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Editorial

Editorial and Ideas for Research Using Mathematical and Statistical Models for Energy with Applications

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Given the mounting evidence favoring quantitative and qualitative analyses, prompted by easy access to data, mathematical and statistical models have gained a formal appreciation for their role in the analytical apparatus of contemporary research methodologies in all fields. Accompanying this line of progress, the development of sophisticated theories in many areas of energy/environment have kept pace. The changing theoretical constructs, based on improved and more urbane foundations, supported by newer information and finer tools, have led to the broader application of these models to issues of public policy. These tools have been used by researchers in the area of energy for quite some time, and their significance continues to grow. Moreover, they appear to have much appeal to the profession that encompasses academics and policymaking circles. Comprehensive analytical methods and tools are considered central and appropriate to the understanding and implementation of intricate policy. The acceptance of such an approach has often produced meaningful results, drawn from real-world data for charting effective policy.

The topic of energy use has been gaining heightened interest among the profession and other relevant personnel for quite some time, and for good reasons, primarily due to its effects on economic growth, the promise of better standards of life for all, and aiding poverty alleviation. However, in recent times, a separate, more relevant factor has generated considerable interest and possibly concerns, particularly over side effects, its tendency to cause damage to the environment in addition to the associated social cost. The effects are of much import as they have local and global ramifications, regarding health, which can affect human capital formation, labor productivity, and thus, economic growth. This causes a circularity or feedback in causality. The available evidence on the direction of casualty has so far shown disconcerting effects, to say the least.

Clearly, the above narrative reflects the potential for conflict. These must be reconciled and pursued simultaneously. It is impractical to choose one over the other—both are critical for the survival of the human race. The former is considered necessary, while the latter is often dubbed as a luxury, implying that its demand is income elastic—a reason adduced for steady economic growth. As the march toward economic prosperity by major emerging nations intensifies, the importance of the topic will only grow.

Energy runs the wheels, is needed for the production of goods and services, along with the maintenance and pursuit of an improved quality of life and standard of living. Many of the emerging economies are growing much faster than earlier projected. This has created a spurt in the demand for energy, led mostly by China and India, the major players. The forecast for global energy consumption points to even higher use. In the long run, demand is projected to continue upward.

Against the backdrop of the above storyline, it is important that the profession take a closer look at the evolving concerns in an effort to address and remedy the relevant problems as they relate to energy, perhaps by combining the tools of mathematics and statistics. The former helps in developing models that describe the underlying characteristics of the economy and their interlinkages, described by a set of functional relationships under study—the mathematical model. The latter uses data, as implied by the sector, to estimate the model coefficients, interpret them and based on the findings; draw inferences prior to making policy recommendations, as appropriate to the context of the sector, at both the micro and/or macro levels. These steps require that the appropriate statistical tests be established to validate the research questions probabilistically. The models might even be simulated to obtain forecast values for some reasonable future periods. Hopefully, these will provide an opportunity to take a glimpse into the conditional future.

This Special Issue "Mathematical and Statistical Models for Energy with Applications", edited by Faridul Islam, Aviral Kumar Tiwari, and Wing-Keung Wong, aims at bringing together related theories, practices, and applications linked to the energy sector in different countries is devoted to research for advancements in and development of the energy sector using the tools and approaches of recent times. This work might be considered both as a contribution to the literature and a helpful compendium to serve as a reference to students, researchers, and policymakers. From the outset, it was envisaged that the volume would solicit papers from well-recognized and established professionals in the field for contribution to the extant knowledge, with a primary focus on quantitative aspects of energy and its applications. The editors have put significant effort in reviewing and selecting the final included publications from the array of high-quality papers that were submitted. For this Special Issue, we invited potential authors across the spectrum of scholars, policymakers, and practitioners to submit manuscripts on their research, specifically that fit the scope and spirit of this issue. Many responded with their generous contributions, which culminated in the success of the project, as we see it. We thank each member of the team as well as the MDPI management responsible for this journal volume, and sponsors—without whose relentless support and efforts, this mission would not have been quite as successful.

This Special Issue sought works related to the following topics but remained open to works related to the theme.

