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Summary of doctoral dissertation titled:  
**Market determinants of retail fuel price dispersion  
in Poland**

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## **Choice of research subject**

Price decisions are one of the key problems, both in economics, marketing and finance. The process of pricing, its importance for businesses, customers, as well as the entire economy were subject of numerous studies and are the most important area of mutual interest of these disciplines.

Once of the most basic economic theories related to price decisions of an enterprise is the law of one price according to which when exchange rates are taken into consideration a given security, commodity or asset should have the same price (Begg, Fisher and Dorbusch, 2007). The law of one price is another way of expressing the concept of purchasing power parity and exists due to arbitrage opportunities. However, the law of one price is almost never empirically valid. Homogeneous goods are often sold at widely different prices by competing sellers, even in environments that one would expect to encourage economic competition (Sorensen, 2000).

A situation in which different sellers present on the market offer the same good at different prices is called price dispersion (Hopkins, 2008). In economics, price dispersion is therefore defined as a variation in prices across sellers of a homogenous good (i.e. assuming fixed characteristics of that good). Maynes and Assum (1982) offer a simpler definition stating that price dispersion concerns a situation when different prices are charged from identical customers for the same quality. As such price dispersion can be regarded as an extent of transactional frictions related to a homogenous product – resulting therefore in violation of the law of one price.

Previous studies have suggested that dispersion of prices occurring in the markets is clear and constant (and as opposed to the law of one price, is a characteristic of most consumer markets). Presence of price dispersion is commonly attributed to consumer search costs or hidden attributes of the good. Already Stigler (1961) indicated that the price dispersion does not result solely from the differences between the products and services offered by the company.

A simple explanation for price dispersion is that it arises in connection with imperfect information on the side of the buyers, who in the absence of full information about which

seller offers the product at the lowest price, purchase from more expensive sellers. Early theoretical literature was trying to find the roots of price dispersion in spatial differences and existence of search cost (Salop, 1977; Salop and Stiglitz, 1982; Varian 1980). However the emergence of internet and online shopping with reduced search costs, yet prevalence of significant price dispersion in on-line markets shows a strong limitation in explaining this phenomenon solely through the search cost differences (Clemons, Hann and Hitt, 2002; Overby and Forman, 2014; Kaplan and Menzio, 2015; Bodur, Klein and Arora, 2015).

A concept that commonly accompanies discussion related to price dispersion is related to price differentiation. Price differentiation is a price strategy aimed at setting the price level most appropriate for local conditions (Nagle, Hogan and Zale, 2006). Based on this fundamental economic principle to maximize profits a price charged for a good should equate to the value of the product to each consumer, rather than selling it at a uniform price to all consumers. Under the assumption that homogenous (therefore undifferentiated) product is sold in different local conditions the term price differentiation is often treated as a synonym to price discrimination with sellers using price discrimination to differentiate prices.

Price dispersion thought of as an outcome of multiple sellers potentially charging different prices for identical products differs therefore from price discrimination (also called price differentiation) in which case the same seller offers a given good at different price levels depending on e.g. customer segment.

Empirical studies relating to the price dispersion are contested by arguments supporting the statement of illusory character of price dispersion phenomenon. Firstly, the price dispersion may be partly explained by the hidden heterogeneity of the offered goods. Sellers offering goods at a higher price achieve market success not due to the ignorance of buyers with regards to the existence of cheaper substitutes, but by offering a product/service with higher quality, impossible to assess solely based on price information. Secondly, price dispersion does not necessarily result in differences in the level of total revenues of individual sellers (Salop and Stiglitz, 1982). Although it can be reasonably expected that the seller offering the good at a lower price reaches a higher sales volume than competitors offering good at higher prices – the price differences between sellers weighted based on their market shares

are lower than if equal market share of all sellers is assumed. At the same time, no economic model was proposed that would explain in full the phenomenon of price dispersion.

Much of the theoretical literature combines the price dispersion with spatial differences and search cost. Varian (1980) suggests that the price dispersion can be a purposeful marketing action aimed at encouraging customers to seek alternatives. Consequently, price dispersion may be considered in the context of the theoretical approaches relating both to external and internal factors affecting business decision - namely, set of factors affects price decision made by a single seller with regards to a homogenous good. However, given that these factors differ between sellers it may lead to different final price outcomes related to seemingly homogenous good – therefore meeting the condition of price dispersion – different prices charged by different sellers for a homogenous good.

