Econometrics Assignment

Hungary year-on-year inflation rate econometric modelling

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October 14, 2025

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Overview

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4. Relevant Economic Hypotheses over the Parameter Estimates
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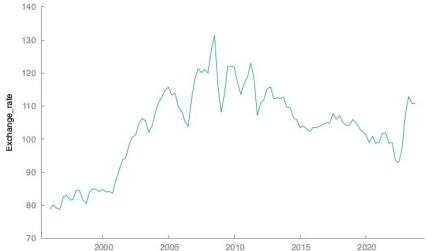
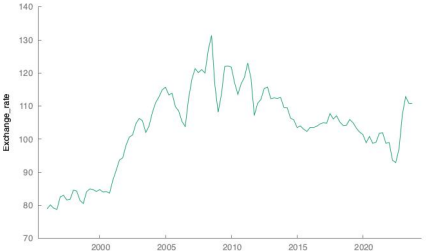
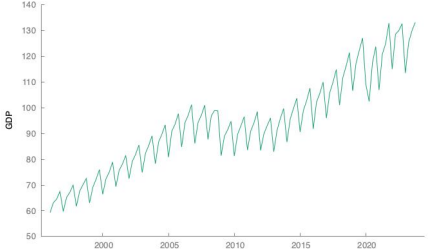
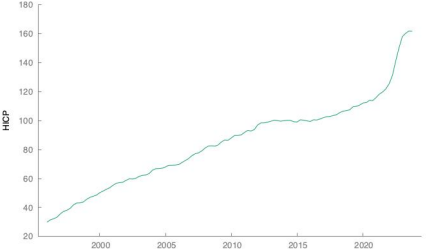
Time Series Plots of Main Variables









Descriptive Statistics

Variable	Mean	SD	Min	25%	Median	75%	Max
HICP	84.71	30.12	29.93	61.23	87.38	101.43	161.99
GDP	93.55	18.56	59.30	81.16	93.23	104.20	133.24
Unemp	7.28	2.32	3.40	5.75	7.30	9.05	11.40
Int. Rate	7.98	6.33	0.60	2.10	7.25	11.00	27.00
Exch. Rate	103.57	12.40	78.79	98.61	104.91	112.40	131.40

- Inflation (HICP) and GDP exhibit a clear upward trend with increasing levels over time.
- Interest rates display the largest variability, ranging from 0.6% to 27%, reflecting major monetary policy shifts.
- Baseline year considered for HICP and GDP: 2010.

AR(1) Model: Inflation (1996:3–2023:4, $T = 110$)

Variable	**Coefficient**	**Std. Error**	**p-value**
d_HICP_1	0.824	0.054	0.000
Model statistics			
R^2 (adjusted)	0.509		
Residual Std. Error	1.130		
F(1, 109), p-value	233.96, <0.0001		
AIC / BIC	340.09 / 342.79		

AR(4) Model: Inflation (1997:2–2023:4, $T = 107$)

Variable	Coefficient	Std. Error	p-value
Constant	0.319	0.145	0.030
*d_HICP*_1	0.872	0.101	0.000
*d_HICP*_2	–0.243	0.133	0.071
*d_HICP*_3	0.082	0.140	0.556
*d_HICP*_4	0.005	0.116	0.966
Model statistics			
R^2 (adjusted)	0.536		
Residual Std. Error	1.111		
F(4, 102), p-value	31.66, <0.0001		
AIC / BIC	331.0 / 344.4		

ARDL(3,3,3,3,3): Inflation (1997:2–2021:1, $T = 96$)

Variable	Coefficient	Std. Error	p-value
Constant	0.367	0.146	0.014
d_d_GDP_1	–0.029	0.0066	0.000
d_d_GDP_3	0.018	0.0072	0.017
d_Exchange_rate_2	–0.052	0.0215	0.017
d_HICP_1	0.355	0.107	0.001
d_HICP_3	0.276	0.108	0.013
Model statistics			
R^2 (adjusted)	0.429		
Residual Std. Error	0.582		
F(15, 80), p-value	5.75, <0.0001		
AIC / BIC	182.9 / 223.9		

**Only statistically significant variables ($p < 0.05$) are reported.*

ARIMA(1,1,1) Models: With and Without Seasonality

Non-seasonal (1996:2–2023:4, $T = 111$)

Parameter	Estimate	Std. Error	p-value
Constant	1.171	0.324	0.000
ϕ_1 (AR)	0.612	0.098	0.000
θ_1 (MA)	0.255	0.120	0.033
Model statistics			
R^2 (adjusted)			0.999
Innovation Std. Dev.			1.075
Log-likelihood			–165.91
AIC / BIC			339.81 / 350.65

** Estimates based on the Hessian. Roots of AR and MA polynomials are stable.*

Seasonal (1997:1–2023:4, $T = 108$)

Parameter	Estimate	Std. Error	p-value
Constant	5.411	1.055	0.000
Φ_1 (seasonal AR)	0.378	0.213	0.076
Θ_1 (seasonal MA)	0.562	0.218	0.010
Model statistics			
R^2 (adjusted)			0.978
Innovation Std. Dev.			4.281
Log-likelihood			–312.15
AIC / BIC			632.30 / 643.03

† Based on the seasonal difference operator $(1 - L^4)$. Φ_1 *marginally significant.*

Diagnostic Checks (1): Residual Autocorrelation

Model	**Test Stat**	**p-value**	**Conclusion**
AR(1)	Q' = 7.68	0.104	No autocorrelation
AR(4)	Q' = 1.79	0.775	No autocorrelation
ARDL(3,3,3,3,3)	Q' = 1.10	0.894	No autocorrelation
ARIMA(1,1,1)	Q' = 3.17	0.205	No autocorrelation
Seasonal ARIMA	Q' = 87.64	$< 10^{-19}$	Severe autocorrelation

