MULTIVARIATE TIME SERIES MODELLING OF TAXES REVENUE IN NIGERIA

BABA GIMBA ALHASSAN

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DEDICATION

This thesis is dedicated to my late father, who taught me that the best kind of knowledge to have been that which is learned for its own sake. It is also dedicated to my late mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Tax is a source of revenue or income for a government to achieve a country's macro economic objectives in the areas of fiscal and monetary policies. However, the effects of tax burden may cause economic recession, financial crises, as well as poor standard of living and economic hardship for the people. In order to tackle these challenges, there is a need for short-term, medium-term, and long-term periods of forecasting models to be developed. In general, financial time series forecasting models are not tax-revenue based-models. Thus, existing models are inadequate to gauge the relationship between tax-based variables that can be particularly volatile. This research bred a model that used data with distinguished variables, obtained from the bulletin of the National Bureau of Statistics and the Central Bank of Nigeria. In this study, Vector Autoregressive model (VAR) and the functional Generalized Autoregression Conditional Heteroscedasticity family (fGARCH) models were combined to consider the behaviour of the financial time series (tax revenue) data. However, because of the high persistence of volatility in the data, the GARCH family model alone is unable to capture the leverage effects in the structural changes of the time series. Hence, the Auto-regression Hidden Markov Model (ARHMM) was proposed to handle this issue. The results show that the VAR with the hybrid of fGARCH models were unable to capture the volatile behaviour of the tax revenue data. On the other hand, the proposed model that used the ARHMM to capture the intensity of volatility persistence performed better. The out-of-sample forecasting accuracy gave less than ten percent of the Mean Absolute Percentage Error (MAPE) for the proposed model. The simulation study has proven that the VARARHMMfGARCH proposed model produced better results as compared to the hybrid of the traditional VAR-fGARCH model. The newly joint VAR-ARHMM-fGARCH model offers an effective forecasting approach for future tax revenue data.

ABSTRAK

Cukai ialah sumber hasil atau pendapatan bagi sesebuah kerajaan untuk mencapai objektif makroekonomi negara dalam dasar polisi fiskal dan monetari. Walau bagaimanapun, kesan beban cukai boleh menyebabkan kemelesetan ekonomi, krisis kewangan, serta taraf hidup yang lemah dan kesusahan ekonomi kepada rakyat. Untuk menangani cabaran ini, terdapat keperluan untuk model ramalan jangka pendek, jangka sederhana, dan jangka panjang dibangunkan. Secara umum, model ramalan siri masa kewangan bukan berasaskan model hasil cukai. Oleh itu, model sedia ada tidak mencukupi untuk mengukur hubungan antara pembolehubah berasaskan cukai yang bersifat tidak menentu. Penyelidikan ini menghasilkan model yang menggunakan data dengan pembolehubah yang berbeza, yang diperoleh daripada Biro Statistik Kebangsaan dan Bank Pusat Nigeria. Dalam kajian ini, model Autoregresif Vektor (VAR) dan keluarga Heteroskedastisiti Bersyarat Autoregresif Teritlak (fGARCH) telah digabungkan untuk mengambil kira sifat data siri masa kewangan (hasil cukai). Walau bagaimanapun, kerana ketidaktentuan yang tinggi dalam data ini, model keluarga GARCH sahaja tidak dapat menangkap kesan keumpilan dalam perubahan struktur siri masa. Oleh itu, Model Markov Tersembunyi Regresi Auto (ARHMM) telah dicadangkan untuk menangani masalah ini. Keputusan menunjukkan bahawa VAR dengan hibrid model fGARCH tidak dapat menangkap sifat ketidaktentuan dalam data hasil cukai. Walau bagaimanapun, model yang dicadangkan yang menggunakan ARHMM untuk menangkap intensiti ketidaktentuan, menunjukkan prestasi yang lebih baik. Ketepatan ramalan luar sampel memberikan kurang daripada sepuluh peratus Ralat Peratusan Mutlak Min (MAPE) untuk model yang dicadangkan. Kajian simulasi telah membuktikan bahawa model cadangan VAR-ARHMMfGARCH menghasilkan keputusan yang lebih baik berbanding dengan hibrid model VARfGARCH tradisional. Model VAR-ARHMM-fGARCH yang baru menawarkan pendekatan ramalan yang efektif untuk data hasil cukai di masa hadapan.

