of economy. The null hypothesis is therefore rejected in both cases on a level of significance on 95 percent. It is then the case that full flex compared to flex, and flex compared to economy are real, not random, differences. This means that the model of vertical product differentiation is verified.

5.1.2 Discussion

Firstly the flight ticket will be defined as a good that is vertically differentiated, as it is the same product but offered in different levels of flexibility that will determine the price. Considering the pricing due to different levels of flexibility it is possible from the theory of vertical product differentiation see the degree of flexibility as the degree of quality, z. And as earlier mentioned in section 2, the sensitivity for quality will be analogue to an assumed sensitivity of flexibility, θ.

The high flexibility contract, the full flex ticket at flexibility level $\bar{z}$, is charged at a higher price than contracts with lower flexibility $z < \bar{z}$. The level of flexibility z should then be decided on the number of flights available in a day and therefore $\bar{z}$ is the highest possible amount of flights offered to the full flex ticket holder. If we consider this, the level of $\bar{z}$ for Malmö Aviation and SAS is higher than the level of $\bar{z}$ for Norwegian because of the fact that they offer fewer flights on almost every connection analyzed. This would then explain why the

Norwegian full flex tickets are less then half the price because of the fact that they offer less than half the amount of flights. One should therefore prefer Malmö Aviation and SAS if one is to have the highest possible flexibility and for a lower price on the account of flexibility, one should prefer Norwegian.

By implementing this theory and keeping $z_1{*} = \bar{z}$ is profit maximizing for Malmö Aviation and SAS as long as there are enough customers available with the demand for that amount of flexibility, θ_1. All the different types of tickets will also help consumers to self-select according to their own preferences to extract the most of the consumer surplus. But if there is a decrease in θ_1 or in the number of consumers with these preferences there are more profit in having just one level of flexibility and this should be the highest possible level of flexibility as, $z_2{*} = z_1{*} = \bar{z}$.

The results are showing that we have a significant difference in prices dependent on the type of contracts. The only thing one could consider is that there could be some underlying costs of producing the full flex ticket but we will have to assume that there are not and that the theory of vertical product differentiation wouldn't apply if there were such costs.

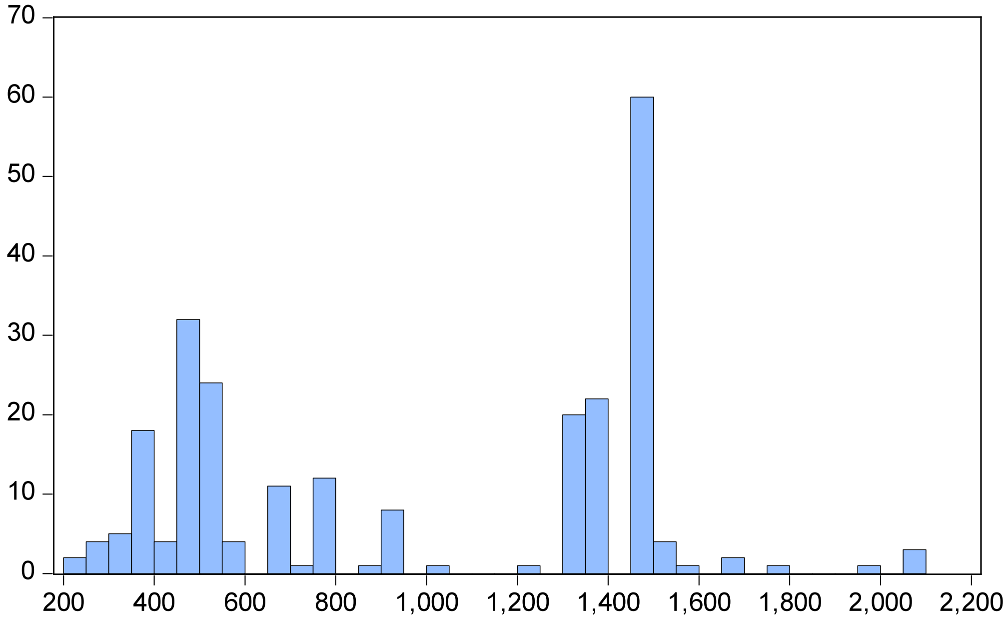
5.2 Peak load pricing

As earlier mentioned it will be assumed that the full flex price is the same as peak load price to make it possible to analyze differences in flex and economy contracts. The test is made to see if peak load pricing is used as strategy to increase profits. To see the two different levels of demand form the model of profit maximization two different intervals of booking and departure date where chosen. The first test is made with 26 days to departure and the second is made with 4 days to departure. Of the 241 observations in the first test 5.2.1 there were 139 peak tickets and 103 off-peak tickets. Of the 77 observations in the second test 5.2.2 there were 40 peak tickets and 37 off-peak tickets.

5.2.1 26 days until departure

The first test of peak load pricing will include data collected 26 days until departure and all connections included. Only flex and economy tickets where included in the test.

