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Does Product Differentiation Relax Price Competition?
An Experimental Answer

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Abstract. The literature on product differentiation predicts that firms are likely to differentiate their products in order to relax price competition. We tested this theoretical result in a laboratory setting, by organizing twenty-four markets where products were offered with different quality levels. We compared two treatments which varied only in the degree of exogenous quality differentiation. The main result was that higher product differentiation determines low price competition and thus higher prices.

JEL Classification: C92, D43, L13.

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1. Introduction

A major issue in Industrial Organization literature is to determine firms' strategies when technology allows for product differentiation. It is well known that two products can be horizontally differentiated (Hotelling, 1929) when there is no ranking among consumers based on their willingness to pay for the product, and vertically differentiated (Mussa, Rosen, 1978) when all consumers agree on the most preferred mix of characteristics and, more generally, on the preference ordering. A typical example of a vertical characteristic is quality. With vertically differentiated products, when there are equal prices there is a natural ordering over the characteristics' space. In these settings, the main question is the degree of product differentiation in equilibrium.

With products defined by only one (vertical or horizontal) characteristic, research has shown that the principle of minimum differentiation (Hotelling, 1929) does not hold when models are "well-behaved" (D'Aspremont et al., 1979, Shaked, Sutton, 1983). The rationale for this result is that both vertical and horizontal differentiation is needed to relax price competition, which should be fierce if firms choose similar locations (Shaked, Sutton, 1982).

Recently some researchers have conducted experiments on horizontal product differentiation, considering products defined along only one dimension (Barreda et al., 2000, Collins, Sherstyuk, 2000, Brown-Kruse et al., 1993), which confirm, overall, the principle of differentiation developed by the theory. Mangani, Patelli (2001) extended the experimental analysis to a context of bi-dimensional and horizontal product differentiation, and found that firms tend to locate towards the center of consumers' distribution (unlike the theory which emphasizes the result of min-max product differentiation[1]). Surprisingly, no experimental study has been carried out regarding vertical product differentiation.

In order to fill this gap, we organized an experiment in which subject-firms competed in a market where products were vertically differentiated, in the sense that they were offered with different quality attributes. The main question that we wanted to answer was the following: is vertical product differentiation, in the laboratory, a source of reduced price competition? The answer was: yes, it is. The laboratory study confirmed what was predicted by the theory. Clearly, the experimental design was much simpler than the traditional models of vertical product differentiation. In particular, the markets designed in the experiment consisted of duopolies, in which subjects-firms offered products with exogenously given qualities, and competed in prices. Despite this, the strength of the results holds. In addition, the experiment

[1] See, among others, Irmen, Thisse (1998) for the result of max-min product differentiation.

gave us further information regarding market structures and potential collusive outcomes which can arise with vertical product differentiation.

The paper is organized as follows. In the next section we briefly describe Tirole's theoretical model (1988), which appears in his internationally famous textbook on Industrial Organization. We chose to use this model-example because it constitutes the framework of several Industrial Organization models where, among other assumptions, products are vertically differentiated. For this reason the model should be familiar and the reader will be able to follow its experimental application. In the third section we show the parameterization of the model and the theoretical predictions in terms of prices, markets shares, and profits, which define the Nash equilibrium solution. Section 4 describes the experimental methods, and in the fifth section of the paper we summarize the results. The last section includes a discussion and comments on the findings.

2. The theoretical model

In organizing the experiment we closely followed the model which Tirole (1988) develops in his Industrial Organization textbook. This model-example is helpful in understanding the interaction of firms' strategies when products are vertically differentiated. This explains why it is used in many applications and models throughout the literature of Industrial Organization. The model can be summarized as follows.

In a market there are several consumers, each of which consumes one unit of a good characterized by a quality index $s\,\hat{I}\,[s_{min}, s^{max}]$. A consumer has the following indirect utility function: $U=R+as-p$, where R is a parameter, large enough for each consumer to have a positive utility, p is the price of the good purchased and a is a parameter which describes the taste for quality. The parameter a is uniformly and continuously distributed across the population of consumers between a_{min} and a^{max}. In addition, assume that $a^{max}=2a_{min}$ (this will ensure a non-negative demand for both firms).

There are two firms in the market. Firm i produces a good of quality s_i, where $s_1>s_2$. The unit cost of production is zero. The indifferent consumer is defined by

(1) $$\bar{a} = \left(\frac{p_1 - p_2}{s_1 - s_2} \right)$$

which determines demands

(2a) $$D_1 = a^{\max} - \left(\frac{p_1 - p_2}{s_1 - s_2} \right)$$

(2b) $$D_2 = \left(\frac{p_1 - p_2}{s_1 - s_2}\right) - a_{\min}$$

Firms compete in a two-stage game: in the first stage firms choose quality, in the second they choose price. The game is solved by backward induction. The equilibrium prices are

(3a) $$p^*_1 = \left(\frac{2a^{\max} - a_{\min}}{3}\right)(s_1 - s_2)$$

(3b) $$p^*_2 = \left(\frac{a^{\max} - 2a_{\min}}{3}\right)(s_1 - s_2)$$

In the first stage profits are

(4a) $$p_1 = \left(\frac{2a^{\max} - a_{\min}}{3}\right)^2 (s_1 - s_2)$$

(4b) $$p_2 = \left(\frac{a^{\max} - 2a_{\min}}{3}\right)^2 (s_1 - s_2)$$

Given these profit functions, the optimal strategy for firm 1 is to maximize *s*, and the optimal strategy for firm 2 is to minimize it. Therefore, in equilibrium, vertical product differentiation is maximized. The economic explanation is that firms maximize quality differentiation in order to relax price competition.

We organized an experiment in which we simulated this demand system. Our aim was to observe price competition according to different configurations regarding product differentiation. In other words, we organized two different and independent treatments: in the first one firms offered products which were maximally differentiated, while in the second the two products were (quasi)minimally differentiated. This means that, in our experiment, quality was exogenous: we did not have the first stage of the game (the quality choice stage), but only the second one, where firms-subjects chose the price. In each treatment we analyzed the intensity of price competition. The next section describes the parameterization of the model and the theoretical predictions deriving from the Nash equilibrium of the duopoly price game.

3. Experimental design and theoretical predictions

In this section we define the parameters of the model in order to obtain the theoretical quantitative predictions to be tested in the experiment. The following table describes the experimental parameters and variables.