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LIST OF ABBREVIATIONS

AIC	-	Autocorrelation Function
AIC	-	Akaike Information Criterion
ADF	-	ADF - Augmented Dickey-Fuller
ANN	-	Artificial neural network
AP	-	Affinity Propagation
APARCH	-	Generalized Autoregressive Conditional Heteroscedasticity
ARCH	-	Autoregressive Conditional Heteroscedasticity
ARFIMA	-	Autoregressive Fractional Integrated Moving Average
ARIMA	-	Autoregressive Integrated Moving Average
ARMA	-	ARMA - Autoregressive Moving Average
BC	-	Before Christ
BEKK	-	Baba, Engle, Kraft, and Kroner
BIC	-	Bayesian Information Criteria
BVAR	-	Bayesian Vector Autoregression
CCC	-	Constant conditional correlation
C-Tax	-	Company Tax
CED-Tax	-	Customs and Exercise Duty Tax
DCC	-	Dynamic conditional correlation
EM	-	Expectation Maximization
ES	-	Expected Shortfall
EGARCH	-	Exponential Generalized Autoregressive Conditional Heteroscedasticity
FGARCH	-	Functional Generalized Autoregressive Conditional Heteroscedasticity
GARCH	-	Generalized Autoregressive Conditional Heteroscedasticity
GDP	-	Gross Domestic Product
GLM	-	Generalized Linear Model
GLS	-	Generalised Least Square
GRA	-	Grey Relationship Analysis
HMM	-	Hidden Markov Model

HMM-FA	-	Hidden Markov Model-based Financial Analysis
HQ	-	Hannah Quine
KNN	-	Kernel Neural Network
LASSO	-	Least Absolute Shrinkage and Selection Operator
LM	-	Lagrange Multiplier
LS-SVR	-	Least Square-Support Vector Regression
MAE	-	Mean Absolute Error
MAPE	-	Mean Absolute Percentage Error
ME	-	Mean Error
MGARCH	-	Multivariate Generalized Autoregressive Conditional Heteroscedasticity
MLE	-	Maximum likelihood estimation
MSE	-	Mean Square Error
MTS	-	Multivariate Time Series
OLS	-	Ordinary Least Square
OLSCS	-	Ordinary Least Square-cumulative Sum
PACF	-	Partial Autoregression Function
PI-Tax	-	Personal Income Tax
PP-Tax	-	Property Tax
QGARCH	-	Quadratic Generalized Autoregressive Conditional Heteroscedasticity
RMSE	-	Root Mean Square Error
SARIMA	-	Seasonal autoregressive integrated moving average
S-Tax	-	Sales Tax
SGARCH	-	Skew generalized autoregressive conditional heteroscedasticity
SV	-	Stochastic Volatility
SVM	-	Support vector machine
TGARCH	-	Threshold generalized autoregressive conditional heteroscedasticity
TR	-	Tax Revenue
TSA	-	Time series analysis
VAR	-	Vector autoregressive

VARMA	-	Vector autoregressive moving average
VAT	-	Value Add Tax
VECM	-	Vector error correction model

LIST OF SYMBOLS

X_t	-	Time series
μ	-	Mean
σ^2	-	Variance
ΔX_t	-	Difference series
z_t	-	Exogenous regressor
ε_t	-	Error term
$\boldsymbol{p}$	-	Autoregressive parameter
d	-	Degree of integration
q	-	Moving average parameter
$\phi(B)$	-	Polynomial of order p
$\theta(B)$	-	Polynomial of order q
P	-	Seasonal autoregressive parameter
Q	-	Seasonal moving average parameter
$\Phi_p(B^s)$	-	Polynomial of order P
$\Theta_p(B^s)$	-	Polynomial of order Q
L	-	Log-likelihood
K	-	Number of variables
u_t	-	Independent white noise
η_t		Standardized residuals
Q	-	Dynamic conditional correlation matrix

$(\alpha+\beta)$	-	Volatility persistence measure
π	-	Initial state probabilities
a_{ij}	-	Transition state probability distribution
b_j^k	-	Emission probability

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents an overview or background of the study, by highlighting some key concepts relating to taxation, tax revenue, and tax revenue forecasting. This was followed by the statement of the problem, justifying the need and the novelty involved for undertaken research on this topic, especially as it relates to a developing economy (i.e., Nigeria) which is characterized by poor tax revenue performance. Conversely, this is followed by a statement on the research questions and objectives of the study. Also, the scope of the study was defined, in addition to the statement on the significance of the research.

1.2 Overview/Background

Taxation is the principal source of every successful economy globally and successful tax administration is a tradition as old as taxation itself (Desai and Hines Jr., 2004). The appraisal act amongst maximizing tax revenues and abating the effect on the public in which the state must involve was apparent as early as 2350 BC (Emmanuel., 2017). The challenge of tax is highly significant in the global economy. One of the oldest means of Taxation by which the cost of providing essential services for the majority of people existing in a specified geographical area is funded (Ngerebo and Masa., 2012). Universally, the responsibility of governments is to provide some basic infrastructures for their citizens. The obligatory functions of government might be obliged its citizens to include redistribution of income, provision of services in the form of public goods and stabilization of the economy (Herbert., 2018).

Tax revenue (TR) has been defined in different ways depending on the angle or the aim of the individual studies, however, it is defined as the amount of revenue generated from the collection of tax over a given period. To raise enough revenue is the primary function of the tax system to finance vital expenditures on the services provided by the government (Oates, 1966; Okoye & Ezejiofor, 2014). Hence, as a way of developing financial time series forecasting, this study focuses on tax revenue contribution towards economic conditions of development.

