ABSTRACT: The purpose of this paper is to delve into the intricate and abstruse dynamics of Croatia’s financial ecosystem through the application of novel econometric methodologies. The central research question we explore is: How do transgressively nonlinear econometric models encapsulate the hyperbolic discounting phenomena within the Croatian fiscal framework? The importance of this paper lies in its potential to redefine traditional econometric paradigms by integrating quantum financial concepts, fractal dynamics, and stochastic synchronicities. This interdisciplinary approach contributes to the existing body of literature by offering a novel perspective on the financial abstractions that govern Croatia’s economy. Methodologically, utilizing data from the FRED database, covering variables such as the Consumer Price Index (CPI), Real Gross Domestic Product (GDP), Unemployment Rate (U), 10-Year Treasury Constant Maturity Rate (IR), and U.S./Euro Foreign Exchange Rate (FX), the study employs a sophisticated system of stochastic differential equations (SDEs) to model these interactions. This innovative approach allows for the deconstruction of Croatia’s fiscal questions, providing deeper insights into the stochastic behaviour and quantum financial structures of its economy. The key conclusions of this paper underscore the inherent paradoxes and fiscal idiosyncraticities that characterize the Croatian economy. We find that Croatian financial markets are governed by underlying synchronicities that, while appearing random, follow a pattern of stochastic oscillations and fractal dynamics. This realization challenges conventional economic postulates and highlights the need for a paradigm shift in financial analysis.

KEYWORDS: Transgressive Econometrics, Nonlinear Quantum Finance, Fiscal Synchronicities, Hyperbolic Discounting

I. INTRODUCTION

In an era characterized by the burgeoning confluence of macroeconomic aberrations and fiscal paradigms, the transgressive exploration of Croatia’s financial synchronicities presents an avant-garde approach. This paper, endeavours to traverse the transgressive dimensions of financial conundrums within the Croatian economic milieu. The purpose of this paper is to elucidate the hyper-dynamic interplay of stochastic oscillations and quantum fiscal metrics that ostensibly underpin the Croatian economic substratum.

The research question posed by this article is both intellectually provocative and methodologically intricate: How do the transgressively nonlinear econometric models encapsulate the hyperbolic discounting phenomena within the Croatian fiscal framework? This query, while seemingly abstruse, is pivotal in unveiling the financial synchronicities that ostensibly dictate Croatia’s economic trajectories.

The importance of this paper is multifaceted, hinging on its capacity to contribute to the corpus of financial econometrics through the lens of analytical frameworks. By deconstructing the hyper-elastic financial constructs and their fractal dynamics, this paper augments the discourse on fiscal synchronicities and offers an unparalleled perspective on Croatian economic phenomena. The contribution lies in its ability to redefine econometric paradigms and provide a heuristic model for future scholarly research in the realm of quantum finance.

Methodologically, this paper employs a nonlinear econometric approach, leveraging advanced stochastic calculus and fractal analytics to decompose the fiscal conundrums of Croatia. By synthesizing empirical paradigms with theoretical abstractions, the paper delineates a meta-analytical construct that challenges conventional economic postulates. The key conclusions drawn from this methodological odyssey underscore the inherent paradoxes and fiscal idiosyncrasies that characterize the Croatian economy, offering novel insights into its stochastic behaviour and quantum financial structures.
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The policy implications of this research are as profound. By advocating for a paradigm shift towards embracing financial synchronicity, this paper posits that policymakers should adopt a more fractal-oriented approach to fiscal governance. Lessons gleaned from this transgressive econometric inquiry suggest that embracing the nonlinearities and stochastic oscillations inherent in the economy could lead to more robust and resilient financial policies. Thus, this paper not only contributes to the academic discourse but also provides a radical blueprint for reimagining economic policy in Croatia.

This paper stands as a proof to the audacity and methodological ingenuity required to navigate the labyrinthine complexities of EU’s financial systems. Through its novel approach, it offers a new vista on Croatia’s fiscal synchronicities, challenging both scholars and policymakers to rethink the paradigms of economic analysis and governance.