Diagnostic Checks (2): Normality (Chi-square test)

Model	Chi-sq(2)	p-value	Conclusion
AR(1)	41.45	0.0000	Severe violation
AR(4)	33.10	0.0000	Moderate violation
ARDL(3,3,3,3,3)	0.27	0.875	Residuals normal
ARIMA(1,1,1)	31.04	0.0000	Moderate violation
Seasonal ARIMA	138.57	0.0000	Severe violation

Diagnostic Check (3): Heteroskedasticity (Breusch-Pagan test)

Model	LM Stat	p-value	Conclusion
AR(1)	82.57	0.0000	Heteroskedasticity present
AR(4)	70.80	< 0.00001	Heteroskedasticity present
ARDL(3,3,3,3,3)	23.23	0.0795	Borderline (10%)
ARIMA(1,1,1)	—	—	Likely present (not tested)
Seasonal ARIMA	—	—	Strongly likely

Final Model Selection

Selected model: ARDL(3,3,3,3,3).

We selected ARDL(3,3,3,3,3) as the most appropriate specification for modelling quarterly inflation in Hungary. The choice is based on the following criteria:

- **Economic significance:** Includes economically relevant predictors such as lagged inflation, GDP growth, and exchange rate variations with statistically significant coefficients.
- **Dynamic adequacy:** No evidence of residual autocorrelation.
- **Residual normality:** Passes the Chi-square normality test (stat = 0.266, p = 0.875).
- **Heteroskedasticity:** Only marginally present (LM = 23.23, p = 0.079), suggesting robust standard errors are sufficient.
- **Balance between flexibility and parsimony:** Captures medium-run inflation dynamics without overfitting.

This model offers the best compromise between goodness of fit, valid inference, and economic interpretability, validating it as a good candidate for forecasting.

Economic Hypotheses and Parameter Estimates

The coefficients of the complete ARDL (3,3,3,3,3) specification (including also non-significant variables) can provide us relevant insights on short-term inflation patterns:

- **Inflation inertia:** Lagged inflation is significant and positive ($d\_HICP\_1 = 0.355$, $p = 0.0013$; $d\_HICP\_3 = 0.276$, $p = 0.0126$), confirming persistent inflation dynamics.
- **Output effects:** GDP growth has a mixed effect. The first lag is negative and highly significant (–0.029, $p < 0.001$), consistent with a short-run Phillips curve. The third lag turns positive (0.018, $p = 0.017$), suggesting delayed adjustment.
- **Unemployment:** None of the unemployment coefficients are statistically significant ($p > 0.15$), suggesting weak short-run inflation-unemployment trade-offs in this sample.
- **Interest rates:** All three lags are insignificant ($p > 0.19$), indicating no detectable short-run pass-through of monetary policy to inflation.
- **Exchange rate pass-through:** The second lag is significantly negative (–0.052, $p = 0.017$), suggesting that currency appreciation reduces inflation with delay.

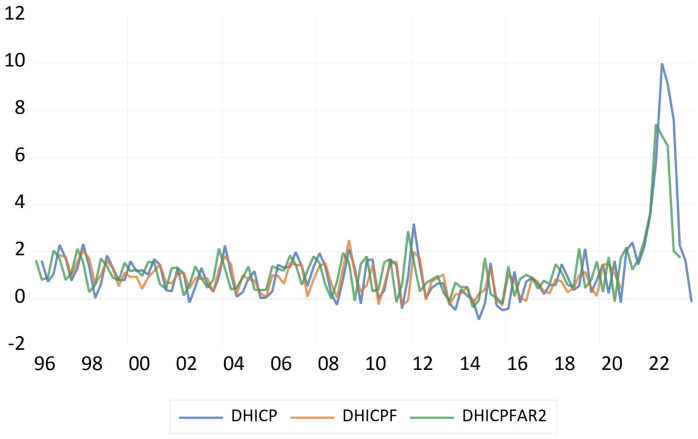
The model supports inflation persistence and partial pass-through from GDP and exchange rates, while rejecting short-run effects from unemployment (Philips curve theories) and interest rates.

1-step Ahead Forecasts (2011–2020)

- **ARDL(3,3,3,3,3)** one-step ahead point forecasts over the last 10 years of the sample.

Quarter	Forecast	Quarter	Forecast
2011Q1	1.4868	2016Q1	1.0375
2011Q2	1.5953	2016Q2	0.7989
2011Q3	–0.2666	2016Q3	0.0837
2011Q4	–0.0572	2016Q4	–0.0822
2012Q1	2.0048	2017Q1	0.9047
2012Q2	1.7169	2017Q2	0.7175
2012Q3	–0.0262	2017Q3	0.3126
2012Q4	0.7400	2017Q4	0.2583
2013Q1	0.8866	2018Q1	0.8426
2013Q2	1.0394	2018Q2	0.7351
2013Q3	–0.2648	2018Q3	0.2926
2013Q4	0.1981	2018Q4	0.4467
2014Q1	0.2187	2019Q1	0.9919
2014Q2	0.5017	2019Q2	1.1428
2014Q3	–0.1903	2019Q3	0.4672
2014Q4	0.2040	2020Q1	1.4564
2015Q1	0.3897	2020Q2	1.4866
2015Q2	1.3016	2020Q3	1.0532
2015Q3	–0.0133	2020Q4	0.4653
2015Q4	–0.2757		

Forecast Comparison: ARDL vs AR(2)



- The two forecasts are similar in all periods.
- The ARDL model is more accurate than the AR(2) model in most periods.