Forecasting medical inflation in the European Union using the ARIMA model

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Topic

As healthcare expenses continue to escalate globally, there is an increasing need to accurately comprehend and predict medical inflation

- governments – national budget preparation,
- policymakers – addressing challenges in proactive manner,
- healthcare providers – startegic allocation of resources,
- insurers – determination of appropriate premiums and models.

'Is the ARIMA model effective for forecasting medical HICP for European Union member states?'

Medical Inflation

Medical inflation represents the general level of price growth in health-care procedures

- diagnostic tools, treatment methods, and pharma-ceuticals,
- developed healthcare systems – higher levels of medical inflation,
- technological development and structural changes in healthcare systems,
- as a healthcare component within the Harmonized Index of Consumer Prices (HICP).

Data Source and Timeframe

Source: Eurostat

Products:

- medical products, devices, and equipment,
- pharmaceutical products,
- pregnancy tests and contraceptive devices,
- therapeutic devices and equipment,
- corrective glasses, contact lenses, and hearing aids.

Services:

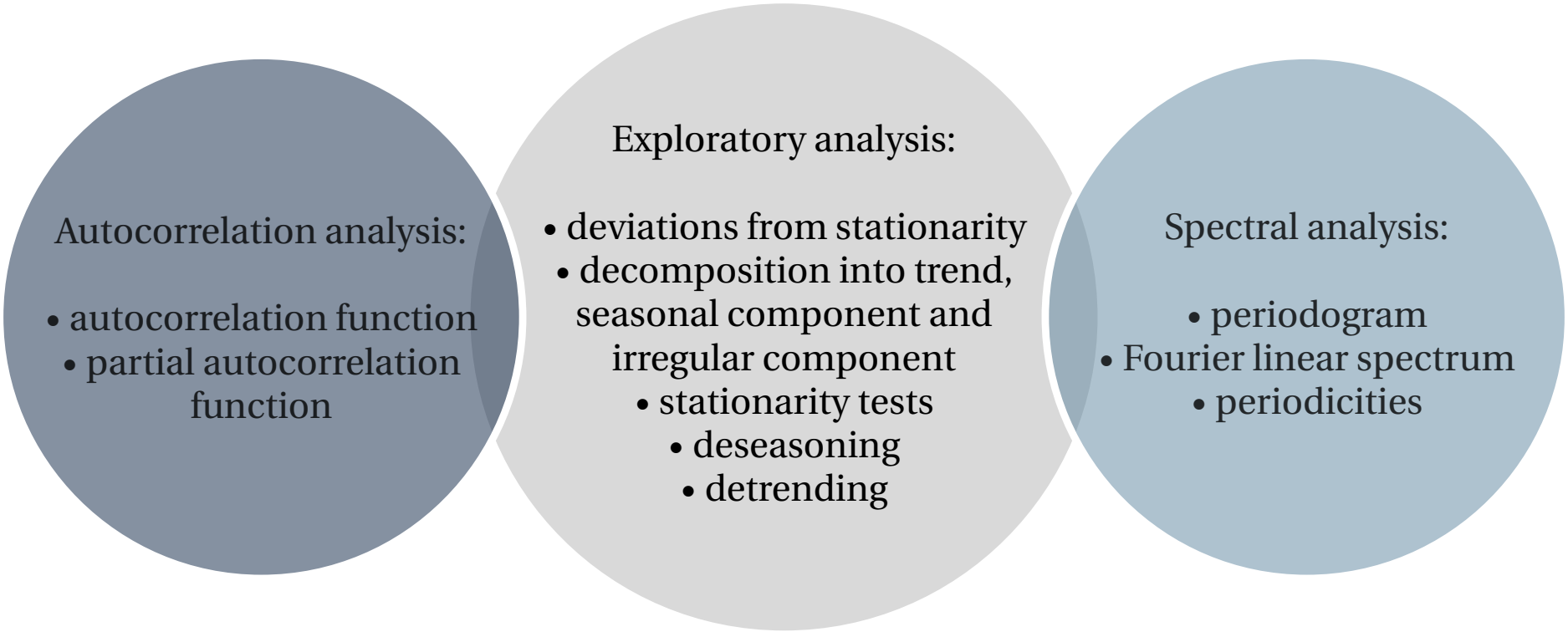
- outpatient services,
- medical and paramedical services,
- hospital services,
- physiotherapy services,
- dental services,
- services of medical laboratories and radiology centers,
- services of spas and health resorts,
- repair of medical and therapeutic equipment.

