

An analysis of variation of gas prices and inflation

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Abstract

This project analyzes the relationship between the annual rate of change in gas prices and inflation. The study's primary goal is to identify a positive correlation between gas prices and inflation and predict the future inflation rate. Both gas prices and inflation data used in the analysis are time-series data. Therefore, the project uses a VAR model for prediction. Moreover, to test the statistical foundation of the analysis, the study includes the Granger's Causality Test, the Cointegration Test, the Augmented Dickey-Fuller Test, the selection of the order p , and the Durbin Watson Statistic.

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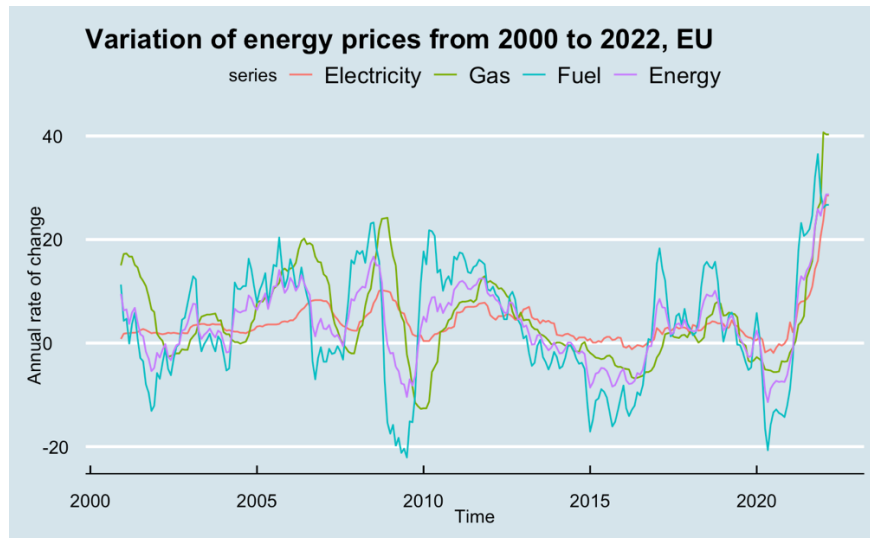
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Introduction

This analysis intends to predict the change in Harmonized Index of Consumer Prices (HICP) given the annual rate of change in gas prices. Due to the recent war that involves Ukraine and Russia (24-25 February 2022), the focus will be on natural gas prices.

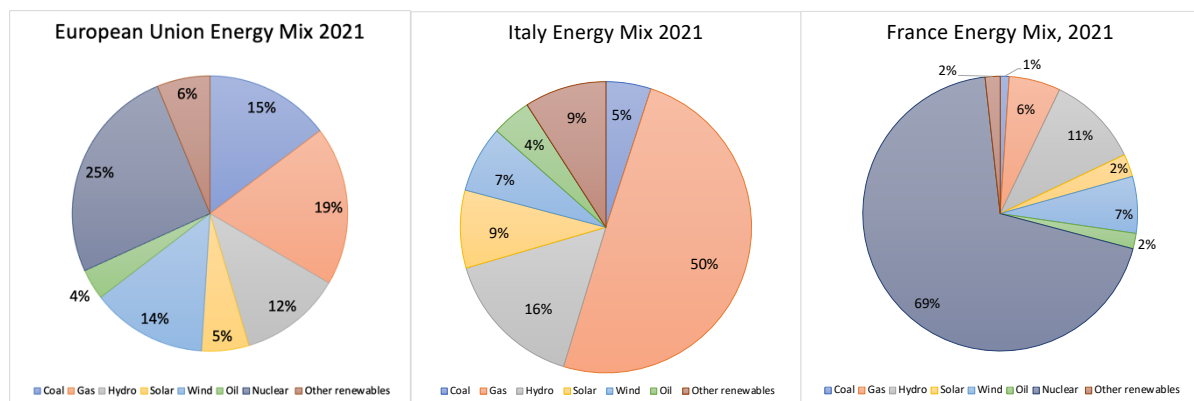
In *Picture 1*, it is possible to see the evolution of the annual rate of change in electricity, gas, fuels and energy in general. As noticeable from *Picture 1*, gas prices have reached an all-time high in March 2022, surpassing every other energy source. From January 2022, natural gas prices spiked by 41%, a 13.5 percentage point increase compared with the previous month.

