Modeling the excess return of ČEZ a.s. share

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ČEZ a.s.

- ČEZ a. s. is an energy giant that owns the ČEZ Group whose main business activities are the production, trade and distribution of electric and thermal energy
- The Czech government holds almost 70% of its shares
- At the Prague Stock Exchange, ČEZ a.s. shares are the most traded stock
- The average number of its trades exceeds 1000 a day at PSE and the average daily trading volume is over CZK325mil over
- 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
- Investment in ČEZ a.s. stock has become more popular with individual investors in Czechia

Motivation and Research Objective

- There are numerous analyses which try to identify factors that can influence the price of ČEZ a.s. stock and its returns
- Banks and brokers also regularly provide investors with analyses and forecasts of future development of price of ČEZ a.s. share
- There is a clear lack of more qualified research on what can influence the price of ČEZ a.s. stock or its returns
- We propose a model to measure the impact of factors which can affect returns of ČEZ a.s. share within the framework of the asset pricing model
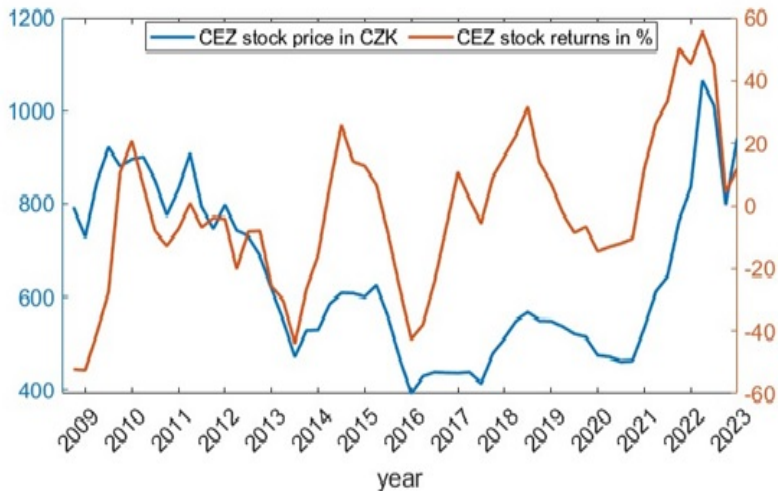- The model will be tested with data available from 9-2007 to 4-2023
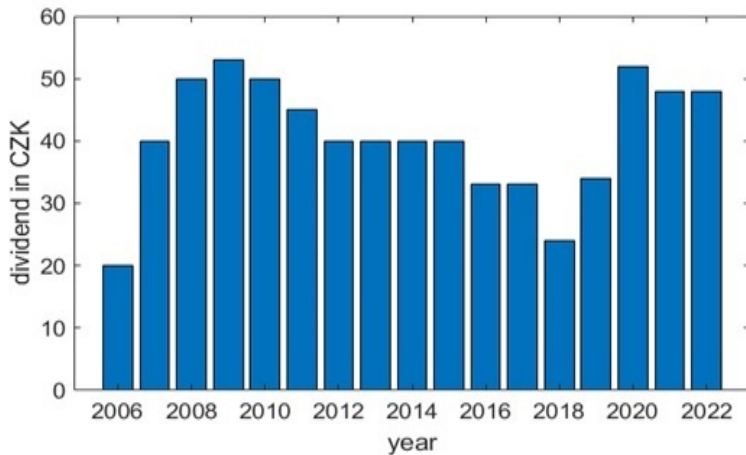
The evolution of price and return of ČEZ a.s. share - Monthly

The evolution of price and return of ČEZ a.s. share - Quarterly

Excess return and security market line

- The excess return of a stock is the return generated by the stock above the risk-free rate of return
- It is a measure of the performance of an investment into the stock compared to investment in a risk free bond
- The Security Market Line (SML) expresses the relationship between the expected return and the systematic risk of an individual security/portfolio
- The expected return of an investment should be directly proportional to its systematic risk measured by β representing the systematic risk of return of a security relative to the broader market

$$\mathbb{E}R_i = r_f + \beta(\mathbb{E}R_m - r_f), \tag{1}$$

where R_i is the return of asset i, R_m is the return of the market portfolio and r_f is the risk-free rate