Methodology

The Autoregressive Integrated Moving Average Model ARIMA(p, d, q):

- statistical parametric model,
- analysis and forecasting of time series,
- p – the number of lag observations,
  – the lag order of AR component,
- d – the number of times the raw observations are differenced,
  – the degree of differencing,
- q – the size of the moving average window,
  – the moving average order of MA component.

Analysis of Medical Inflation in EU Countries



Test Forecasts

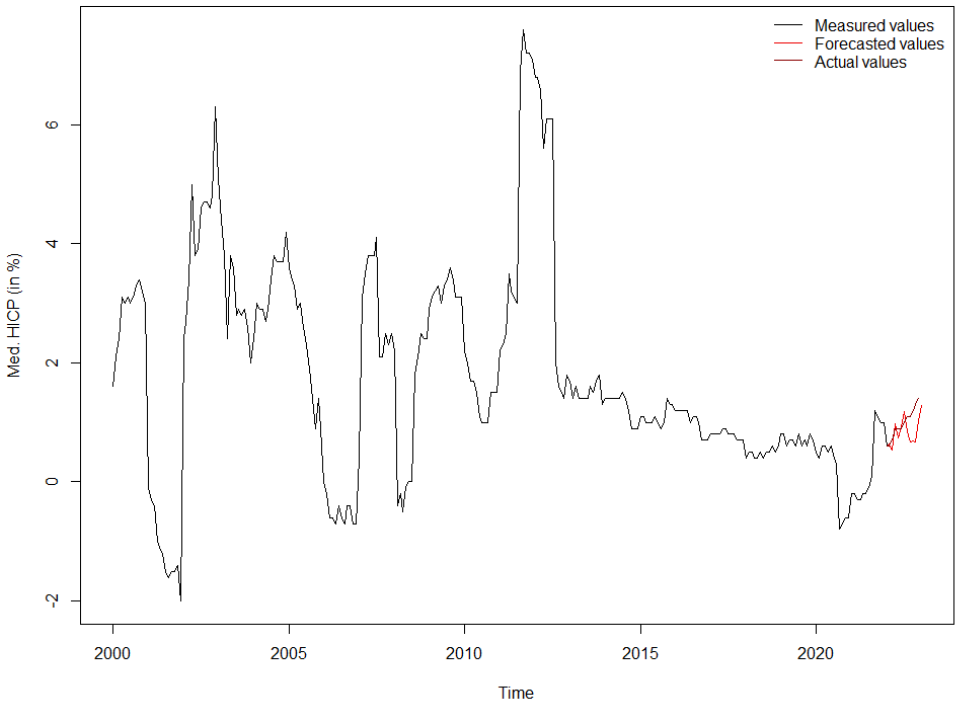


Figure 1: Test forecast – Italy

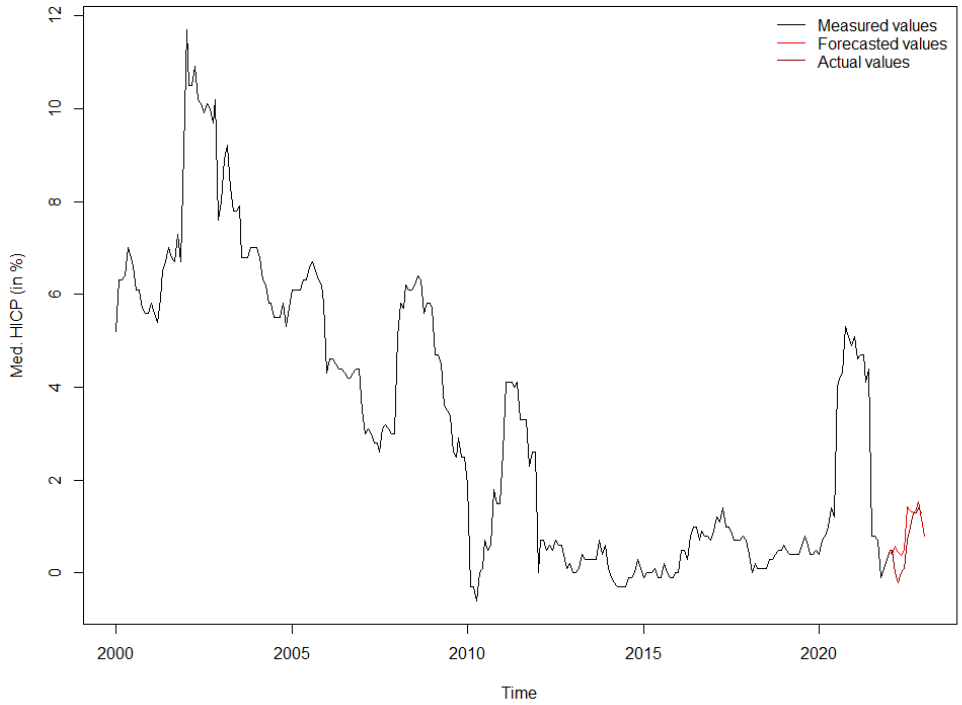


Figure 2: Test forecast – Ireland

Actual Forecasts

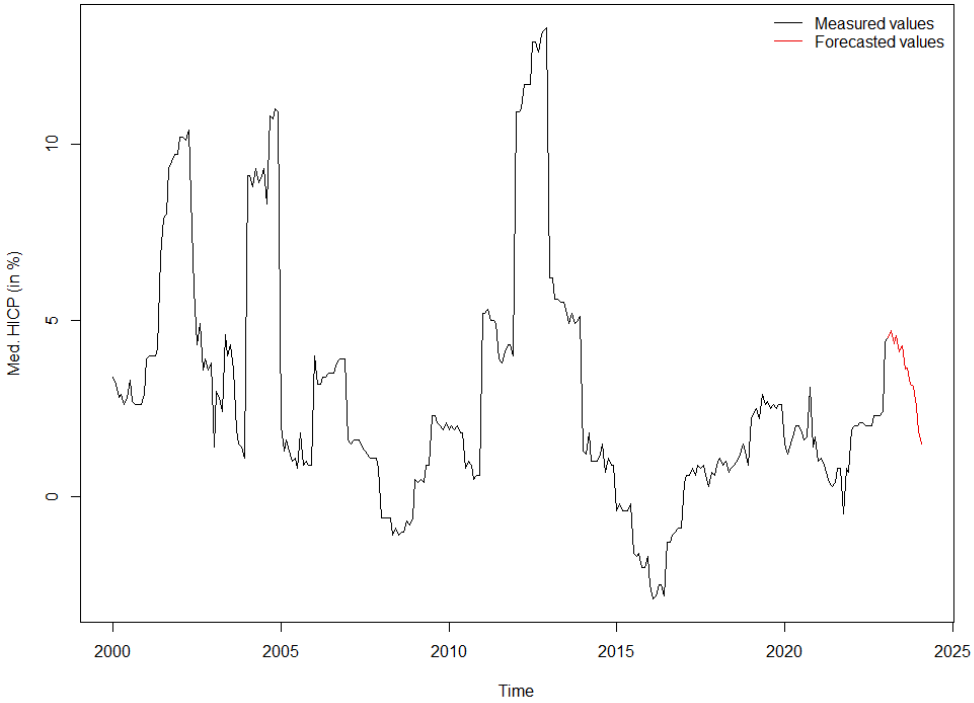


Figure 3: Forecast – Netherlands

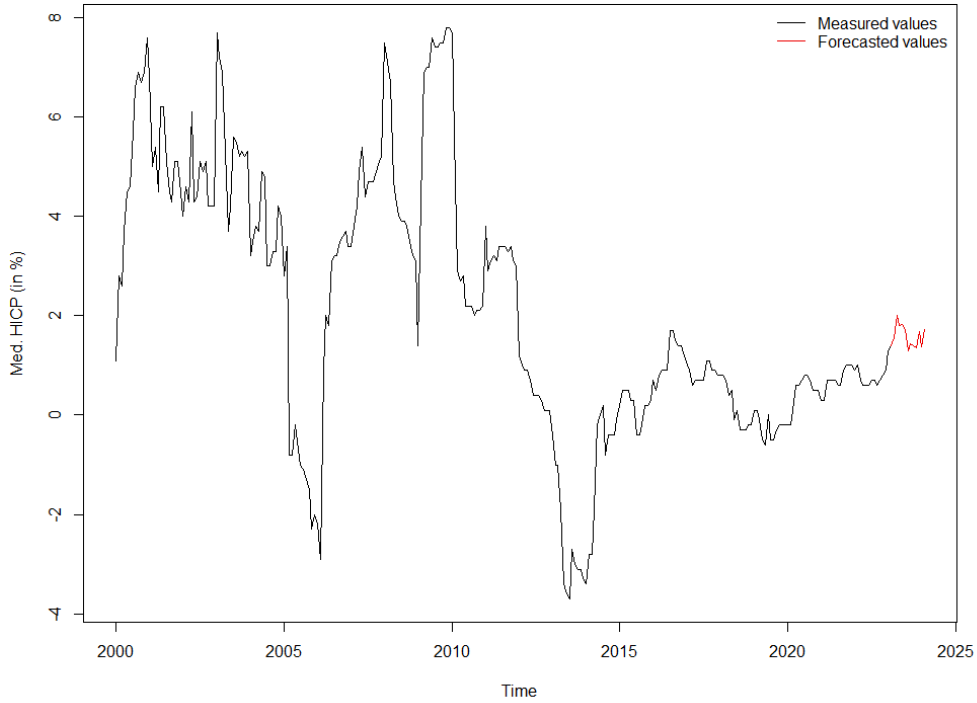


Figure 4: Forecast – Cyprus

Absolute Differences Between Forecasted and Actual Values of Medical HICP in pp

Member state	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Average
Austria	0.68	1.02	0.12	0.91	0.69	0.77	0.43	0.89	2.00	1.86	2.12	3.34	1.23
