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DEMAND AND COMPETITION IN THE RETAIL MARKET OF DIESEL FUEL IN BULGARIA

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Key words:
Retail diesel fuel market, demand, competition, price elasticity

Abstract

The purpose of the article is to evaluate the parameters of demand for diesel fuel by households in Bulgaria, the structure of the retail fuel market and the effectiveness of competition. Based on statistical data, the parameters of the demand function for diesel fuel by households were estimated and the price and income elasticity was determined. Models of market behaviour are applied and theoretical values of equilibrium quantities and prices are estimated. The hypotheses of cartel existence, revenue maximization, competitive market with low market concentration and perfect competition are tested.

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1. Introduction

The increase in fuel prices is being received painfully and with understandable concern by consumers in the EU and especially in Bulgaria, mainly due to the relatively low household incomes. Periodic protests have been calmed by declarations and promises by governments and the initiation of investigations by prosecutors and regulatory institutions. Promises of revelations of cartel agreements between gas station chains and the imposition of penalties have not been realized for more than a decade. The Commission on Protection of Competition (CPC 2017) did not find violations during the inspections of gas station chains and gave contradictory recommendations in its decisions

The present article aims, based on the Industrial Economy paradigm, to test the hypothesis of the presence of non-competitive behaviour in fuel pricing in the retail market and to offer an adequate explanation of the market situation. A reasonable assumption of a cartel can be made at market prices and sales profitability that are equal to or close to the theoretical levels of monopoly prices and corresponding values of the Lerner index under monopoly. To determine these theoretical values, it is necessary to estimate the demand function, the price elasticity of demand, and the value of the marginal costs of gas stations.

Aggregated annual data on household consumption, average fuel prices and average cash income per household from national statistics were used to estimate the demand function. Data were used on the diesel fuel consumption per 100 households, diesel fuel prices and household incomes for 2012-2021. A linear multiple regression model was used to estimate the demand, the parameters of which were estimated using the method of least squares. squares. The regression model describes the dependence of consumed fuel quantities on households' average prices and monetary incomes.

2. Literature review

On the problems of retail fuel prices, there are numerous publications by researchers from different countries, which are directed in several directions. Chalakova-Todorova (2019) examines the factors of retail fuel pricing related to supply chains, the characteristics of market participants, as well as the influence of EU and Bulgarian legislation. In the publication, direct and indirect factors are highlighted, along with the main price-forming factors, the main competitors behaviour and the demand's price elasticity are indicated. Balke (1998), Clerides (2010) and other authors comment on the relationship between US retail motor fuel prices and oil prices. The analysis emphasizes the propagation of price shocks and the symmetry of the change in retail prices when crude oil prices increase and decrease. The authors point out that the source of asymmetry is the sellers' market power and consumers' costs of price research.

A. Todorov (2019) analyzes the regional market structure and price levels of the fuel market in Bulgaria. A negative correlation was found, albeit weak, between the number of gas stations and the average prices of all types of motor fuels in the individual administrative regions of the country.

Based on several studies of fuel markets in the United States, Great Britain and Canada, Druzic (2018) et al. rate the price elasticity of demand as very low, especially in the short run at -0.26 and in the long run at -0.58. The median income elasticity has a positive value of 0.57. Taghvaee (2014), Alves (2003) and Lin (2013) find low price and income elasticities of fuel demand in Iran, Brazil and China.

Nowakowski and Karasiewicz (2016) find a positive relationship between market concentration and fuel retail margins in 24 European Union countries, and this trend is particularly strong in the presence of multinational and vertically integrated companies.

3. Theoretical model

The degree of competition in the diesel fuel market can be determined by comparing the theoretical values of equilibrium prices under different market structures and firm behaviour with actual market prices. Theoretical price values are calculated using the demand function, the assumed market structure and the behaviour of firms. The quantity demanded of diesel fuel is a function of the market price and household income, and the parameter values can be determined by the method of least squares. Hypotheses about market structure and firm behaviour are profit-maximizing cartels, revenue-maximizing cartels, profit maximization in low-concentration markets and perfectly competitive markets.