Figure 5. Histogram of data concerning distribution of peak hours. Y =**Number of observations,** X =**Price**



Source: Online booking of SAS, Malmö Aviation and Norwegian. Own work

The histogram in figure 5 is representing the distribution of peak and off-peak hours on the two ticket types flex and economy. A regression analysis is made to find if peak hours are significantly more expensive than off-peak hours.

Table 3. Peak load pricing, dependent variable price, 26 days until departure, base off-peak hour

Variable	Coefficient	Std. Error	t-Statistic	Probability
Peak	73.10421	63.09210	1.158690	0.2477
C	937.7087	47.81616	19.61071	0.0000

In table 3 there is a difference but not significant enough according to the significance level of 95 percent and the null hypothesis can't be rejected. Then it is not possible to tell if prices are higher in peak hours than in off-peak hours depending on the assumed higher demand in those hours. With this test we can't determine if peak hours affect prices.

5.2.2 T-test

To find if the difference is real and not random a t-test is presented.

Table 4. Test for equality of means for price, T-test, peak hour

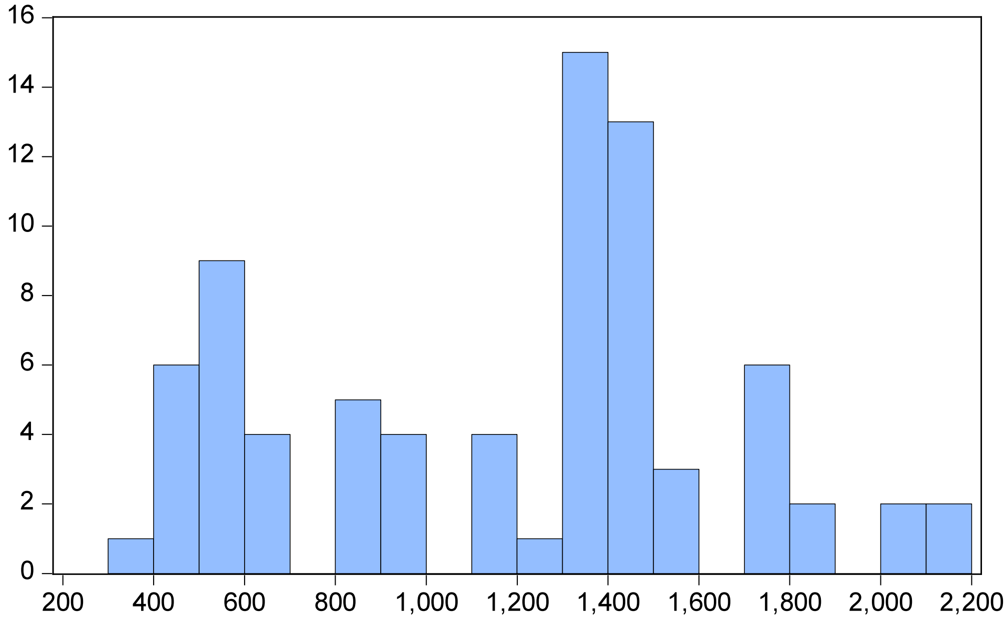
	Mean price, hour	Mean price, other	t-value	Prob.
Peak	1010.813	937.7087	-1.158690	0.2477

There is nothing in the t-test that is a significant real difference on a significance level of 95 percent. The difference that might occur in peak hours is then random because of the failure to reject the null hypothesis.

5.2.2 Four days until departure

This study does only contain sample of flights between Stockholm and Gothenburg, but as shown in 5.3 there are nothing to tell that the distance of the flight affects the price. Therefore this sample can be used to analyze peak load pricing when there are only four days until departure.

Figure 6. Histogram of data concerning distribution of peak hours. Y **=Number of observations,** X **=Price**



Source: Online booking of SAS, Malmö Aviation and Norwegian. Own work

In figure 6 the prices are more evenly distributed than the data of figure 5 and the result of this is presented in table 5.

Table 5. Peak load pricing, dependent variable price, 4 days until departure, base off-peak hour

Variable	Coefficient	Std. Error	t-Statistic	Probability
Peak	272.0466	106.2847	2.559604	0.0125
C	1049.378	76.60467	13.69862	0.0000

In table 5 there is a significant difference in the prices when the departure date is approaching. The probability is in the critical region and the null hypothesis is rejected on a significance level of 95 percent. This will then as assumed in 2.2.3 apply to the model of two different levels of demand and it is possible to see peak load pricing. This is an effect that the peak hour tickets are more limited now compared to the first test 5.2.1. It is also noticeable that the base has increased as an effect of peak load pricing.

5.2.3 T-test

To find if the difference is real and not random a t-test is presented.

Table 6. Test for equality of means for prices, T-test, peak hour				
	Mean price, hour	Mean price, other	t-value	Prob.
Peak	1321.425	1049.378	-2.559604	0.0125

There is a difference in the t-test that is a significant real difference on a significance level of 95 percent. The difference that might occur in peak hours is then not random but a real difference because of rejecting the null hypothesis.

