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Determinants of the Relationship between Wholesale and Retail Energy Prices in the Czech Republic

Marie PAVLÁKOVÁ DOČEKALOVÁ[1], Jiří LUŇÁČEK[1], Lukáš RADIL[2], Adam P. BALCERZAK[1], Tomáš MELUZÍN[1], Justyna ŁAPIŃSKA[3] and Marek ZINECKER[1]*

Authors' affiliations and addresses:
[1] Faculty of Business and Management, Brno University of Technology, Kolejni 2906/4, 612 00 Brno, Czechia
e-mail: marie.pavlakova.docekalova@vut.cz
e-mail: lunacek@vutbr.cz
e-mail: a.balcerzak@uwm.edu.pl
e-mail: tomas.meluzin@vut.cz
e-mail: zinecker@vutbr.cz

[2] Faculty of Electrical Engineering and Communication, Brno University of Technology, Technicka 3082/12, 612 00 Brno, Czechia
e-mail: radil@vut.cz

[3] Nicolaus Copernicus University in Toruń, Faculty of Economic Sciences and Management, ul. Gagarina 13a, 87-100 Toruń, Poland
e-mail: justlap@umk.pl

***Correspondence:**
Adam P. Balcerzak, Faculty of Business and Management, Brno University of Technology, Kolejni 2906/4, 612 00 Brno, Czechia
e-mail: a.balcerzak@uwm.edu.pl

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Abstract
Rising energy prices have become a focus of interest for politicians at the international, European, and national levels. Energy prices are the main determinant of profitability or even the existence of the industrial sector. So, it is accepted that energy policy aims to ensure a secure, sustainable, competitive, and affordable energy supply for households and businesses. However, the recent geopolitical situation has significantly affected the energy policy of the European Union, raising concerns about energy security and an energy crisis. This crisis has had social, economic, and political consequences, including energy poverty. In this context, it is essential to understand the determinants of the relationship between wholesale and retail energy prices. This paper presents a model proposal to be used by the Czech Energy Regulatory Authority. The model of average retail prices depends on the type of contract - spot or forward, with the three-year forward contract having the largest weight on the retail price. Therefore, our study shows that long-term contracts significantly impact retail energy prices, highlighting the importance of regulatory monitoring of market strategies. Methodologically, the model is based on a multivariate regression analysis solved with the least absolute deviations and data for the period 2012 to 2023. The findings of the study contribute to a better understanding of the complexity of the dynamics of energy prices and support policymakers while attempting to ensure energy affordability and sustainability.

Keywords
retail energy prices, energy regulation, least absolute deviation regression

Introduction

The energy prices and the shape of the energy sector are currently some of the main determinants of the existence of not only traditional heavy industry but also new emerging industries and sectors. So, the energy prices determine the characteristics and the level of industrialisation of the European economies (Turek et al., 2023; Santana et al., 2023). Undoubtedly, this factor is of special importance for Central European Economies and their speed of catching up with the most developed European countries. Obviously, the increase in energy prices can become the main factor that will threaten Central Europe's successful convergence process with developed EU members (Kolupaieva & Tiesheva, 2023; Šoltés et al., 2023). These factors make the topic of high importance not only for policy but also for scientific research.