The effectiveness of competition is assessed by the Lerner index (Elzinga, K., and Mills, D., 2011), and its relationship with the price elasticity of demand and market concentration is explained by Carlton and Perloff (1990).

Monopoly market

The monopolist produces and supplies the entire market quantity (Q) by trying to supply the quantity at which it will maximize profit. The monopolist's profit is the difference between revenue, variable and fixed costs and can be represented by the following formula familiar from the microeconomic theory of the firm.

$$\pi = P.Q - c.Q - FC \rightarrow max$$

It is assumed that the monopolist seeks to maximize profit by restricting supply until the revenue from the final product equals the marginal cost of its production. The optimal quantity for the monopolist can be determined by the quantity at which the first partial derivative of the profit function equals zero:

$$\frac{\partial \pi}{\partial Q} = \frac{\partial P.Q}{\partial Q} + P - c = 0$$

After converting the above equation, we get:

$$-\frac{\partial P.Q}{\partial Q.P} = \frac{P - c}{P}$$

The expression on the left is the reciprocal of the price elasticity of demand:

$$-\frac{1}{e} = \frac{P-c}{P}$$

The expression on the right-hand side is the Lerner index, the value of which, according to the equation, is inversely proportional to the price elasticity of demand. On the other hand, the Lerner index is a ratio between the profit (margin) from the sale of a unit of product and the revenue from that sale, or profitability of sales. The equation shows that the monopolist's sales profitability is objectively limited by the price elasticity of demand. From the same equation, it follows that high profitability is possible only in markets with low price elasticity, where consumption shrinks to a lesser extent than the increase in the market price. The low price elasticity is explained by several characteristics of the product and market demand, but mostly by the degree of necessity and urgency of the consumption of the goods, the presence of high market barriers and the lack of close substitute products. Conversely, under perfectly elastic demand (e=∞) the profitability of sales is zero and the minimal increase in price will cause demand for the firm's products to disappear. Theoretically, perfect price elasticity of demand is one of the characteristics of markets with perfect competition, with a homogeneous product, free entry, perfect information, and a large number of sellers and buyers. It can be assumed that the presence of low price elasticity of demand for diesel fuel is a prerequisite for large margins and profitability in an alleged monopolist or cartel.

Market with n number of firms:

There are n-number of equal-sized firms in the market that sell equal quantities of a product (Q/n). The profit function for one of the firms can be represented as follows:

$$\pi = P.\frac{Q}{n} - c.\frac{Q}{n} - FC \rightarrow max$$

$$MR - c = 0$$

Marginal revenues take the following form:

$$MR = \frac{\partial P.Q}{\partial Q}.\frac{1}{n} + P$$

Marginal revenue is substituted into the profit maximization equation:

$$\frac{\partial P.Q}{\partial Q}.\frac{1}{n} + P - c = 0$$

Market power is determined by the price elasticity of demand and the number of firms. Market power increases as the price elasticity of demand decreases and as the number of firms decreases. If firms offer equal quantities, then a firm's market share can be represented as s=1/n.

$$-\frac{1}{e}.s = \frac{P-c}{P}$$

According to the above expression, the profitability of sales (market power) of one of the firms operating in the market is inversely proportional to the price elasticity of demand and directly proportional to the market share. A high market share is the second necessary prerequisite for obtaining monopoly profits.

The industry or market profitability of sales (Lerner index) can be calculated as the weighted average profitability of the sales of the firms operating in the market using their market shares as weights.

$$the\ -\frac{1}{e}.\sum s^2 = \frac{P-c}{P}$$

The sum of the squares of the market shares is the market concentration index (Hirschman and Hirfendahl):

$$-\frac{1}{e}.HHI = \frac{P-c}{P}$$

The market power of firms in a market is determined by the product of the reciprocal of the price elasticity of demand and the market concentration index. The value of the market concentration index HHI can be

calculated as the sum of the squares of the market shares defined as a ratio (0-1) or as a percentage (0-100%). In the first case, the value of the index varies from 0 to 1, and in the second from 0 to 10,000.