Tax revenue is classified into many categories: 1) Direct tax. This is generated through either sale of the ticket (receipt) or charges for the break of law and order or offense committed by individuals or companies; 2) Indirect tax. This is generated through personal income tax, sales tax, company tax, etc. 3) Petroleum tax. This is derived from the sales premium motor spirit PMS; and 4) Value-added tax (or VAT), which is built-in consumer products (Afolabi, 2010). The fulfilment of these responsibilities depends largely on the amount of generated revenue by the government thru numerous means (Clark & Wilson, 1961; Stoker, 2016). Tax revenue is the total sum of resources collected either per hour, per week, per month, per quarter, and per annum which are referred to as time-series data (Philip and Olalekan., 2017). Forecasting financial time series data is the method in which the previous year's data is used to make a forecast referring to the record of the data itself (Dave and Adam., 2016).

Ifere. et al. (2014) worked on Tax Innovation, Administration, and Revenue Generation in Nigeria: Case of Cross River State. However, since there's a correlation amongst the variables, then there exists heteroscedasticity in the data. Although, a great number of the literature review applied linear models on tax revenue data.

However, in recent times there are numerous kinds of literature reviewed, it is obvious that volatility in the financial time series data (tax revenue) still suffers a great challenge from both the data and the model that were used to capture the heteroscedasticity in the data. Meanwhile, different types of multivariate time series forecasting models have been utilized and yet the problem persists. More so we observed that there is a high correlation exists in the tax revenue data which also

constrain another problem in the data. Consequently, most of the financial time series modeling and forecasting concentrated on stock exchange data, though a lot of research has been advancing in hybrid models to model and forecast short-term and long-term predictions of the stock market. Besides there are no much studies on tax revenue that has hybrid models or forecast to this effect, in which this study is undertaken to hybrid models that can address the issues of high correlation, and volatility that are residing in the tax revenue data, this will go long way to minimize the tax revenue challenges for Nigeria and states with related economic structures.

1.3 The Problem Statement

Breeding an analytic time series model to describe the relationships among highly correlated explanatory variables has been quite challenging due to the difficult nature and the inadequate knowledge of the basic mechanisms that are accountable for the relationship. In some cases, the univariate time series analysis is adequate. While, in some situations, it may be restricted. The univariate analysis focuses on a single variable (component), but for some variables, they are correlated and needed to be incorporated in the analysis as well. This study proposes a multivariate model for modeling and forecasting for effective management of tax administration and revenue growth in Nigeria.

VAR modeling is regarded as appropriate for the estimation if it does not exhibit significant autocorrelation and heteroscedastic effects which can be captured by the nonlinear multivariate GARCH family models. Furthermore, it is very well known that volatility is one of the properties of financial time series associated with risk (Kogan et al 2009; Leal and Napoletano, 2019) which is indicated by the sum of the two parameters in GARCH models. It was debated that financial volatility is in two stages; high and low, a common feature of these models seems to be switching between low and high activity regimes with heavy-tailed durations of regimes which might be due to certain factors which GARCH models alone cannot capture (Lamoureux and Lastrapes, 1990; Fulvio et al., 2005) and the results may be misleading (Polzehl and Spokoiny, 2006). This study tends to develop and evaluate a

pioneering multivariate GARCH family model that will take into consideration the volatility stages in financial time series. Among the conservative ways of measuring risk connected with the behavior of financial time series are done thorough studies of the variance (McNeil and Frey, 2000; Malakhov and Simon, 2018). Meanwhile, very few financial kinds of literature emphasize resolving both challenges, heteroscedasticity, and persistence in volatility. Thus, in this study, these two challenges will be tackled utilizing financial (tax revenue) data series The standard time-homogeneous discrete HMMs has been used by researchers for volatility levels classification but these models (HMM) suffer from limited dynamic expressiveness due to their finite number of states, which affect their performances in classifying the volatility levels.

Autoregressive Hidden Markov Models (ARHMMs) are an extension of the standard discrete HMMs that is another HMM family models have been developed with the goal of improving the performance of classification levels. The hybrid models were proven to be a better model and give higher accuracy compared to conventional single models in modeling applications. However, the combination of the VAR, ARHMM and GARCH family model will be interesting and effective in classifying the volatility levels.

1.4 Research Questions

Hence, our focal research questions are hereby summarized as follows:

1. Do autocorrelation and heteroscedasticity affect the behaviour and characteristics of the financial time series (tax revenue) data?

2. Can the benchmark models VAR treat the autocorrelation and heteroscedasticity incorporating GARCH family models?

3. Does the proposed model reduce the volatility persistency in the residual of financial tax revenue variables?

4. Does the proposed model capable of improving the tax revenue forecasting?

1.5 Research Objectives

This study is aimed at modelling tax revenue using the proposed model, with the following objectives:

1. To identify the tax revenue series data structure, behaviour, and characteristics of federal inland revenue service (FIRS) of Nigeria.

