Modeling the Excess Return of ČEZ a.s. Share

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Abstract

To evaluate the excess return of ČEZ a.s. shares, we propose a multifactor asset pricing model derived from the Asset pricing theory. In addition to market risk, factors that may affect the performance of ČEZ a.s. shares are added. These are price of electricity, price of natural gas, price of CO2 emission allowances and the industrial production index. To take into account a possible persistence of the excess return and external shocks, autoregressive and moving average terms are also included into the model. Thus, from an econometric point of view, it is an ARMAX model. We verify the validity of the model on monthly and quarterly data from 9-2007 to 4-2023. The results of our analysis show that the proposed model can explain exceedingly well the variability of excess return of ČEZ a.s. stock in both monthly and quarterly time frequencies.

Key Words

excess return, ČEZ a. s. stock, asset pricing theory, CAPM model, ARMAX model

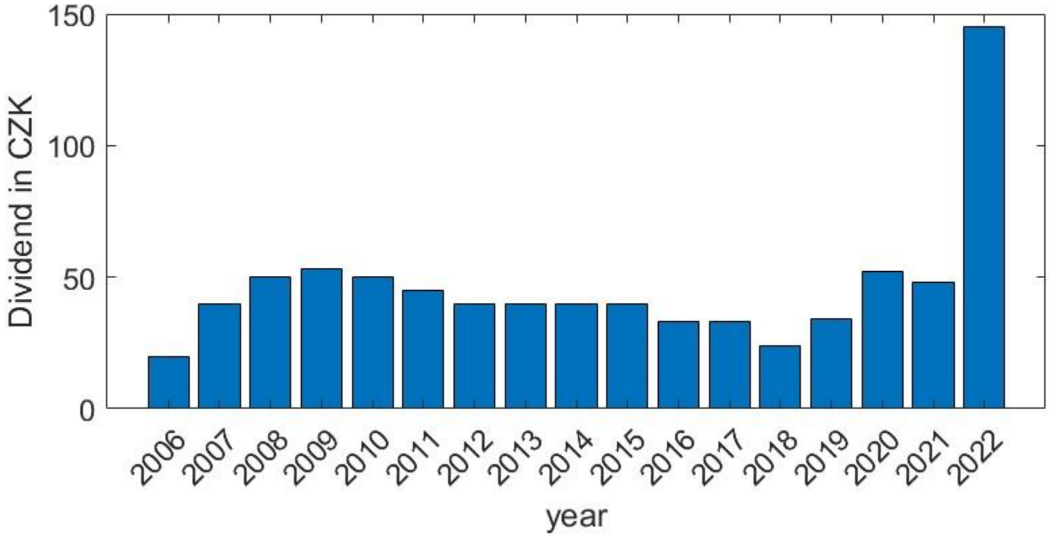
JEL Classification: C21, R13

Introduction

ČEZ a. s. is a typical utility firm in the Czech Republic. It is an energy giant that owns the ČEZ Group whose main business activities are the production, trade and distribution of electric and thermal energy, trade and sale of natural gas as well as coal mining. Its main shareholder is the Czech government who holds a share of almost 70% of its shares. Given the liquidity of the Prague Stock Exchange, ČEZ a.s. shares are the most traded security there. The average number of its trades exceeds 1000 a day and the average daily trading volume is over CZK325mil over the last 12 months. ČEZ a.s. has also been paying regular dividends to its shareholders regularly since 2006 up to now, see Figure 1. Though the interest of individual investors in investing into stocks may not be as widespread as in more developed economies since the tradition is not as deeply rooted here, the shares of ČEZ a.s. are attractive for both domestic and foreign institutional investors from the point of view of both dividend income and capital gains.