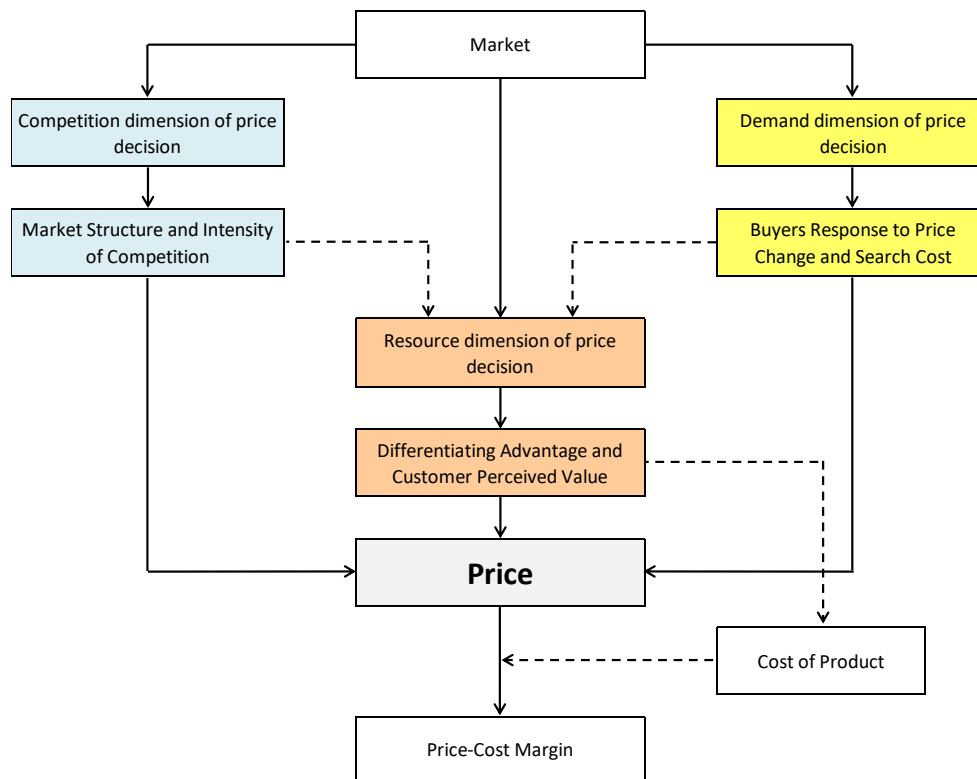
Accordingly, three key dimensions of factors which affect price decisions of an enterprise and dispersion of price include:

- **Competition dimension** focused on market structure and the intensity of competition – with price setting ability of an enterprise affected by the competitive environment in which it operates. The dominant position of one supplier allowing him to execute near monopoly power and reduces the need for price competition. Hence, the level of price equilibrium in highly concentrated market, in the simple theoretical background, should be different from the markets in which multiple sellers are present.
- **Demand dimension** focused on buyer's reaction to price decisions of an enterprise – including price elasticity of demand and price sensitivity of buyers as well as consumer search cost with bounded rationality of the parties involved in the exchange and opportunistic behavior (i.e. the tendency to maximize individual utility) leading to price dispersion. The buyers assess costs associated with obtaining additional price information as well as the benefits of obtaining additional price information in relation to the cost of obtaining this information. Price dispersion is therefore based on the search cost and an assumption that in a situation where buyers are looking for information on prices for the product, and therefore bear the costs - suppliers will be motivated to differentiate the level of prices in the market.

- **Resource dimensions** focused on enterprise resources and product differentiation – with heterogeneity of the seller’s offer and market structure being a result of higher performance capacity of individual companies. Business model defines the way in which a company aims to monetize on operations and resources. At the same time, a seemingly identical good may be sold at different price levels due to hidden differentiation expressed by a variety of available auxiliary amenities and possibility to exercise competitive advantage through superior customer perceived value.

In theory, each of the above-mentioned approaches explains the price dispersion in equilibrium. Yet, the mechanisms supporting the dispersion differ. According to search cost theoretic approach, a firm with a high price at a time may be the cheapest location tomorrow. Market structure and product differentiation models provide that the price dispersion is stable if the characteristics of the products or the market remain stable over time (therefore ignoring the possibility of existence of consumers with imperfect information).

**Figure 1: Model of market determinants of price dispersion**



Source: Prepared by the author

According to the model presented in Figure 1 price decisions of an enterprise are affected by factors that may be clustered into three groups (distinguished by specific colors in the model). These factors are relatively unique for each seller present in the market. In consequence, different sellers set prices for homogenous product under different market (demand, competitive and resource) condition which then leads to a situation that homogenous good is priced differently leading to market price dispersion.

First group of factors is related to the outside influences that can impact a business. Numerous external factors can impact the price decisions leading to realization of businesses strategic goals and objectives. In the context of price dispersion, external factors include in the first-place intensity of competition in the market and buyer's reaction to the price, while internal factors may be analyzed from the perspective on enterprise resources and product differentiation – all of which will be presented in the sections to follow.

Placing the factors affecting the price level into three categories – namely competition based (market structure and intensity of competition), demand based (buyers' response to price change and search cost) and enterprise resources based allows to build a framework for further analysis.

Motor fuel is one of the most commonly consumed products closely monitored by the buyers. Buyers carefully follow fuel prices, while media (television, radio, press and internet) daily present numerous reports on the subject. Buyers are conscious about observable differences in fuel prices between different outlets. At the same time, in the past few years, it was possible to observe growth in network of websites related to the search for fuel prices.

