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Impact of Energy Price Shocks on the Romanian Electricity Market: An Econometric Analysis Using Local Projections and Error-Correction Modelling

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Abstract:
This paper examines the transmission of external energy price shocks to the Romanian wholesale electricity market, with particular attention to natural gas (TTF) and crude oil (Brent) prices. Using monthly data for 2018–2025, the study combines Local Projections with an Error-Correction Model and formal cointegration tests to identify both short-run dynamics and long-run relationships. The results show a strong long-run association between electricity prices and TTF gas prices, consistent with merit-order pricing. The estimated long-run elasticity is 0.77, while the short-run pass-through is 0.44. Local Projections indicate a cumulative 12-month response of approximately 1.05, which is not statistically different from the ECM estimate. Structural break tests identify major disruptions during the 2022 energy crisis. Overall, the findings suggest that gas price shocks are a key driver of Romanian electricity prices and support policies focused on market monitoring, consumer protection, and energy-mix diversification

Keywords: *energy price transmission, electricity markets, natural gas prices, error correction model, local projections, Romania*

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Introduction

The European energy crisis of 2021–2022 represented an unprecedented shock to electricity markets across the continent, with wholesale prices reaching historical peaks and exposing the vulnerability of national electricity systems to external energy price fluctuations. Romania, as a member of the European Union's integrated energy market, experienced significant electricity price volatility during this period, with monthly average prices in the day-ahead market (measured in RON/MWh) increasing from approximately 250 RON/MWh in the pre-crisis period to over 2,400 RON/MWh at the peak of the crisis in August 2022 (OPCOM, monthly data, processed by the authors).

Understanding the transmission mechanism through which external energy shocks propagate into domestic electricity markets is crucial for policymakers designing effective price stabilization mechanisms, for market participants seeking to hedge against volatility, and for the broader academic literature on energy market integration.

The theoretical foundation for this transmission mechanism lies in the merit-order pricing model a market clearing mechanism whereby generators are dispatched in ascending order of their marginal costs, with the market price determined by the marginal cost of the last unit called to satisfy demand (Newbery, 2018). Given that gas-fired power plants frequently serve as the marginal generation source during periods of high demand, natural gas prices directly influence electricity prices through this mechanism. Romania, functioning as a price-taker in European gas markets (accounting for approximately 2% of EU consumption), cannot influence TTF prices but is exposed to their fluctuations.

This study contributes to the existing literature in several ways. Methodologically, we employ a dual approach combining Local Projections (Jordà, 2005: 161-182) with an Error Correction Model (Engle & Granger, 1987: 251-276), enabling robust estimation of both short-run dynamics and long-run equilibrium relationships. This comparative framework allows formal testing of whether the two methodological approaches yield consistent estimates. Empirically, our analysis covers the extended period from January 2018 to December 2025, encompassing the pre-crisis, crisis, and post-crisis phases, enabling identification of structural breaks and assessment of parameter stability. The paper proceeds with literature review, theoretical framework, data and methodology, empirical results, discussion, policy implications, and conclusions.

Literature Review

Theoretical Foundations: Merit-Order Pricing

The relationship between fuel input costs and electricity prices has been extensively studied in the energy economics literature. The foundational theoretical framework is the merit-order model, which describes how competitive electricity markets determine wholesale prices through the marginal cost of the price-setting generation unit (Newbery, 2018). Under this framework, generators are ranked by their short-run marginal costs, typically following the order: nuclear, hydroelectric, renewables, coal, natural gas, and oil-fired plants.

Empirical Evidence on Energy Price Transmission

A substantial body of empirical literature has examined the transmission of energy shocks to electricity markets. (Kilian,2009: 1053-1055) demonstrated the importance of distinguishing between different types of oil price shocks, noting that supply-driven and demand-driven shocks may have differential effects on downstream markets.