Utilities stocks tend to offer investors stable and consistent dividends. Their price is often less volatile than the overall equity markets. Hence, the performance of the stock of these companies is a main focus of researchers and practitioners and many studies on the performance of utilities stocks and the factors which can affect their returns around the globe, for example Oberndorfer (2009), McDonald (2010), Da (2017), Ji (2019), Reboredo and Ugolini (2018), Zhang (2020), and Pham et al (2023). There are numerous analyses in the form of qualification theses at universities across the country on the identification of factors that can influence the price of ČEZ a.s. stock and their returns, for example Kajurová and Dvořáková (2016). As ČEZ a.s. shares are a prominent component of the Prague Stock Exchange, banks and brokers also regularly provide investors with analyses and forecasts of its future development. As a regional stock, it has not attracted much attention either from practitioners or from theorists. There is a clear lack of more qualified research on what can influence the price of ČEZ a.s. stocks or their returns. In order to fill this gap in the literature, we propose a model to measure the impact of factors which can reasonably influence the excess returns of ČEZ a.s. share within the framework of the well-known CAPM model. We extend the basic version of this model with other factors that may affect both the supply and demand of electricity produced by ČEZ a.s.. We will test our model with data available from 9-2007 to 4-2023 for monthly and quarterly data. Based on the results obtained, we will draw some conclusions about the excess return on ČEZ a.s. share.

Fig. 1: The evolution of dividends paid by ČEZ a.s. in 2006–2022



Source: authors' calculations in Matlab, company (CEZ)

1. Methodology

The basic theoretical framework for modeling the excess return of ČEZ a.s. stock is the capital asset pricing model where the expected rate of return of an individual security $E(r_i)$ is a function of systematic risk reflecting the volatility of its return. This model is called the Security Market Line (SML) and it can be formalized as

$$E(r_i) = r_f + \beta_i[E(r_m) - r_f], \quad (1)$$

where $E(r_m)$ is the expected return of the market portfolio, r_f is the risk-free rate and β_i is a measure of the systematic risk of this security, see Barucci and Fontana (2017). Inserting the intercept in equation (1) gives a modification of SML which, also known as the single index model

$$E(r_i) - r_f = \alpha_i + \beta_i[E(r_m) - r_f] + e_i, \quad (2)$$

where α_i is the excess return that is specific to the security, and e_i is the non-systematic risk. The excess return of ČEZ a.s. stock may be influenced by other factors specific to the electricity market. These can be the market price of electricity, its demand and cost of its production. If these factors are added to model (2), we obtain the multifactor version of the asset pricing theory.

$$\mathrm{E}(r_i) - r_f = \alpha_i + \beta_i[E(r_m) - r_f] + \sum_{j=1}^{p} \gamma_j X_j + e_i, \quad (3)$$

where X_j is the j-th factor from the total number of factors *p*. Let's set $R_i = E(r_i) - r_f$ as the excess return of stock *i* and $RM = E(r_m) - r_f$ and if we assume that the excess return has a certain persistence and that the effect of external shocks can be carried over to the next period, the model gets the following specification by adding these two terms:

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$$R_i = \alpha_i + R_i(-1) + \beta_i RM + \sum_{j=1}^{p} \gamma_j X_j + e_i + \mu e_i(-1). \quad (4)$$

Model (4) is an ARMAX model, where the exogenous variables are the excess market return and other factors that influencing the excess return of ČEZ a.s. shares.

2. Data

We verify the validity of model (4) using data available from the Bloomberg database. We use monthly and quarterly data. The reason is that both monthly and quarterly time horizons are important for investment decision-makers and this allows us to analyze how different factors can affect the excess return with respect to the different length of the time span. The data cover the period from 9-2007 to 4-2023. The excess return of ČEZ a.s. stock R is computed as the year-to-year change in its price minus the risk-free interest rate for the corresponding period. In this research, the overnight indexed swap rate is used as the risk-free rate. It is a fixed/float interest rate swap where the floating leg is computed using a published overnight index rate. The index rate is typically the rate for overnight unsecured lending between banks. The " risk-free" nature of these contracts is due to their short maturity (1 month or 3 months) and the fact that they are derived from the interbank market, where counterparty risk is low, and thanks to central bank supervision. They are also actively traded and therefore liquid contracts. The excess return on the stock market return RM is calculated in the same way from the Prague Stock Exchange index PX. Other factors included in the model are the future price of electricity (ELEC), the price of natural gas (GAS), the price of CO2 emission allowances (CO2) and the index of industrial production (IPV). The data on industrial production are primarily provided by the Czech Statistical Office, they are called the monthly and quarterly basic index of industrial production, respectively. The inclusion of these variables can be observed in works of Adi (2022), Ji et al. (2019), Mo et al. (2012). As electricity, natural gas and emission permits are priced in euro, we also use the series of EUR/CZK spot exchange rate[1] to convert these series into corresponding series in CZK. Then we compute the corresponding series of year-to-year changes. All the year-to-year changes of variables are computed as follows