At first glance, retail fuel market seems to have the qualities necessary for a market close to perfect competition, that is: a relatively homogeneous product, many buyers and manufacturers, transparency of price information, which would suggest one price level. As an explanation for the observed differences in prices between gasoline stations, one can accept product differentiation, market power of market participants or exploitation of information asymmetries. Fuel sold at gasoline stations may however vary in several dimensions, such as e.g. location, auxiliary services available at the station or intangible

assets (e.g. brand). This combined lead to a situation where no unique equilibrium price is observed.

Development of effective price strategy is based on well-defined product attributes, target customer segments and knowledge of their characteristics and preferences. The study results should determine how these factors are expressed in retailer's decisions related to fuel price in Poland. The outcome of the research may also contribute to customer welfare by clarifying whether certain price dispersion may arise due to exercising of monopoly power by sellers in certain micro-markets.

At the same time, price dispersion is subject to limited discussion in Poland<sup>1</sup>. Thus while the choice of the subject stems from the author's professional interest in retail fuel pricing it allows to complement local research in the subject.

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<sup>1</sup> Main papers addressing issue of price dispersion in Poland are those by Szumilak (2003), Żelazowski (2011), Waniowski (2012), Zawajska (2012), Adamiak and Napierała (2013; 2014) and Galewski (2015a; 2015b), while only Sobiechowska-Ziegert (2011) relates to the subject of price dispersion on retail fuel market.



## Purpose of dissertation and hypothesis

The main objective of the dissertation and empirical study was to determine the impact of market factors on price level and its dispersion in the retail fuel market in Poland.

The work combines multiple theoretical approaches related to management and economics and therefore shows price dispersion phenomenon as determined by different types of factors. The dissertation should clarify, what is the influence of external factors (such as market concentration, competitive environment, different types of buyers present in the local market) and internal characteristics of a seller (such as enterprise resources and offer and business model, according to which seller's business activities are carried out) on the retail fuel price level.

The study is conducted in the form of quantitative analysis. Quantitative data related to market and gasoline station characteristics is available for entire population of gasoline stations in Poland which makes it a unique and valuable data set allowing defining the desired gasoline station characteristics and connecting them with available retail fuel price data. Ability to specify market factors affecting price level and its dispersion allows guiding managers of businesses operating in retail fuel sector with regards to developing a fit for purpose price strategy.

Several research questions related to the factors affecting dispersion in retail fuel prices in Poland arise from the research problem presented – namely:

- How do the sellers determine the level of retail fuel prices?
- Which market factors affect the level of retail fuel prices?
- How do seller's brand and business model, resources and offer (amenities), as well as local competitive environment influence the level of retail fuel prices?

Based on the review of both theoretic and empirical literature review a set of preliminary hypotheses likely to provide answers to questions related to the problem of study have been drawn up.

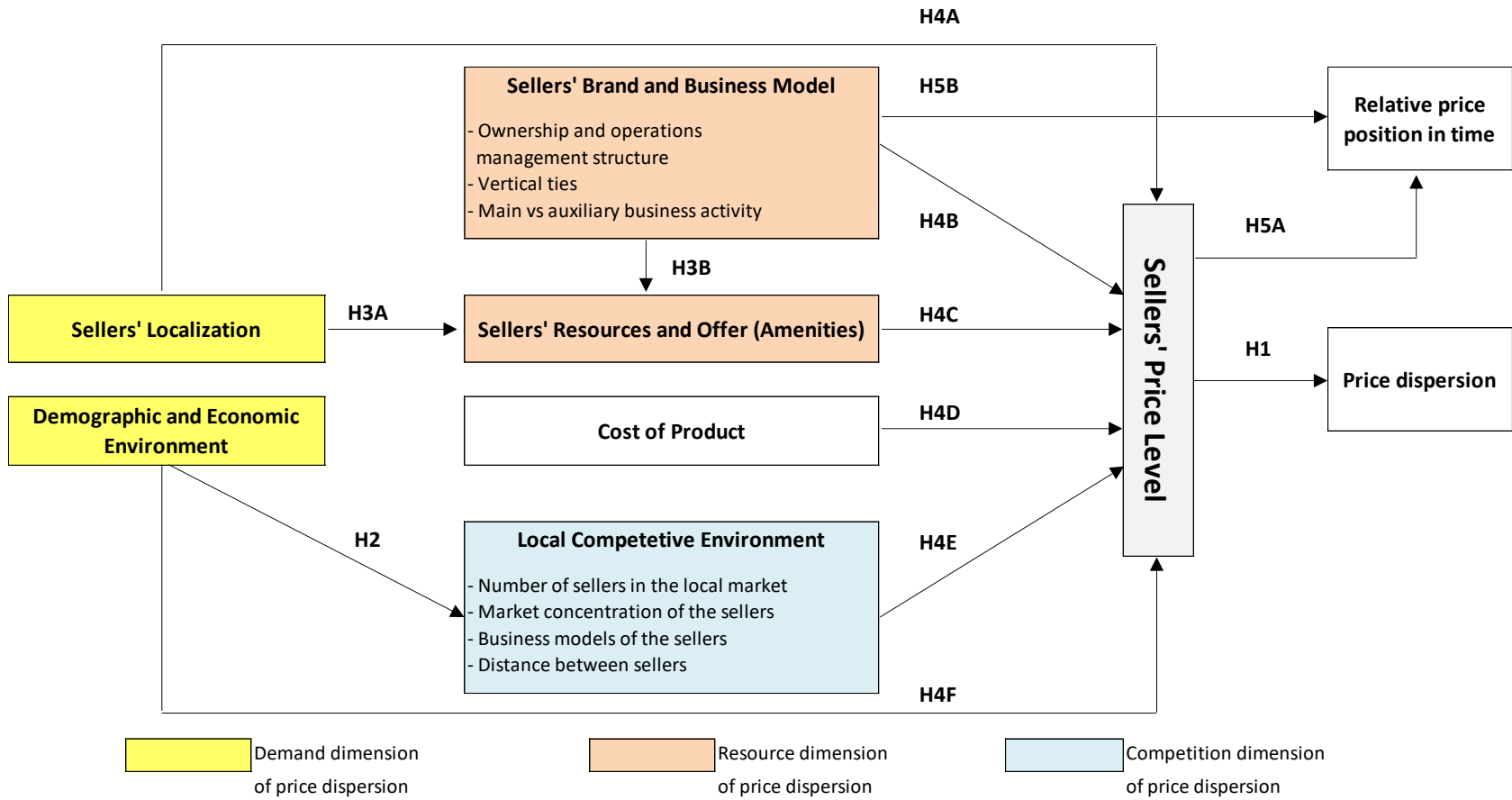
- **Hypothesis 1:** Retail fuel market in Poland is characterized by prevalent and visible price dispersion.