Within this context, rising energy prices are the focus of policymakers and scientists at international level (for instance, United Nations energy pricing for developing countries: High-level policy recommendations, 2022), European level (for instance, the Communication Tackling rising energy prices: a toolbox for action and support, 2021, the Communication REPowerEU: Joint EU action for more affordable, secure and sustainable energy, 2022, Regulation on an emergency intervention to address high energy prices (EU 2022/1854) and national level. The United Nations, in its 2030 Agenda, has defined 17 Sustainable Development Goals (SDGs) to be achieved by 2030. The seventh SDG is affordable and clean energy, as lack of access to energy supply is a barrier to human and economic development (UN General Assembly, 2015). The European Energy Policy builds on the EU Strategy (COM/2015/80) of 2015, which aims to build an Energy Union to provide EU households and businesses with a secure, sustainable, competitive, and affordable energy supply. The aim is to decarbonise the EU economy and transition to a low-carbon economy in line with the Paris Agreement. Due to the current geopolitical situation, EU energy policy is also greatly influenced by energy security concerns (see, for instance, Jonek-Kowalska, 2022; Kuzemko et al., 2022; Misik, 2022; Rabbi et al., 2022; Streimikiene, 2022b; Sánchez García & Galdeano Gómez, 2023) and the term energy crisis is used in this context. The EU energy crisis developed in 2021 and escalated after the Russian invasion of Ukraine in February 2022 (von Homeyer, Oberthür & Dupont, 2022). The additional costs spent on energy have social, economic, and political impacts. The Institute for European Environmental Policy has analysed the impact of energy price spikes on the welfare of European households. It reports that the patterns and impacts of energy consumption depend not only on income but also on gender, age, and location (Institute for European Environmental Policy, 2023). A related socio-economic issue is energy poverty, which can threaten energy decarbonisation and energy transition (Balcerzak et al., 2023; 2024). Energy poverty is a type of material deprivation and is defined by the Social Climate Fund as "a household's lack of access to essential energy services that provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing social policy and other relevant policies, caused by a combination of factors, including, but not limited to unaffordability, insufficient disposable income, high energy expenditure, and poor energy efficiency of homes" (Regulation (EU) 2023/955). In 2022, 9.3% of the EU population, that is, more than 41 million people, were unable to keep their homes adequately heated, compared to 15.8% of single-person with dependent children households (Eurostat, 2023).

External shocks and the associated high volatility of the European energy market in 2021 led to the collapse of energy suppliers in several European countries, including the Czech Republic. The common denominator of these suppliers was risk management processes, specifically no or minimal energy price hedging. A well-known example in the Czech Republic was the BOHEMIA ENERGY group. Although the group still reported an after-tax profit of more than CZK 600 million in 2021, record price increases on the stock exchange combined with a risky business model led to this energy supplier terminating supplies to approximately 900,000 customers literally overnight at the end of 2021 (Energy Regulatory Office, 2022). The average household in the Czech Republic faced an energy price inflation of 61.5% between June 2021 and 2023 (Research Institute for Labour and Social Affairs, 2023). These events sparked calls for stricter regulation and oversight of energy suppliers.

It is obvious that the issue of energy poverty is highly socially relevant and increasingly topical given the ongoing socio-economic context (Streimikiene, 2022a; Uddin et al., 2023; Balcerzak et al., 2023; 2024; Oesterreich & Barej-Kaczmarek, 2024). The regulatory authority in the Czech energy market, the Czech Energy Regulatory Office, created a demand for a model that would describe and quantify the influence of key factors on the formation of the exchange price of electricity and the resulting retail prices offered by the end suppliers. With regard to this demand, we focused in our research on proposing such a model as presented in this paper. An econometric model was developed to analyse the relationship between wholesale and retail electricity prices, which revealed that three-year contracts significantly affect retail prices. Established companies typically use long-term contracts, while Bohemia Energy focuses more on forward +2 contracts. The findings underline the need for greater market transparency, price stability measures, diversification of energy sources, support for vulnerable consumer groups and enhanced European cooperation on energy policy.

The paper is structured as follows. In the first section, we review the relevant literature on the determinants of electricity prices. Then, the data and methods of its processing are introduced. In the following section, an econometric model is developed. Finally, the applicability of the model and its limitations are discussed.

Theoretical approach to the determinants of the relationship between wholesale and retail energy prices

The determinants of the relationship between wholesale and retail energy prices are important in energy and pricing policy. This issue concerns how energy prices at the wholesale level are reflected in prices to final consumers at the retail level. The main factors affecting these relationships are supply and demand, market volatility, regulation, distribution and transmission costs, and contractual relationships between suppliers.