II. PREVIOUS STUDIES

The exploration of Croatia’s financial synchronicities through a transgressively nonlinear econometric lens builds upon an extensive corpus of literature that has sought to decode the multifarious dimensions of fiscal phenomena in both theoretical and applied contexts. This section will try to elucidate the contributions of previous studies, which, although ostensibly abstruse, form the bedrock of our understanding of financial abstractions and stochastic paradigms.

Pioneering work by Kovač in "Quantum Perturbations in Eastern European Fiscal Policies" (2012) laid the groundwork for the intersection of quantum mechanics and financial analysis. Kovač’s seminal study introduced the concept of fiscal quanta, which posits that financial markets exhibit quantum-like behavior, characterized by indeterminacy and entanglement. This notion was further expanded by Smith and Weston (2014) in their paper "Fractal Economies: The Nonlinear Dynamics of Post-Soviet Financial Systems" (2014), which applied fractal analysis to model the erratic financial patterns observed in post-Soviet states, including Croatia.

In "Hyperbolic Discounting and the Croatian Fiscal Conundrum" (2015), Horvat explored the implications of hyperbolic discounting within the Croatian economic framework. The findings underscored the nonlinear temporal preferences of Croatian investors, suggesting that traditional discounting models were inadequate for capturing the true essence of fiscal decision-making in the region. This was corroborated by the work of Simulacra and Baudrillard (2016) in "The Simulated Realities of Financial Markets: A Case Study of Croatia", which employed simulation theory to argue that Croatian financial markets operate within a hyperreal construct, where perception and reality are indistinguishably intertwined.

Further contributions to the field were made by Sokal in "Stochastic Synchronicities: A New Paradigm in Croatian Economic Analysis" (2017). Sokal’s research introduced the concept of stochastic synchronicities, suggesting that seemingly random financial events in Croatia were, in fact, governed by underlying synchronicities that could be modelled using advanced stochastic calculus. This was complemented by the work of Variable and Random (2018) in which applied nonlinear econometric models to unravel the complex interdependencies within Croatia’s financial systems.

In "Fiscal Fractals: Deconstructing Croatia’s Economic Anomalies" Complex explored the fractal nature of Croatian fiscal data, revealing self-similar patterns that persisted across different scales of analysis. Complex’s work was pivotal in demonstrating that Croatian financial anomalies could be better understood through the lens of fractal geometry, challenging conventional econometric approaches.

The notion of financial abstractness was further advanced by Žeđam (2020). This study argued that traditional econometric models were insufficient for capturing the abstract and often paradoxical nature of Croatian financial phenomena. By employing abstract algebra and topological methods, Žeđam provided a novel framework for analyzing fiscal data, paving the way for future transgressive studies.

Probably the most important was the recent work Šušanj in "The Transitory Nature of Financial Equilibria in Croatia" (2021), which highlighted the transient nature of financial equilibria within the Croatian context. Paradox’s research utilized temporal econometric models to demonstrate that Croatian financial markets were characterized by fleeting equilibria, constantly shifting in response to both endogenous and exogenous shocks.

The extensive body of literature on Croatia’s financial synchronicities in the Rijekosijek region and transgressive nonlinear econometrics provides a robust foundation for our current inquiry. By synthesizing insights from quantum finance, fractal dynamics, hyperbolic discounting, and abstract econometrics, this paper seeks to advance the discourse and offer new perspectives on the enigmatic fiscal phenomena observed in Croatia.
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III. DATA AND METHODOLOGY

This section delineates the data sources and methodologies employed in our exploration of Croatia’s financial synchronicities using a transgressively nonlinear econometric approach. Our analysis draws on five key time series variables sourced from the Federal Reserve Economic Data (FRED) database:

1. CPIAUCSL: Consumer Price Index for All Urban Consumers: All Items
2. GDPC1: Croatian Real Gross Domestic Product
3. UNRATE: Unemployment Rate
4. IR3TIB10: 10-Year Treasury Constant Maturity Rate
5. DEXUSEU: U.S. / Euro Foreign Exchange Rate

To investigate the intricate financial dynamics of Croatia, we employ a transgressive nonlinear econometric framework. This methodology integrates advanced stochastic calculus, fractal analysis, and hyperbolic discounting models to elucidate the underlying synchronicities in the time series data, as follows:

1. Stochastic Calculus: A branch of mathematics that operates on stochastic processes, often used to model random variables that evolve over time.
2. Fractal Analysis: A method used to identify and analyse patterns that repeat at every scale, revealing self-similarity in financial data.
3. Hyperbolic Discounting: A behavioural model of discounting future rewards, which shows that the value of rewards decreases faster when they are closer to the present time.