2. To model the correlation and heteroscedasticity residual time series utilizing the multivariate model.

3. To propose a model ARHMM-based-VAR model to reduce the identified persistent volatility in the residual.

4. To evaluate the performance of the proposed model in (iii) through simulation.

1.6 Significance of the Study

Choosing the best model is very significant in modeling the multivariable (tax revenue) data since it can assist the tax authorities in the decision-making process on tax administration management for future planning and development. Moreover, tax revenue modeling from the optimal measuring model will give a factual insight into the long-term running plan. Consequently, the anticipated computation is designed for future economic growth and development. Hence, this thesis will contribute to the financial time series in numerous ways as explained below. This study designs a hybrid model of VAR and functional generalized autoregression conditional heteroscedasticity GARCH family model, that is, the VAR-GARCH family model.

Although the multivariable tax revenue data can perform better with the application of the linear model, the presence of heteroscedasticity must be checked to reconfirm the adequacy of the model constructed. The existence of this effect indicates that the linear model is not appropriate to fit the data behavior. Plus, the heteroscedasticity effect is a major concern in regression analysis as its presence can invalidate the statistical test of significance. Therefore, this research highlights the handling of heteroscedasticity (leverage effect). Moreover, this study introduces the HMM model using the expectation-maximization (EM) algorithm to the base of the VAR model by separating the volatility into two levels. The proposed approach offers a valuable way of modeling the relationship between the conditional mean and variance of a process that exhibits strong persistence in its level while considering the time-varying volatility.

1.7 Scope of the Study

The covering scope of data for this study were obtained from Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS) for 456 (four hundred and fifty-six) months spanning from 1981 to 2018 other includes (i) descriptive analysis of tax revenue data series in identifying the design and features of the tax revenue variables (ii) modeling the linear behaviour of tax revenue data stationarity and structural changes (iii) Incorporate VAR with GARCH family models to enhance the understanding the persistent volatility of tax revenue data, (iv) propose probabilistic technique with hidden states model for volatility persistency reduction, (v) use the proposed hybrid model performance and compare with other models, and (vi) And lastly run the simulation analysis.

1.8 Thesis Organization

The organization of this study begins with Chapter one presenting the introduction to the study. Sequentially, Chapter two presents the reviews of the related kinds of literature, and Chapter three discusses the development of the theoretical method utilized in the study. Chapter 4 investigates the analysis and findings of the study. It deals with the main features of tax revenue variables, the mean and variance model, the terse but limitations of the preceding model. The model's performance and use of the proposed model for simulation analysis are in Chapter 5. Finally, Chapter 6 draws out the conclusion of this study and recommends future research works.

REFERENCES

Adammer, P., Bohl, M. T., & Ledebur, E.-O. von. (2016). Dynamics Between North American And European Agricultural Futures Prices During Turmoil And Financialization. *Bulletin of Economic Research.*

Adenomon, M. O., & Oyejola, B. A. (2015). Forecasting Meteorological Time Series Data with a Reduced Form Vector Autoregressive (VAR) Model and Three Univariate Time Series Techniques: A Comparative Study. *Social and Basic Science Research Review,* 2(3), 139-152.

Adediran, O. S., Oluwatoyin, M. A., and, B. O. C., & Folasade, A. B. (2017). Monetary Policy Shocks and Inclusive Growth in Nigeria A VAR Approach. *The International Journal Of Humanities & Social Studies, 5*(2), 173-179.

Ado, A. B. A., & Goni, K. (2018). DeterminantsofTaxEvasioninNigeria. *International Journal of Advanced Studies in Social Science & Innovation (IJASSI), 2*(3). doi:10.30690/ijassi.23.01

Afolabi, A. (2010). The Colonial Taxation Policy among Yoruba of Southwestern Nigeria and its Implications for Socio-Economic Development. *Journal of the Historical Society of Nigeria, 19,* 63-92.

Al-Mejren, A. (2015). Impacts of Fiscal Legal Setting and Institutions on Budget Outcomes in the Rentier State of Kuwait. In Economic Research Forum Working Paper (No. 920)..

Alamro Rawan, Andrew McCarren, and Amal Al-Rasheed (2019) Predicting Saudi Stock Market Index by Incorporating GDELT Using Multivariate Time Series Modelling ICC 2019, CCIS 1097, pp. 317–328, 2019. https://doi.org/10.1007/978-3-030-36365-9_26

Alani, E, Olusegun, Efuntade, O. Omotayo & Akinwumi, O. Akinola, (2020) Tax Revenue and Its Effect on Government Expenditure in Nigeria, The International Journal of Business & Management ISSN 2321–8916, pp 279-287 Vol 8 Issue 9 DOI No.: 10.24940/theijbm/2020/v8/i9/BM2009-077 www.theijbm.com