As with most commodities, the price of energy at the wholesale level is influenced by supply and demand. If there is a surplus of energy on the market, prices at the wholesale level can fall, which may result in lower retail prices. In the context of the decarbonisation of the EU economy and the reduction of CO_2 emissions, the impact of renewable energy sources (RES) on electricity supply and price behaviour in the energy market is examined. The zero or very low marginal costs of RES shift the wholesale electricity supply curve to the right and thus reduce the average electricity price. This effect is called the merit-order effect and is negative in the short run, i.e., an increase in RES in the energy mix leads to a decrease in wholesale prices, as documented in studies in European markets (e.g., Gelabert, Labandeira & Linares, 2011; Sensfuß, Ragwitz & Genoese, 2008) and non-European markets (e.g., Prol, Steininger & Zilberman, 2020). In the long run, the merit order effect is zero in perfect competition and negative in monopoly (Werner & Muesgens, 2021). Volatility in the energy market is affected by factors such as changes in fuel prices, political events, or natural disasters. Cevik and Ninomiya (2023) studied European electricity markets during a period of sharply rising energy prices and examined the impact of RECs on wholesale electricity prices and their volatility in 24 European countries between 2014 and 2021. The findings highlight a significant correlation between the integration of RECs and a reduction in wholesale electricity prices, showing an average price reduction of 0.6 per cent for every 1 percentage point increase in the share of renewables. However, the intermittent nature of RES generation also presents a challenge in terms of the difficulty of storing surplus electricity generated during periods of low demand, which limits the ability to manage the generation effectively. It also potentially contributes to the volatility of electricity prices due to greater supply instability, causing an imbalance between supply and demand. This uncertainty could lead to higher prices to cover the risk borne by distribution companies.

In many countries, the energy market is regulated, which involves the application of laws, regulations, or rules to protect the public from the negative impacts of market imperfections (Kraus, 2005). However, these regulations may limit the ability of wholesale prices to be reflected in retail prices. Electricity prices vary depending on politically imposed taxes and fees. Retail energy prices are also affected by the cost of distributing and transmitting energy to consumers. Taxes and charges are a significant component, and in some European countries, the predominant component of the price of electricity to final consumers.

Some large energy retailers may enter into long-term contracts with wholesale suppliers. These contracts can ensure price stability for retail customers even when prices on the wholesale market change. Mirza and Bergland (2012) have estimated how changes in wholesale electricity prices affect end-user prices in the Norwegian electricity market, focussing on variable price contracts. Their study shows a significant asymmetry in how retail prices respond to changes in wholesale prices. Retailers pass on price increases faster than price decreases. The study further suggests that dominant retailers may be exploiting their market power in the retail electricity market. Spot-price contracts address this problem. Economic savings, peak load reduction, and market efficiency improvements are addressed by distributed energy systems and blockchain-enabled smart contracts (Aloqaily et al., 2020; Kirli et al., 2022; Wang et al., 2019). These new technologies are not yet widely used in the energy sector, in part because it is a regulated industry.

The Czech Republic's energy vision is focused on partial decarbonisation in technologically neutral ways, particularly favouring nuclear energy expansion. This approach is influenced by the country's industrial tradition and the growing scepticism toward the large-scale deployment of renewable energy sources (Čabeláková et al., 2020). The energy strategy is described as inward-looking and status quo, but the development of renewable energy sources in neighbouring countries challenges this status quo, leading to a potential change in the Czech energy sector (Osička et al., 2022; Jakubelskas & Skvarciany, 2023). Like other liberalised markets, the Czech energy market is characterised by concentration and oligopolistic tendencies. Our study should shed light on the formation of retail prices in the Czech energy market. The main user of the results of the study is the Energy Regulatory Office of the Czech Republic, which does not yet have such a study.

Materials and Methods

The definition of the retail price for electricity is quite problematic. It is not a homogeneous product from the consumer's point of view. Each retailer offers many products that correspond to a specific use on the consumer side. From the point of view of a single vendor, there may be as many as dozens of products. Until about 2023, it was important to divide the price of electricity into high and low tariffs, where the change parameter was the time of consumption. From the vendors' point of view, this was a use of price discrimination tools. However, the most

widely used tariff for households has long been the D02d single-tariff. About 65% of households in the Czech Republic use this. Electricity prices, even in this tariff, will be examined in more detail in the article.