In the parasite analysis methodology, the CPC (2009) provides guidance on the relationship between HHI values, the degree of market concentration and market competitiveness. With index values up to 1000 (0.1), the market has low concentration and is defined as competitive. For values between 1000 and 2000 (0.1 – 0.2), the level of concentration is medium and the market is relatively competitive and for values above 2000 (0.2) the concentration is high and the market is weakly competitive. For a market to fall into the first group, the market must have more than 10 companies of the same size, in the second group between 5 and 10 companies, and in the third – less than 5 companies of the same size.

The market power that a firm can exercise is the result of the demand conditions determined by price elasticity, the market structure determined by the firm's market share and the firm's behaviour (profit maximization, market capitalization, revenue maximization).

A Model of fuel demand and price elasticity

The fuel demand function is represented by a linear multi-regression model. The dependent variable is the amount in litres of fuel consumed per 100 households. The independent variables are the average annual fuel prices in BGN and the annual income of 100 households.

By definition, demand is a function of product price, prices of substitute goods, and consumer income.

$$Qd = f(P, Pi, Y)$$

To the extent that automotive fuels, and diesel in particular, have no close substitutes, demand can be assumed to be a function of fuel prices and household income.

$$Qd = a.P + b.Y + \varepsilon$$

Where:

Qd – the amount of demand in litres of diesel fuel per 100 households;

P – the price of diesel fuel in BGN per litre;

Y – annual monetary income of 100 households in BGN.

The model parameters were estimated using the method of least squares. In the given form of the demand function, the partial derivative of demand with price is equal to the regression coefficient (a).

$$\frac{\partial Q}{\partial P} = a$$

The value of the price elasticity of demand can be calculated as the product of the regression coefficient and the relationship between price and quantity. The linear demand function is characterized by variable price elasticity, and due to the negative relationship between price and quantity, as price increases, the P/Q ratio increases, and along with this, the price elasticity of demand increases.

$$e = a.\frac{P}{Q}$$

From the demand function, the price function (inverse demand function) can be derived.

$$P = \frac{Q}{a} - \frac{b}{a}.Y$$

Profit maximization, cartel

We assume that the hypothesized cartel tries to maximize profit by supplying to the market the quantity at which revenue from the last unit of product sold equals marginal cost. A monopolist's revenue is defined as the product of quantity and price:

$$TR = P.Q = \frac{Q^2}{a} - \frac{b}{a}.Y.Q$$

Profit can be represented as the difference between income and expenses:

$$\pi = TR - TC$$

$$\pi = \frac{Q^2}{a} - \frac{b}{a}.Y.Q - c.Q - FC \quad max$$

The quantity at which the monopolist maximizes profit is:

$$Q_m = \frac{a.c + b.Y}{2}$$

and the monopoly price will be:

$$Pm = \frac{c}{2} - \frac{b.Y}{2a} = 1/2.(c - \frac{b.Y}{a})$$

The behaviour of firms (supply) under perfect competition

In perfectly competitive markets, firms make no economic profit and the price is equal to the marginal cost. With a linear demand function and constant marginal cost, the market equilibrium under perfect competition will be established at twice the monopoly quantities.

$$Q_c = a.c + b.Y$$

Profit maximization in an n-firm market

Supply in a market with n number of firms can be derived from the Cournot model, in which firms try to maximize profits by accepting competitors' supply permanently. The result of such behaviour is a partition of the market without the need for negotiation, and the market quantity is determined by the number of firms. In this market model, n-firms that independently maximize profits will produce n/(n+1) of the equilibrium quantity under perfect competition (Carlton, D., Perloff , J. , 1990, p.267) . So, for example, a monopolist offers ½ of the competitive quantity, a duopoly offers 2/3, three firms 3/4, and so on.

$$Q_n = \frac{n}{n+1}.Qc$$

If we assume that firms offer the same quantities and in the above formula we replace n with 1/HHI, then the supply at the corresponding degree of market concentration will be:

$$Q_{HHI} = \frac{1}{HHI + 1}.Qc$$

The above formula makes it possible to estimate the market supply according to the degree of market concentration defined by the CPC methodology. With a low degree of concentration and competitive markets (HHI<1000 /0.1), the market quantity under independent profit maximization will be no less than 90.9% of the quantity under perfect competition. In relatively competitive markets with a medium degree of concentration (1000<HHI<2000) the market quantity will be between 83.3% and 90.9% of competitive markets and in weakly competitive markets with high concentration (HHI>2000), the market quantity will be between 50% and 83.3% of the competitive amount.