Belgium	0.06	0.25	0.25	0.30	0.33	0.63	0.82	1.07	1.16	1.30	1.48	4.07	0.98
Bulgaria	0.17	0.45	0.92	1.37	1.86	2.02	1.64	1.89	4.22	6.70	9.59	11.02	3.49
Croatia	0.28	1.38	2.14	2.27	2.48	3.66	5.06	5.67	6.12	6.28	6.59	8.17	4.18
Cyprus	0.09	0.14	0.66	0.41	0.46	0.33	0.02	0.11	0.06	0.08	0.47	0.12	0.25
Czechia	0.69	0.87	0.11	0.38	0.64	0.98	0.83	1.49	0.51	1.56	2.19	2.86	1.09
Denmark	0.72	0.69	0.43	0.12	1.35	1.03	1.02	0.69	1.71	1.92	2.67	2.71	1.25
Estonia	0.67	1.31	1.15	2.03	2.57	3.05	3.21	4.93	6.18	5.65	6.83	7.22	3.73
Finland	1.30	1.22	1.52	2.00	0.40	0.68	0.60	0.92	0.76	0.77	0.84	0.29	0.94
France	0.42	0.82	1.19	0.95	1.14	0.66	0.17	1.06	1.58	1.01	1.15	1.58	0.98
Germany	0.01	0.18	0.06	0.03	0.45	0.45	1.99	2.41	2.60	2.64	2.71	2.73	1.35
Greece	0.38	0.59	0.15	0.87	1.59	2.00	2.17	3.01	3.51	3.33	4.07	4.88	2.21
Hungary	0.20	0.00	0.51	1.26	2.17	3.48	5.25	6.95	9.34	11.16	12.75	12.64	5.48
Ireland	0.11	0.59	0.64	0.38	0.38	0.73	0.34	0.01	0.06	0.14	0.13	0.01	0.29