Tab. 1

Parameters and variables	First treatment	Second treatment
s	[1, 10]	[1, 10]
$c(s)$	0	0
s_1	10	6
s_2	1	5
a_{min}	½	10
a^{max}	½	10
p	[0.5, 60]	[0.5, 60]
D_1	$10-\left(\frac{p_1-p_2}{9}\right)$	$10-(p_1-p_2)$
D_2	$\left(\frac{p_1-p_2}{9}\right)-\frac{1}{2}$	$p_1-p_2-\frac{1}{2}$

As one can see from the table, the quality costs are zero, and, overall, equal for each level of quality: a firm offering a product with quality 1 sustains the same costs with respect to a firm offering a product with quality 10. We will return to this assumption later, when we discuss the results of the experiment. In the first treatment product differentiation is maximal, while it is minimal (or quasi minimal) in the second treatment. The expressions for demands are obtained directly by substituting the values of the exogenous qualities in (2.a) and (2.b). Finally, the distribution of preferences for quality and the price interval are the same in both treatments. Given this simple framework, the theoretical predictions of the one-shot price game between the two firms is summarized in the next table.

Tab. 2

Theoretical predictions	First treatment	Second treatment
p^*_1	58.5	6.5
p^*_2	27	3
Firm 1’s market share	68.42	68.42
Firm 2’s market share	31.58	31.58
Firm 1’s profit	380.25	42.25
Firm 2’s profit	81	9
Consumer surplus (R=5000)	590	3512.5

In table 2 it is possible to observe the equilibrium prices and market shares. The total demand is always the same (each consumer always buys at least one unit of the product), thus the market shares are perfect indicators of the firms' demand. Note that, in equilibrium, the distribution of market shares in the two treatments is the same. This is an interesting characteristic of the Tirole (1988) model, which has never been commented on by any previous authors. The reason for this result is as follows: substitute the equilibrium prices at the second stage, (3.a) and (3.b), in the expression of the indifferent consumer, (1), and obtain

(5) $$\bar{a} = \frac{a^{\max} + a_{\min}}{3}$$

which means that the indifferent consumer, given the assumed distribution of preferences, is invariant with respect to the products' quality level. This makes the market always partitioned between the two firms in the same way. Only when the distribution of preferences varies, can the market shares vary. This is a peculiar property of the model, and it recalls the so-called property of "natural oligopoly", in the general sense that when products can be vertically differentiated the market tends to be more concentrated. The additional theoretical result derived here is that with the distribution of preferences that we have assumed, the market structure may be static over time, regardless of the degree of product differentiation in equilibrium. Despite this, what we expect is that in the second treatment the variance of the markets shares would be higher. This is because in the second treatment the two products are quasi homogeneous and therefore a low price reduction is enough to leave the other firm with a zero market share.

In the first treatment the equilibrium prices are considerably higher than in the second treatment: in this sense we can say that product differentiation relaxes price competition. In the second treatment the products are very similar in terms of quality. As a result of lower prices, in the second treatment the expected profits are lower for both firms.

Finally, note that the consumer surplus, computed assuming R=5000, is higher under the second treatment: minimal product differentiation, in other words, is preferable with respect to maximal product differentiation. In a market with two vertically differentiated products and with the assumed consumer preferences, the general expression for consumer surplus is

(6) $$CS = \int_{a_{\min}}^{\bar{a}} (as_1 - p_1)dv + \int_{\bar{a}}^{a^{\max}} (as_2 - p_2)dv$$

The values of consumer surplus shown in table 2 were calculated using formula (6). In the next section we will summarize the technical organization of the experiment conducted at the University of Siena.

4. Experimental procedures

The experiment was computerized, with each student-subject sitting in front of a computer which was connected to a server. Undergraduate students were recruited at the University of Siena, Faculty of Economics. Forty-eight students formed twenty-four anonymous pairs, which did not change during the experiment. Therefore, each treatment was given by 12 pairs who competed in prices. The two treatments were independent samples.

Each treatment lasted 30 price periods plus 5 practice periods, and students were not informed about the actual last period. During the experiment, subjects had perfect information: prices, market shares, and profits were communicated to each student after each price choice. In the next table we show an example of a computer screen after each price choice.

Tab. 3

period	your price	other's price	your share	other's share	profit	cumulative profit
1	13	56	34.6	63.4	198	198
2	34	54	23.2	76.8	345	543
3	58.5	27	68.42	31.58	380.25	923.25
4	…	…	…	…	…	…

We decided to show the market shares because they are an exact proxy for demand, given that the total demand was equal period to period (as shown previously, it is equal to 9.5). On the other hand, we decided not to show the profit of the opponents, because the model of vertical product differentiation implies a natural asymmetry between the two firms: the firm offering the product with high quality earns, in equilibrium, higher profits. For this reason, it is better for each subject to concentrate only on his/her profits. We showed the market shares of both firms since this also help the subjects to understand how the market reacts in relation to different quality-price strategies. Before the beginning of the experiment, each subject was given the instructions reported in Appendix A. The subjects were then requested to ask any questions.

Each subject could earn from 6.20 to 21 Euros according to the profits earned at the end of the experiment (the 5 practice periods were not taken into account when computing the payments). The software used in organizing the experiment was Ztree, and the program was written by the author[2].

In the next section we will describe the results, each of which will be separately discussed.

[2] The experimental program is available upon request.

5. Results

In the following tables we show the summary statistics of the experiment. In computing each value we have considered the last ten periods of the total 35 played, in order to consider the behavior of subjects quite experienced with the game[3]. In the following tables, means, medians, and relative variance are shown. These values summarize well the general outcome of the experiment, which confirms the theoretical predictions of the model. In appendices B and C it is possible to observe the price behavior of all the subjects throughout the experiment, from the first effective period to the last (that is, from period 6 to period 35), as well as the trend of market shares (appendices D-E).

Tab. 4 - PRICES

FIRST TREATMENT	High quality (10)	Low quality (1)
MEAN	44.01	18.12
MEDIAN	45	15
SD/Mean	0.24	0.61
SECOND TREATMENT	**High quality (6)**	**Low quality (5)**
MEAN	8.46	5.42
MEDIAN	8.25	4.655
SD/Mean	0.49	0.83

Tab. 5 - MARKET SHARES

FIRST TREATMENT	High quality (10)	Low quality (1)
MEAN	74.94	25.06
MEDIAN	75.61	24.39
SD	12.69	12.69
SD/mean	0.16	0.50
SECOND TREATMENT	**High quality (6)**	**Low quality (5)**
MEAN	68.94	31.05
MEDIAN	71.05	28.94
SD/mean	0.35	0.77

[3] The average values computed by considering the total observations are similar.