Revenue maximization, cartel

Revenue maximization is an alternative strategy by which firms attempt to maximize market share. Baumol's model underlies many studies of oligopoly behaviour (Amihud and Jacob, 1979). To follow such a strategy, firms try to increase the quantities sold until the price of the final product drops to zero. Firms will make profits if the average cost of quantities sold exceeds marginal cost or losses at prices below cost. The implementation of the strategy in the second case depends on the ability of the trader to absorb the potential losses for a certain period.

$$\frac{\partial TR}{\partial Q} = \frac{2.Q}{a} - \frac{b}{a}.Y = 0$$

$$Q = \frac{b}{2}.Y$$

According to the above formula, the revenue-maximizing supply is determined only by the parameters of the demand function and will be equal to half the demand at a market price equal to zero.

Statistics and results

Table 1 presents statistics on annual diesel fuel consumption in litres, cash income per 100 households and the average price of diesel fuel per litre for the period 2012-2021.

Table 1

Cash income, consumption per 100 households and diesel prices

Year	Diesel fuel litres	Price	Cash income
2012	2577.9	2.62	1003700
2013	3337.8	2.61	1122400
2014	3860.9	2.51	1148900
2015	5398.1	2.2 0	1172300
2016	6630.1	1.92	1196600
2017	7269.4	2.02	1269700
2018	8459	2.17	1328600
2019	9146.8	2.22	1422500
2020	8844.1	1.96	1497700
2021	8864.3	2.15	1601500

Source: National Statistical Institute

The annual consumption per 100 households during the period 2012-2021 ranges from 2577.9 to 9146.8 litres with the highest value in 2019 and lower consumption in the following two years due to the covid 19 pandemic. The average annual consumption for the period is 6438.8 litres. with a standard deviation of 2367.7.

Diesel fuel prices range between BGN 1.92 and BGN 2.62/l. with the highest values recorded in the first three years of the research period. The average price is BGN 2.238/l, and the standard deviation is 0.245.

The cash income of 100 households increased from BGN 1,003,700 to BGN 1,601,500 with an average value of BGN 1,276,390 and a standard deviation of BGN 176,159.

Table 2

Descriptive statistics

Indicator	Diesel fuel	Price	Cash income
Min	2577.9	1.92	1003700
Max	9146.8	2.62	1601500
Average	6438.84	2,238	1276390
St. dev.	2367.7	0.245	176159

Source: own calculations

Estimation of demand and price elasticity

Fuel demand was estimated using a linear two-factor regression model. The dependent variable is the amount of diesel fuel consumed per 100 households in litres, the independent variables are the average annual fuel prices in BGN and the average annual income of 100 households.

$$Qd = a \,.\, P + b \,.\, Y$$

Where:

Qd – the amount of demand in litres of diesel fuel per 100 households;

P – the price of diesel fuel in BGN per litre;

Y – annual monetary income of 100 households in BGN.

The model parameters were estimated using the method of least squares.

Table 3

Regression analysis results

Regression Statistics	
Multiple R	0.994377
R Square	0.988786
Adjusted R Square	0.862385
Standard Error	812.2257
Observations	10

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0					
Price	-2894.54	520.9514	-5.55626	0.000537	-4095.86	-1693.22
Cash income	0.010112	0.00091	11.1092	3.85E-06	0.008013	0.012211

Source: own calculations

The regression model (Table 3) explains over 86% of the variation in diesel consumption. Regression coefficients are statistically significant at the 95% confidence interval.