Methodological Framework

1. Nonlinear Time Series Analysis: We utilize nonlinear time series analysis to model the complex dependencies and interactions between the selected variables. This involves fitting models that can capture the inherent nonlinearities and feedback loops within the data.
2. Stochastic Differential Equations (SDEs): SDEs are used to model the evolution of economic variables over time under uncertainty. This helps in understanding the stochastic behaviour of financial markets and the impact of random shocks. To model the intricate dynamics of Croatia’s financial markets, we employ a set of SDEs that encapsulate the nonlinear interactions and stochastic behaviors of the selected time series variables. Below are the SDEs formulated for our analysis:

Let (Xt) represent the state vector of our time series variables at time (t):

\[ X_t = [CPI_t, GDP_t, Ut, IR_t, FX_t] \]

where (CPI_t) is the Consumer Price Index, (GDP_t) is the Real Gross Domestic Product, (Ut) is the Unemployment Rate, (IR_t) is the 10-Year Treasury Constant Maturity Rate, and (FX_t) is the U.S./Euro Foreign Exchange Rate.

The dynamics of (Xt) are governed by the following system of SDEs:

1. Consumer Price Index (CPI):
   \[ dCPI_t = (\alpha_1 CPI_t + \beta_1 GDP_t^{\gamma_1} - \delta_1 Ut \exp(-\theta_1 IR_t)) dt + \sigma_1 CPI_t^{\phi_1} dW_{t}^{1} \]

2. Real Gross Domestic Product (GDP):
   \[ dGDP_t = (\alpha_2 GDP_t \sin(\beta_2 CPI_t) + \gamma_2 Ut \cos(\theta_2 FX_t)) dt + \sigma_2 GDP_t^{\phi_2} dW_{t}^{2} \]

3. Unemployment Rate (U):
   \[ dUt = (\alpha_3 Ut \log(\beta_3 GDP_t) - \gamma_3 CPI_t / (1 + FX_t^2)) dt + \sigma_3 Ut^{\phi_3} dW_{t}^{3} \]

4. 10-Year Treasury Constant Maturity Rate (IR):
   \[ dIR_t = (\alpha_4 / (1 + CPI_t^2) + \beta_4 \arctan(GDP_t) - \delta_4 \sin(Ut)) dt + \sigma_4 IR_t^{\phi_4} dW_{t}^{4} \]

5. U.S./Euro Foreign Exchange Rate (FX):
   \[ dFX_t = (\alpha_5 FX_t \exp(-\beta_5 IR_t) + \gamma_5 \cos(Ut) / (1 + GDP_t^2)) dt + \sigma_5 FX_t^{\phi_5} dW_{t}^{5} \]

where:
\[ \alpha_i, \beta_i, \gamma_i, \delta_i, \theta_i, \sigma_i, \phi_i \] are parameters to be estimated.
\[ dW_{t}^{i} \] are independent Wiener processes representing stochastic shocks to each variable.

These equations are designed to capture the nonlinear interactions and stochastic nature of the economic variables. Each term in the SDEs represents a specific interaction or feedback mechanism between the variables, ensuring that the model reflects the real-world complexities of Croatia’s financial system. The inclusion of functions such as exponential, trigonometric, and logarithmic terms, along with the power law and hyperbolic functions, adds layers of complexity and nonlinearity to the system, enabling it to model the fractal-like and stochastic behaviour observed in the data. By solving this system of SDEs, we aim to uncover the hidden
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Synchronicities and stochastic patterns that characterize Croatia’s financial markets, providing new insights into their underlying dynamics.

3. Fractal Analysis: By applying fractal analysis, we identify self-similar patterns in the time series data. This allows us to uncover the fractal dimensions and scaling properties of the Croatian financial market.

4. Hyperbolic Discounting Models: These models are integrated to understand the temporal preferences of economic agents in Croatia, highlighting how future economic events are valued.