Since liberalisation, the retail market has been characterised by an increasing number of providers. This is known both to the Czech Energy Regulatory Authority and can be identified through the number of points of consumption and transmission, where the energy market operator OTE a.s. publishes monthly summaries of the number of connected points and individual suppliers. However, in terms of the existence of a supplier, this situation does not automatically imply that each supplier is also active in the normal retail market. Typically, these are large technology companies that resell energy to their subsidiaries. However, this market segment is not open to the public; the business relationships formed here are not known and, therefore, cannot be captured in detail for the market description.

Due to the very wide range of merchant offerings to households, obtaining data through primary research was not technically feasible. Some traders have left the market to date, so their offers are no longer known. A different approach was chosen to obtain the data in the context of the related research project. A complete data package was purchased, including all known offers from individual dealers for the retail market, from the company managing the TZB-info.cz website, which specialises in comparing offers from individual distributors. As the following table shows, there is a rather large disproportion between the number of companies officially publishing offers for households and the number of companies reporting more than 100 consumption points to the market operator OTE a.s.

Tab. 1. Number of suppliers according to TZB-info and OTE

Year	***Number of companies according to TZB - info***	***Number of companies by OTE***
2011	*13*	*39*
2012	*17*	*48*
2013	*47*	*55*
2014	*52*	*59*
2015	*45*	*57*
2016	*64*	*66*
2017	*65*	*71*
2018	*71*	*83*
2019	*86*	*87*
2020	*88*	*119*
2021	*94*	*144*
2022	*70*	*127*
2023	*46*	*115*

Source: own elaboration according to TZB-info.cz and OTE.cz.

The input data sample includes all offers that were available to consumers in the retail market at the time. The following fact should be noted here. If the contract was fixed, then depending on the number of years of fixation, the contract from 2015 may still be valid in 2018. A customer looking for a supplier in 2018 cannot return to the prices offered in previous years. However, from the perspective of data sorting, it is not possible to define in detail, just from knowing the list prices, how many households have prices fixed by the list prices of the past and which ones are dynamically changing every year because they do not use the fixation. This information is available to retailers and is part of their business strategies. End prices also vary depending on the area where the customer is located. However, the differences in distribution prices for a particular product are relatively small, representing tens of CZK per MWh at most. The geographical distribution of customers in the Czech Republic is shown in Figure 1.

Fig. 1. Distribution network in the Czech Republic
Source: TZB-info.cz1

[1] https://www.tzb-info.cz/ceny-paliv-a-energii/211-jak-zjistim-ke-ktere-distribucni-soustave-elektriny-patrim-a-mohu-si-zvolit-jinou

The following procedure was used to create the benchmark price. Individual bids from each retailer were averaged over the year for all individual commercial bids. The same procedure was used to create average prices in the three distribution territories. The price was chosen as the end-customer price, i.e. including all charges, and is taken net of VAT per MWh.

Tab. 2: Descriptive statistics of the data

Year	Number of bids	Average	Median	Minimum	Maximum	Lower quartile	Upper quartile	SD	Skew	Kurt
2012	348	3834.72	3829.82	3444.46	4220.01	3704.64	3965.01	166.58	0.26	-0.41
2013	570	3879.79	3881.05	2490.05	4597.31	3796.58	4006.31	177.82	-0.81	7.00
2014	696	3455.43	3451.62	2266.37	4002.97	3403.75	3510.97	150.96	-3.71	29.71
2015	666	3373.53	3361.19	2977.78	3984.27	3301.78	3432.27	106.85	0.93	3.21
2016	962	3270.24	3253.19	2138.39	4011.81	3189.57	3337.39	154.41	-0.29	9.70
2017	972	3329.00	3282.00	2171.92	4285.07	3212.00	3389.54	199.55	1.11	6.77
2018	1297	3513.88	3501.14	2261.10	4721.14	3396.14	3614.42	210.14	-0.28	9.97
2019	1481	3822.95	3844.32	2269.21	4430.32	3714.66	3968.21	275.94	-2.28	11.33
2020	1523	3939.58	3921.93	3475.42	5528.38	3775.42	4062.93	239.16	1.45	5.95
2021	2618	4676.17	4275.91	2166.44	11631.37	3894.50	5428.44	1173.24	1.47	3.97
2022	2510	7476.32	7060.55	2171.17	19520.55	5763.55	8576.39	2365.99	1.28	2.45
2023	901	7712.43	6677.83	2915.76	17878.74	6358.74	9666.76	2299.98	1.45	1.75

Source: own processing.