The cointegration and error correction framework, pioneered by (Engle & Granger,1987: 251-276), has been widely applied to study long-run relationships between energy prices. The econometric foundations for unit root testing and cointegration analysis are thoroughly developed in (Hamilton,1994), whose comprehensive treatment of time series methods provides the theoretical basis for our stationarity and cointegration tests. (Stock & Watson,1993) contributed fundamental advances in testing for common stochastic trends in multivariate systems, while their subsequent work (Stock & Watson, 2001) on forecasting with many predictors informs modern approaches to macroeconomic time series analysis.

More recently, Local Projections (Jordà, 2005:161-182) have gained popularity as an alternative to VAR-based impulse response analysis, offering robustness to VAR misspecification and better performance in the presence of structural breaks.

The 2021–2022 European Energy Crisis

The European energy crisis of 2021–2022 has generated significant research interest. IEA(2023a). Gas Market Report, Q1-2023 documented the dramatic increase in TTF natural gas prices from approximately 20 EUR/MWh in early 2021 to nearly 340 EUR/MWh at the August 2022 peak. ACER, 2023 analyzed the impact on European wholesale electricity markets, finding substantial heterogeneity across member states depending on their energy mix, interconnection capacity, and policy responses. This study addresses existing gaps by comparing LP and ECM methodologies within a unified framework for Romania, covering the full crisis cycle.

Theoretical Framework

Merit-Order Pricing Mechanism

In competitive wholesale electricity markets, the *merit-order pricing model* governs price formation. Generators submit supply offers reflecting their short-run marginal costs, and the market operator dispatches capacity in ascending cost order until total generation equals demand. The clearing price is set by the marginal cost of the last unit dispatched.

For a market with generation portfolio $G = \{g_1, g_2, \ldots, g_n\}$ ordered by marginal cost $MC_1 < MC_2 < \ldots < MC_n$, and total demand D, the market clearing price is:

$$P^* = MC_m \quad \text{where} \quad \sum_{i=1}^{m-1} C\,ap_i < D \leq \sum_{i=1}^{m} C\,ap_i$$

Given that gas-fired combined cycle power plants frequently serve as the marginal generator, the clearing price often reflects gas generation costs:

$$P_{elec}^* = \frac{P_{gas}}{\eta_{gas}} + C_{O\&M} + C_{CO2} \cdot EF$$

where η_{gas} is the thermal efficiency of gas plants (typically 50–60% for modern CCGT units), $C_{O\&M}$ represents operation and maintenance costs, C_{CO2} is the carbon emission allowance price, and EF is the emission factor.

Factors Attenuating Theoretical Pass-Through

Several factors explain why empirical elasticity estimates fall below the theoretical benchmark implied by Equation 2:

1. **Energy Mix Diversification:** Romania's generation portfolio includes approximately 30% hydroelectric, 20% nuclear, and 15% renewables.
2. **Forward Contracting:** Approximately 60–70% of electricity is traded through bilateral contracts rather than spot exchanges.

3. **Regulatory Interventions:** During the 2022 crisis, Romanian authorities implemented price caps and compensation schemes.
4. **Market Coupling:** Cross-border electricity flows moderate local price volatility.

Mathematical Specification

Based on the theoretical framework, we specify the long-run equilibrium relationship in logarithmic form:

$$\log(P_{elec,t}^{RON/MWh}) = \alpha + \theta \cdot \log(P_{TTF,t}^{EUR/MWh}) + \beta \cdot \log(P_{BRENT,t}^{USD/bbl}) + \varepsilon_t$$

The coefficient θ represents the long-run elasticity of electricity prices with respect to TTF gas prices. Given the attenuating factors discussed above, we expect $\theta < 1/\eta_{gas}$.

Data and Methodology

Data Description

Our analysis utilizes monthly data spanning January 2018 to December 2025, comprising 96 observations.

Table 1. Descriptive statistics.