Result 1: Price competition in the first treatment is relaxed. This result is supported in table 4, where the average prices in the second treatment are considerably lower than the average prices in the first treatment, both for the high quality and low quality firms. The differences in the average prices were tested using a parametric test (t) and two nonparametric tests - the Mann-Whitney (MW) test and Kolmogorov-Smirnov test (KS). All the tests allowed us to reject the null hypotheses with a level of confidence higher than 0.01[4]. The fact that product differentiation relaxes price competition is particularly relevant when we consider the low quality firms: with a product quality equal to 5, these firms charge, on average, a price which is considerably lower than the price charged by the firms offering a product with quality equal to 1.

Thus the data confirm that product differentiation significantly softens price competition. This result can also be observed in appendices B-C, where the prices charged throughout the experiment are shown. The graphs highlight two facts: first, prices are considerably lower in the second treatment for all the subjects-firms considered, and, second, the prices charged by firm 1 (high quality) and firm 2 (low quality) are, in the second treatment, considerably closer than in treatment 1.

Accordingly, profits in the second treatment are lower, for both firms, than in treatment 1, as predicted by the theory. However, in the first treatment the average profits are lower than the ones predicted by the model (313 for the high quality firm and 43.13 for the low quality firm, against theoretical predictions of, respectively, 380.25 and 81), while in the second treatment the average profits are higher than the theoretical ones (55.4 for the high quality firm and 15.98 for the low quality firm, against theoretical predictions of, respectively, 42.25 and 9)[5]. This occurs because of the two following results.

Result 2: Average prices in the first treatment are lower than the theoretical predictions. Although in the first treatment the average prices are considerably higher than in the second treatment, they are lower than the theoretical predictions. The theoretical prices corresponding to the Nash equilibrium are 58.5 for firm 1 and 27 for firm 2. Only in one case (the tenth group-pair in treatment 1, see appendix B), subjects have charged prices equal or very similar to those predicted by the Nash equilibrium. How can we explain the differences?

Firstly, as it was possible to note during the experiment, subjects were interested in profits, but also in market shares, even if the instructions were clear about this point (see Appendix A). This

[4] In the case of high quality firms, $MW=13.36$, $KS=0.98$, $t=33.67$, against, respectively, 2.57, 0.21 and 2.57. Taking the low quality firms, we have $MW=10.21$, $KS=0.7$, $t=11.63$.

[5] Average earnings from subjects in the first treatment have been of 14.5 euro, whereas in the second treatment they have averaged 17.3 euro.

may have caused a risk aversion behavior, in the sense that the high quality firms preferred to charge a price lower than the Nash equilibrium prediction in order to avoid having to deal with a zero market share in the current period.

Secondly, it is important to note that in all the duopolies in the first treatment, prices seem to begin to increase in the last ten periods of the experiment. In other words, one could argue that with an experiment consisting of more than 35 periods subjects could have reached the predictions of the Nash solutions in term of prices. Clearly, this would mean making people stay in front of a computer for two hours instead of one, and this could make subjects lose concentration and thus lead to irrational or random choices.

Result 3: Average prices in the second treatment are higher than the theoretical predictions. In treatment two we obtained a result which goes against the one obtained in treatment 1. This can be observed in table 4, by remembering that the theoretical prices predicted by the Nash equilibrium solution were 6.5 for firm 1 and 3 for firm 2. Also in the second treatment there are, however, pairs whose price behavior resembles the theoretical predictions. How can we explain the higher average prices?

One possible explanation is related to the likelihood of tacit collusion over prices. If we look at appendix C, we can see that after a rapid decrease in prices in the first effective periods, prices tended to rise for both firms. We can also see some attempts to signal the intention to charge higher prices, especially from the low quality firm. Sometimes this signaling ends up with a zero market share for more than one period, but in other cases this strategy succeeds in raising the prices of the subsequent periods of the price game.

In the second treatment the two products are offered with quality 5 and 6. In other words, the two products are very similar from the point of view of quality differentiation, and they can be considered as quasi-homogeneous. It is a well known result of oligopoly theory that the more the products are homogeneous, the more likely it is that a tacit collusion strategy takes place. This seems to be confirmed by the data: for firms offering similar products, it is easier to coordinate their price strategy and charge prices which are higher than the Nash equilibrium solution.

Result 4: The variance of market shares is higher in the second treatment. In the second treatment the average market share for firm 1 is 68.94, against a theoretical value of 68.42. In other words, the experimental markets reflect what is predicted by the Nash equilibrium solution. However, the variance in market shares in the second treatment is very high, both with respect to the first treatment, and in general. This can be seen by looking at table 5 and at appendices D-E.[6].

This was expected at the beginning of the experiment: in treatment 2, products were quasi-homogeneous and a little decrease in the price determined a zero market share for the opponent.

Also, in the first treatment, the average market shares were different from those predicted by the theory. This can be explained in the following way. As we have seen in the analysis of price strategies, the high quality subject-firm (firm 1) preferred, in most cases, to charge a price lower than the Nash equilibrium solution. This was in order to gain a larger market share. This is confirmed by the data regarding the market share in treatment 1: the average market share of firm 1 is 74.93, against a theoretical value of 68.32. In other words, the high quality firm can use the asymmetric (and favorable) market situation in order to obtain a larger market share instead of searching for the profit maximizing strategy. This prevents price-raising for firm 2 (the low quality firm) and leaves the profits at a low level.

These are the four main results that we obtained in the experiment. In the next section we will discuss these data further and we draw some conclusions about product differentiation in the laboratory. In addition, we will return to some assumptions that we made in organizing the experiment.

6. Conclusions and future research

In the experiment described in this paper we tested in the laboratory whether or nor product differentiation relaxes price competition. In particular, we considered the example of vertical product differentiation presented by Tirole (1988) in his textbook on Industrial Organization. In the theoretical example, two firms compete in a market where products possess different quality attributes. Firms compete in a two-stage game: first they choose quality, then the price. In this context, firms are expected to (maximally) differentiate their products, in order to relax price competition: when the two products are not similar, price competition is therefore expected to be low (Shaked, Sutton, 1982).