The previous section was devoted to defining the conditions for identifying retail prices. Wholesale prices from the traders' point of view can be described as follows. It is either a purchase at the spot price or a future contract in the form of a forward. Electricity is traded for a maximum of 3 years ahead in the Czech environment. Forward contracts allow a generator and a buyer of electricity to agree in advance on a fixed price at which the buyer can purchase a set amount of electricity. Forward contracts are common in practice. Forward purchase ratios in different countries are also known from the literature. Reguant (2014) states that it is up to 85% in Spain. In Australia, this share is similar (Wolak, 2007). Forward contracts are then an important tool for firms to eliminate risks and also from a planning perspective for the electricity producer (Wolak, 2022).

Tab. 3. Structure of individual prices of contracts traded on the Prague Stock Exchange between 2012 and 2022

Contract	Valid	Average	Median	Minimum	Maximum	Lower quartile	Upper quartile	SD	Skew	Kurt
SPOT (marginal price, EUR/MWh)	2,750	66.5089	42.6196	6.10375	703.258	35.0013	53.7775	77.7479	3.82283	17.2286
$Forward_{+1}$	2,750	65.4633	41.845	21.45	984	33.65	50.87	84.2708	4.18359	20.8799
$Forward_{+2}$	2,750	56.2880	42.15	20.6	473.67	32.2	50.17	51.7195	3.26445	11.6369
$Forward_{+3}$	2,750	50.2146	41.59	20.15	286.7	31.3	50.1	35.3020	3.03244	9.75379

Source: own processing.

The relationship between wholesale and retail energy prices is complex and depends on many variables. Therefore, due to the nature of the phenomenon, it is necessary to apply multivariate methods, specifically multivariate regression, which is solved by the method of least absolute deviations. The following reasons lead to this approach. The least squares method is one of linear models' oldest and most widely used statistical tools. The theoretical properties of this procedure have been applied in many descriptions. Despite its many excellent properties, least-squares estimation can be sensitive to outliers and is therefore referred to as non-robust. Applicability in terms of accuracy and statistical inference can be compromised when the data contain large outliers and are heterogeneous. An alternative is to use the least variance method, which is a useful and acceptable alternative (Liu & Yang. 2020).

One more important fact should be mentioned in terms of the data used. The final prices for consumers change with a one-year lag only during the crisis in 2022, when prices changed several times a year. However, the majority of consumers enter into a price fixation of one year. Therefore, the modelled variable represents the change between levels. For this reason, the otherwise necessary stationarity test has been dropped from the model. If stationary data were used in the model, the predictive capacity of the model would deteriorate.

Research Results

Suppliers can enter into several types of contracts. The first is the so-called spot trade, which is closed and cleared immediately. Next, suppliers can choose a forward, which is considered an over-the-counter type of trade; forwards cannot be traded on an exchange. The last option is bilateral contracts, which have the character of classic trades, i.e. a contract between a producer (supplier) and an energy supplier (customer). This type of trade is also subject to some regulation, and practically, the only difference is that the trades are not cleared on an exchange. The price of energy is directly linked to the price at which the supplier has purchased energy on the exchange. There is a time lag because the supplier buys energy mainly through forward contracts. Each supplier offers different prices due to the fact that each supplier has a different purchasing strategy.

