

SUPPLY AND DEMAND CURVES OF THE ELECTRICITY SPOT MARKET

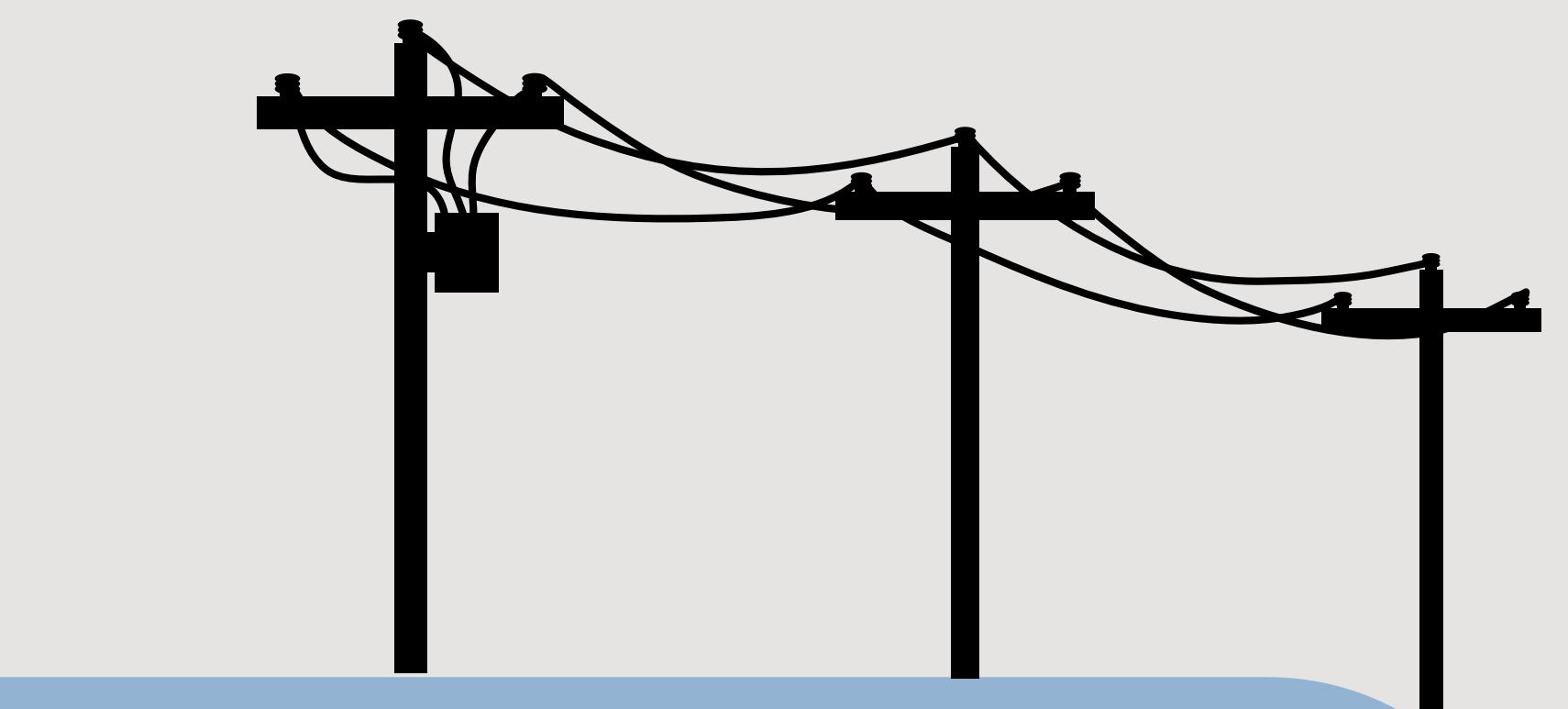
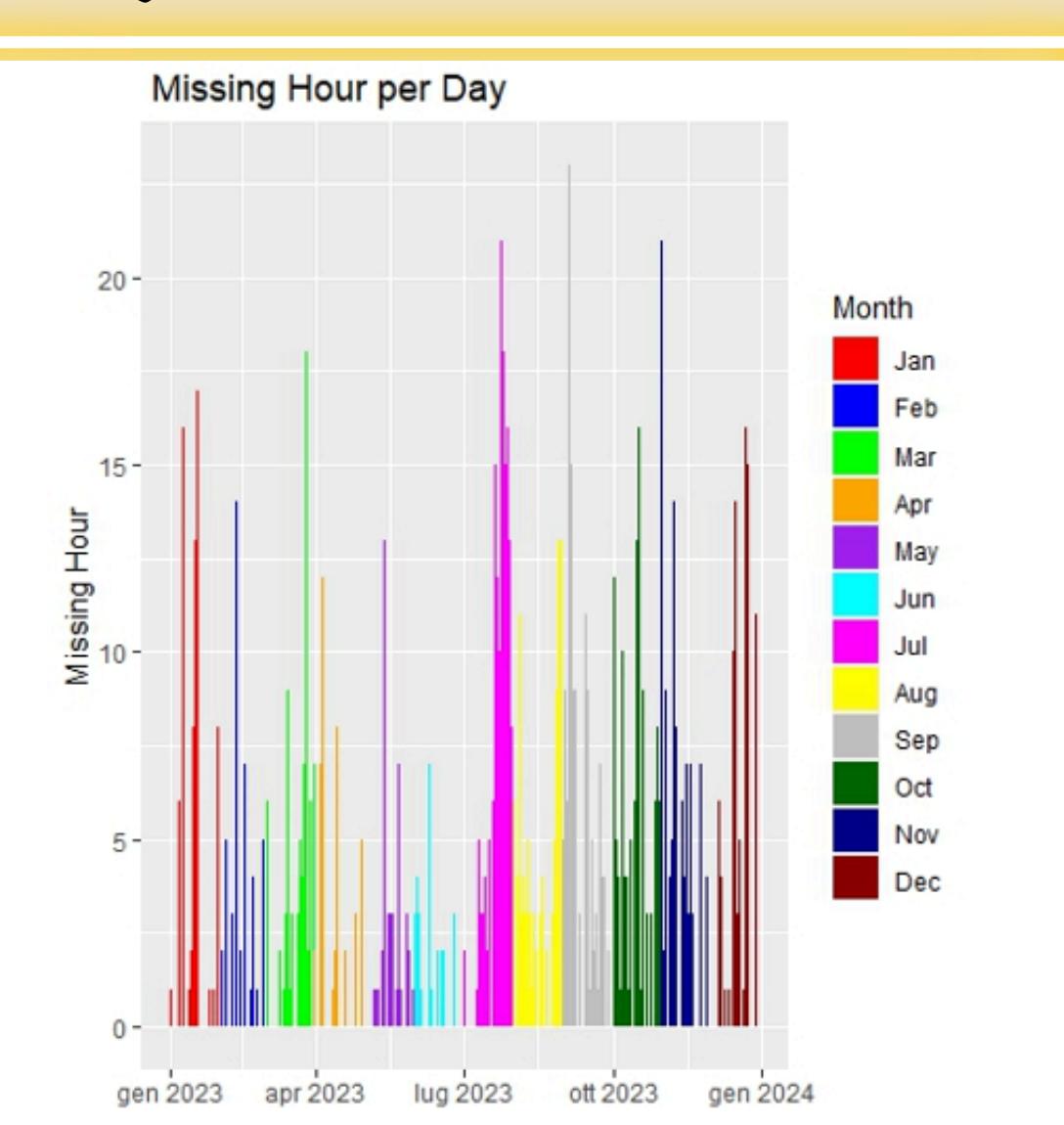