5.2.4 Discussion peak load pricing

This theory presented in describes the peak load pricing of a big private company in a satisfying manner. Considering the results in the case with peak-load pricing, they do not show a large difference in prices depending on peak and off-peak demand. But it will be assumed that the closer to departure date we get, the more limited the access to peak hour flight seats become and prices will increase. The peak load pricing strategy will be more distinguished as we approach the departure date.

The data shows that the peak load generally is covered by a higher amount of flights, and this surely strategic to make it possible to make this kind of pricing possible. The peak-load will then have to bear the cost for the off-peak not being able to fill all seats, but also increase the profits as shown in figure 2.

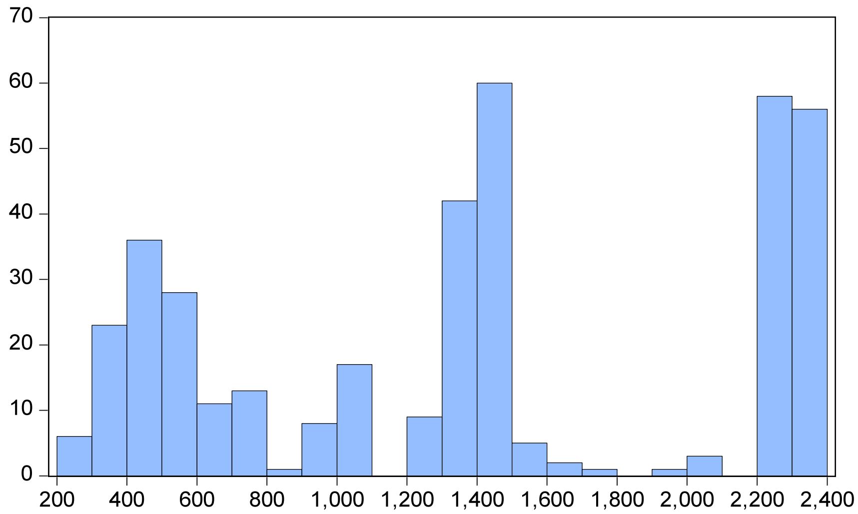
It is easy to see using the results where it is found that base prices rise the closer we get to departure, and this is because of that cheap tickets no longer are available and on the margin every ticket becomes more expensive if you want to travel on a peak-load flight.

Peak load pricing is then significant but only when the departure date is approaching. This should be tested but the particular question if the number of days until departure is significant for peak load pricing is not to be answered in this paper. It will be assumed that it is significant because of the observed increase in demand comparing the two results.

5.3 Ruling out flight distance as a factor that affects prices

To be able to substantiate the hypothesis that the level of flexibility decides the price of the tickets even more, a test was made to find if the flight distance had any significant effect on the ticket price. All flights were on way flights and the distance is generalized into cities, not airports.

Figure 7. Histogram of data concerning prices of tickets. Y **=Number of observations,** X **=Price**



Source: Online booking of SAS, Malmö Aviation and Norwegian. Own work

Studying the distribution of figure 7 one will find that it is the same distribution as in figure 4 representing the tickets. This is not strange as it is the same prices and the same amount of contracts that have been plotted. If the flight distance have a significant effect on the price of the contracts will be presented in table 7.

Table 7. Flight distance, dependent variable price, base UME-STO

Variable	Coefficient	Std. Error	t-Statistic	Probability
GOT-STO	-37.45426	101.3067	-0.369712	0.7118
MMX-STO	20.03429	102.5195	0.195419	0.8452
C	1398.347	83.42357	16.76201	0.0000

Studying table 4 there are no significant variables on a significance level of 95 percent to be able to explain if the flight distance has any effect on the ticket prices. Flexibility is then the only observed variable that price depend on.

5.3.2 Discussion

The study of flight distance was made in the purpose of finding non-significant estimates to be able to make the theory of flexibility as vertical product differentiation more substantiated.

It seems like the flights does not at all depend on the distance flown but only of the preferred flexibility of the ticket. The flight distance is then normalized and can be assumed to be the same on all domestic one-way flights.

6 Conclusion

There will be no doubt that flexibility is a factor that drives the price on the tickets available. The model of vertical product differentiation is verified and differentiation between tickets is used to set the price based on the level of flexibility. It is not hard to see that the different levels of flexibility of the tickets are a pure case of vertical product differentiation and that it is used as a strategy from the airlines to link the right customer to the right ticket. The price is set to match the level of flexibility preferred by the consumer but how that is done, and what type of mechanism the airlines use the find the right price is another question. But with great significance flexibility is setting the price on flight tickets.

Peak-load pricing can affect prices and in this case the strategy is used when the high demand is registered and the number of tickets are running out. The peak-load pricing seems to be something that is used commonly in private companies that meets variable demand. This is a strategy that will make the business more efficient, to make the high demand periods cover for periods of low demand and to increase profits. Also efficient in the way that the people that needs to travel in the peak hours will have that possibility because of the higher pricing that will shut out those who care less about departure and arrival time.

7 Sources

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All data presented was collected from the on-line booking of SAS, Malmö Aviation and Norwegian on two different occasions, the 19th of April and the 10th of May, using the same departure date, the 14th of May.
www.sas.se
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