Picture 1: Evolution of energy prices from 2000 to 2022, EU ¹



In 2020 the percentage of natural gas imported from Russia by the European Union was equivalent to 38,1% of total importation. Italy is among the countries that depend on Russian gas the most (43,25%), while France has only a tiny percentage of dependence (16,8%)². In *Picture 2*, it is possible to see the energy mix of Europe, France and Italy, making understandable the dependence on gas for energy production. European Union's dependency on gas is 19%, Italy 50% and France 6%.

Picture 2: Percentage of energy mix in 202 for EU, Italy and France ³



From this study, it is expected that an increase in gas prices will lead to an increase in inflation. Gas is part of the basket of goods on which inflation is calculated (whose weight is only 2%⁴) and is a fundamental source of energy production. Gas as an energy source impacts all productive sectors of the economy, especially those with high energy consumption. Therefore, an increase in gas prices implies an increase in production costs for companies and, consequently, an increase in prices. We, therefore, expect a positive gas price shock to lead to an increase in inflation.

¹ Source: Eurostat, https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MANR_custom_2508289/default/table?lang=en, last visited April 2022

² Source: Our World In Data, <https://ourworldindata.org/electricity-mix>, last visited April 2022

³ Source: European Central Bank, https://www.ecb.europa.eu/stats/ecb_statistics/escb/html/table.en.html?id=JDF_ICP_COICOP_INW, last visited April 2022