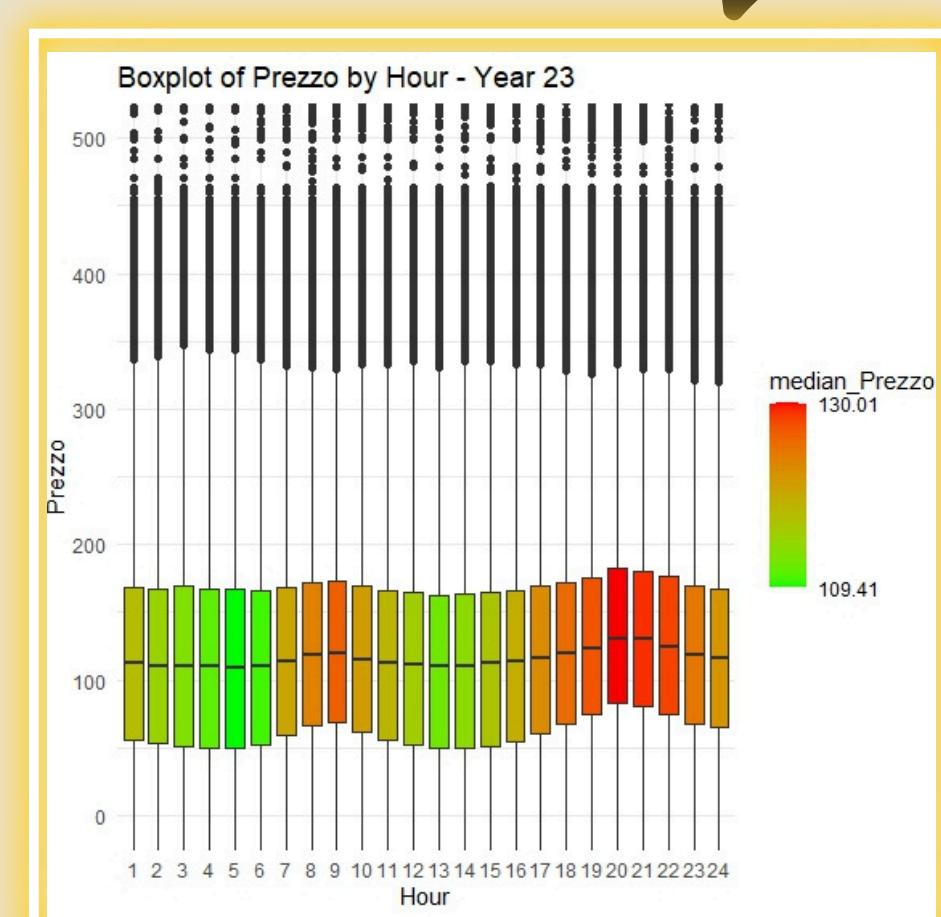
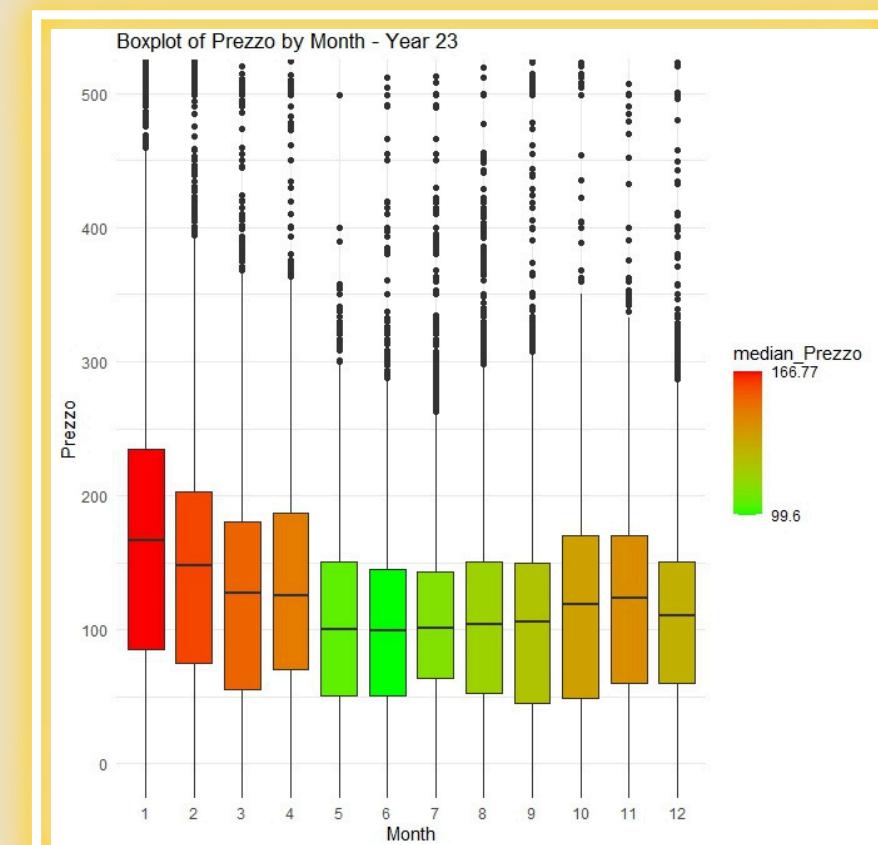
INTRODUCTION