$$\Delta Z_t = \frac{Z_t - Z_{t-1}}{Z_{t-1}}.100, \quad (5)$$

where Z_t is the value of a variable at the current period, Z_{t-1} is the value of a variable at the same period of the previous year. The descriptive statistics of the time series used in the econometric analysis are presented in Tables 1 and 2. The development of the price of ČEZ a.s. shares and its returns can be observed in Figures 1 and 2. All computational work was done with Matlab.

[1] A spot exchange rate is the current price an investor can exchange one currency for another, for delivery on the earliest possible value date.

Tab. 1: Descriptive statistics of monthly data

Characteristic	R	RM	ELEC	GAS	CO2	IPV
Mean	-2.071	-1.841	8.825	9.904	34.154	1.298
Median	-2.098	0.506	-4.270	6.941	10.789	2.822
Minimum	-59.415	-80.181	-99.726	-113.189	-85.954	-42.478
Maximum	59.836	51.439	175.416	195.364	710.513	43.860
25 percentile	-16.055	-12.102	-18.845	-29.181	-23.788	-1.516
75 percentile	13.851	9.321	22.923	31.615	43.497	5.879
Std deviation	24.766	22.904	48.505	63.770	126.951	9.330
Skewness	0.120	-1.003	1.390	0.932	3.783	-0.837
Kurtosis	2.954	5.373	5.269	4.070	18.091	8.914
Num of Obs.	175	175	175	175	175	175

Source: authors' calculations in Matlab

Fig. 2: The evolution of monthly CEZ stock price and its returns

Source: authors' calculations in Matlab

Tab. 2: Descriptive statistics of quarterly data

Characteristic	R	RM	ELEC	GAS	CO2	IPV
Mean	-2.279	-1.886	8.485	9.700	30.612	1.704
Median	-5.016	0.396	-4.498	6.760	8.638	2.714
Minimum	-53.147	-74.353	-66.728	-102.384	-79.869	-15.449
Maximum	54.196	44.909	162.739	181.124	640.871	16.500
25 percentile	-15.032	-11.091	-17.716	-30.405	-24.225	-1.332
75 percentile	11.672	7.081	21.360	26.343	37.922	7.015
Std deviation	24.359	22.323	47.669	62.927	118.545	6.917
Skewness	0.108	-1.119	1.502	0.975	3.960	-0.678
Kurtosis	2.890	5.737	5.352	4.019	19.941	3.077
Num of Obs.	58	58	58	58	58	58

Source: authors' calculations in Matlab

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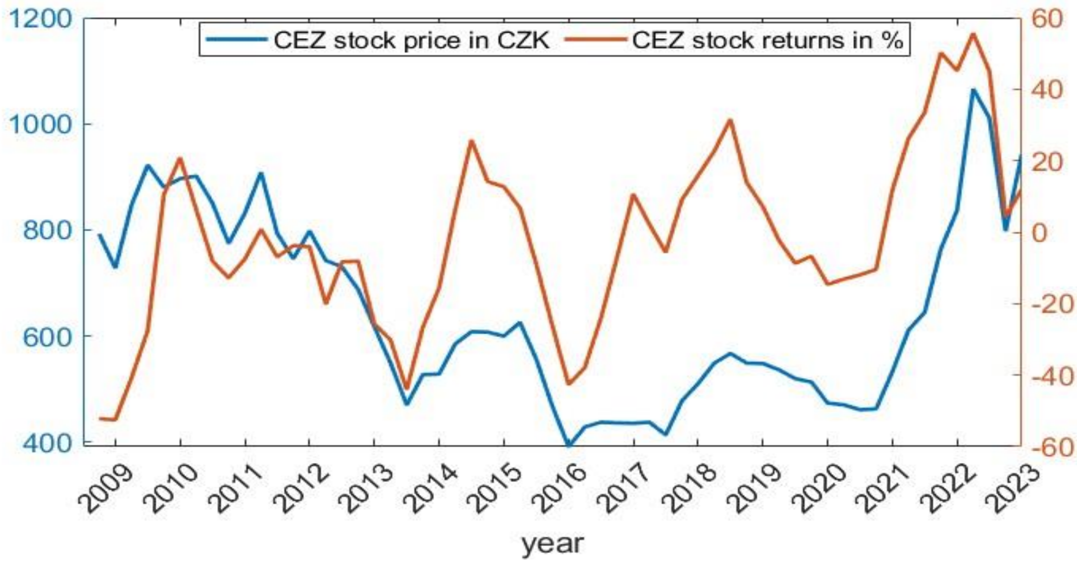
Fig. 3: The evolution of quarterly CEZ stock price and its returns