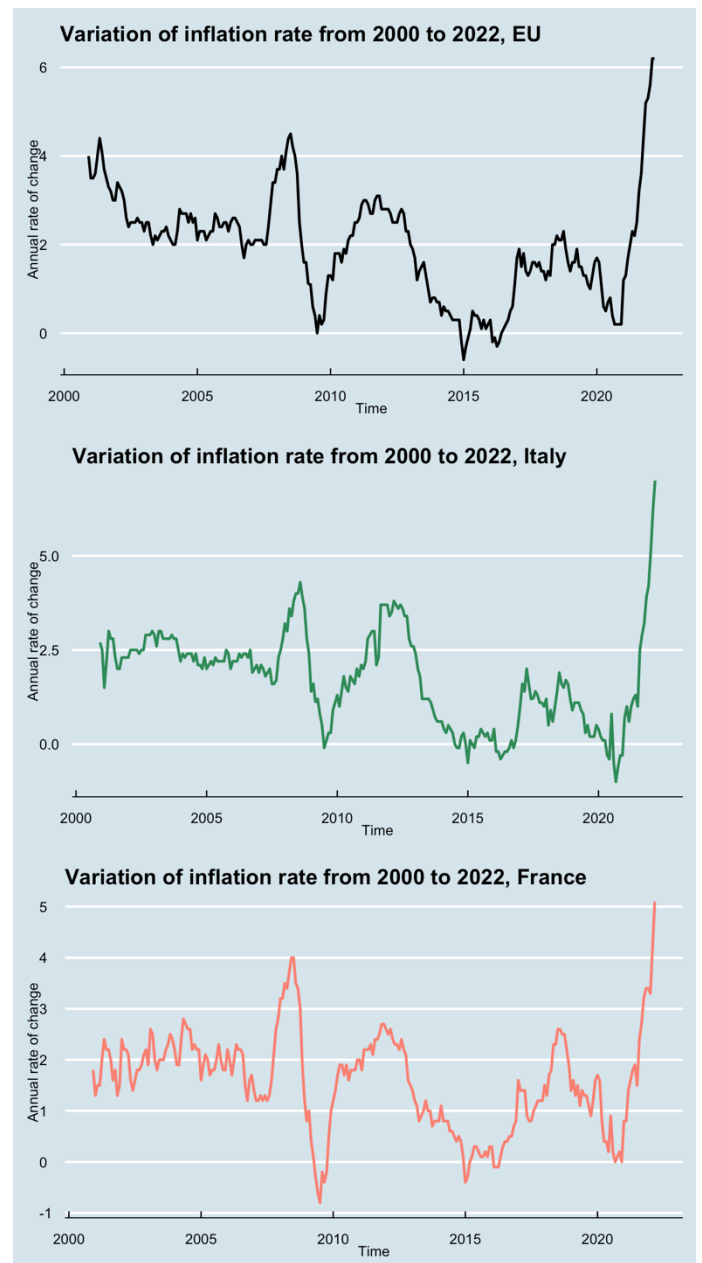
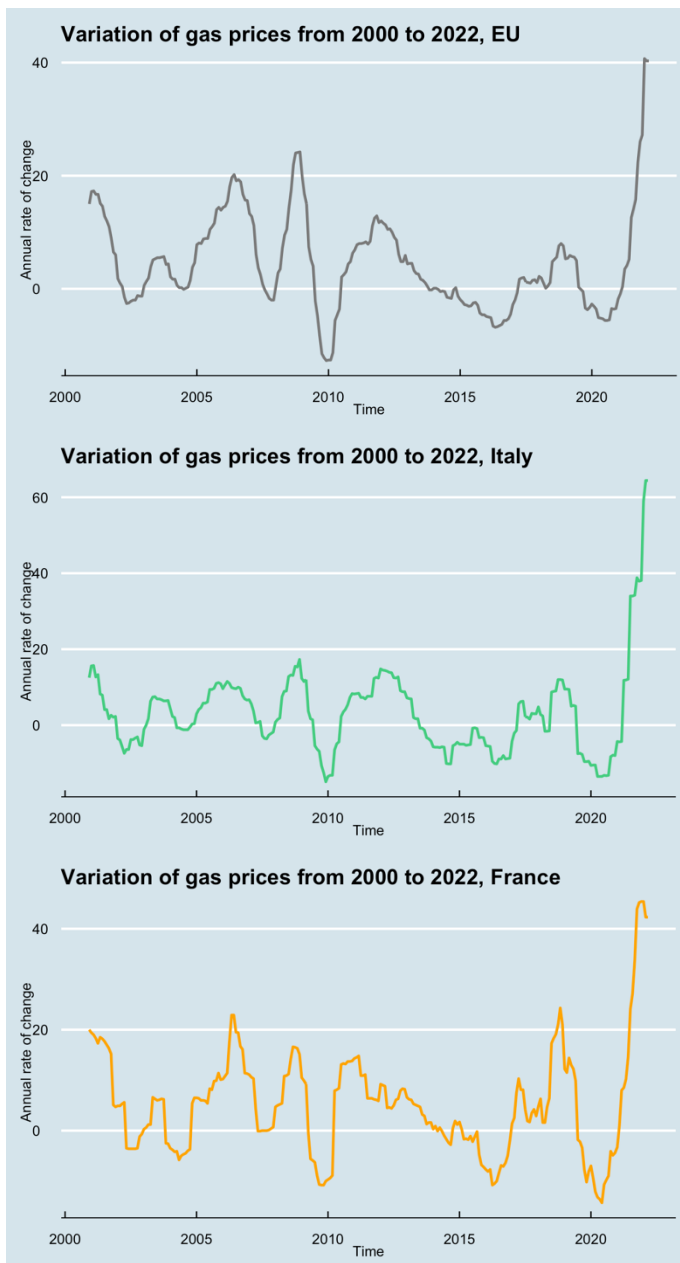
Analysis

Visualization of the time series

As mentioned, this analysis uses time-series data. The annual rate of change in gas prices and HICP were collected monthly from 2000 to 2022 (256 months). The research uses three different datasets: one studies the annual rate of change in gas prices and HICP for the EU, one for Italy, and one for France. The time series are displayed in *Pictures 3 and 4*.

Picture 3: Variation of gas prices from 2000 to 2020, for EU, Italy, and France ⁵

Picture 4: Variation of HICP from 2000 to 2022, for EU, Italy, and France ⁶



⁵ Source: Eurostat, gas: https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MANR_custom_2508289/default/table?lang=en, last visited April 2022

⁶ Source: Eurostat, inflation: <https://ec.europa.eu/eurostat/databrowser/bookmark/ef343afd-597c-406a-a7d6-f6b6cafbcb0b?lang=en>, last visited April 2022

The study applies a VAR model to each of the three datasets. The models were trained on every month of the dataset except March 2022, which is the month the analysis aims to predict.