According to the results of the regression analysis, an increase in the price of diesel fuel by BGN 1 is expected to reduce the consumption of 100 households by 2,894 liters. The price elasticity of demand can be calculated by multiplying the regression coefficient by the price and dividing it by the quantity consumed in the corresponding year.

$$Qd = -2894{,}54 \,.\, P + 0{,}010112 . Y$$

At the same time, the demand function changes as household income (Y) increases. The regression dependence shows that other things being equal, the demand for fuels will increase by approximately one litre for every one hundred BGN increase in the annual monetary income.

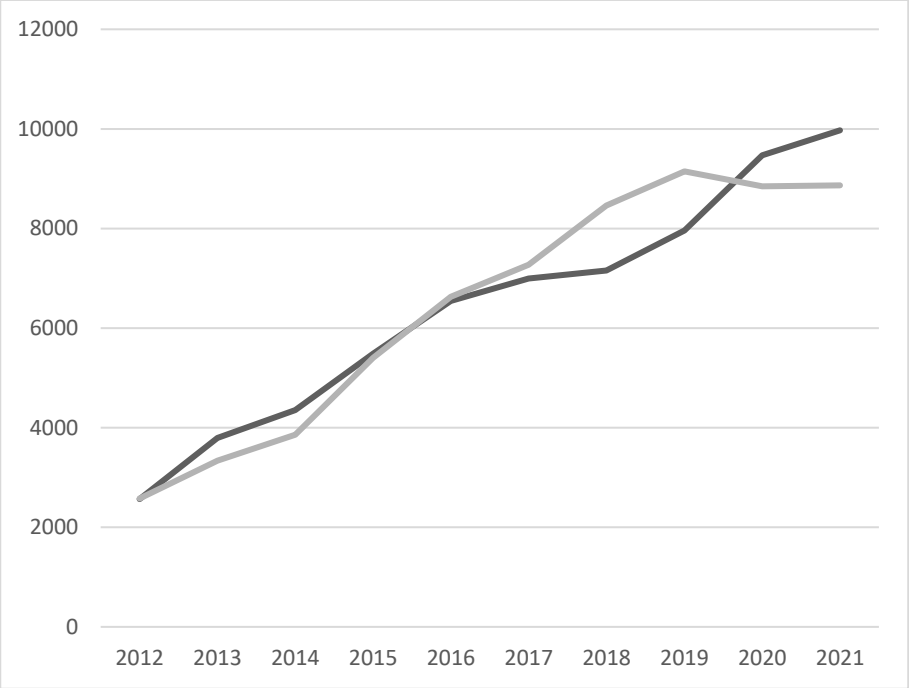

Figure 1. Actual consumption *(grey)* and estimated consumption *(black)* of diesel fuel
Source: National Statistical Institute (NSI) and own calculations

The demand function estimated as a dependence between price and quantity at a fixed household income for 2021 has the following form:

$$Qd = 16194{,}4 - 2894{,}5\,.P$$

The price elasticity of demand is defined as the partial derivative of demand with respect to price (the regression coefficient) multiplied by the relationship between market price and quantity:

$$e = -2894{,}5\,.\frac{P}{Q}$$

The linear form of the demand function implies a variable price elasticity, the value of which increases with an increase in price and a corresponding decrease in the quantity demanded, due to an increase in the P/Q ratio, which is also seen in the following table. Based on the parameters of the regression model, at the level of household income in 2021, the values of demand and price elasticity were calculated for fuel prices in the range of BGN 1.50 to BGN 4.50 per litre.

Table 4

Price, demand and price elasticity of demand for diesel fuel

Price	Demand	Price elasticity	Price	Demand	Price elasticity
1.50	11853	-0.366	3.10	7221	-1,243
1.60	11563	-0.401	3.20	6932	-1.336
1.70	11274	-0.436	3.30	6642	-1,438
1.80	10984	-0.474	3.40	6353	-1,549
1.90	10695	-0.514	3.50	6064	-1,671
2.00	10405	-0.556	3.60	5774	-1.805
2.10	10116	-0.601	3.70	5485	-1.953