- **Hypothesis 2:** Demographic and economic environment influences the shape of local competitive environment.
- **Hypothesis 3:** Shape of seller's resources and offer (amenities) is influenced by (H3A) seller's localization and (H3B) seller's brand and business model.
- **Hypothesis 4:** The level of seller's prices is influenced by: (H4A) seller's localization, (H4B) seller's brand and business model, (H4C) seller's resources and offer (amenities), (H4D) cost of product, (H4E) local competitive environment, and (H4F) demographic and economic environment.
- **Hypothesis 5:** Gasoline stations change their relative position in the price distribution over time (H5A). The frequency of the change is influenced by business model under which gasoline station is operated, seller's resources and offer (amenities) (H5B).

The graphical representation of the initial hypotheses placed within the research model is presented in the Figure 2 below. Key assumptions behind presented research model correspond to the overall model of market price dispersion provided in Figure 1.

Empirical verification of hypotheses derived from the presented research problem and, therefore, specific theories of price dispersion in the market are performed with the use of quantitative research methodology. Accordingly, sources and methods for data collection will be presented, followed by description and explanation of variables chosen for the study.

**Figure 2: Graphical depiction of research model**



Source: Prepared by the author

## **Research methodology**

Quantitative research methodology is applied to empirically verify the hypotheses derived from the presented research problem.

Performing analyses aimed at validating research hypothesis required extensive data collection including both quantitative representation of gasoline pump prices and qualitative variables differentiating in most effective way each unique gasoline station.

Consequently, four types of data were collected:

- 1) List of gasoline stations
- 2) Gasoline station characteristics, competitive environment, demographic and economic environment
- 3) Retail fuel prices at station level
- 4) Cost of product data

### **List of gasoline stations**

Complete list of gasoline stations operating in Poland as of December 2015 was assembled. Although, there was no single source providing with a comprehensive list of gasoline stations, a complete list of sites has been constructed using the information available on the websites of all major and minor petroleum companies' networks as well as hypermarket chains. After collecting the complete list of branded gasoline stations, additional sources of data were used (including motorist websites such as [Stacjebenzynowe.pl](http://Stacjebenzynowe.pl) and [Autocentrum.pl](http://Autocentrum.pl)) to identify remaining gasoline stations operated by independent retailers. Near 100% match with number of stations reported by POPIHN was reached (6565 gasoline stations in Poland with exact geographical localization - latitude and longitude coordinates).

### **Gasoline station characteristics, competitive environment, demographic and economic environment**

Through an examination of past research, variables have been assigned to all the examined retail gasoline outlets. The list of variables and type of data sourced from the market is provided in the Table 1.

Data addressing these variables was collected from public sources including information published directly by the gasoline stations, statistical office and supplemented by observations performed by the author.