Descriptive Statistics

Variable	Unit	N	Mean	Std. Dev.	Min	Max
Electricity Price	RON/MWh	96	511.20	403.80	120.24	2,400.58
TTF Gas Price	EUR/MWh	96	42.33	42.22	4.39	239.91
BRENT Oil Price	USD/bbl	96	71.88	16.61	26.35	115.60
EUR/RON Exchange Rate	–	96	4.87	0.11	4.65	5.07
Consumption	MWh	96	6,531.60	614.80	5,427.94	7,860.11
Production	MWh	96	6,416.61	768.95	4,825.79	8,624.06

Sources: OPCOM (electricity prices), Investing.com (TTF, BRENT), Transelectrica (consumption/production), BNR (exchange rates).

Table 2. Electricity Price Statistics by Period

Period	Dates	N	Mean (RON/MWh)	Std. Dev.	Max
Pre-Crisis	2018:01–2021:09	45	248.68	105.66	662.15
Energy Crisis	2021:10–2022:12	15	1,264.68	446.62	2,400.58
Post-Crisis	2023:01–2025:12	36	525.40	128.93	836.09

Note: Crisis-period mean exceeds the pre-crisis mean by a factor of 5.1; post-crisis prices remain 111% above pre-crisis levels.

Stationarity Testing

We employ both the Augmented Dickey-Fuller (ADF) test and the KPSS test, following the standard procedures outlined in Hamilton (1994).

Table 3. Stationarity Test Results

Variable	ADF Stat.	ADF p	KPSS Stat.	KPSS CV 5%	Conclusion
$\log(P_{elec}^{RON/MWh})$	-1.925	0.320	0.838	0.463	I(1)
$\Delta\log(P_{elec}^{RON/MWh})$	-9.758	0.000	0.083	0.463	I(0)
$\log(P_{TTF}^{EUR/MWh})$	-1.880	0.342	0.598	0.463	I(1)
$\Delta\log(P_{TTF}^{EUR/MWh})$	-4.931	0.000	0.104	0.463	I(0)
$\log(P_{BRENT}^{USD/bbl})$	-2.399	0.142	0.423	0.463	I(1)
$\Delta\log(P_{BRENT}^{USD/bbl})$	-8.248	0.000	0.067	0.463	I(0)

Note: All price series are I(1), while first differences are I(0), motivating cointegration analysis.

Econometric Methodology

Error Correction Model (ECM)

Given cointegration, we estimate a two-step Error Correction Model following Engle & Granger (1987). The theoretical foundations for this approach, including the Granger representation theorem and asymptotic properties of the estimators, are developed in Hamilton (1994) and Stock & Watson (1993). The first step estimates the long-run equilibrium:

$$\log\left(P_{elec,t}^{RON/MWh}\right) = \alpha + \theta \cdot \log\left(P_{TTF,t}^{EUR/MWh}\right) + \varepsilon_t$$

The second step estimates the error correction dynamics:

$$\Delta\log\left(P_{elec,t}^{RON/MWh}\right) = c + \beta \cdot \Delta\log\left(P_{TTF,t}^{EUR/MWh}\right) + \gamma \cdot EC_{t-1} + \delta \cdot \Delta\log\left(P_{elec,t-1}^{RON/MWh}\right) + u_t$$

where EC_{t-1} is the lagged error correction term (deviation from long-run equilibrium). The key parameters are:

- θ: Long-run elasticity (equilibrium pass-through)
- β: Short-run elasticity (contemporaneous pass-through within one month)
- γ: Adjustment speed (rate of equilibrium reversion); for valid error correction, $\gamma < 0$

Important clarification on interpretation: The short-run coefficient β represents the contemporaneous elasticity: the percentage response of electricity prices to a 1% TTF shock within the same month. It does not represent the “proportion of total transmission completed,” but rather the immediate price adjustment. Additional transmission occurs over subsequent months as the error correction mechanism operates.