Alexander, C. (2001), "Orthogonal GARCH", Chapter 2 (pp. 21–28) in C. Alexander (Ed.), Mastering Risk. London: Financial Times-Prentice Hall

Alexander, S. (2001), "E-learning developments and experiences", Education + Training, Vol. 43 No. 4/5, pp. 240-248. https://doi.org/10.1108/00400910110399247

Alexander J. McNeil and Rudiger Frey (2006) Estimation of tail-related risk measures for heteroscedastic financial time series: an extreme value approach *Journal of Empirical Finance* 7 2000 271–300 Ž . www. Elsevier. comrlocatereconbase

Akaike, H. (1974). "A new look at the statistical model identification." IEEE Transactions on Automatic Control, 19(6), 716-723.http://doi.org/10.1109/TAC.1974.1100705

Andersen, T.G. and T. Bollerslev Answering the Skeptics: Yes, Standard Volatility Models Do Provide Accurate Forecasts. Inter. Econ. Review, 39, 885-905, 1998.

Andersen Torben. G, Richard A. Davis, Kreib. Jens-Peter and Mikosch Thomas., (2009) Handbook of Financial Time Series DOI: 10.1007/978-3-540-71297-8_0, © Springer-Verlag Berlin Heidelberg 200

Andrén L. & Å Andreasson & R. Eggertsen (2007) Interaction between a commercially available St. John's wort product (Moving) and atorvastatin in patients with hypercholesterolemia Eur J Clin Pharmacol (2007) 63:913–916 DOI 10.1007/s00228-007-0345-x

Antonakakis, N., and Filis, G. (2013). Oil prices and stock market correlation: a time-varying approach. International Journal of Energy and Statistics, 1 (1), 17-29.

Apergis, N., Miller, S. M. (2009). Do structural oil-market shocks affect stock prices? Energy Economics, 31(4), 569-575.

Araneda, A. A. (2021). Asset volatility forecasting: The optimal decay parameter in the EWMA model. *arXiv preprint arXiv:2105.14382*.

Arin Meral J., MD, Jens Ba¨te, MD, Thomas Krieg, MD, and Nicolas Hunzelmann, Silicone granuloma of the face treated with minocycline American Academy of Dermatology, Inc. doi:10.1016/j.jaad.2004.07.014

Arora, S. (2018). Monetary versus fiscal policy in India: an SVAR analysis. *Macroeconomics and Finance in Emerging Market Economies*, *11*(3), 250-274.

Arouri, M., Nguyen, D.K. (2010), Oil prices, stock markets, and portfolio investment: Evidence from sector analysis in Europe over the last decade. Energy Policy, 38, 4528-4539.

Asai, Manabu; McAleer, Michael; and YU, Jun. Multivariate stochastic volatility: A review. (2006). Econometric Reviews. 25, (2/3), 145-175. Research Collection School of Economics.

Ashwani, K., Kapil, K., Naresh, K., Satyawati, S., & Saroj, M. (2010). Renewable energy in India: Current status and future potentials. *Renewable and Sustainable Energy Reviews, 14*, 2434–2442

Atoi, N. V. (2014) "Testing volatility in Nigeria stock market using GARCH models". CBN Journal of Applied Statistics, 5: 65-93.

Aue A, Horváth L, Pellatt DF. 2017. Functional generalized autoregressive conditional heteroscedasticity. Journal of Time Series Analysis 38: 3–21.

Auerbach A., Gorodnichenko Y. (2012) Measuring the output responses to fiscal policy Am. Econ. J. Econ. Policy, 4 (2) (2012), pp. 1-27

Ayele, A. W., Gabreyohannes, E., & Tesfay, Y. Y. (2017). Macroeconomic determinants of volatility for the gold price in Ethiopia: the application of GARCH and EWMA volatility models. *Global Business Review*, *18*(2), 308-326.

Ayertey, S. (2018). *An evaluation of online service failures and recovery strategies in the UK fashion industry* (Doctoral dissertation, University of Plymouth).

Bach., S., Beznoska, M.A., & Steiner, V. (2014). A Wealth Tax on the Rich to Bring Down Public Debt? Revenue and Distributional Effects of a Capital Levy in Germany. *FISCAL STUDIES*, *35*(1), 67-89.

Badi, B. H., Bernard, F.A., & Alain, P. (2014). Estimating and Forecasting with a Dynamic Spatial Panel Data Model*. *Oxford Bulletin of Economics and Statistics*, *76*(1), 112-138. doi:10.1111/obes.12011

Bae, K. H., Karolyi, G. A., & Stulz, R. M. (2003). A new approach to measuring financial contagion. *The Review of Financial Studies*, *16*(3), 717-763.

Bala, D. A., & Takimoto, T. (2017). Stock markets volatility spillovers during financial crises: A DCC-MGARCH with skewed-t density approach. *Borsa Istanbul Review*, *17*(1), 25-48.

Balasubramanian, V. Equivalence and reduction of hidden Markov models [Ph.D. thesis], Massachusetts Institute of Technology, 1993.