We used this standard approach to conduct an experiment in which two firms offer a different and exogenously given product quality and compete in prices. We compared two treatments, defined respectively by maximal product differentiation and minimal product differentiation. The laboratory data confirm the theoretical predictions: with higher product differentiation

[6]We conducted a parametric and a non-parametric test in order to analyze the differences in the distributions of the high quality firms' market shares. With a confidence level of 0.01, the *t* test and the Mann-Whitney test allow us to accept the null-hypotheses, while for the Kolmogorov-Smirnov test the null-hypotheses should be rejected. In particular, we have *MW=1.33*, *KS=0.24*, *t=2.41*. Naturally, the tests conducted with the low quality firms' data yield the same results.

prices were significantly lower for both firms, and therefore price competition was relaxed. This result is particularly relevant since so far only horizontal differentiation has been tested in the laboratory, while vertical product differentiation has sometimes been analyzed in empirical studies.

Returning to the theoretical model, we need to briefly consider the assumption of zero production costs. Naturally, this assumption is not completely realistic. Note, however, that the theoretical model implies a result of product differentiation even in the absence of production costs. Moreover, without costs the experimental data confirms the prediction of the model: product differentiation relaxes prices competition. Now, if we introduce costs for quality, we would expect our main result to be reinforced. In other words, assuming zero quality costs makes the result more robust.

We also found other significant results when analyzing the data. For example, with higher product differentiation, average prices are lower than predicted by the theory, while with minimal product differentiation they are higher than predicted by the theoretical model. These two particular results can be explained in several ways, some of which have been described in section 5. However, the main result of price competition relaxed by product differentiation holds, even if the theoretical Nash equilibrium prediction does not fully explain the data.

Another interesting result is in the distribution of market shares. In our particular theoretical framework, the distribution of markets shares is invariant with respect to the quality configuration: whatever the quality offered by firms is, in the Nash equilibrium solution the structure of the market is blocked. Experimentally, we found that market shares are similar to those predicted in both types of quality configuration (maximal and minimal product differentiation). However, under maximal product differentiation, it seems that the high quality firm faces a higher market share than under minimal product differentiation. This occurs because the market asymmetry (which favors the high quality firm) is stronger under the former.

An interesting issue thrown up by the experimental data is as follows: theoretically, consumer surplus is considerably higher under minimal product differentiation, as shown in table 2. However, the data show that with minimal product differentiation a tacit collusion outcome is likely. This causes prices to be higher than the ones predicted. Therefore a tradeoff exists between product differentiation considerations and the likelihood of tacit collusion: although product differentiation should be taken into consideration whenever one (for example, an antitrust authority or a regulator) has to decide about alternative market configurations, we should pay careful attention to the effects of those configurations on the possibility of collusive behavior.

The results presented here could be extended, by using different approaches in the laboratory. For example, we could introduce more than one dimension along which the products can be differentiated. This would complicate the analysis, but it could provide a further step towards a better comprehension of real markets, where products are rarely characterized by one attribute alone. Also, future research could introduce endogenous quality choice in the standard framework. In this way, the interaction between quality and price choice would be more accurately studied. It is well known that there are several theoretical features of oligopoly models which are very difficult to reproduce in the laboratory (for example backward induction processes). However, we hope that the refinement of the experimental procedures will facilitate the analysis of more complex oligopoly contexts.

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Appendix A -Translation of instructions (first treatment, high quality firm)

Today you are a firm, A, which is offering its product in a market, and whose goal is to maximize profits. In your market there is another firm, B, who is your competitor. The products offered vary according to quality and price.

The products' quality varies between 1 and 10. The quality of your product is given and equal to 10. Your competitor offers a product with quality 1. You and your competitor have to simultaneously choose the price of your products.

The willingness to pay for quality is uniformly and continuously distributed across several consumers and varies between ½ and 10.

Your demand function and the demand of your competitor are, respectively

$$D_A = 10 - \left(\frac{p_B - p_A}{q_B - q_A}\right) \quad \text{and} \quad D_B = \left(\frac{p_B - p_A}{q_B - q_A}\right) - \frac{1}{2}$$

where p_A and p_B are, respectively, your price and the one charged by firm B, and q_A and q_B are the quality of your product and the quality of your competitor's product. Given the price choices, consumers are divided into those who buy your product and those who buy product B.

The profits are given, for each firm, by the chosen price multiplied by the demand obtained (quality costs are zero). The higher your profits are at the end of the experiment, the higher your monetary earning will be by participating in this experiment. At the end of the experiment, which will last about 45 minutes, the remuneration will be between 6.2 and 21 Euros according to the profits you make.

The market is organized into several identical periods in which you have to choose the price maximizing your profits, given the price choice of your competitor. In each period you and your competitor have to simultaneously decide the price in the interval [0.5, 60]. When you have both made this choice, the information about your market share, the competitor's market share, charged prices, and your profit will be disclosed. Again, you will be requested to choose your price. Period by period you will be able to see your cumulative profits.

Bear in mind the following points:

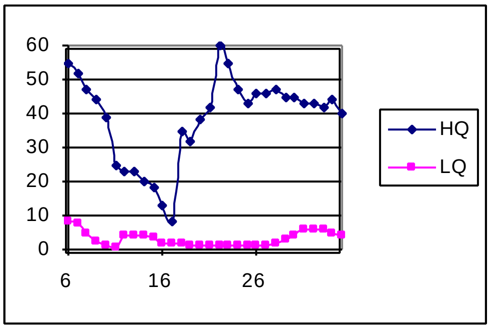
-your goal is to find a price-quality combination which maximizes your profits given the other's choices; remember that the two products are offered with different qualities;

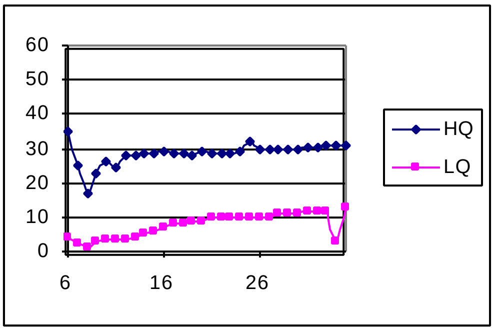
-concentrate on profits and not on market shares;