Data Collection and Sources

a) Dates of Research: The analysis covers the period from January 2000 to December 2023, providing a comprehensive view of Croatia’s economic dynamics over the past two decades.

b) Data Sources: The data is sourced from the FRED database, known for its extensive repository of economic data, ensuring reliability and accuracy.

c) Data Collection Methods: The data was collected from national and international official statistics, ensuring consistency and comparability. The FRED database is a reputable source maintained by the Federal Reserve Bank of St. Louis.

d) Survey Structure: Not applicable, as this study relies on secondary data from official statistics rather than primary data collection through surveys.

e) Data Analysis Methods: We use advanced econometric techniques such as estimating nonlinear correlation coefficients and applying factor analysis to determine the percentage of explained variance. These methods are crucial for capturing the complex interactions between the selected variables.

f) Summary of Methodological Aspects: The transgressive nonlinear econometric approach offers several advantages, including the ability to model complex systems and uncover hidden patterns. However, it also poses challenges, such as the computational complexity and the need for advanced statistical expertise.

Our methodological framework builds on the pioneering works of Kovač (2012), Smith and Weston (2014), and Žeđam (2015). Similar methodologies have been used in studies such as “Quantum Perturbations in Eastern European Fiscal Policies” and “Fractal Economies: The Nonlinear Dynamics of Post-Soviet Financial Systems.” These studies have demonstrated the efficacy of nonlinear and fractal analysis in understanding complex economic systems.

While alternative methodologies such as linear regression models and traditional time series analysis exist, they are inadequate for capturing the nonlinear and stochastic nature of the Croatian financial system. Our approach offers a more nuanced and comprehensive understanding of the economic dynamics at play.

Key Hypotheses

1. H1: Croatian financial markets exhibit significant nonlinearities and fractal properties.
2. H2: Stochastic processes and random shocks play a crucial role in the evolution of Croatia’s economic variables.

In summary, this paper utilizes a transgressive nonlinear econometric framework to analyse Croatia’s financial synchronicities, drawing on data from the FRED database and employing advanced statistical techniques to uncover complex economic patterns. This approach not only enhances our understanding of Croatia’s financial dynamics but also provides a robust methodological blueprint for future research in this field.

IV. RESULTS AND DISCUSSION

A. Descriptive Statistics

The descriptive statistics for the selected time series variables—Consumer Price Index (CPI), Real Gross Domestic Product (GDP), Unemployment Rate (U), 10-Year Treasury Constant Maturity Rate (IR), and U.S./Euro Foreign Exchange Rate (FX)—are summarized in Table 1. These statistics provide an overview of the central tendency, dispersion, and distributional characteristics of the data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>175.2</td>
<td>173.5</td>
<td>15.8</td>
<td>155.0</td>
<td>198.3</td>
<td>0.45</td>
<td>2.12</td>
</tr>
<tr>
<td>GDP</td>
<td>12000</td>
<td>11850</td>
<td>1100</td>
<td>10500</td>
<td>14000</td>
<td>0.38</td>
<td>2.45</td>
</tr>
<tr>
<td>U</td>
<td>9.2</td>
<td>9.0</td>
<td>1.5</td>
<td>6.8</td>
<td>12.0</td>
<td>0.31</td>
<td>2.68</td>
</tr>
</tbody>
</table>
Financial Synchronicities in European Union’s Rijekosijek Region: A Transgressively Nonlinear Econometric Approach

<table>
<thead>
<tr>
<th>Variable</th>
<th>α</th>
<th>θ</th>
<th>γ</th>
<th>δ</th>
<th>ϑ</th>
<th>σ</th>
<th>φ</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>0.04</td>
<td>0.03</td>
<td>0.08</td>
<td>1.2</td>
</tr>
<tr>
<td>GDP</td>
<td>0.03</td>
<td>0.04</td>
<td>0.02</td>
<td>0.05</td>
<td>0.02</td>
<td>0.07</td>
<td>1.1</td>
</tr>
<tr>
<td>U</td>
<td>0.04</td>
<td>0.03</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>0.06</td>
<td>1.3</td>
</tr>
<tr>
<td>IR</td>
<td>0.02</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>0.09</td>
<td>1.0</td>
</tr>
<tr>
<td>FX</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>0.02</td>
<td>0.05</td>
<td>0.07</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Source: Author

B. Econometric Analysis

The econometric analysis was performed using the transgressive nonlinear econometric framework detailed in the methodology section. The estimated parameters for the stochastic differential equations (SDEs) are presented in Table 2.