Source: authors' calculations in Matlab

3. Results of the Research

Prior to the econometric analysis, a unit root test was carried out to ensure the stationarity of the time series used in the following estimation. The standard augmented Dickey-Fuller test was applied. The testing results of this test for both monthly and quarterly frequencies are presented in Table 3. The results in Table 3 show that all time series generated for the empirical verification of our model are stationary and they can be used as input data for the ARMAX model.

The estimation of coefficients of our ARMAX model was performed in Matlab and it strictly follows a standard methodological procedure, see Wooldridge (2001). First, the model for monthly data was estimated. In addition to the intended variables, two dummy variables D01 and D02 were also included into the model specification. They are intended to capture the sharp decline due to the financial crisis in 9-2008 and its recovery a year later. However, in the case of the Czech Republic, this fall occurred one month later, i.e. in 10-2008, as did the recovery. The estimation results are shown in Table 4. Except the intercept and the coefficients for GAS and CO2, all other estimated coefficients are statistically significant at the level $\alpha = 0.95$ including the dummy variables indicating that their inclusion is fully justified. Furthermore, the value of the coefficient of determination R2 = 0.9345 and the Durbin-Watson statistic DW = 2.04 show that the model has high predictive power and there is no autocorrelation in the residuals.

Tab. 3: Results of unit root test of time series

Series	Monthly Data		Quarterly Data	
	Test stat	p-value	Test stat	p-value
R	-3.087	0.0022	-2.774	0.0064
RM	-4.231	0.0000	-6.965	0.0000
ELEC	-3.415	0.0007	-4.553	0.0000
GAS	-4.215	0.0000	-4.830	0.0000
CO2	-4.957	0.0000	-5.481	0.0000
IPV	-5.829	0.0000	-3.485	0.0008

Source: authors' calculations in Matlab

Tab. 4: Estimation results with monthly data

Variable	coefficient	SE	t-stat	pval
C	-0.254	0.548	-0.464	0.643
R(-1)	0.783	0.037	21.437	0.000
RM	0.173	0.035	4.955	0.000
ELEC	0.078	0.032	2.460	0.015
GAS	-0.030	0.021	-1.397	0.164
CO2	0.002	0.005	0.491	0.624
IPV	-0.129	0.064	-2.014	0.046
D01	-34.325	6.988	-4.912	0.000
D02	18.879	6.713	2.812	0.006
MA	0.358	0.080	4.497	0.000

Source: authors' calculations in Matlab

We proceeded in a similar way for the quarterly data. The only exception is the inclusion of five dummy variables into the specification: D01 for Q4-2008 for the 2008 crisis, D02 for Q3-2013, D03 for Q4-2017, D04 for Q2-2022 and D05 for Q1-2023. The estimation results for quarterly data are shown in Table 5. In this case, all estimated coefficients except the one for CO2 are statistically significant at level $\alpha = 0.95$ and higher. the value of the coefficient of determination R2 = 0.9185 and the Durbin-Watson statistic DW = 1.982 indicate similar conclusions as in the case of monthly data.