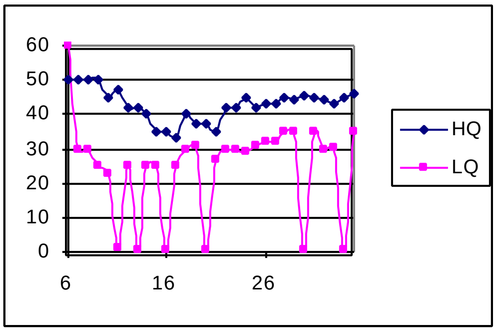
-do not waste time in computing: adjust your price in an attempt to achieve profits which are higher than those earned in the previous periods;

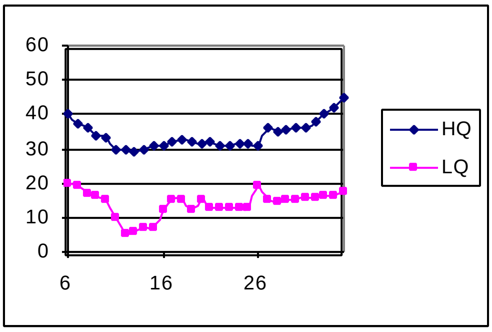
-do not make random or irrational choices: these will be found out by the researchers and will be excluded from the overall observations.

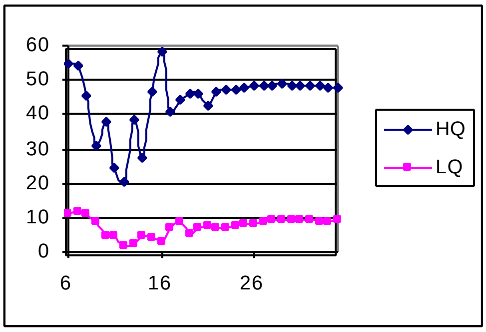
Appendix B: First treatment prices

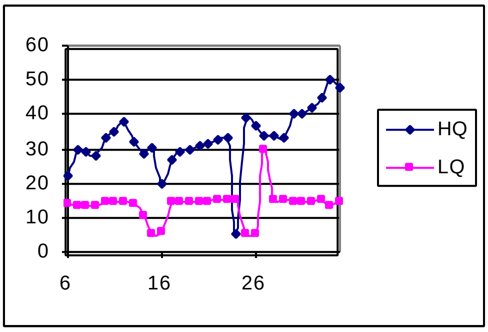


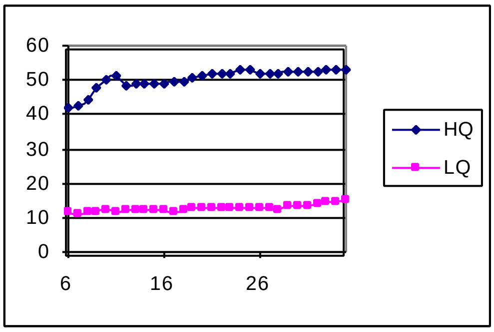











60
50
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30
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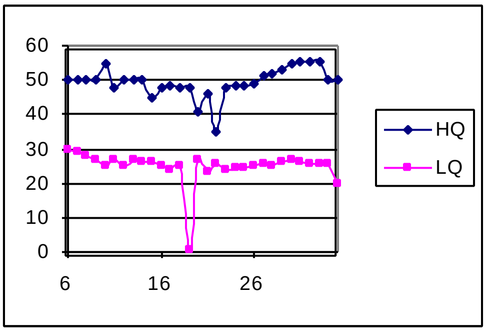
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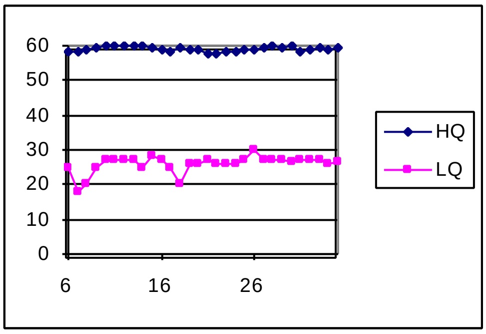
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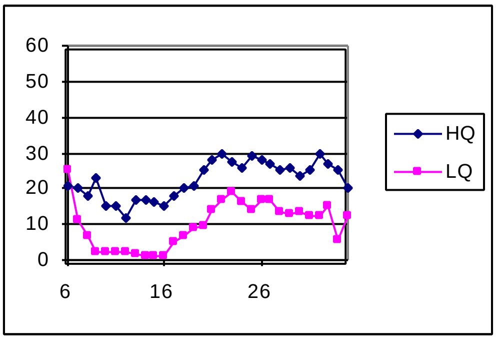
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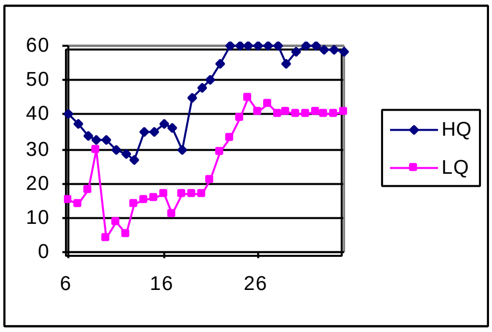
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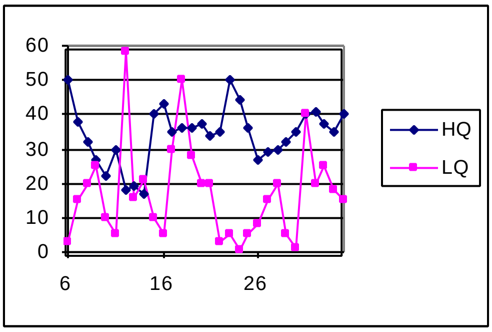
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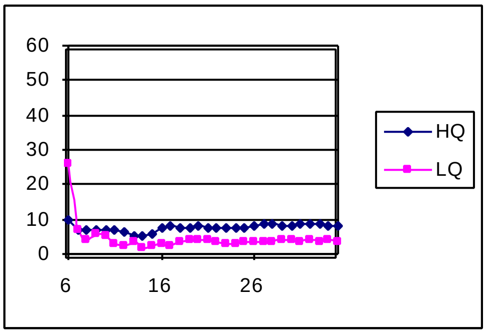
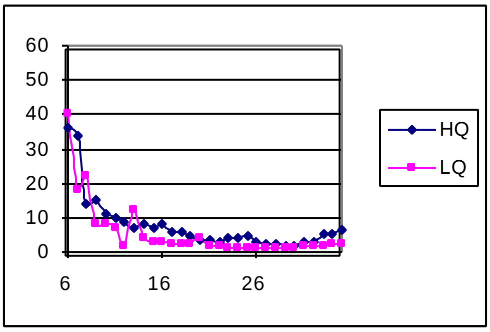
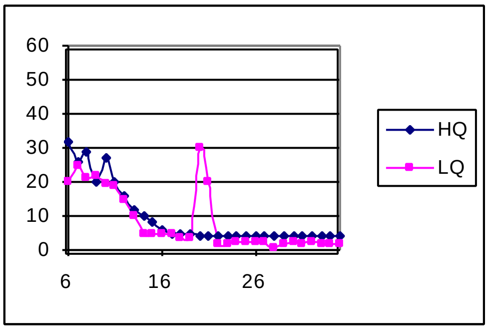
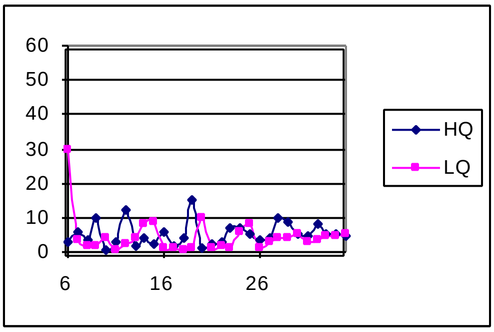
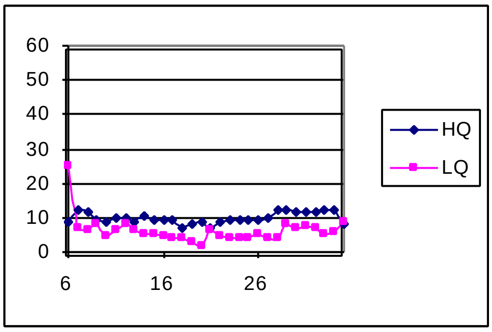
Appendix C: Second treatment prices