**Table 1: Gasoline station related variables**

Variable	Variable type	Definitions
<b>Brand and firm related variables</b>		
Business model	Binary	Oligopolistic Company-owned operator, Dealer-owned station, Hypermarket operator, Independent operator
Brand category	Binary	Major premium brand (Orlen, BP, Shell, Lotos, Statoil, Lukoil, Total), Major economy brand (Bliska, Lotos Optima, 1-2-3), Minor brand (e.g. Huzar, Moya, Pieprzyk, Oktan), and Unbranded
Integrated company	Binary	Locally vertically integrated oil company
Distance to depot	Integer	Distance to nearest supply source
<b>Site location and site accessibility variables</b>		
Accessibility to traffic	Binary	Accessible from primary, secondary or multiple roads
Primary road traffic lanes	Integer	Number of traffic lanes on the primary road
Primary road speed	Binary	Speed limit observed on the primary road: above 120 km/h; 100-120 km/h, 80-99 km/h, 60-79 km/h, 40-59 km/h, below 39 km/h
Carriage way barriers	Binary	Access only from one traffic flow direction
Road type	Binary	Local, District, National, Highway
Site location type	Binary	Commercial; Industry & Office; Residential; Rural; Transit; Urban Transit
Site visibility	Cluster	Poor, Average, Good
Site accessibility	Cluster	Poor, Average, Good
Traffic builders	Binary	Location nearby supermarket, shopping mall, supermarket and shopping mall
<b>Site level offer and characteristics variables</b>		
Fuel products offered	Binary	Diesel, Premium Diesel, Unleaded Gasoline, Premium Unleaded Gasoline, LPG
Number of fueling positions	Integer	Number of vehicles that may simultaneously refuel
Site appearance	Cluster	Poor, Average, Good
Night closure	Binary	Site is closed during night
Price monolith	Binary	Price information is visible to drivers
Self-service site	Binary	Site is automated
Shop on site	Cluster	Kiosk or none, small shop, big store
Branded store	Binary	Store operated under brand
Café / Bistro	Binary	Coffee and fast food offer
Catering facility	Cluster	Availability of catering facility on or adjoining the site, unbranded, branded
Car Wash	Binary	Automatic, Self-Service, Automatic + Self-Service
Truck amenities	Binary	High speed pump, Truck parking
Other amenities	Cluster	Hotel, ATM, WiFi

**Table 1: Gasoline station related variables (continued)**

Variable	Variable type	Definitions
<b>Competitive environment variables at district level</b>		
Number of sites	Integer	Number of sites in a district
HHI	Decimal	Herfindahl-Hirschman Index within district
CR4	Decimal	4-firm concentration rate within district
Share of leader	Decimal	Market share of the largest firm
Share of operator category	Decimal	Share of company-owned, dealer-owned, hypermarket, independent
<b>Competitive environment variables at gasoline station level</b>		
Nearest competitor	Decimal	Distance to nearest non- same brand outlet
Business model effect	Binary	Major company-owned, dealer-owned, hypermarket, independent within 1, 2 and 5 km
Number of competitors	Integer	Number of competitors within 1, 2 and 5 km
Average distance	Decimal	Average distance to competitors within 1, 2 and 5 km
HHI	Decimal	Herfindahl-Hirschman Index within 1, 2 and 5 km
CR4	Decimal	4-firm concentration rate within 1, 2 and 5 km
<b>Competitive environment variables at district level</b>		
Population	Integer	Inhabitants in district
Population density	Continuous	Inhabitants per gasoline station in district
Area	Integer	Area in square meters
Network density	Continuous	Area in square meters per gasoline station in district
Motorization	Integer	Registered vehicles in district
Motorization per site	Continuous	Registered vehicles per gasoline station in district
Gross salary	Integer	Average gross remuneration in district $k$

Source: Prepared by the author

### **Retail fuel prices data**

The data on retail gasoline prices was collected from two types of sources: public motorist websites (i.e. websites that report fuel prices to the public through crowdsourcing and relationships with stations and are represented by StacjeBenzynowe.pl, StacjePaliw.pl and AutoCentrum.pl) and historical gasoline pump price information provided directly by the gasoline station networks.

For data collection, an online application was developed, which enabled collection of the retail pump price information reported on those websites in a user-friendly format. Consequently, the data was collected on a daily basis during the period from 1<sup>st</sup> January 2014 until 31<sup>st</sup> July 2016. The summary of price data collected is presented in the Table 2 below.

**Table 2: Summary of collected price data**

	<b>Unleaded 95</b>	<b>Diesel</b>
Daily price reports collected	1436512	1420772
Weeks represented	134	134
<i>Weekly site level price reports</i>		
Min	0.0	0.0
Average	31.0	30.5
Max	134.0	134.0
Standard deviation	48.2	48.2
<b>Total</b>	<b>203653</b>	<b>200527</b>

Source: Prepared by the author

Both analyzed types of fuels are represented evenly with 3456 sites represented in Diesel price reports and 3506 sites represented in Unleaded 95 price reports.

However, to improve the quality of price data applied in the research, only those sites with at least 10 weeks of price data represented are accounted for. 41% of all sites in Poland are represented with more than 10 weeks of data available.

### **Cost of product data**

To estimate the marginal cost of fuel products, the author utilizes the information on ORLEN and LOTOS spot wholesale gasoline price quotations as published on the respective official websites<sup>2</sup>. The detailed mechanisms behind the wholesale price creation have been explained in Chapter 2 of the dissertation. Depending on the dimension of the analysis, the author is using the average wholesale spot price valid during the week of the actual pump prices as well as daily wholesale spot price valid during the day of the actual pump prices. The goal of approach to use marginal costs for gasoline stations based in Poland is to apply a limit pricing argument in that marginal costs are equal to the cost of product plus transportation costs and variable remuneration of gasoline operators. The drawback of using wholesale prices as a reference cost of product is bound with the fact that volume based discounts, which might be enjoyed by certain market players are not captured.