(i) Pricing of energy resources for domestic and global market, relating to renewable and nonrenewable sources, including hydrocarbon, e.g., oil, gas, coal; nuclear, hydrogen wind-solar, hydraulic, and similar sources;
(ii) Model for pricing of carbon emissions that apply to domestic and international groups;
(iii) Modeling of financial returns and volatility of energy and other natural resources;
(iv) Forecasting the use pattern and performance of energy commodities, natural resources, and carbon emissions individually and as joint or interrelated products;
(v) Analyzing the use of energy commodities, natural resources, and carbon emissions as financial commodities in financial portfolios for optimal hedging, insurance, or maybe other financial portfolios;
(vi) Analysis of the real and potential impacts of energy use on the environment from the perspective of sustainability and the expected role pricing of carbon emissions;
(vii) The impacts of energy on health, agriculture, and livestock sectors, including pricing of carbon emissions.

The authors were allowed the liberty to choose and provide statistically valid prices for energy commodities, natural resources, and carbon emissions using robust modeling approaches and explore financial aspects, e.g., returns, cost–benefit, and volatility of energy commodities, or as they might consider broadly relevant. Researchers were encouraged to consider the above items in the context of future financial commodities or financial portfolios, in optimal hedging (or insurance) of financial portfolios. Another aim was to evaluate the impacts on the environment and the underlying issues of sustainability to assess the effects on the basic features of the economy as appropriate to a particular stage of its economic growth.

This Special Issue is a collection of 9 papers carefully selected for publication, and a summary of the papers is offered below. Esmaeil et al. [1] employ the panel autoregressive-distributed lag model to examine the nexus of Arab revolutions, oil price shocks, selected bank-specific macroeconomics series, and bank profitability indicators. They explore the short- and long-run causality for Islamic and conventional banking in the Gulf Cooperation Council (GCC) countries and find that, in the end, most of the used series had a significant effect on the dependent variable. These are return on equity, return on asset, and net interest margin/net profit margin for both conventional banks (CBs), and Islamic banks (IBs). Interestingly, they find that the post-Arab springs oil price shock is more noteworthy in CBs compared to IBs. The latter has a higher sustainable profit compared to the former. The authors document that each type has some similarity with the other and conclude that any regular approach should consider prudent macro regulation to address oil price shock for the banks in the GCC countries.

In exploring the impact of oil prices on tourism income, Hesami et al. [2] implement the cointegration approach, searching for a long-term equilibrium relationship. They find a unidirectional Granger causality from oil prices to tourism receipts. They argue that the impact of oil price fluctuations on tourism income can be useful in predicting investors' and policymakers' behavior. Khan et al. [3] use a novel approach with Caputo operator to obtain a closed-form solution for some heat-like equations with the desired rate of convergence that can solve the fractional-order problems.

Liu et al. [4] employ time-varying dynamic correlations, asymmetric model, quantile regression, and the cross-quantilogram framework to investigate the safe-haven, hedging hypothesis along with the diversification function of crude oil for conventional currencies of major oil exporters and importers. They find that conditional diversification of oil yields higher benefits in the lower quantiles, while the hedging effectiveness of oil favors the oil-exporting countries. Employing different time-varying coefficients, Mikayilov et al. [5] find cointegration among gasoline demand, price, and income. They computed the income and price elasticities of demand for gasoline in countries with fuel subsidies. Qin et al. [6] applied the semi-analytical procedures to solve the Caputo derivative differential equations systems, adding that the method converges faster requiring fewer steps and computations, and even shows that it can solve the problems with derivatives of fractional order.

Rodríguez et al. [7] use a wind-speed index model in designing a price up-and-in wind barrier option by capturing the effect using the autoregressive fractionally integrated moving average model on the wind speed, and the associated risk with wind power generation. They then use their model to analyze an electricity market in the Colombian context, which is affected by the El Niño phenomenon, which they find affecting the decision to sell their wind-generated energy to the grid. Velásquez-Gaviria [8] employ the traditional Kupiec and Christoffersen tests, and the recent back-testing expected shortfall (ES) techniques to estimate and validate the value-at-risk (VaR) and the ES. They apply the AR(1)-GARCH(1,1), AR(1)-EGARCH(1,1), and AR(1)-APARCH(1,1) models with innovations under different distribution scenarios. The aim is to compare the performance of renewable energy with traditional energy stocks. They find that the generalized error distribution and the skewed-t serve as better tools in drawing implications for the portfolio managers and policymakers. Yang et al. [9] employ the fuzzy-analytic network process approach to develop a comprehensive evaluation system from social, economic, and environmental benefits from the point of view of energy efficiency. They then apply the approach to evaluate the benefits of a 100-megawatt storage project. Finally, we confer future research ideas on the use of mathematical and statistical models for energy with applications.

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