Balcilar, M., Gupta, R., Wohar, M. E. (Forthcoming). Common cycles and common trends in the stock and oil markets: Evidence from more than 150 years of data. Energy Economics.

Bauwens, L., Laurent, S., Rombouts, J. V. K. (2006). Multivariate GARCH: a survey. Journal of Applied Econometrics 21:79–109.

Bauwens Luc, Christian Hafter and Sébastien Laurent. (2006). Volatility models Discussion Paper Centre for Operations Research and Econometrics

Baumeister, C., Peersman, G., and van Robays, I. (2010). The Economic Consequences of Oil Shocks: Differences across Countries and Time. In Fry, R., Jones, C., and Kent, C. (eds.), Inflation in an Era of Relative Price Shocks, Sydney, 91-128.

Baum, Leonard E., Ted Petrie, George Soules, and Norman Weiss. 1970. A maximization technique occurring in the statistical analysis of probabilistic functions of Markov chains. The Annals of Mathematical Statistics 41: 164–71.

Baumeister, C., and Peersman, G. (2013). Time-varying effects of oil supply shock on the US economy, American Economic Journal: Macroeconomics, 5(4), 1-28.

Baumeister, C., and Kilian, L. (2014). What Central Bankers Need to Know about Forecasting Oil Prices, International Economic Review, 55(3), 869-889.

Baumeister, C., and Kilian, L. (2015a). Forecasting the Real Price of Oil in a Changing World: A Forecast Combination Approach, Journal of Business and Economic Statistics, 33(3), 338-351.

Baumeister, C., Kilian, L. (2015b). 40 years of oil price fluctuations: why the price of oil may still surprise us, Mimeo, University of Notre Dame.

Baumeister, C., Kilian, L., and Lee, T.K. (2015). Are There Gains from Pooling Real-Time Oil Price Forecasts? Energy Economics, 46, S33-S43.

Bauwens Luc, Sebastien Laurent and Jeroen V. K. Rombouts (2006) Multivariate GARCH Models: A Survey Journal of Applied Econometrics J. Appl. Econ. 21: 79–109 (2006) Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/Jae.842

Bekiros, S. (2014). Nonlinear causality testing with stepwise multivariate filtering: Evidence from stock and currency markets. *The North American Journal of Economics and Finance,* 29(303854), 336-348. http://doi.org/10.1016/j.najef.2014.06.005

Blanchard, O., & Perotti, R. (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. The Quarterly Journal of Economics, 117(4), 1329–1368. doi:10.1162/003355302320935043

Bollerslev, T. (1990). Modelling the Coherence in Short-Run Nominal Exchange Rates : A Multivariate Generalized Arch Model. The Review o f Economics and Statistics, 72(3), 498-505.

Bollerslev, T., Engle, R. F., & Wooldridge, J. M. (1988). A Capital Asset Pricing Model with Time-Varying Covariances. Journal o f Political Economy, 96(1), 116-131. http://doi.org/https://doi.org/10.1086/261527

Bollerslev, T., Engle, R. F., & Nelson, D. B. (1994). ARCH models. *Handbook of econometrics*, *4*, 2959-3038.

Bollerslev, T. Generalized Autoregressive Conditional Heteroscedasticity. J. Econometrics, 31, 307-327, 1994.

Bouri, E., Das, M., Gupta, R., & Roubaud, D. (2018). Spillovers between Bitcoin and other assets during bear and bull markets. Applied Economics, 1–15. doi:10.1080/00036846.2018.1488075

Boussama, F., Fuchs, F., & Stelzer, R. (2011). Stationarity and geometric ergodicity of BEKK multivariate GARCH models. *Stochastic Processes and Their Applications***,** 121(10), 2331-2360. http://doi.org/10.1016/j.spa.2011.06.001

Brockwell, P. J., and R. A. Davis, Time Series: Theory and Methods, 2nd ed. (New York: Springer-Verlag, 2002).

Box, G.E.P., Jenkins, 1976. Time-series analysis Forecasting and control, 2nd ed. Holden-Day. San.

Box-Steffensmeier, J. M., Brady, H. E., & Collier, D. (2008). *The Oxford handbook of political methodology* (Vol. 10). Oxford Handbooks of Political.

Bulla, J., Lagona, F., Maruotti, A., & Picone, M. (2012). A Multivariate Hidden Markov Model for the Identification of Sea Regimes from Incomplete Skewed and Circular Time Series. Journal o f Agricultural, Biological, and Environmental Statistics, 17(4), 544-567. http://doi.org/10.1007/s13253-012-0110-1

Burnside, C., Eichenbaum, M., & Fisher, J. D. (2004). Fiscal shocks and their consequences. *Journal of Economic theory*, *115*(1), 89-117.