2.20	9826	-0.648	3.80	5195	-2,117
2.30	9537	-0.698	3.90	4906	-2,301
2.40	9248	-0.751	4.00	4616	-2,508
2.50	8958	-0.808	4.10	4327	-2,743
2.60	8669	-0.868	4.20	4037	-3,011
2.70	8379	-0.933	4.30	3748	-3,321
2.80	8090	-1.002	4.40	3458	-3,683
2.90	7800	-1.076	4.50	3169	-4,110
3.00	7511	-1.156	4.60	2890	-4,607
			4.70	2590	-5,253

Source: own calculations

With an average price of diesel fuel for 2021 of BGN 2.15 and fixed cash income of households as of 2021, the demand function is:

$$Qd = 16194{,}4 - 2894{,}5\,.\,2{,}15 = 9971$$

The value of the price elasticity of demand at the given price and quantity is -0.62.

$$e = -2894{,}5\,.\frac{2{,}15}{9971} = -0{,}62$$

Inelastic demand can be explained by the lack of substitutes for diesel fuel. The calculated data in table 4 show that the demand has unit elasticity at a diesel fuel price of about BGN 2.80 per litre and is inelastic at lower prices.

Behaviour of companies

The market behaviour of firms can be judged on the basis of the level of current market prices compared to theoretical price levels when following different strategies by firms. The hypotheses that can be tested are about:

- maximizing profits by forming a cartel;
- maximizing revenue by forming a cartel;
- independent (uncoordinated) maximization of individual profits;
- acceptance of the market price (market with perfect competition).

Market Structure and Market Behaviour in 2022

Cartel, profit maximization

The existence of monopoly power and its use by the would-be monopolist or cartel can be tested by comparing market prices and quantities with monopoly prices. Since the quantities for the current (2022) year are not known, a comparison can be made between current prices and the prices at which the monopolist (cartel) would maximize profits. The monopoly price can be calculated from the inverse demand function at the cartel's profit-maximizing quantity.

The price function (inverse demand function) can be derived from the demand function:

$$Q = 16195 - 2895\,.\,P$$

$$P = 5{,}59 - 0{,}345\,.\,Qk$$

Where: Qk is the quantity in thousands of litres.

By 2022 the monetary income of a family for the last four quarters is BGN 18,386, therefore the demand function would change to:

$$Q = 18592 - 2895 \,.\, P$$

$$P = \ 6{,}42 - 0{,}345 \,.\, Qk$$

To maximize profit, the monopolist supplies a quantity at which marginal revenue (MRm) equals marginal cost. Marginal revenue is the partial derivative of the demand function with respect to quantity, and the monopolist's revenue function is obtained by multiplying the market price by the sales quantity:

$$TRm = P \,.\, Q = \ 6{,}42 \,.\, Qk \ - \ 0{,}345 \,.\, Q_k^2$$

The wholesale price of diesel fuel, which as of the date of the study was BGN 2.94 per litre, was taken as the value of the marginal costs.