The Granger's Causality Test

Granger's Causality Test shows if the analyzed time series are influenced by each other (Table 1). The null hypothesis of Granger's Causality Test is that the past values of the time series X (columns of Table 1) do not cause the other series Y (rows of Table 1). If the p-value is smaller than the significance level of 0.05, the null hypothesis is rejected; therefore, there is a Granger Causality.

Table 1: Granger's Causality Test on the time serie (Eu, Italy, France).

	gas_eu_x	hicip_eu_x		gas_it_x	hicip_it_x		gas_fr_x	hicip_fr_x
gas_eu_y	1.000	0.0	gas_it_y	1.0000	0.0	gas_fr_y	1.000	0.0
hicip_eu_y	0.047	1.0	hicip_it_y	0.0002	1.0	hicip_fr_y	0.034	1.0

The target variable is HICP (represented in Table 1 by hicip_eu, hicip_it, hicip_fr). Looking at the Granger Cause of gas prices (represented in Table 1 by gas_eu, gas_it, gas_fr) on inflation, it is possible to see that:

- P-value of EU gas prices on inflation is 0,047;
- P-value of Italy gas prices on inflation is 0,0002;
- P-value of France gas prices on inflation is 0,034.

By looking at the P-Values above, it is safe to say that all the variables in the respective datasets are interchangeably causing each other. This makes this system of multi-time series a good candidate for using VAR models to forecast.

The Cointegration Test

The Cointegration Test is used to establish a statistically significant connection between the series. When two or more time series are cointegrated, they have a long run, statistically significant relationship. In Picture 5, it is possible to see the output of the Cointegration Test: cointegration is true for the variables gas_eu and gas_fr.

Picture 5: Variation of HICP from 2000 to 2022, for EU, Italy and France.

Name	::	Test Stat	>	C(95%)	=>	Signif	Name	::	Test Stat	>	C(95%)	=>	Signif	Name	::	Test Stat	>	C(95%)	=>	Signif
gas_eu	::	20.98	>	12.3212	=>	True	gas_it	::	3.8	>	12.3212	=>	False	gas_fr	::	18.47	>	12.3212	=>	True
hicip_eu	::	1.12	>	4.1296	=>	False	hicip_it	::	0.08	>	4.1296	=>	False	hicip_fr	::	0.71	>	4.1296	=>	False

The time series is split into training data and test data. Since the aim is to predict the impact of gas prices on inflation due to the recent Ukrainian-Russian war, the test data will be the month of March.

The Augmented Dickey Fuller Test, the selection of the order p and the Durbin Watson Statistic

Augmented Dickey-Fuller Test is performed to check for stationarity. Europe's and Italy's models were stationary after the 2nd difference while France model was stationary after the 1st difference. The observed criterion will be the AIC. The order (P) of the VAR model is 3. The selection of the model was performed by using the Akaike Information Criterion. The Durbin Watson Statistic⁷ was used to test if there is any correlation left in the residuals. Checking for serial correlation ensures that the model can sufficiently explain the variances and patterns in the time series. From the results in *Picture 6*, it is safe to say that VAR (3) is a good model approximation.

Picture 6: Output of the Durbin Watson Statistic on the residuals for EU, Italy and France VAR (3)

gas_eu	: 1.86	gas_it	: 1.99	gas_fr	: 2.01
hicp_eu	: 1.98	hicp_it	: 2.04	hicp_fr	: 1.94

Results of the Forecast and conclusions

The forecast performed presents the following results:

- Inflation in the EU in March 2022 is predicted to be 6,7%;
- Inflation in Italy in March 2022 is predicted to be 6,8%;
- Inflation in France in March 2022 is predicted to be 5%.

Data retrieved from Eurostat state that:

- Inflation in the EU in March 2022 is 7,5%;
- Inflation in Italy for March 2022 is 7,0%;
- Inflation France for March 2022 is 5,1%.

By comparing the results of the Forecast with the actual data provided by Eurostat, it is possible to say that the model represents a good approximation of the HICP for every geopolitical entity tested. The difference between the forecast results and the actual data is relatively small. The result confirms the initial purpose of the analysis: the price of gas proved to be a good predictor of inflation.

⁷ The value of this statistic can vary between 0 and 4. The closer the value is to 2, the lesser the serial correlation is. The closer the value is to 0, the more positive is the serial correlation. The closer the value to 4, the more negative the serial correlation is.