Italia	0.04	0.16	0.08	0.15	0.03	0.18	0.26	0.43	0.52	0.63	0.37	0.81	0.30
Latvia	0.08	1.29	1.72	2.55	2.88	3.23	3.19	3.94	4.76	4.66	5.91	6.29	3.38
Lithuania	0.11	0.04	0.72	1.40	1.76	2.23	2.75	2.59	3.70	3.39	4.58	3.62	2.24
Luxembourg	0.83	0.64	2.47	3.04	3.27	3.27	3.57	4.58	4.22	4.59	5.21	5.65	3.45
Malta	0.46	0.07	0.32	0.70	0.25	0.45	0.93	1.49	1.93	1.93	2.39	2.11	1.09
Netherlands	0.40	0.04	0.37	0.32	0.14	0.18	0.61	0.40	0.91	0.47	1.10	3.66	0.72
Poland	0.51	1.34	1.97	2.72	2.89	3.06	3.09	3.40	4.21	5.01	5.06	6.67	3.33
Portugal	0.37	0.12	0.04	0.17	5.05	5.45	5.34	5.18	5.46	4.47	4.39	4.23	3.36
Romania	0.51	1.45	2.97	4.30	6.11	7.25	8.33	9.55	11.11	12.84	14.37	15.64	7.87
Slovakia	0.48	0.92	1.56	2.89	2.60	3.25	4.20	5.20	5.03	6.22	7.28	7.68	3.94
Slovenia	0.95	0.67	0.28	0.52	0.48	0.09	1.97	2.00	1.44	3.95	5.50	3.75	1.80
Spain	0.32	0.20	0.11	0.07	0.50	0.41	0.57	0.80	0.81	1.18	1.05	1.05	0.59
Sweden	0.45	1.54	2.23	2.92	3.16	2.52	4.01	4.36	3.95	4.24	5.33	6.08	3.40
Average	0.42	0.66	0.91	1.30	1.70	1.93	2.31	2.78	3.25	3.63	4.30	4.77	2.33

