Seasonality

Executive summary

We have conducted a series of statistical tests to figure whether it is reasonable to assume that energy prices are, on average, the same, across different months, different times of the day, and days of the week. It is not reasonable to make this assumption. This however, shows that it might be feasible to make predictions of energy prices based on seasonality. *All though we still do not have the technical skills to make such a prediction. A reasonable timeline would be that we would have such skills (of needed) within a few months.*

Introduction

This report investigates whether it is feasible to make accuracte predictions of the energy prices. The goal of this report is not to actually produce predictions, but merely to demonstrate, using statistical techniques, whether it might be possible. Specifically, hourly prices on electricity in the period 2022-10-26 to 2025-04-09 are used to test whether there is *seasonality* at the hourly, monthly, and day of week level. *If* these vary systematically, then there is room to build predictions based on this (using regression analysis, which we introduce later in this course).

Descriptive statistics

Summary statistics

Table 1: Summary statistics

|  |  |
| --- | --- |
| **Standard summary stats** | |
| Mean | 0.086967 |
| Standard dev. | 0.069661 |
| Observations | 21504 |

Notes: This table contains summary statistics  
Source: *www.elprisenligenu.dk*

Table 2: Summary statistics by year

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 2022 | 2023 | 2024 | 2025 |
| Mean | 0.191502 | 0.081255 | 0.070863 | 0.097831 |
| Standard dev. | 0.139442 | 0.050119 | 0.052209 | 0.055981 |
| Observations | 1585 | 8760 | 8784 | 2375 |

Notes: This table contains standard summary by year

Figure 1: Energy prices over time (95% CI of the average price by year)

Notes: This figure shows the 95% CI using the normal distribution around the mean for each year

Interpretation:

* The average is 0.087 EUR per kWh with a standard deviation of 0.07. (Table 1)
* The standard deviation is relatively stable over time, with the exception of 2022. (Table 2)
* A 95% CI around the average prices shows no overlap between any of the years, although the year 2022 stands out with visible much larger prices (Figure 1).
* A concern with the data for 2022 and 2025 is that we have fewer observations. And those observations, that we do have are from a specific time period. (*Comment on potential errors from that).*

Hypotehesis testing

We set up three null hypotheses to test one by one, which probes for different types of seasonality:

1. Day week

1. Month of the year

1. Hour of the day

We test each these with ANOVA.

*Potentially think other hypotheses to test? And tests for validity?*

Table 3: ANOVA by day of week

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 2,607956 | 6 | 0,434659 | 91,84231 | 2,6E-114 | 2,099017 |
| Within Groups | 101,7382 | 21497 | 0,004733 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 104,3461 | 21503 |  |  |  |  |

Table 4: ANOVA by the month of the year

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 9,618658 | 11 | 0,874423 | 198,3913 | 0 | 1,789093 |
| Within Groups | 94,72749 | 21492 | 0,004408 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 104,3461 | 21503 |  |  |  |  |

Table 5: ANOVA by the time of the day

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *c* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 7,127623 | 23 | 0,309897 | 68,47028 | 0 | 1,529742 |
| Within Groups | 97,21853 | 21480 | 0,004526 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 104,3461 | 21503 |  |  |  |  |