The results of the method of least absolute deviations are shown in Table 4. The residuals of the model are shown in Figure 1. The resulting average retail price model has the following equation:

$$Price = 2642 + 1.7\ SPOT - 3.70\ Forward_{+1} - 0.94\ Forward_{+2} + 29.28\ Forward_{+3} \quad (1)$$

Where:
Price = final retail price excluding VAT for consumers
SPOT = current OTE exchange price
$Forward_{+1}$ = the contracted price between the distributor and the energy supplier for the period + 1 year
$Forward_{+2}$ = the contracted price between the distributor and the energy supplier for the period + 2 years
$Forward_{+3}$ = the contracted price between the distributor and the energy supplier for the period + 3 years

Tab. 4. Model results

	Coefficient	SD	t-share	p-value
cons	*2641.95*	*11.2853*	*234.1*	*0*
SPOT	*1.70692*	*0.361536*	*4.721*	*2.46E-06*
$Forward_{+1}$	*−3.69599*	*0.365902*	*−10.10*	*1.40E-23*
$Forward_{+2}$	*−0.941600*	*0.547575*	*−1.720*	*0.0856*
$Forward_{+3}$	*29.2851*	*0.702591*	*41.68*	*1.24E-294*

Source: own processing.

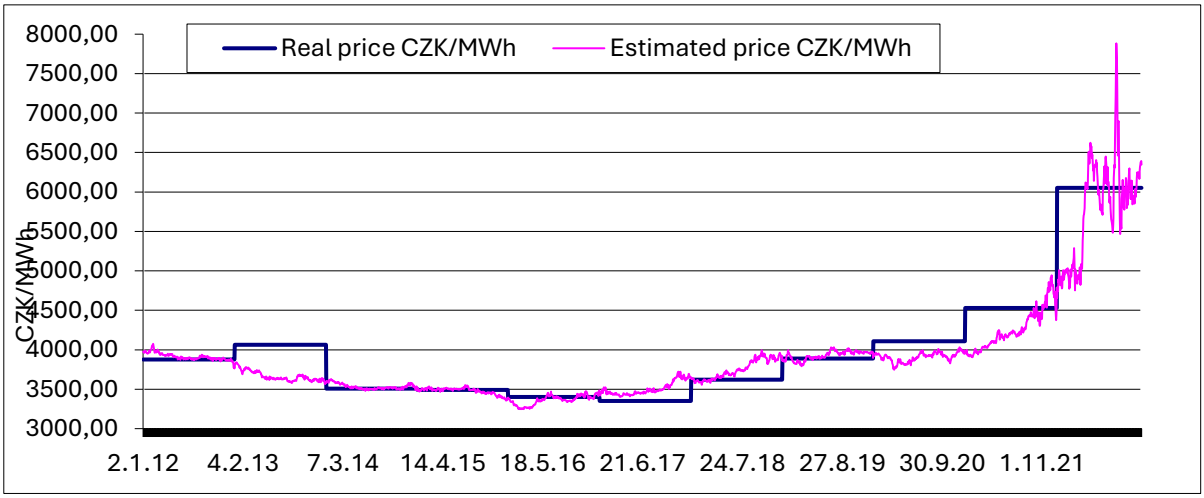

Fig. 1. Comparison of actual and predicted values

Source: own processing.

The results of the model can be interpreted as follows. The three-year contract has the highest weight in terms of retail price. An increase of 1EUR in the price of the forward causes a change of 29 CZK in the average price of 1 MW of electricity supply to households. This result also shows that most traders focus on long-term contracts and buy smaller quantities at spot prices. The model residuals from 2021 to the present are quite large. The energy crisis has fundamentally entered trading strategies at this time, and therefore, the model has not been able to react to this fact.

A more interesting view of the situation is shown by the variant in which the purchasing strategies of individual retailers are evaluated in isolation. The companies chosen here are among those with a significant market share. At the same time, they have been chosen to represent a comparison of the original suppliers operating on the market before liberalisation (CEZ. PRE). Entities that have been operating internationally in the energy market for a long time (E.ON) and new firms that entered the market after the competition was relaxed (Centropol)

have also left the market due to their poor economic performance (Bohemia Energy). A comparison of the resulting coefficients is presented in Table 5.