Difference Between Forecasted and Actual Values

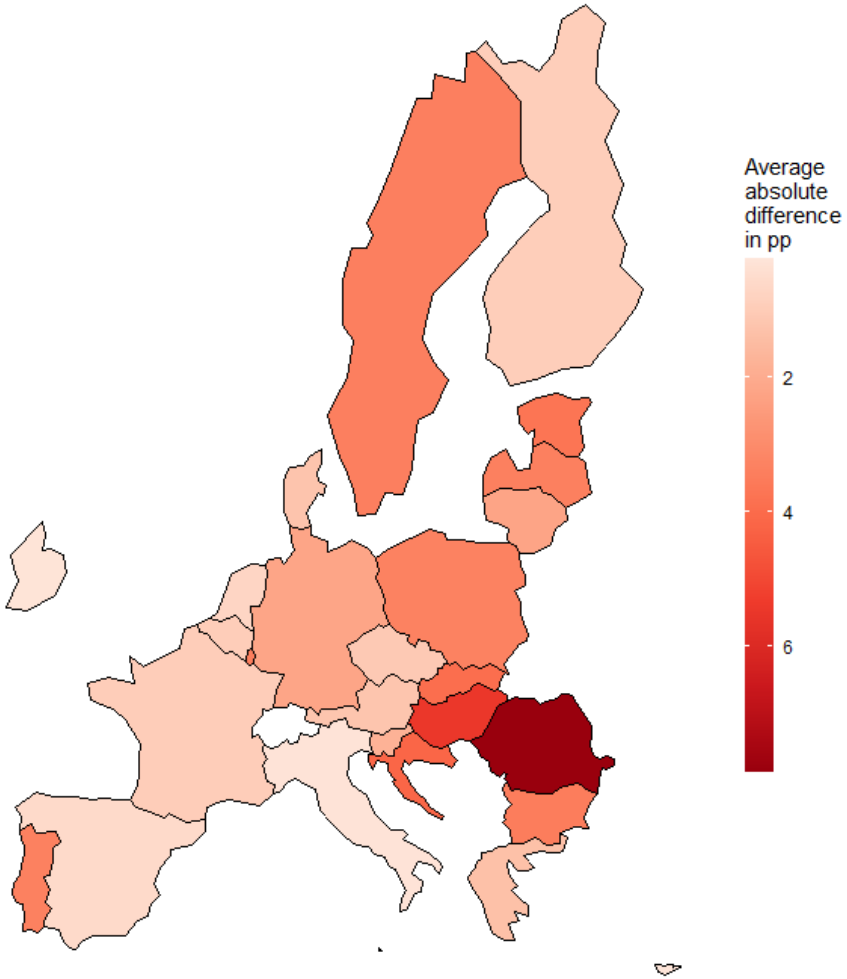


Figure 5: Average absolute difference between forecasted and actual values of medical HICP

Discussion

The findings reveal the ARIMA model's effectiveness for the EU countries in capturing the temporal patterns of medical inflation:

- extentions: dependencies analysis,
  extending the forecasting horizon,
  inclusion of exogenous variables,
  machine learning algorithms,
- alignment: partial alignment with existing studies,
- limitations: complex non-linear relationships not fully captured,
  appropriate for short or medium-term forecasting.

Conclusion

- Reliable predictions – proactive addressing of challenges posed by the rapid development of the healthcare sector
- Implications for policymakers of euro area countries, health insurance companies and healthcare entities

An important contribution to ensuring financially accessible and high-quality healthcare for the residents of the EU

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