Multifactor asset pricing model

- The multifactor asset pricing model extends the capital asset pricing model by incorporating multiple risk factors to explain the expected returns of assets
- The general equation for a multifactor asset pricing model is as follows

$$\mathbb{E}R_i = r_f + \sum_{i=1}^{k} \beta_i F_i, \tag{2}$$

  where F_i is the i-th factor which can affect the expected returns of the asset
- The return of ČEZ share can be affected by these factors: demand for electricity, the price of electricity, the price of oil and natural gas/coal and the price of CO_2 emission allowances

Intrinsic dynamics of returns

- Return may exhibit time persistence which can be model by an autoregressive process
- Returns may depend not only on current pricing signal, but also on signals from previous periods which can be modeled by a moving average process
- Together, its intrinsic dynamics can be captured by an ARMA model
- Combining the ARMA model for the intrinsic dynamics with all factors that can affect the return of a share, we can model the expected excess returns with the following model

$$r_{i,t} = \alpha + r_{i,t-1} + \sum_{j=1}^{k} \beta_j F_j + e_t + \phi e_{t-1}, \qquad (3)$$

where the excess return $r_{i,t} = \mathbb{E}R_i - r_f$, e_t is the error term at time t

- We use monthly and quarterly averages of price of ČEZ a.s share at PSE and for the market portfolio averages of index PX
- We use averages of risk free rate for one month and for a quarter
- For the demand of electricity, the monthly and quarterly industrial production indices are used
- Series of forward price of electricity and natural gas
- Averages price of CO_2 emission allowances
- Data are from period 9-2007 to 4-2023

Data pre-processing

- We compute year-to-year logarithmic returns of ČEZ a.s. share price and index PX

- Then the respective excess returns series are computed

- We use series of monthly and quarterly EUR/CZK exchange rate to convert the price price series of electricity, natural gas and CO2 emission allowances to CZK and then compute the year-to-year logarithmic price changes

- Similarly, the IPV index series are converted into year-to-year changes series

- Descriptive statistics of these series are displayed in the next to tables

- We test the stationarity of these series using Augmented Dickey-Fuller unit root test

Descriptive statistics of monthly data

Stat	R	RM	ELEC	GAS	CO2	IPV
Mean	-2.071	-1.841	8.825	9.904	34.154	1.298
Median	-2.098	0.506	-4.27	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	43.86
25 prctile	-16.055	-12.102	-18.845	-29.181	-23.788	-1.516
75 prctile	13.851	9.321	22.923	31.615	43.497	5.879
Std. dev.	24.766	22.904	48.505	63.77	126.951	9.33
Skewness	0.12	-1.003	1.39	0.932	3.783	-0.837
Kurtosis	2.954	5.373	5.269	4.07	18.091	8.914
N. of Obs.	175	175	175	175	175	175

Descriptive statistics of quarterly data

Stat	R	RM	ELEC	GAS	CO2	IPV
Mean	-2,279	-1,886	8,485	9,7	30,612	1,704
Median	-5,016	0,396	-4,498	6,76	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	16,5
25 prctile	-15,032	-11,091	-17,716	-30,405	-24,225	-1,332
75 prctile	11,672	7,081	21,36	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	3,96	-0,678
Kurtosis	2,89	5,737	5,352	4,019	19,941	3,077
N. of Obs.	58	58	58	58	58	58

The results of unit root testing

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

Estimation resuklts for 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
RM	0.173	0.035	4.955	0
ELEC	0.078	0.032	2.46	0.015
GAS	-0.03	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
D02	18.879	6.713	2.812	0.006
MA	0.358	0.08	4.497	0

Estimation results for 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
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
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

- Monthly data model: D01 = 10-2008, D02 = 10-2009
- Quarterly data model: D01 = Q4-2008, D02 = Q3-2013, D03 = Q4-2017, D04 = Q2-2022, D5 = Q1-2023
- Coefficient of determination R2 = 0.9345 and 0.9185 respectively
- Durbin Watson stats DW = 2.04 and 1.98 respectively

- We proposed a model derived from asset pricing theory for the excess return of ČEZ a.s. share
- The model then was verified with appropriate monthly and quarterly data for the time period from 9-2008 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
- We assume that 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

Thank you for your attention!