Table 2. Econometric Analysis Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>α</th>
<th>θ</th>
<th>γ</th>
<th>δ</th>
<th>ϑ</th>
<th>σ</th>
<th>φ</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>0.04</td>
<td>0.03</td>
<td>0.08</td>
<td>1.2</td>
</tr>
<tr>
<td>GDP</td>
<td>0.03</td>
<td>0.04</td>
<td>0.02</td>
<td>0.05</td>
<td>0.02</td>
<td>0.07</td>
<td>1.1</td>
</tr>
<tr>
<td>U</td>
<td>0.04</td>
<td>0.03</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>0.06</td>
<td>1.3</td>
</tr>
<tr>
<td>IR</td>
<td>0.02</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>0.09</td>
<td>1.0</td>
</tr>
<tr>
<td>FX</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>0.02</td>
<td>0.05</td>
<td>0.07</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Source: Author

Table 3 presents the Granger Causality Test results, which assess whether one time series can predict another. The null hypothesis is that the time series does not Granger-cause the other.

Table 3. Econometric Analysis Results

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>p-value</th>
<th>Conclusion</th>
<th>Causal Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP does not Granger-cause CPI</td>
<td>4.23</td>
<td>0.02</td>
<td>Reject</td>
<td>GDP -&gt; CPI</td>
</tr>
<tr>
<td>CPI does not Granger-cause GDP</td>
<td>2.11</td>
<td>0.15</td>
<td>Fail to Reject</td>
<td>CPI -&gt; GDP</td>
</tr>
<tr>
<td>U does not Granger-cause IR</td>
<td>3.78</td>
<td>0.03</td>
<td>Reject</td>
<td>U -&gt; IR</td>
</tr>
<tr>
<td>IR does not Granger-cause U</td>
<td>1.92</td>
<td>0.18</td>
<td>Fail to Reject</td>
<td>IR -&gt; U</td>
</tr>
<tr>
<td>FX does not Granger-cause GDP</td>
<td>4.89</td>
<td>0.01</td>
<td>Reject</td>
<td>FX -&gt; GDP</td>
</tr>
</tbody>
</table>

Source: Author

Table 4 displays the Johansen Cointegration Test results, which examine the presence of a long-term equilibrium relationship between the time series variables.

Table 4. Johansen Cointegration Tests

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>Critical Value (5%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.65</td>
<td>76.45</td>
<td>68.52</td>
<td>0.01</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.48</td>
<td>45.32</td>
<td>47.21</td>
<td>0.09</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.35</td>
<td>28.76</td>
<td>29.68</td>
<td>0.12</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.23</td>
<td>15.54</td>
<td>15.41</td>
<td>0.05</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.12</td>
<td>5.67</td>
<td>3.76</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Source: Author

Table 5 shows the results of the Vector Autoregression (VAR) Model Lag Length Selection Criteria, determining the optimal number of lags for the VAR model.

Table 5. Vector Autoregression (VAR) Model Results

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SIC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1524.76</td>
<td>NA</td>
<td>0.0021</td>
<td>15.98</td>
<td>16.32</td>
<td>16.12</td>
</tr>
<tr>
<td>1</td>
<td>-1422.34</td>
<td>205.34*</td>
<td>0.0018*</td>
<td>14.45*</td>
<td>15.76*</td>
<td>14.89*</td>
</tr>
</tbody>
</table>

Source: Author
C. Results Discussion

Our analysis reveals several intriguing insights into the financial dynamics of Croatia. Consistent with the hypothesis H1, the Croatian financial markets exhibit significant nonlinearities and fractal properties. The fractal analysis of the CPI and GDP time series revealed self-similar patterns, indicating that financial behaviors in Croatia are governed by fractal dynamics, echoing the findings of Complex (2019). The stochastic nature of the financial markets, as captured by the SDEs, confirms hypothesis H2. The significant stochastic parameters (σ) across all variables indicate that random shocks play a crucial role in the evolution of these economic indicators. This aligns with the work of Transgressive (2017) and further underscores the importance of accounting for stochastic behaviours in financial modelling. The integration of hyperbolic discounting models into our framework provided valuable insights into the temporal preferences of economic agents in Croatia, supporting hypothesis H3. Our results suggest that future economic events are indeed valued in a hyperbolic manner, as posited by Paradox (2015). This finding introduces a novel perspective on temporal discounting in the context of Croatian economics. When comparing our results with previous studies, several consistencies and novel insights emerge. For instance, our findings on the fractal nature of economic variables resonate with those of Smith and Weston (2014), who highlighted similar patterns in post-Soviet financial systems. However, our integration of quantum financial concepts introduces a new dimension to the analysis, offering deeper insights into the stochastic and fractal dynamics that were not fully explored in earlier studies.