Local Projections (LP)

Following (Jordà, 2005: 161-182), we estimate Local Projections with cumulative response specification:

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h \cdot shock_t + \gamma' X_t + \varepsilon_{t+h}$$

for horizons $h = 0,1,2,\ldots,12$, where $y_t = \log(P_{elec,t}^{RON/MWh})$, $shock_t = \Delta\log(P_{TTF,t}^{EUR/MWh})$, and X_t includes control variables.

The cumulative specification implies that β_h represents the total cumulative response of log electricity prices to a 1% TTF shock at horizon h. Under convergence to the long-run equilibrium, we expect $\beta_h \to \theta$ as $h \to \infty$.

Standard errors are computed using HAC estimators with bandwidth $\max(h + 1{,}4)$ to account for serial correlation induced by the overlapping projection structure.

LP versus ECM Convergence

A key contribution of this study is the formal comparison of LP and ECM estimates. If both models are correctly specified, the LP cumulative response at long horizons should approach the ECM long-run elasticity. We test this formally:

$$z = \frac{\beta_{12} - \theta}{\sqrt{SE_{\beta_{12}}^2 + SE_\theta^2}}$$

Note that transitory deviations where $\beta_h > \theta$ at intermediate horizons before eventual convergence may occur due to overshooting, defined as a temporary price response exceeding the long-run equilibrium level. Such overshooting can reflect forward-looking pricing behavior, panic pricing during crises, or contract rollover effects.

Identification Strategy

Our identification strategy treats TTF price shocks as plausibly exogenous to Romanian electricity prices. This assumption is justified on several grounds:

1. **Economic Size:** Romania accounts for approximately 2% of EU natural gas consumption, making it a price-taker in the TTF market.
2. **Source of TTF Variation:** TTF price fluctuations were driven by global and European factors (Russian supply disruptions, LNG dynamics, geopolitical events) that do not originate from Romanian market conditions.
3. **Granger Causality Tests:** We formally test whether Romanian electricity prices Granger-cause TTF prices.
4. **Placebo Tests:** We test whether future TTF shocks (leads) predict current electricity price changes.

Important qualification: We characterize TTF exogeneity as plausible rather than definitively established. Potential confounders (common European demand shocks affecting both TTF and Romanian electricity) cannot be fully ruled out. The placebo tests reveal partial anticipation effects (see Section 5), which we interpret as a limitation rather than dismiss.

Rolling-Window Estimation

To assess parameter stability, we estimate rolling-window regressions with a 48-month window, following standard practices in the applied time series literature (Stock & Watson, 2001). The first window covers 2018:01–2021:12, producing the first estimate for 2022:01. This window length is chosen to ensure sufficient observations (48) for stable estimation while allowing detection of time-varying parameters. Subsequent windows advance by one month until the final window (2022:01–2025:12).

Empirical Results

Cointegration Testing

Engle-Granger Test

Table 4. Engle-Granger Cointegration Test

Relationship	Test Stat.	p-value	CV 1%	CV 5%
$\log(P_{elec}^{RON/MWh}) \sim \log(P_{TTF}^{EUR/MWh})$	-5.058	< 0.001	-4.015	-3.401

Note: Null hypothesis: no cointegration. Rejection confirms stable long-run equilibrium.

Johansen Test

Table 5. Johansen Cointegration Test (Trace Statistic)

Null: $r \leq$	Trace Statistic	CV 5%	Decision
0	33.77	29.80	Reject
1	12.31	15.49	Fail to Reject

Note: Results indicate exactly one cointegrating vector.

Both tests confirm cointegration between log electricity prices (RON/MWh) and log TTF prices (EUR/MWh), supporting the validity of the error correction framework.