4. Discussion

The results of the econometric analysis in Tables 4 and 5 show that although the estimated α is negative in both cases, it is insignificant in the shorter horizon but is significant in the longer one. This does not mean that the investing in ČEZ a.s. share is associated with a negative excess return. Rather, it can be explained by the dividend that ČEZ a.s. regularly pays to its shareholders. As for β, it is positive and significant, but much lower than one, which means that ČEZ a.s. stocks do not share so much systemic risk with the stock market. It also confirms the less volatile nature of utilities stocks. The estimated value of β consistent with the values of beta of various utilities firms across the world in McDonald et al (2010). The coefficients of the AR and MA terms are positive, indicating that there is a significant persistence in the excess return of ČEZ a.s. stock and that the effect of external shocks can be extended to the next period. The value of the AR term in the quarterly data model is lower than the one in the shorter time span version indicating that it dies out faster in the longer time span. The opposite is true for the MA term. The impact of the electricity price on the excess return of ČEZ a.s. stock is positive in both cases, but it is higher with quarterly data. This may be due to the fact that it takes time for the price factor to be reflected in the company's performance. This result is consistent with the finding of Lin and Chen (2019). The same is true for the cost factor represented by the price of natural gas. While in the short term, the effect of this factor may not be visible in the financial performance of the company, in the longer term it negatively affects the performance of the excess return of ČEZ a.s. shares. This inference is in agreement with the results of Pham et al (2023) and Ordu and Soytas (2016) about the time varying connection between the natural gas price and returns of utilities stocks. Regarding the role of the price of CO2 emission allowances, the estimated coefficient of this factor is very small and statistically insignificant indicating, which indicates that this factor has no impact on the excess return of ČEZ a.s. stock. The comparison of our result with those of other studies is rather challenging as the effect of CO2 emission allowances on

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performance of energy producing firms is ambiguous. While Mo et al (2012) claim that it is time-varying, i.e. it was insignificant at the beginning and becomes more effective as the CO2 emission related measures grow in severity over time, Koch and Bassen (2013) have found that for majority of power producers CO2 price movements are not a relevant risk factor. Tian et al (2016) have also come to a similar conclusion while according to Ji et al (2019) the effect of CO2 price on the performance of the electricity producing firms depends on their specific power generation mix and carbon intensity. As far as the demand for electricity is concerned, it is represented by the industrial production as we assume the higher it is, the more electricity the industrial production (the economy as well) will consumes, the result is interesting. In the shorter time horizon, the demand has a negative impact on the performance of the excess return of ČEZ a.s. stock. In the longer term, however, its impact becomes positive. In both cases, the effect is statistically significant. The explanation may be that wholesale customers may have long-term contracts with ČEZ a.s. for the supply of electricity. This result is in contrast with the finding of Da et al (2017) who argue that rising demand for electricity may lead to a decline of returns of stocks in the future.

Tab. 5: Estimation results with quarterly data

Variable	coefficient	SE	t-stat	pval
C	-4.066	1.252	-3.248	0.002
R(-1)	0.241	0.074	3.274	0.002
RM	0.239	0.071	3.349	0.002
ELEC	0.365	0.073	5.033	0.000
GAS	-0.145	0.048	-3.045	0.004
CO2	-0.006	0.012	-0.519	0.606
IPV	0.399	0.183	2.186	0.034
D01	-23.183	10.496	-2.209	0.032
D02	-20.461	8.226	-2.487	0.017
D03	36.807	8.753	4.205	0.000
D04	23.085	8.458	2.729	0.009
D05	21.797	8.315	2.621	0.012
MA	0.835	0.142	5.864	0.000

Source: authors' calculations in Matlab

Conclusion

We proposed a model based on asset pricing theory for the excess return of ČEZ a.s. share. In addition to the market risk factor, we included in the model other factors that may affect profits, costs of production and demand for electricity – the main product of ČEZ a.s. - into the model. The model then was verified with appropriate monthly and quarterly data for the time period from 9-2007 to 4-2023. The results of the verification show that the model has extremely high predictive power and produces interpretable outputs which are in line with common economic wisdom. Therefore, it can provide some important insights into how various factors can influence the excess return of ČEZ a.s. stock. We assume that the results are encouraging so this approach can be extended to examine excess returns of other stocks from various markets in the region as well as in the further abroad.