$$MRm = \ 6{,}42 \ - \ 2 \,.\, 0{,}345 \,.\, Qk \ = c = 2{,}94$$

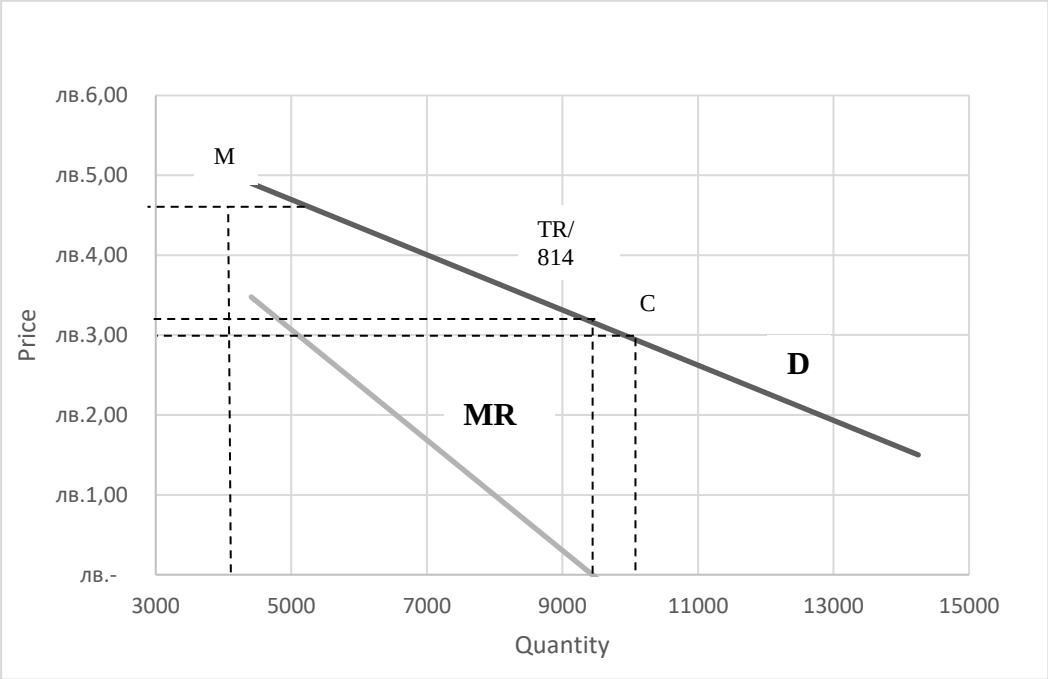

Figure 2. Market equilibrium under cartel, competitive market, perfect competition 2022.

Source: own calculations

Solving the above equation determines the quantity at which the potential cartel will maximize profits, which in this particular case is at a quantity of 5,043 litres per year per 100 households. With this monopoly quantity, the market price should reach BGN 4.68 per litre.

$$Q_k^m = \frac{6{,}42 - 2{,}94}{2 \,.\ 0{,}345} . = 5{,}043$$

$$Pm \ = \ 6{,}42 \ - \ 0{,}345 \,.\, 5{,}043 \ = 4{,}68 \ BGN/l.$$

Profit maximization is illustrated by point M in Figure 2.

Learner index value is 0.372.

Cartel, revenue maximization

A possible cartel would maximize revenue (point TR in Fig.2) when it sells (offers) the last product where the increase in revenue (marginal revenue) will be equal to 0.

$$MRm = \ 6{,}42 \ - \ 2 \,.\, 0345 \,.\, Qk \ = 0$$

$$Qk = \frac{6{,}42}{2 \,.\ 0{,}345} . = 9{,}304 \text{ х. л.}$$

With this quantity, the equilibrium market price will be BGN 3.21/l.:

$$P(maxTR) = 6{,}42 - 0{,}345 \,.\, 9{,}304 = 3{,}21 \text{ лв.}$$

In a perfectly competitive market (point C in Fig. 2), the market price will be equal to the marginal cost (BGN 2.94), and the market quantity will be twice the monopoly quantity.

$$P = 6{,}42 - 0{,}345 \,.\, Qk = 2{,}94$$

$$Q_k^c = \frac{6{,}42 - 2{,}94}{0{,}345} = 10{,}09 \; litre$$

The return on sales for such market behaviour is 0.092.

A competitive market with a low level of concentration

A study by A Todorov (2019) defines the retail fuel market in Bulgaria as a market with a low and medium degree of concentration according to the criteria of the methodology of the Commission for the Protection of Competition. The calculated Hirschmann and Hirfendahl index for regions in Bulgaria ranges from 509 for the Stara Zagora region to 1456 for the Vidin region, with a mean of 814, a median of 792, and a standard deviation of 254.

The market quantity that traders would offer in a competitive market with concentration HHI=0.814 (point 814 in fig.2) is 9.33 thousand litres. per 100 households:

$$Q_{HHI} = \frac{1}{0{,}0814 + 1} . 10{,}09 = 9{,}33$$

The equilibrium price for this quantity is BGN 3.20:

$$P(HHI814) = 6{,}42 - 0{,}345 \,.\, 9{,}33 = 3{,}20 \; BGN$$

This price is just over 2% higher than the average market price for 2022 [1]. The price elasticity of demand is -0.996 and the value of Learner 's index is 0.082, which indicates a low degree of market power.