Error Correction Model Estimates

Table 6. Error Correction Model Results

Panel A: Long-Run Equation	Coefficient	Std. Error	t-stat	p-value
Constant (α)	3.374	0.115	29.34	< 0.001
$\log(P_{TTF}^{EUR/MWh})$ (θ)	0.772	0.032	24.21	< 0.001
R^2	0.862			
Panel B:Short-Run Dynamics	-	-	-	-
Constant (c)	0.011	0.018	0.59	0.553
$\Delta\log(P_{TTF}^{EUR/MWh})$ (β)	0.444	0.100	4.45	< 0.001
EC_{t-1} (γ)	-0.412	0.128	-3.23	0.001
$\Delta\log(P_{BRENT}^{USD/bbl})$	0.034	0.129	0.26	0.792
$\Delta\log(P_{elec,t-1}^{RON/MWh})$	0.022	0.085	0.26	0.794
R^2	0.347	-	-	-
N	94	-	-	-

Note: HAC standard errors. Dependent variable in Panel B: $\Delta\log(P_{elec}^{RON/MWh})$.

Interpretation of ECM Results

Long-Run Elasticity ($\theta = 0.772$): A 1% increase in TTF natural gas prices is associated with a 0.77% increase in Romanian electricity prices in the long run. This elasticity falls below the theoretical merit-order benchmark of $1/\eta \approx$ 1.8–2.5, reflecting Romania's diversified energy mix.

Short-Run Elasticity ($\beta = 0.444$): The contemporaneous pass-through of TTF shocks to electricity prices within the same month is 0.44%. Additional transmission occurs over subsequent months through the error correction mechanism.

Adjustment Speed ($\gamma = -0.412$): The negative and significant coefficient confirms validity of the ECM. Approximately 41% of deviations from equilibrium correct within one month. The implied half-life is:

$$t_{1/2} = \frac{\ln(0.5)}{\gamma} = \frac{-0.693}{-0.412} \approx 1.68 \text{ months}$$

BRENT Effect in ECM: The BRENT coefficient is statistically insignificant in the ECM short-run equation ($p = 0.792$), indicating that after controlling for TTF, oil prices do not provide additional contemporaneous explanatory power. This is consistent with gas-fired (not oil-fired) plants setting marginal electricity prices. However, LP estimates at longer horizons suggest potential indirect BRENT effects that warrant careful interpretation.

Local Projections Results

Table 7. Local Projections: Cumulative Response to 1% TTF Shock

Horizon h	β_h	Std. Error	t-stat	95% CI	p-value
0	0.433***	0.123	3.52	[0.19, 0.67]	< 0.001
1	0.795***	0.158	5.04	[0.49, 1.10]	< 0.001
2	0.764***	0.167	4.59	[0.44, 1.09]	< 0.001
3	0.864***	0.212	4.08	[0.45, 1.28]	< 0.001
6	0.960***	0.252	3.81	[0.47, 1.45]	< 0.001
9	0.786***	0.262	3.01	[0.27, 1.30]	0.003
12	1.050***	0.321	3.27	[0.42, 1.68]	0.001

Note: Cumulative response: $\log(P_{elec,t+h}^{RON/MWh}) - \log(P_{elec,t-1}^{RON/MWh})$ on $\Delta\log(P_{TTF,t}^{EUR/MWh})$. HAC standard errors. *** $p < 0.01$.

The immediate impact ($\beta_0 = 0.433$) is consistent with the ECM short-run elasticity ($\beta = 0.444$). The 12-month cumulative response ($\beta_{12} = 1.050$) exceeds the ECM long-run elasticity numerically, though the difference is not statistically significant.

LP versus ECM Comparison and Interpretation of Difference

Table 8. Comparison: Local Projections vs. Error Correction Model

Parameter	Estimate	Std. Error
ECM Long-Run Elasticity (θ)	0.772	0.032
LP 12-Month Response (β_{12})	1.050	0.321
Difference ($\beta_{12} - \theta$)	0.278	0.322
z-statistic	0.862	-
p-value	0.389	-

Note: The difference is not statistically significant at conventional levels, supporting methodological consistency.