Cai, Y. (2011). Multi-variate time-series simulation. Journal o f Time Series Analysis, 32(February), 566-579. http://doi.org/10.1111/j.1467-9892.2010.00715.x

Cai, J. A Markov Model of Unconditional Variance in ARCH. J. Bus Econ. Statist., 12, 309-316, 1994.

Campbell, J.Y., (2008) Viewpoint: estimating the equity premium, Canadian Journal of Economics, 41, 1–21.

Campbell Sean D. and Diebold Francis X. (2005) Stock Returns and Expected Business Conditions: Half A Century of Direct Evidence Working Paper 11736 http://www.nber.org/papers/w11736

Caporin, M., & McAleer, M. (2006). Dynamic asymmetric GARCH. *Journal of Financial Econometrics*, *4*(3), 385-412.

Caporin, M., & Preś, J. (2012). Modeling and forecasting wind speed intensity for weather risk management. *Computational Statistics & Data Analysis*, *56*(11), 3459-3476.

Caproni M, McAleer M. 2006. Dynamic asymmetric GARCH. Journal of Financial Econometrics 4: 385–412.

Cartella, S. T. Liu, S. (2012) Meganck, J. Lemeire, and. Sahli, "Online adaptive learning of left-right continuous HMM for bearings condition assessment," *Journal of Physics: Conference Series*, vol. 364, Article ID 012031, 2012, http://iopscience.iop.org/1742-6596/364/1/012031.

Cerovecki, C., Francq, C., Hörmann, S., & Zakoian, J. M. (2019). Functional GARCH models: the quasi-likelihood approach and its applications. *Journal of econometrics*, *209*(2), 353-375.

Chai, T., & Draxler, R. R. (2014). Root mean square error (RMSE) or mean absolute error (MAE)? - Arguments against avoiding RMSE in the literature. Geoscientific Model Development, 7(3), 1247-1250. http://doi .org/10.5194/gmd-7-1247-2014

Chen, S. K., Lin, B. X., Wang, Y., & Wu, L. (2010). The frequency and magnitude of earnings management: Time-series and multi-threshold comparisons. *International Review of Economics & Finance*, *19*(4), 671-685.

Chen Kevin G, Julio C. Valencia, Jean-Pierre Gillet, Vincent J. Hearing and Michael M. Gottesman (2009) Involvement of ABC transporters in melanogenesis and the development of multidrug resistance of melanoma. Pigment Cell Melanoma Res. 22; 740–749

Chepngetich M, and John Kihoro. (2015) Application of Vector Autoregressive (VAR) Process in Modelling Reshaped Seasonal Univariate Time Series. Science Journal of Applied Mathematics and Statistics. Vol. 3, No. 3, 2015, pp. 124-135. doi: 10.11648/j.sjams.20150303.15

Chiang, Y. M., & Feng, S. J. (2008). On the Nevanlinna characteristic of f (z+η) and difference equations in the complex plane. *The Ramanujan Journal*, *16*(1), 105-129.

Chien, J.-T. and C.-H. Huang, (2003) "Bayesian learning of speech duration models," *IEEE Transactions on Speech and Audio Processing*, vol. 11, no. 6, pp. 558–567, 2003.

Chowdhury., U. N., Chakravarty, S. K., and, & Hossain, N. T. (2018). Short-Term Financial Time Series Forecasting Integrating Principal Component Analysis and Independent Component Analysis with Support Vector Regression. *Journal of Computer and Communications*, *06*(03), 51-67. doi:10.4236/jcc.2018.63004

Chung, S. L., Hung, C. H., & Yeh, C. Y. (2012). When does investor sentiment predict stock returns?. *Journal of Empirical Finance*, *19*(2), 217-240.

Clarida, r. H. & Friedman, b. M. (1984). The behavior of us Short-term interest rates since October 1979. The Journal of Finance, 39(3), 671-682.

Clark, P. B.A., & Wilson, J. Q. (1961). Incentive Systems A Theory of Organizations. *Sage Publications, Inc. Stable URL: http://www.jstor.org/stable/4354966*, *6*(2), 129-166.

Collie, M. J., Dowe, D. L., & Fitzgibbon, L. J. (2005, November). Stock market simulation and inference technique. In *Fifth International Conference on Hybrid Intelligent Systems (HIS'05)* (pp. 5-pp). IEEE.

Cyril, C. (2017). Forecasting Tax Revenue and its Volatility in Tanzania. *African Journal of Economic Review, 5*(1), 84-109.

Dabral, P. P., & Murry, M. Z. (2017). Modelling and forecasting of rainfall time series using SARIMA. *Environmental Processes*, *4*(2), 399-419.

Da Silva, L. M., Alvarez, G. B., da Silva Christo, E., da Silva Garcia, V., & Sierra, G. A. P. Time series forecasting using ARIMA for modeling of glioma growth in response to radiotherapy Previsão com séries temporais usando ARIMA para modelagem de crescimento de glioma em resposta à radioterapia.