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<sup>2</sup> <http://www.orklen.pl/PL/DlaBiznesu/HurtoweCenyPaliw/Strony/default.aspx>,

[http://www.lotost.pl/144/dla\\_biznesu/hurtowe\\_ceny\\_paliw](http://www.lotost.pl/144/dla_biznesu/hurtowe_ceny_paliw)

## **Outline of dissertation**

The dissertation consists of 4 chapters. The first chapter introduces the subject of price dispersion and price decisions. Chapter begins with the presentation of the pricing process of a company and the definitions of pricing strategy. This is followed by dividing factors affecting price decisions of an enterprise into those of external and internal nature. Elements such as market structure and intensity of competition, search cost, consumer's price sensitivity, price elasticity of demand or business resources are described. When discussing different market structures, a special reference is made to price decisions in oligopoly, price leadership and collusive behavior.

The second chapter is entirely devoted to the retail fuel market in Poland. The synthetic method presents the history of retail fuel sector in Poland. Demand and supply conditions related to sale of fuels in Poland are presented in detail. A reference is made to marketing activities of fuel retailers including different types of business models under gasoline stations are operated, portfolio of products available at sales outlets and promotional activities of retailers. Emphasis is placed on the role of taxation, costs of production and components of retail fuel prices, market competition, distribution and consumers. Introduction to the retail fuel market is followed by overview of past areas of empirical study aimed at explaining drivers behind differences in retail fuel prices between gasoline stations. These main areas of empirical studies include asymmetric price transmission, collusive price behavior and spatial and non-spatial product differentiation. The review of the literature points also out to areas that were given a limited cover in past research.

In the third chapter, the author presents the data sources and research methodology. The dataset collected by the author and applied in the dissertation is used for the first time and unique with regards to the scope by addressing the methodological issue related to availability of complete data encountered by numerous researchers in the past. Research model is presented and explained. Comprehensive set of variables used in the analysis is defined and described in detail along with empirical data used, its sources and process of collection. Approach used to verify the accuracy of data used is presented as well. Methodology to deal with missing data and limitations of data sources are provided. Finally, presentation of variables is followed by insightful descriptive statistics of data.



The fourth chapter is entirely dedicated to the statistical analysis of defined variables and presentation of econometric models addressing each hypothesis. Methods used for estimation include Generalized Least Squares regression of cross-sectional time-series (panel) data, Ordinary Least Squares regression of cross-sectional data, discrete choice logit regression as well as graphical presentation of data. Methodological assumptions behind model used for a given hypothesis are explained and followed by presentation of results. Results showing which factors and to what extent influence retail fuel price dispersion are then discussed and provided with a commentary and possible implications.

The dissertation ends with a summary, which contains the most important conclusions of the study, study related limitations as well as proposed directions of future research. A reference is made to the accomplishment of the objectives of the research and verification of hypotheses stated.

## **Selected results**

The aim of the dissertation was to determine the influence of market factors on price levels and their dispersion in the retail fuel market in Poland. Through the conducted research it was possible to determine market factors affecting retail fuel price dispersion in Poland. The methodology and framework applied in the study were in general successful in addressing the research questions and hypothesis. This allowed to address the research gap, perform research on entire population of gasoline stations in Poland and providing new insights in the field of drivers of price dispersion in retail markets. During the research, large amounts of data on the retail fuel prices, differentiators of retail gasoline stations and information related to functioning of retail fuel market in Poland and globally were collected.

The gathered data and knowledge enabled the author to verify some of key price dispersion drivers suggested by the literature, to negate some of them and to supplement them with additional observations and dimensions. While the existing tools for investigating price dispersion proved sufficient for performing final analysis, these had to be supplemented by applying logistic regression not applied previously in related research. Likewise, the list of variables used by the past research had to be significantly extended, to be able to capture entirety of market factors affecting analyzed subject.

Through the analysis performed it was possible to determine the influence of market factors on price levels and their dispersion in the retail fuel market in Poland (see Chapter 4 of the dissertation). The influence of discussed market factors was established – with a novel finding that influence of seller’s business model on price level surpasses the influence of particular elements of enterprise resources and offer (amenities).

It was possible to determine how do seller’s brand and business model, resources and offer (amenities), as well as local competitive environment influence the level of retail fuel prices. This objective was addressed and accomplished through a quantitative study presented in Chapter 3 and 4 of the dissertation.

Generalized Least Squares method was used to analyze cross-sectional time series of station level retail price data. The model aimed at explaining the retail price level as a dependent variable covered eight vectors of grouped explanatory variables addressing: cost of product,

brand and business model, basic features and characteristics, localization, amenities, local competitive environment, demographic and economic environment. The model was built in multiple specifications to address different fuel types, and different definitions of competitive environment. Estimation of model parameters is provided in Chapter 4 of the dissertation. Fit of the model is very good in all specification with adjusted  $R^2 > 0.95$  for Diesel and  $R^2 > 0.90$  for Unleaded95 Gasoline. All key variables are statistically significant at the standard significance level of 0.05.