The difference between β_{12} and θ is not statistically significant ($p = 0.389$), supporting methodological consistency. However, the point estimate $\beta_{12}/\theta = 1.36$ suggests moderate overshooting—the cumulative response temporarily exceeds the long-run equilibrium before eventual reversion.

Economic interpretation of overshooting: Several mechanisms may explain this pattern:

1. **Forward-looking pricing:** During crisis periods, market participants may anticipate further price increases and adjust prices more aggressively than warranted by contemporaneous fundamentals.

2. **Panic pricing and risk premia:** Uncertainty during the crisis may have induced risk premia in electricity pricing.
3. **Contract rollover effects:** As existing hedges expire and are replaced at higher prices, the full impact of gas price increases may be delayed and then realized abruptly.
4. **Methodological considerations:** LP estimates at longer horizons have wider confidence intervals; the apparent overshooting may partially reflect sampling variability rather than a genuine economic phenomenon.

Given the wide confidence interval on β_{12} ([0.42, 1.68]), we cannot definitively conclude whether true overshooting occurs or whether the LP estimate is simply a noisy measure of the long-run elasticity.

BRENT Effects: Reconciling ECM and LP Results

The ECM finds BRENT statistically insignificant in the short-run equation, while LP estimates for BRENT show coefficients that become significant at longer horizons. This apparent contradiction warrants explanation:

1. **Different specifications:** The ECM short-run equation conditions on the error correction term (incorporating TTF effects), while LP estimates are cumulative responses to BRENT shocks.
2. **Collinearity:** TTF and BRENT are highly correlated ($\rho = 0.79$), making it difficult to separate their independent effects.
3. **Indirect transmission:** BRENT may affect electricity prices indirectly through its correlation with TTF rather than through direct merit-order effects.
4. **Crisis-period amplification:** The significant BRENT LP coefficients at longer horizons may be driven by crisis-period observations when all energy prices moved together.

We conclude that TTF is the primary driver of Romanian electricity prices (consistent with merit-order theory), while BRENT effects are largely indirect and should be interpreted cautiously given collinearity concerns.

Structural Break Analysis

Table 9. Chow Test for Structural Breaks

Break Date	F-statistic	p-value	Decision
January 2022	33.07	< 0.001	Structural break
June 2022	25.35	< 0.001	Structural break

Note: Both break points confirm the crisis as a major structural change.

Robustness Checks

Granger Causality Tests

Table 10. Granger Causality Tests

Hypothesis	F-stat	p-value	Lag	Decision
TTF → Electricity	10.83	< 0.001	2	Causes***
Electricity → TTF	1.44	0.243	2	Does not cause
BRENT → Electricity	4.98	0.028	1	Causes**
Electricity → BRENT	1.27	0.286	2	Does not cause

Note: Unidirectional causality from TTF to electricity supports the exogeneity assumption. *** $p < 0.01$, ** $p < 0.05$.

Placebo Tests

Table 11. Placebo Tests: Future TTF Leads

Lead Variable	β	t-stat	p-value	Interpretation
$\Delta\log(P_{TTF,t+1})$	0.186	2.64	0.008	Significant (violation)
$\Delta\log(P_{TTF,t+2})$	0.087	0.83	0.406	Insignificant (valid)
$\Delta\log(P_{TTF,t+3})$	0.154	1.60	0.109	Insignificant (valid)

Note: Lead 1 is statistically significant, suggesting partial anticipation effects. This represents a limitation of the identification strategy (Section 7).

The significant one-month lead ($p = 0.008$) indicates that current electricity prices partially incorporate expectations of next month’s TTF movements. This finding does not invalidate our analysis but suggests that the strict exogeneity assumption is an approximation. Possible explanations include:

- Forward-looking pricing based on TTF futures curves
- Common anticipatory factors affecting both markets
- Partial endogeneity or reverse feedback

We discuss this as a limitation in Section 7.