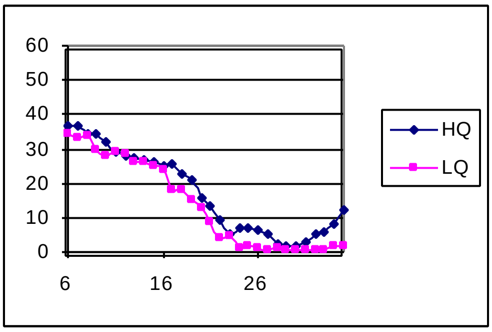


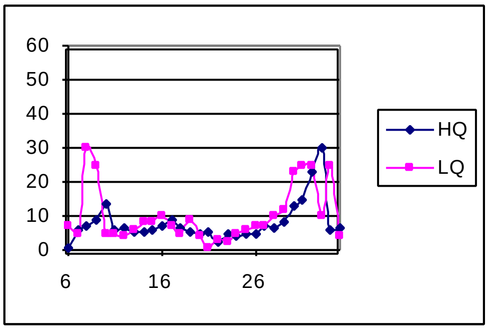








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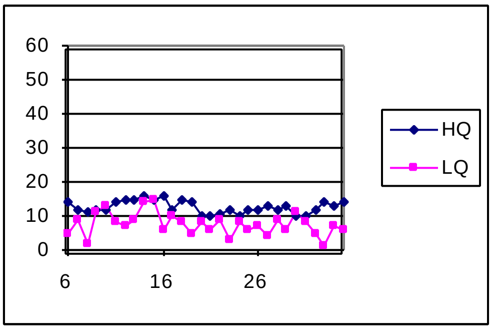
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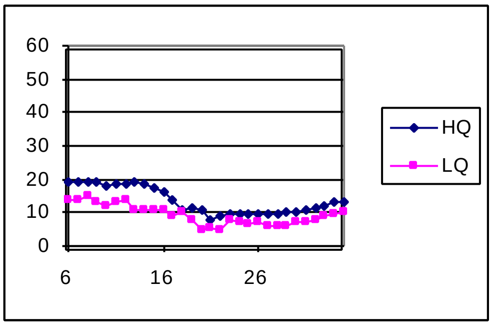
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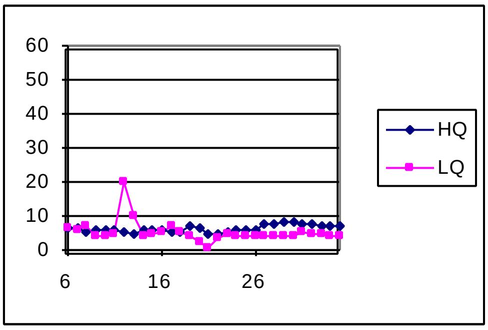
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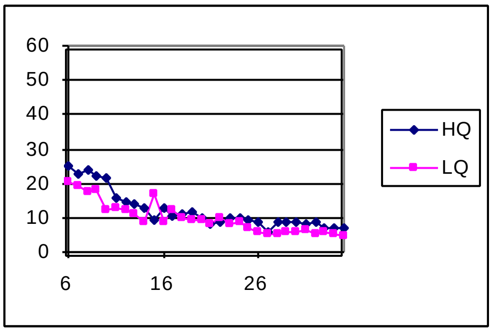
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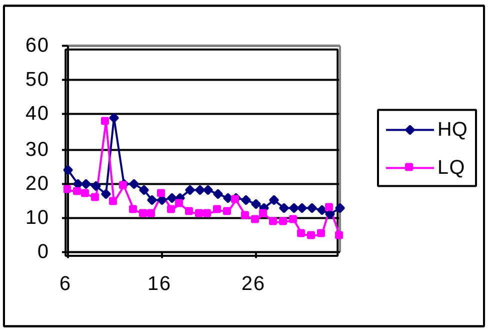
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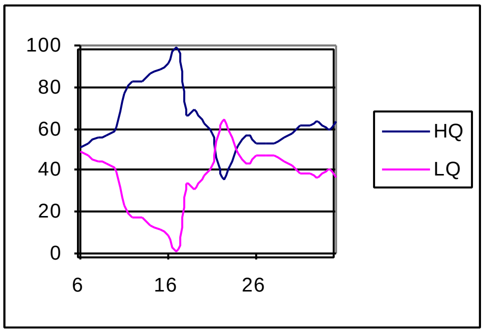
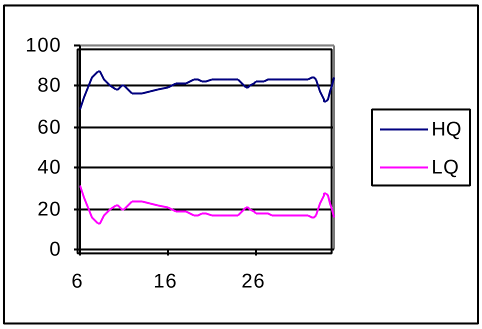
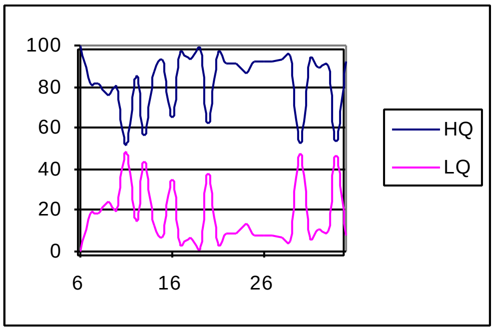
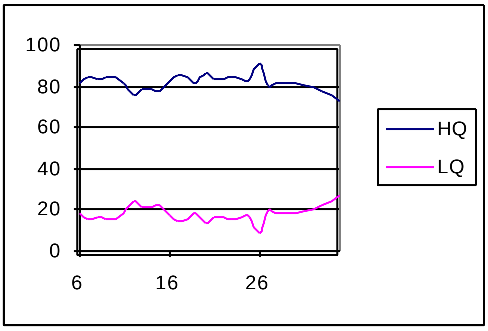
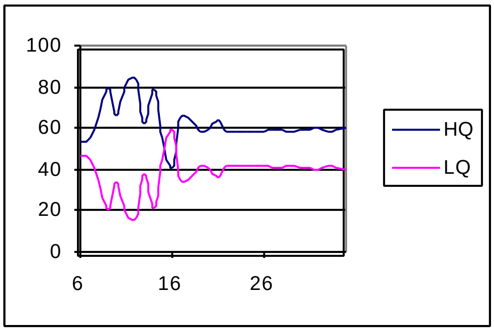
Appendix D: First treatment market shares