Ordinary Least Squares method was used to analyze aggregated station level estimated Price-Cost-Margin (dependent variable). The model covered seven vectors of grouped explanatory variables addressing: brand and business model, basic features and characteristics, localization, amenities, local competitive environment, demographic and economic environment. Estimation of model parameters is provided in Chapter 4 of the dissertation. The model has an adjusted  $R^2 > 0.50$  meaning that it explains above 50% of the variability of the response data around its mean. This leads to a conclusion that cost of product is a strong predictor of retail gasoline prices at station level, while remaining variables still explain important part of price dispersion.

Referring to the empirical results, it is possible to state that retail fuel market in Poland is characterized by a long term and prevalent price dispersion. Prices charged by a gasoline station are linked to multiple market factors. While retail fuel prices charged in the market are strongly linked to cost of product changes, seller's business models and brand appear to be strong predictors of prices charged by a gasoline station. Likewise, demographic and economic environment influence the level of prices charged in the micro-market. At the same time – it seems apparent that gasoline stations do not follow stable in time price setting rules and frequently change their position in price distribution over time – possibly due to the oligopolistic nature of the market and continuous dynamic interaction between market players.

The summary of results for empirical verification of hypotheses derived from the presented research problem is provided in Table 3.

**Table 3: Overview of analysis results**

	<b>Hypothesis tested</b>	<b>Result</b>
<b>H1</b>	Retail fuel market in Poland is characterized by prevalent and visible price dispersion.	Verified – the price dispersion is prevalent, while its magnitude is stronger during the period of high market prices.
<b>H2</b>	Demographic and economic environment influences the shape of local competitive environment.	Verified – the density of gasoline stations is positively influenced by population and motorization in the area, and negatively influenced by salary level, market concentration, presence of market leader and dominating firm.
<b>H3A</b>	Shape of seller’s resources and offer (amenities) is influenced by seller’s localization.	Verified – localization affects the shape of seller’s offer across multiple gasoline station characteristics.
<b>H3B</b>	Shape of seller’s resources and offer (amenities) is influenced by seller’s brand and business model.	Verified – localization affects the shape of seller’s offer across multiple gasoline station characteristics.
<b>H4A</b>	The level of seller’s prices is influenced by: seller’s localization.	Verified – with strongest positive influence observed for Highway locations.
<b>H4B</b>	The level of seller’s prices is influenced by: seller’s brand and business model.	Verified – with negative influence observed for gasoline stations operated by Hypermarkets and Oligopolistic players and positive influence of Brand on price.
<b>H4C</b>	The level of seller’s prices is influenced by seller’s resources and offer (amenities).	Not verified – the seller’s resources and offer (amenities) appear to be connected to seller’s brand and business model, which then influence the price decisions of a gasoline station operator.
<b>H4D</b>	The level of seller’s prices is influenced by cost of product.	Verified – cost of product is a strong predictor of retail fuel prices.
<b>H4E</b>	The level of seller’s prices is influenced by local competitive environment.	Verified – high level of market concentration (expressed in HHI index) has a positive influence on the price level. Presence of gasoline stations operated by Hypermarkets is associated with lower prices in the market.
<b>H4F</b>	The level of seller’s prices is influenced by demographic and economic environment.	Verified – increase of salary leads to higher retail fuel price level, while increase in population density.
<b>H5A</b>	Gasoline stations change their relative position in the price distribution over time.	Verified – gasoline stations with their long-term average price position close to the sample average prices appear to frequently change their position in price distribution over time.
<b>H5B</b>	The frequency of the change is influenced by business model under which gasoline station is operated and seller’s resources and offer (amenities).	Verified – with gasoline stations operated by hypermarkets changing their relative price position less frequently than others and oligopolistic owned stations characterized by higher price volatility. Influence of other characteristics appears to be inconclusive.

The empirical estimations presented in Chapter 4 demonstrate that **brand and business model, basic features and characteristics, localization, amenities, local competitive environment, demographic and economic environment are differentiating dimensions in the retail fuel market**. It was estimated that branding provides operators with an opportunity to charge significant premium (especially in case of premium brands) compared to non-branded outlets. In addition, business model influences price setting with lower prices charged by oligopolistic players and hypermarkets. In the case of latter business model pricing strategies, may show evidence of using fuels as a loss leader with business activity focused on retailing. Appearance of gasoline station is negatively related to the price level, which can be explained by economy of scale effect. Localization plays an important role with gasoline station characterized by highway location and good accessibility being able to charge location rent. Key amenities directly influencing price level are Wi-Fi and ATM. Competitive environment affects price levels in a predicted direction – higher market concentration is associated with higher price levels as is the distance to the nearest competitor. Interestingly higher disposable income (i.e. salary level) in a given micro-market is associated with higher fuel prices, while increase in population density leads to decrease in prices (which can be connected with economy of scale effect).

The limited direct influence of seller's resources and offer (amenities) on the price level, is explained by applying Logistic regression (the method applied refers to probability of certain outcome) to establish link between business model and specific resources (see Chapter 4 of the dissertation). **The results explain seller's offer (amenities) and station location with a specific type of gasoline retailing business model, which then affects the price level**. This finding is a complete novelty when compiled with results of past studies and points out to a role of business model as an resource – collector of specific amenities.