Figure 3 illustrates the relationship between price, revenue and profits of an alleged cartel, determined based on the consumption of 100 households. At an average market price for 2022 of BGN 3.14, the behaviour of an alleged cartel is more revenue-maximizing than retailer profit-maximizing.

[1] Data at www.fuelo.bg



Figure 3. Revenues and profits of an alleged cartel
Source: own calculations

The data from the analysis of the various hypotheses for the competitive behaviour of retailers in the diesel fuel market before 2022 are summarized in Table 5:

Table 5

Hypotheses for market structure and company Behaviour 2022.

Hypotheses	**Equilibrium price**	**% of the average price**	**Learner Index**
Cartel	4.68	149%	0.372
Maximize revenue	3.21	102.3%	0.092
A competitive market with low concentration	3.20	102%	0.082
Perfectly competitive	2.94	94%	0
Average market price *	3.14	100%	0.064

Source: Own calculations, fuelo.bg

Closest to the 2022 average market prices are the equilibrium prices of the low-concentration competitive market models (+2%) and cartel revenue maximization (+2.3%), followed by the perfectly competitive market (- 6%). The most distant in terms of prices is the assumption of a cartel (+49%), making it also the least likely.

The presence or absence of monopoly power and monopolistic practices in diesel retail, apart from price levels, can also be assessed by the value of the Lerner index, which is 0.064 at current market prices and theoretical values 0.082 at a competitive market, 0.092 under revenue maximization and 0.372 under a cartel.

Market structure and behaviour of companies in 2021.

In the test for a competitive market in 2021, both the equilibrium prices in the various market behaviour

models can be compared with the averages for the year and the equilibrium quantities with those reported by the statistics.

Table 6

Hypotheses for market structure and company behaviour 2021.

Market Structure and behaviour hypothesis	Quantity thousand l.	% of the actual quantity	Equilibrium price	% of the average price	Learner Index
Cartel	5,172	58%	3.81	177%	0.470
Maximize revenue	8,097	91%	2.80	130%	0.279
Competitive market	9,566	108%	2.29	107%	0.118
Perfect competition	10,345	117%	2.02	94%	0
Statistics *	8,864	100%	2.15	100%	0.06

Source: own calculations and NSI

Table 6 shows the results for the equilibrium quantities and prices for the investigated variants of market behaviour. The values are compared with statistical data on quantities and market prices published by NSI. In terms of equilibrium quantity, the closest to the actual data are the competitive market model (+8%) and revenue maximization (-9%). The remaining assumptions are respectively +17% for a perfectly competitive market and -42% for a cartel.

Regarding the equilibrium price, the closest to the average price reported by NSI are the assumptions for a perfectly competitive market (-6%) and a competitive market (+7%). The other two guesses are at +30% for revenue maximization and +77% for cartel, respectively.

The theoretical value of the Learner index in a competitive market is closest to the calculated value in the 2021 statistics.

The analyzes made and comparisons between the theoretical value of the prices at the actual concentration levels with the current market prices, confirm the conclusions of the economic models that the retail market prices of diesel fuel are most likely the result of independent actions of traders to maximize individual profits in the conditions in a competitive (HHI=814) market and not by entering into prohibited agreements (cartel) to extract monopolistically high profits. A possible revenue-maximizing cartel would achieve the same prices as a competitive, profit-maximizing market, so it is unlikely.

Anomalies in retail prices may possibly result from market structures or non-competitive behaviour of companies involved in fuel distribution, production or crude oil markets.

Conclusion

Based on information from national statistics, a two-factor regression model was applied, in which statistically significant parameters of the demand for diesel fuel by households were estimated as a function of the price of monetary income. The price elasticity of demand and the values of the equilibrium quantities and prices have been determined under the hypotheses of 1. a profit-maximizing cartel; 2. a revenue-maximizing cartel; 3. independent behaviour of traders in a competitive market with a low degree of market concentration; 4 perfectly competitive market. The conclusions drawn regarding the market structure and behaviour of retailers in the household diesel fuel market are substantiated by comparing the theoretical values of equilibrium prices, quantities of fuels consumed and the Learner index under different models of market structure and behaviour with the statistical data of quantities and prices for 2021. and average prices for 2022.

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