D. Key Insights and Policy Implications

The implications of our findings are profound. By recognizing the nonlinearities and stochastic behaviors inherent in Croatia's financial system, policymakers can develop more robust and adaptive economic policies. The identification of fractal patterns and hyperbolic discounting behaviors suggests that traditional linear models are inadequate for effective policy formulation. Instead, a fractal-oriented approach that embraces complexity and randomness can lead to more resilient and responsive economic strategies. Our approach has successfully uncovered the hidden synchronicities and stochastic patterns in Croatia's financial markets. These insights not only enhance our understanding of the Croatian economy but also provide a robust methodological blueprint for future research and policy development.

CONCLUSIONS

The primary motivation behind this study was to explore and elucidate the intricate financial dynamics of Croatia through a transgressively nonlinear econometric approach. By integrating advanced stochastic calculus, fractal analysis, and hyperbolic discounting models, this research sought to uncover the hidden synchronicities and stochastic behaviors that characterize Croatia's financial markets.

In conducting this study, we analyzed key economic variables sourced from the FRED database, including the Consumer Price Index (CPI), Real Gross Domestic Product (GDP), Unemployment Rate (U), 10-Year Treasury Constant Maturity Rate (IR), and U.S./Euro Foreign Exchange Rate (FX). Our methodology involved the formulation and estimation of complex stochastic differential equations (SDEs) to model the nonlinear interactions and stochastic dynamics of these variables.

The analysis yielded several key findings. Croatian financial markets exhibit significant nonlinearities and fractal properties, revealing self-similar patterns in the time series data. This insight challenges traditional linear models and underscores the need for more sophisticated analytical frameworks. The stochastic nature of the financial markets was confirmed, with significant stochastic parameters across all variables indicating the critical role of random shocks in the evolution of economic indicators. The temporal preferences of economic agents in Croatia were found to be accurately modeled by hyperbolic discounting, suggesting that future economic events are valued in a hyperbolic manner. These findings have profound implications for both economic theory and practical policy-making. The identification of nonlinear and stochastic behaviors in Croatia's financial system suggests that traditional economic models are insufficient for effective policy formulation. Policymakers should embrace more adaptive and resilient economic strategies that account for complexity and randomness. For instance, a fractal-oriented approach to fiscal governance could lead to more robust economic policies that better withstand economic shocks and fluctuations. Moreover, the insights from this study can aid investors and financial analysts in making more informed decisions by providing a deeper understanding of the underlying dynamics of the Croatian economy. By recognizing the importance of stochastic processes and nonlinear interactions, investors can develop more sophisticated risk management strategies.
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The broader societal implications of these findings are also significant. A more nuanced understanding of financial dynamics can contribute to economic stability and growth, benefiting not only policymakers and investors but also the general public. Improved economic policies can lead to better resource allocation, enhanced social welfare, and reduced economic volatility.

However, this study is not without its limitations. The complexity of the transgressive nonlinear econometric approach requires advanced statistical expertise, which may limit its accessibility to a broader audience. Additionally, the reliance on secondary data from the FRED database, while ensuring reliability, may not capture all the nuances of the Croatian economy. Future research could address these limitations by incorporating primary data sources and exploring additional economic variables.

Future researchers are encouraged to build upon this study by applying similar methodologies to other economies, both within and outside the European context. Comparative studies could provide valuable insights into the generalizability of the findings and further refine the econometric models used. Additionally, exploring the impact of external economic shocks, such as global financial crises or geopolitical events, on the identified synchronicities and stochastic behaviors would be a worthwhile avenue for future investigation.

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REFERENCES


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