Tab. 5. Model coefficients

	EON	***Centropol***	***CEZ***	***Bohemia***	***PRE***
constant	*2770*	*2466*	*2526*	*3103*	*2647*
Spot RP	*1.7*	*1.77*	*2.08*	*-0.49*	*1.56*
Forward +1	*-5.82*	*-3.05*	*-3.14*	*-34.06*	*-7.06*
Forward +2	*1.47*	*-3.18*	*-2.93*	*41.4*	*0.91*
Forward+3	*26.2*	*36.42*	*33*	*6.18*	*30.93*

Source: own processing.

Compared to previous results, the common ground is evident. Continuing firms have similar weights for individual items of the energy market. They have a combined share of between 1.5 and 2. At the same time, there is a large share of long-term purchased prices; here, *Forward* $_{+3}$ has a value between 26 and 36. The coefficient for all suppliers was 29. The supplier that differs fundamentally is Bohemia Energy. The purchasing strategy here was clearly different, with *Forward* $_{+2}$ having the highest weight. The proposed model allows the regulator of the Czech energy market to analyse the business strategies of individual sellers.

Discussion

Given the nature of energy, the market would benefit from perfect competition. However, liberalised electricity markets are characterised by deviations from perfectly competitive behaviour, often by oligopoly (Hajiyev et al., 2021; Newbery & Greve, 2017). The Czech energy market is also characterised by an oligopolistic structure - in 2023, the market share of the four largest energy companies was 85 %. In 2021, the Czech energy market experienced the biggest shock in its history: As a result of rising wholesale electricity and gas prices, the Bohemia Energy group, which serves approximately 900,000 customers, ceased operations overnight. In one day, more customers were forced to switch electricity suppliers than they usually do in a whole year. The company closed down due to its risky energy purchasing strategy, but also due to the unfavourable market situation on the energy exchange. After the collapse of Bohemia Energy, the public, as well as politicians, started to demand tighter regulation for suppliers and supervision of suppliers, but also an increase in the powers of the Czech Energy Regulatory Office. The question naturally arose of whether the collapse of such a major distributor could have been foreseen.

The Czech Energy Regulatory Office requested an econometric model to describe the relationship between wholesale and retail electricity prices in the Czech market. The model shows that three-year contracts have the most significant impact on retail prices. The energy crisis has had an impact on the business strategies of firms operating in the market. Analysis of the purchasing strategies of individual retailers reveals insights into the market dynamics. Established firms maintain similar strategies with a significant share of long-term contracts. However, Bohemia Energy stands out with a different approach as it focuses more on forward + 2 contracts. Existing models reported in the literature focused primarily on forecasting, i.e., modelling electricity spot prices and volatility evaluation (for instance, Božić et al., 2020; Gabrielli et al., 2022; Lago et al., 2018). The model presented in this study allows the analysis of consumer energy pricing based on historical data and the detection of non-standard and potentially risky purchasing strategies. A situation similar to the Bohemia Energy crash is unlikely to happen again in the near future due to the tightening of market supervision. The Bohemia Energy crash had tremendously negative impacts on consumers and companies, mostly those who fell into the supplier of last resort mode and were on spot prices for several months. On the positive side was the quick response of suppliers, who adapted during the period and contracted out most of the former clients of the defunct Bohemia Energy.

Ensuring energy security has become a priority of EU energy policy (Kuzemko et al., 2022). The war in Ukraine that started in 2022 triggered a paradigm shift regarding the degree of state intervention. From an emphasis on market integration to liberalise European energy markets and increase their efficiency, we have witnessed a more interventionist approach, as manifested, for example, by the nationalisation of European gas companies in response to rising import costs (Goldthau & Sitter, 2022). The war in Ukraine highlighted the broader political and security risks associated with high energy dependence and the need to rethink the trade-offs between economic considerations and energy security (Goldthau & Youngs, 2023).