## **Limitations of the study and future research areas**

The study however has some limitations. In the first place, the study is narrowed to a single industry – namely retail fuel market, and specific geography – namely Poland. Hence, the results of the study may be subject to polarization arising from specifics of functioning of the researched market – both from the supply and demand point of view, type of product offered (i.e. commodity) and specific market structure – i.e. oligopoly. Likewise, dynamics of competitive price interactions in the retail fuel market may not be comparable to other markets. While some findings for retail fuel market may be generalized across different markets, country specific issues (such as regulatory environment) may exist.

Secondly, study limitations arise from the research methodology, namely:

- 1) Sources used for collection of data related to retail fuel prices and seller's outlet characteristics. The crowdsourcing nature of price data may be biased due to human errors, intentional price over- or under-reporting, as well as stockpiling effect. This limitation however has been addressed by an exercise aimed at verifying accuracy of the price reporting data (described in detail in Chapter 3 of the dissertation).
- 2) Unbalanced character of analyzed price data (resulting directly from sources used for its collection) – with certain geographies, regions, brands and operators over- or under- represented within the analyzed sample. This issue has however been encountered by most of past researches and often led to limiting the scope of research to most represented localization or brand only. Implications of the unbalanced panel have been discussed in detail in the research methodology section.
- 3) Aggregation of analyzed price data – while analysis was performed on average weekly site level prices data, additional insights into retail fuel pricing could be reached when using more granular data.
- 4) Duration of period subject to study – while the study covers a period of 31 months (January 2014 to July 2016), most of this time was characterized by strong volatility of oil prices, which directly affected price decisions on retail fuel market.
- 5) Static character of variables describing each gasoline station – while vast range of variables applied in the study may enhance the generalizability of study related

findings, the number of sellers present in the market (and description of each outlet) have been collected at a single point of time. Similarly, the underlying assumption of the study is that characteristics of single sales outlet remain constant over the period of 31 months.

- 6) Potential subjectivisms of gasoline station characteristics evaluation – while assessment of characteristics of sales outlet were largely based on quantitative assessment (and often based on information provided directly by the operator of chain of stations), certain characteristics (e.g. overall appearance, accessibility etc.) were of qualitative nature.
- 7) Buyer perception of gasoline station attributes – the study does not address the issue of how buyers value different attributes that make up an individual product or service.

It should be underlined that all the limitations presented above were known at the beginning of the study and resulted from the choice of subject of research and research methodology (particularly data sources). Navigating some of these limitations would be possible had the author agreed to narrow down the scope of study to a limited geography (e.g. one city) or limited number of operators. However, decision to do so would result in inability to extend the research results to entire retail fuel market in Poland and likely result in certain variables and theoretical approaches being impossible to verify.

The discussed issues are very interesting both from the point of view of the theorist, practice of business and customer welfare. Yet, the subject of price dispersion has not been sufficiently studied in the literature. In addition, uncovering one layer explaining the subject studied directs to another worth analyzing. For this reason, retail fuel market and subject of price decisions constitute an interesting material for further research.

Future possible research could be split into five areas. In the first-place research focused on performing similar analysis while **applying data of different frequency** (e.g. daily or even hourly), which would most likely require limiting the study to a much-narrowed geographical areas (to allow for frequent data collection) or single operator (given complete internal price data is handed over for research purposes). Applying such frequency of information would then allow to observe key triggers of station level fuel price changes and

build a network of interdependencies, hence, being able to identify existence (or lack) of price leadership in the market

Secondly there is an opportunity in research **combining price analysis with changes in station level demand** – hence helping to establish price elasticity of demand in context of retail fuel market in Poland (as well as defining drivers of this elasticity). The challenge here would be based on data availability, with sales information commonly deemed as proprietary. In addition, need of analyzing gasoline stations for which both price data and sales data is available could lead to significant decrease in sample available for studying

In addition, special insights could be generated by research focused on benchmarking different micro-market's and addressing more detailed level of traffic data (instead of road size as applied in the thesis) and **different dimensions of competitive environment** could be leveraged (such as commuting routes attributable to direct presence of buyers). The case might be that the competitive environment is not based on distance to competitors but rather traffic flow and visibility relevancy with shopper journey direction being the key influencer on price decisions

**Addressing changes in gasoline station characteristics in time** as an explanatory variable could allow to observe if gasoline stations operators leverage investments made to change price level or rather use new amenities to attract customers from competitive outlets. Introducing new amenities or expanding offer by one player present in micro-market, by strengthening competitive position of a given sales outlet may lead to increase in competitive intensity and fiercer price competition (as other sellers could try to fight back lost sales volume by decreasing prices).

Finally, it would be interesting to investigate **price dispersion in other than fuel products** offered by gasoline stations (e.g. convenience retail offer) possibly in combination with retail fuel price dispersion. Such research would enable to observe if some gasoline station operators may be using loss leader position on fuel products to generate profits on convenience retail products through higher margins or higher turnover



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