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References

ADI, T. W. (2022). The international gas and crude oil price variability effect on Indonesian coal mining companies listed at IDX. *International Journal of Energy Economics and Policy*, 12(5): 1-10. https://doi.org/10.32479/ijeep.13263

BARUCCI, E., and C. FONTANA. (2017). *Financial Markets Theory: Equilibrium, Efficiency and Information.* London: Springer-Verlag.

DA, Z., HUANG, D., YUN, H. (2017). Industrial electricity usage and stock returns. Journal of Financial and Quantitative Analysis, 52.1: 37-69. https://doi.org/10.1017/s002210901600079x

JI, Q., et al. (2019). The information spillover between carbon price and power sector returns: Evidence from the major European electricity companies. *Journal of Cleaner Production*, 208: 1178-1187. https://doi.org/10.1016/j.jclepro.2018.10.167

KAJUROVÁ, V., and K. DVOŘÁKOVÁ (2016). Faktory ovlivňující kurz akcií společnosti ČEZ, a.s.. Diplomová práce, Masarykova univerzita, Brno.

KOCH, N., BASSEN, A. (2013). Valuing the carbon exposure of European utilities. The role of fuel mix, permit allocation and replacement investments. *Energy Economics*, 36: 431-443. https://doi.org/10.1016/j.eneco.2012.09.019

LIN, B., CHEN, Y. (2019). Does electricity price matter for innovation in renewable energy technologies in China?. *Energy Economics*, 78: 259-266. https://doi.org/10.1016/j.eneco.2018.11.014

MCDONALD, J. B.; MICHELFELDER, R. A.; THEODOSSIOU, P. (2010). Robust estimation with flexible parametric distributions: estimation of utility stock betas*. Quantitative Finance*, 10.4: 375-387. https://doi.org/10.1080/14697680902814241

MO, J., ZHU, L., and Z. FAN (2012). The impact of the EU ETS on the corporate value of European electricity corporations. *Energy*, 45(1): 3-11. https://doi.org/10.1016/j.energy.2012.02.037

OBERNDORFER, U. (2009). Energy prices, volatility, and the stock market: Evidence from the Eurozone. *Energy Policy*, 37.12: 5787-5795. https://doi.org/10.1016/j.enpol.2009.08.043

ORDU, B. M., SOYTAŞ, U. (2016). The relationship between energy commodity prices and electricity and market index performances: evidence from an emerging market. *Emerging Markets Finance and Trade*, 52.9: 2149-2164. https://doi.org/10.1080/1540496x.2015.1068067

PHAM, S. D., NGUYEN, T. T. T.; DO, H. X. (2023). Natural gas and the utility sector nexus in the US: Quantile connectedness and portfolio implications. *Energy Economics*, 120: 106632. https://doi.org/10.2139/ssrn.4172977

REBOREDO, J. C., UGOLINI, A. (2018). The impact of energy prices on clean energy stock prices. A multivariate quantile dependence approach. *Energy Economics* 76: 136-52. https://doi.org/10.1016/j.eneco.2018.10.012

TIAN, Y., et al (2016). Does the carbon market help or hurt the stock price of electricity companies? Further evidence from the European context. *Journal of Cleaner Production*, 112: 1619-1626. https://doi.org/10.2139/ssrn.1976794

WOOLDRIDGE, J. M. (2001). *Econometric Analysis of Cross Section and Panel Data.* Massachussets: The MIT Press.

ZHANG, W., et al. (2020). How does the spillover among natural gas, crude oil, and electricity utility stocks change over time? Evidence from North America and Europe. *Energies*, 13.3: 727.

BLOOMBERG L.P. (2023). Data for Econometric Analysis 9/07 to 4/2023. Retrieved from Bloomberg database

MATLAB, 2022. *version 9.13.0 (R2022b)*, Natick, Massachusetts: The MathWorks Inc.