Conclusions

In this study, we focus on analysing the determinants of the relationship between wholesale and retail energy prices in the Czech Republic. The interest in this topic is highlighted not only at the national level but also at the European and international level, especially in the context of the current geopolitical situation and efforts to

decarbonise the economy. Understanding the determinants of the relationship between energy prices in the wholesale and retail markets is crucial for effective management and regulation of the energy sector in the Czech Republic. The importance of this topic is reinforced by current challenges, such as the drive to reduce CO_2 emissions and to ensure affordable and sustainable energy supply for citizens and businesses. We have developed an econometric model to analyse the relationship between wholesale and retail energy prices using the method of least absolute deviations. The results of the model provide important information to understand these relationships and can be used to formulate effective policies and strategies in the energy sector. Climate and decarbonisation policy aims to ensure a sustainable energy sector in the long term, which in the short term means recognising the need for higher costs, especially as a result of investment. The EU governments expect these changes to deliver benefits to consumers in the short term while achieving longer-term sustainability objectives.

One of the main limitations of this study is the dependence on secondary data sources, particularly for the analysis of wholesale and retail energy prices. Although efforts have been made to obtain complete data from reliable sources such as TZB-info.cz and OTE.cz, the accuracy and completeness of these datasets cannot be guaranteed. Additionally, the absence of certain variables or incomplete records may have affected the results and subsequent conclusions. The study focuses mainly on data from 2012 to 2023, which may not fully capture long-term trends or cyclical patterns in energy prices. The economic, political, and environmental factors that affect the energy markets can evolve over time, and an expanded time scale could provide a more complete understanding of the determinants of wholesale and retail energy prices. The analysis focuses on the Czech Republic, with energy markets linked regionally and globally. Therefore, the findings of this study may not fully account for the influences on energy prices, such as international energy trade, geopolitical tensions, or regional policy differences. Although the findings of this study contribute to understanding the determinants of energy prices in the Czech Republic, caution is necessary when extrapolating these results to other contexts or jurisdictions. Differences in market structures, regulatory frameworks, energy sources, and consumer behaviours can limit the study's conclusions about the Czech energy market. While the study uses a multivariate regression model to explore the relationship between wholesale and retail energy prices, certain assumptions and simplifications inherent in econometric modelling can pose limitations. For example, the ability of the model to capture complex interactions between variables or to account for non-linear relationships may be limited, leading to biased estimates or bias due to omitted variables.

The implications resulting from this study for policymakers are as follows. First, research results improve transparency in energy markets, including the dissemination of timely and accurate information on wholesale and retail energy prices. This will enable consumers to make informed decisions and promote competition between energy suppliers. The regulatory authority should establish greater transparency requirements for market participants to improve market efficiency and consumer welfare. Second, we should emphasise that implementing policies to promote price stability in energy markets is essential. Regulatory interventions and mechanisms to mitigate price volatility could help protect consumers from sudden fluctuations in energy prices, thereby improving energy affordability and social and economic welfare. Third, policy measures aimed at diversifying energy sources, in particular by promoting the development and deployment of renewable energy technologies, could reduce dependence on volatile fossil fuel markets. By reducing exposure to fluctuations in fossil fuel prices, such measures can contribute to long-term energy security and environmental sustainability. Next, given the socio-economic impacts of rising energy prices, policies should prioritise measures to support vulnerable consumer groups facing energy poverty or financial hardship. Targeted subsidies, energy efficiency programmes, and social measures can help alleviate the burden of energy costs for low-income households and promote inclusive economic development in line with the UN SDGs. Finally, given the interconnected nature of energy markets, energy policy must be based on European cooperation and coordination to address common challenges, promote the integration of energy markets, and strengthen regional energy security. Harmonisation of policies and infrastructure development will strengthen resilience to external shocks and support the transition to sustainable energy systems.

The ongoing research will focus on the determinants of demand in the Czech energy market. The research aims to model and interpret the impact of several selected price levels on consumer and investor behaviour. Research will focus on the analysis of price indicators and the elasticity of the market to these price changes. For the investor, the relationship between environmental energy savings and the financial benefits of these measures is important. Therefore, the ongoing project focuses on socio-economic aspects, using a methodology to set up support rules to promote the deployment of new technologies.

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