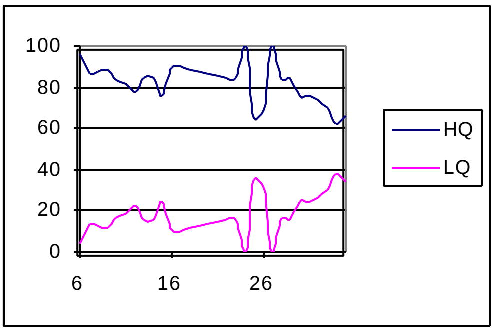


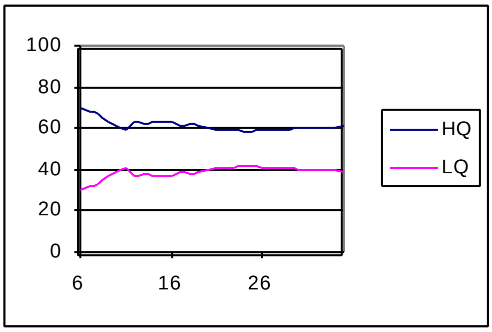








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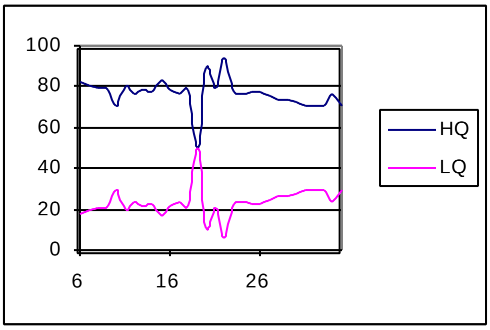
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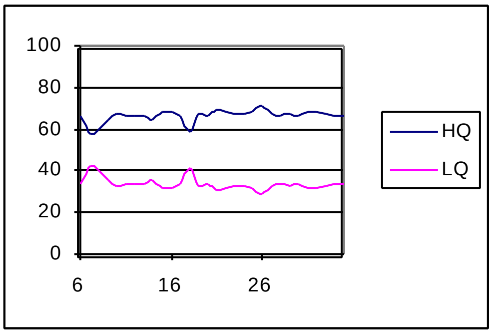
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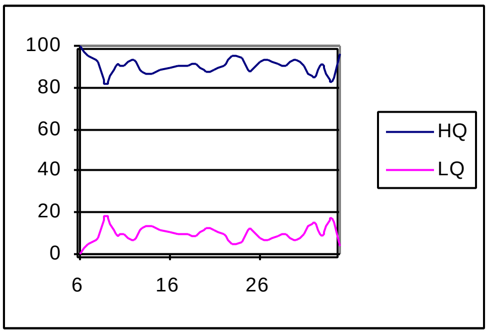
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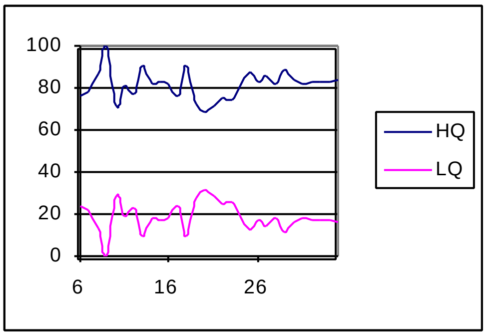
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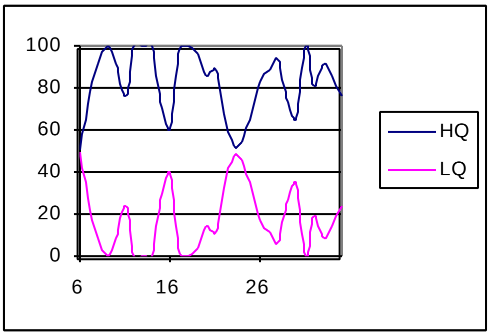
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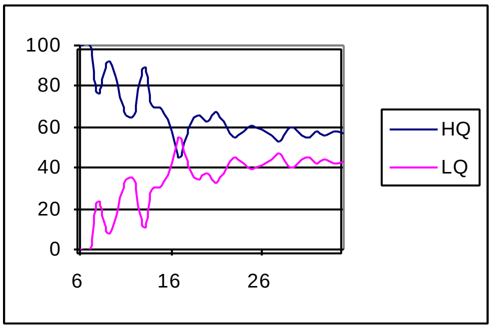
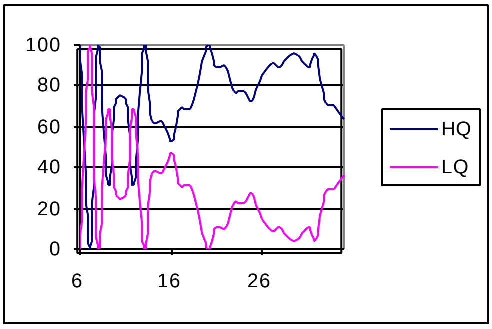
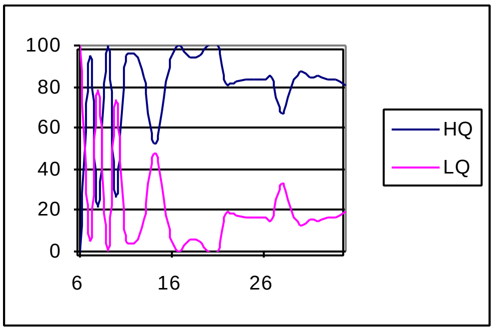
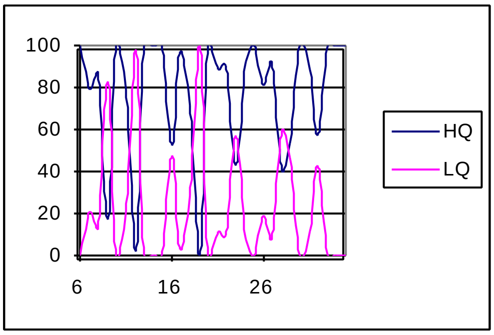
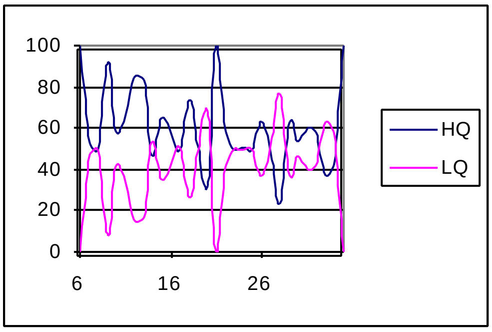
Appendix E: Second treatment market shares