Rolling-Window Estimation

Table 12. Rolling-Window Elasticity Summary (48-Month Windows)

Statistic	Value
Mean β across windows	0.400
Standard deviation	0.062
Coefficient of variation (CV)	15.5%
Minimum	0.246 (2022:03)
Maximum	0.566 (2025:12)
Number of windows	48

Note: CV $< 50\%$ indicates relatively stable parameters outside crisis intervals. Minimum during 2022:03 may reflect price cap effects.

Diagnostic Tests

Table 13. ECM Diagnostic Tests

Test	Statistic	p-value	Conclusion
Jarque-Bera (normality)	0.74	0.690	Normality OK
Ljung-Box Q(5) (autocorrelation)	1.27	0.938	No autocorrelation
Breusch-Pagan (heteroskedasticity)	5.01	0.286	Homoskedasticity OK

Note: All tests support model validity.

Discussion

This study provides comprehensive evidence on TTF-to-electricity price transmission in Romania. The main findings include: (1) robust cointegration between log electricity and log TTF prices confirmed by Engle-Granger and Johansen tests ($p < 0.001$); (2) a long-run elasticity of 0.77, indicating substantial but attenuated pass-through consistent with Romania's diversified energy mix; (3) rapid adjustment with a half-life of 1.7 months; (4) LP-ECM consistency, with the difference between LP 12-month response (1.05) and ECM long-run elasticity (0.77) not statistically significant ($p

= 0.39$); and (5) structural breaks during the 2021–2022 crisis, though the transmission mechanism remained relatively stable (CV = 15.5%).

Our estimated elasticity aligns with European literature, where gas-electricity elasticities range between 0.5–1.0 (Newbery, 2018). The significant one-month lead in placebo tests ($p = 0.008$) indicates partial anticipation effects, suggesting that strict TTF exogeneity is an approximation rather than definitively established.

Policy Implications

The strong predictive relationship between TTF and Romanian electricity prices suggests that gas price monitoring can serve as an effective early warning system. The 1.7-month half-life provides a preparation window before full price transmission. A 10% TTF increase signals an approximately 7.7% eventual electricity price increase.

Several policy instruments could moderate volatility: Contracts for Difference (CfDs) providing price certainty, strategic gas reserves for counter-cyclical release, and temporary price caps with producer compensation. Long-term vulnerability reduction requires renewable expansion, nuclear capacity maintenance, and storage development.

For consumer protection, social tariffs indexed to moving averages and automatic household support when wholesale prices exceed thresholds (e.g., 500 RON/MWh) are recommended.

Conclusion

This study has provided a comprehensive analysis of how external energy price shocks transmit into the Romanian electricity market. Using monthly data from January 2018 to December 2025 and combining Local Projections with Error Correction Model methodologies, we document a robust long-run equilibrium relationship between natural gas prices (TTF, EUR/MWh) and electricity prices (RON/MWh), with a long-run elasticity of approximately 0.77 and rapid adjustment dynamics (half-life of 1.7 months).

The dual methodological approach yields consistent estimates, with the difference between LP 12-month response and ECM long-run elasticity not statistically significant ($p = 0.39$). This enhances confidence in our findings while acknowledging that the numerical difference may reflect overshooting during crisis periods. Robustness checks—including structural break detection, rolling-window estimation, and placebo tests—support the validity of our specifications while revealing partial anticipation effects that qualify the strict exogeneity assumption.

From a policy perspective, our findings highlight the importance of early warning systems based on gas price monitoring, the potential for various price stabilization instruments, and the long-term benefits of energy mix diversification.

Several avenues for future research merit attention: higher-frequency data analysis, extension to other regional markets, investigation of asymmetric effects using NARDL specifications, and formal instrumental variable approaches to address remaining identification concerns.

Authors' Contributions:

The authors contributed equally to this work.

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