The Italian electricity market operates through auctions where buyers and producers submit their bids and offers. Our method examines each individual bid and offer within these auctions, enabling us to construct hourly purchase and sale curves. The market equilibrium, where these two curves intersect, establishes a uniform price for both sales and purchases. This intersection point defines the market clearing price and the corresponding quantity. We suggest modeling these hourly curves with functional models. This approach is particularly suitable because purchase and sale curves, typically represented by thousands of data points, are best understood as varying continuously. The data is provided by GME Gestore Mercati Energetici.

DATA EXPLORATION

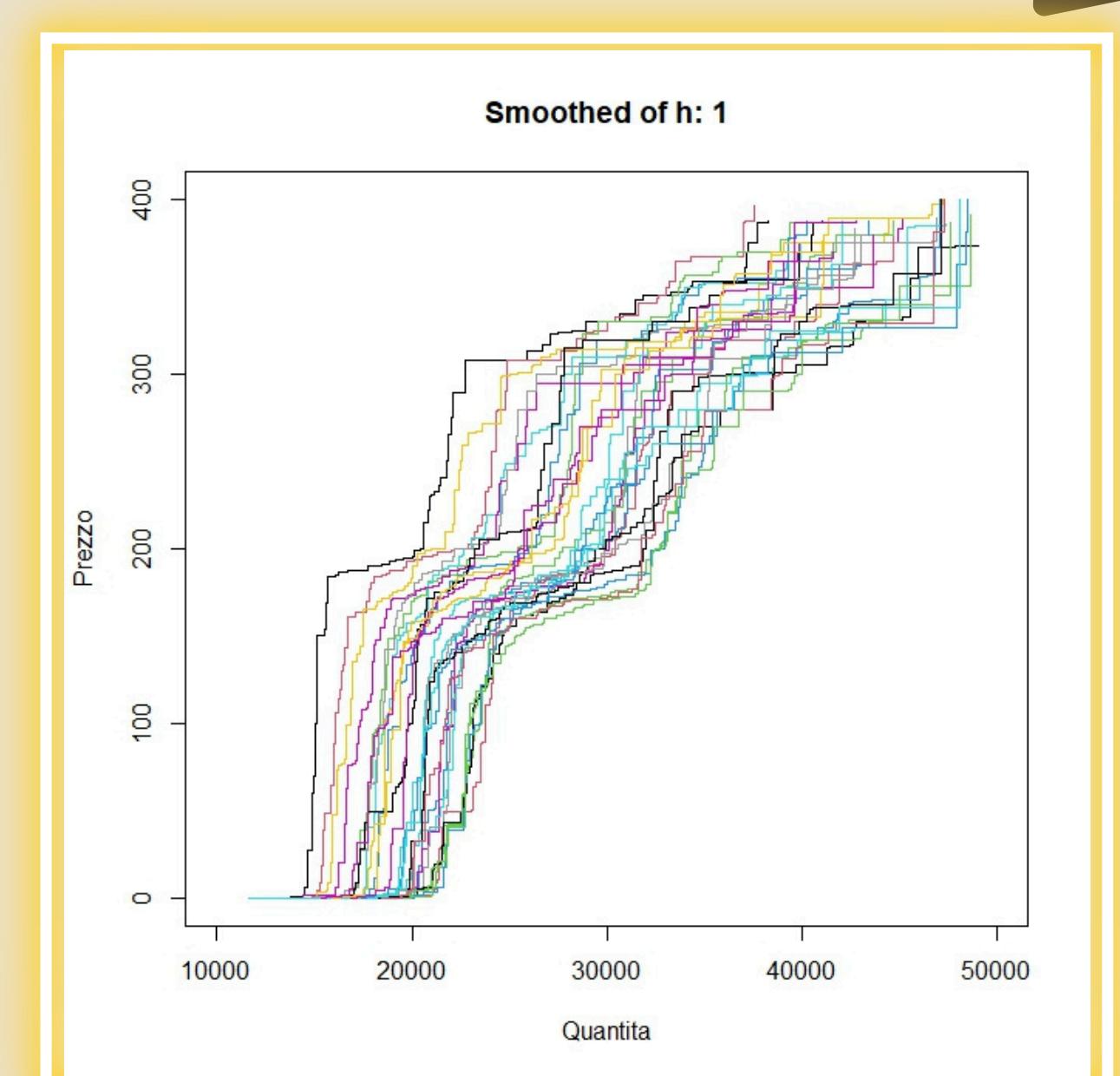
We generated boxplots illustrating the equilibrium price per hour and per month for the year 2023, revealing peaks in evenings and early mornings and in colder months.