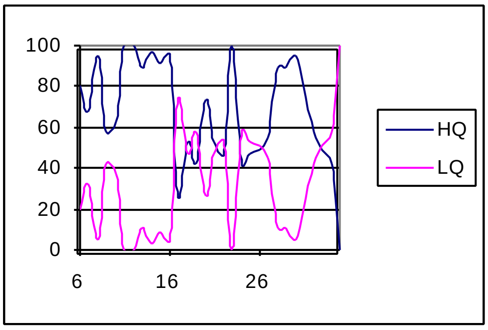


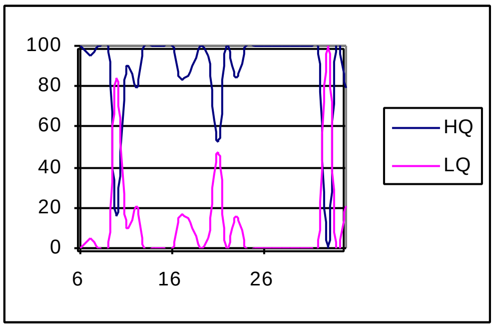








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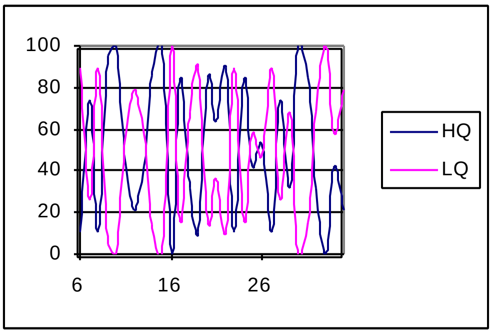
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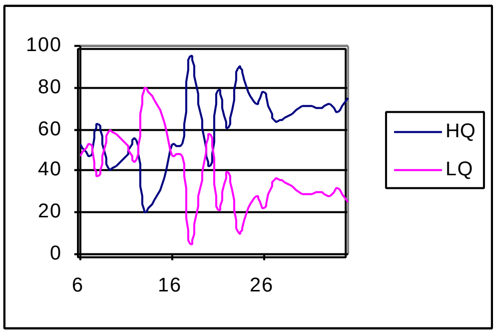
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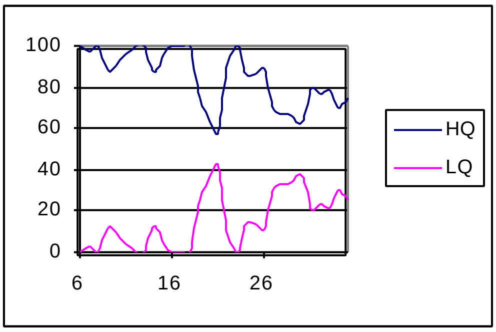
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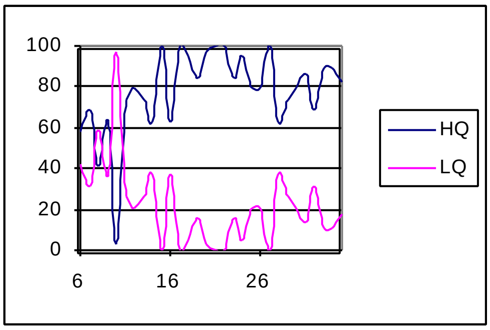
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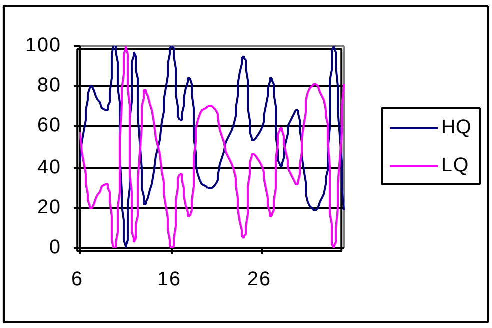
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