Additionally, considering the largest region we identified a substantial number of missing data points. Consequently, we aggregated together the six major regions.



SMOOTHING

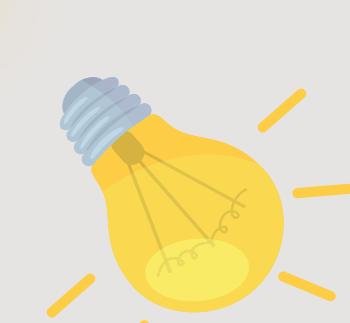
Given that our dataset is made up of various curves of interest, each with its unique range of quantities, we employed **second-order splines** for smoothing to establish a uniform reference system. The positioning of **knots** is adjusted based on whether they correspond to bid or offer curves, with a focus on placing more knots in areas where the ranges intersect.



GOAL:

This project aims to construct a predictive model for the intersection of the offer and bid curves

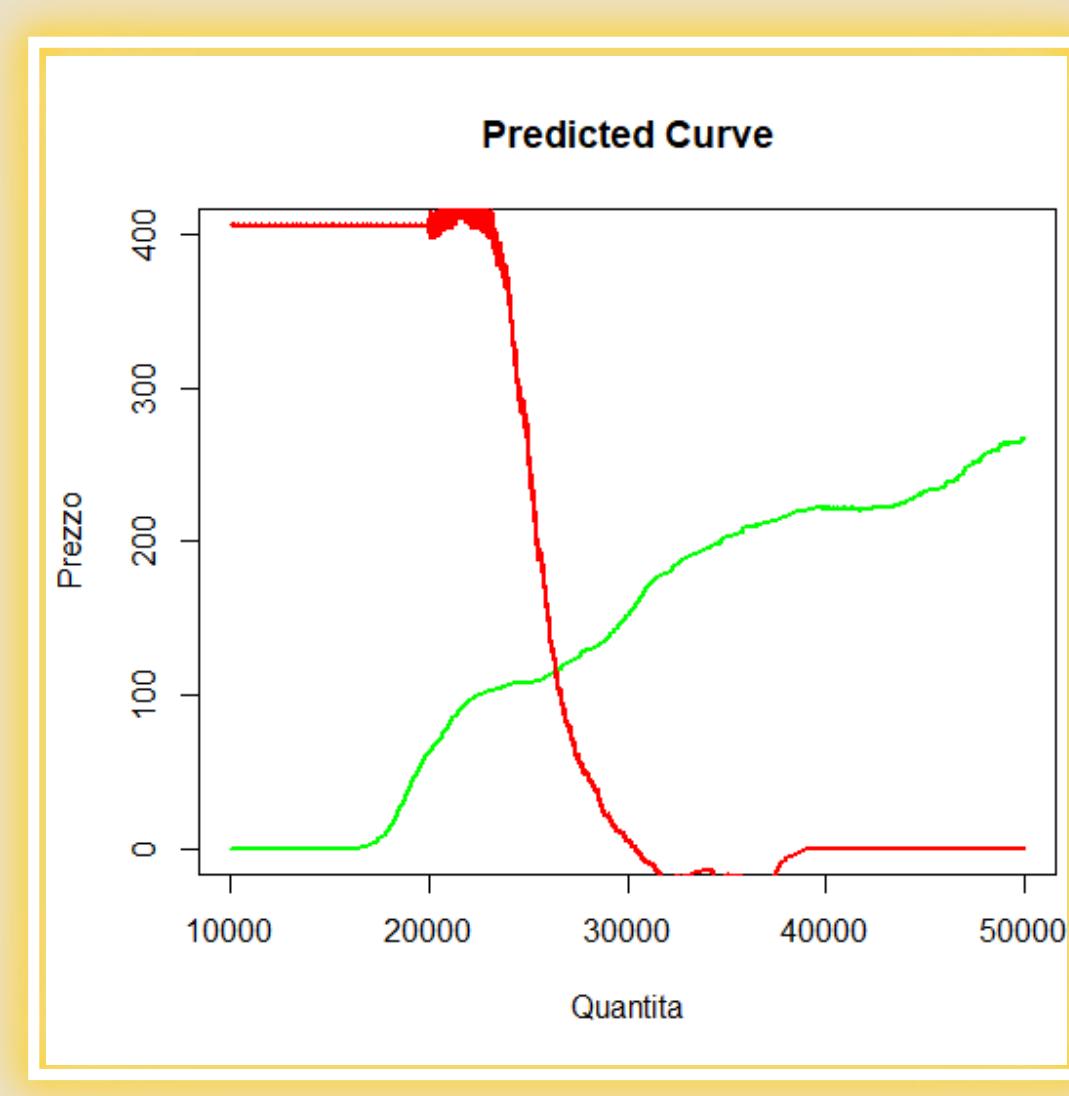
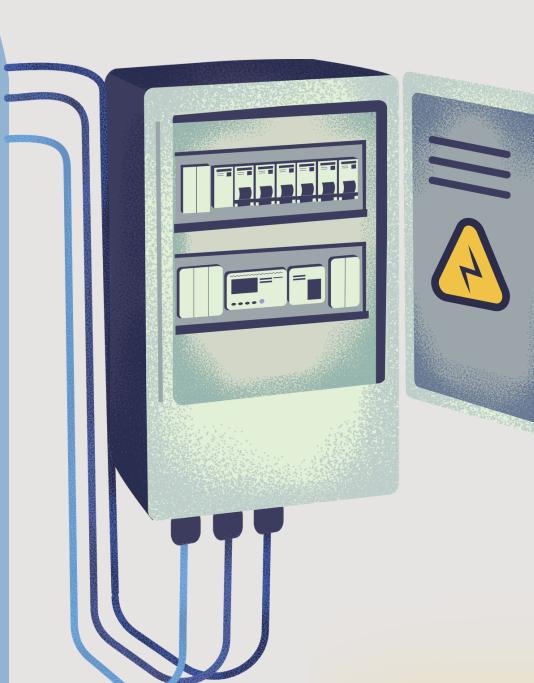
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FPCA & ARIMA

After identifying the Functional Principal Component Analysis (fPCA) components, we aimed to use historical scores to predict future scores on these principal components for k-time steps ahead. To achieve this, we utilized the ARIMA (AutoRegressive Integrated Moving Average) model, denoted as ARIMA(p,d,q). The model components are:

- AutoRegressive terms (p): These terms refer to the lags of the differenced series.
- Integrated (d): This represents the number of differences required to make the time series stationary.
- Moving Average terms (q): These terms refer to the lags of the forecast errors.



Ora	Mean Difference	%	SD
1	-4.217	5.120	10.285
8	-8.340	9.312	19.971
13	17.754	13.999	9.677
20	-9.398	8.907	18.517

Data table with Mean Difference and SD by hour

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PREDICTION

Using the fitted ARIMA model, we predicted the future scores. By applying these forecasts to weigh the functional principal components, we were able to reconstruct the new curve. We applied this procedure to both "BID" and "OFF" data, constructing two separate curves. The intersection of the curves provides our prediction. We tested our model, you can see the results in the table above and an example below.

	Quantita'	Prezzo
Real	27262.777	120.137
Predicted	26250.631	126.168

Day: 2023-06-17 , h: 08:00 A.M.