Dave, D.A., & Adam, S. (2016). The View from Above: Applications of Satellite Data in Economics. *Journal of Economic Perspectives, 30*(4), 171-198. doi:10.1257/jep.30.4.171

De Luca, G. & Loperfido, N. (2012) "Modeling multivariate skewness in financial returns: an SGARCH approach". The European Journal of Finance, 1 -19 first. http://dx.doi.org/10.1080/1351847X.2011.640342

Deming, D. J.A., & Walters, C. R. (2018). The Impact of State Budget Cuts on US Postsecondary Attainment. *scholar.harvard.edu*.

Desai, M. A.A., & Hines Jr, J. R. (2004). Old rules and new realities Corporate tax policy in a global setting. *Working Paper Series, 920*.

Di J, Gangopadhyay A. 2015. A data-dependent approach to modeling volatility in financial time series. Sankhya B 77: 1–26.

Ding, Z. (1994), Time Series Analysis of Speculative Returns. PhD Dissertation, University of California at San Diego

Du, L; M. Chen, J. Lucas, and L. Carin, (2010) "Sticky hidden Markov modeling of comparative genomic hybridization," IEEE Transactions on Signal Processing, vol. 58, no. 10, pp. 5353–5368, 2010.

Duan, J. C., Gauthier, G., Simonato, J. G. & Sasseville, C. (2006). "Approximating the GJR-GARCH and EGARCH option pricing models analytically". Journal of Computational Finance, 9 (3) 1 -29.

Dueker, M. J. (2005). Dynamic forecasts of qualitative variables: a Qual VAR model of US recessions, Journal of Business and Economic Statistics, 23, 96–104.

Dueker, M., and Assenmacher-Wesche, K. (2010). Forecasting macro variables with a Qual VAR business cycle turning point index, Applied Economics, 42, 2909–2920

Eja, B. R., Idaka, S. E., & John, O.-A. (2018). Inhibiting factors to tax revenue generation in Cross River State, Nigeria. *Global Journal of Social Sciences, 17*(1), 11. doi:10.4314/gjss.v17i1.2

El Hedi Arouri, M., Lahiani, A., & Nguyen, D. K. (2015). World gold prices and stock returns in China: Insights for hedging and diversification strategies. *Economic Modelling, 44*, 273-282. http://doi.org/10.1016/j.econmod.2014.10.030

Elliott, R. J., Hunter, W. C., & Jamieson, B. M. (1998). Drift and Volatility Estimation in Discrete Time. *Journal of Economic Dynamics and Control*, 22(2), 209-218.

Emmanuel, I. (2017). Tax revenue and economic growth of nigeria (1981-2015). *Thesis*, 1-119.

Engle, R. (2002). Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models. ***Journal of Business & Economic Statistics,*** 20(3), 339-350.http://doi.org/10.1198/073500102288618487

Engle, R.F., Gallo, G.M. and Velucchi, M. (2012), "Volatility spillovers in East Asian financial markets: a MEM-based approach", Review of Economics and Statistics, Vol. 94 No. 1, pp. 222-223.

Engle, R.F., Granger, C.W.J., (1987), "Co-Integration and Error Correction: Representation, Estimation, and Testing", Econometrica, 55 (2), 251-276.

Engle RF. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of U.K. inflation. Econometrica 50: 987–1008.

Engle, R. F., Granger, C. W. J., & Kraft, D. (1984). Combining competing forecasts of inflation using a bivariate ARCH model. *Journal o f Economic Dynamics andControl1*, 8(2), 151-165. http://doi.org/https://1889(84)90031-9

Engle RF. (1990). Discussion: stock market volatility and the crash of 87. Review of Financial Studies 3: 103–106.

Engle RF, Ng VK. 1993. Measuring and testing the impact of news on volatility. The Journal of Finance 48: 1749–1778.

Engle, R.F., Lilien, D.M., Robins, R.P., 1987. Estimating time-varying risk premia in the term structure: the ARCH-M Model. Econometrica 55 Ž2., 391407

Engle Robert F, Olivier Ledoit & Michael Wolf f (2017): Large Dynamic Covariance Matrices, Journal of Business & Economic Statistics, DOI: 10.1080/07350015.2017.1345683

Erdogan, O., Bennett, P., Ozyildirim, C. (2015). Recession Prediction Using Yield Curve and Stock Market Liquidity Deviation Measures, Review of Finance, 19(1), 407-422.

Fan, J., Wang, M., & Yao, Q. (2008). Modelling multivariate volatilities via conditionally uncorrelated components. *Journal of the Royal Statistical Society: series B (statistical methodology)*, *70*(4), 679-702.

Fasanya, I. O., Adegbemi, B. O., and, & Mariam, A. A. (2014). <Does Monetary Policy Influences Economic.pdf>. *African Economic and Business Review Vol. 12, No. 1, Spring 2014.*, *12*(1).

Fatas, A & Mihov, I. “The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence.” Humboldt University Berlin. CEPR Discussion Paper No. 2760

Faust Jon (1998) The Robustness of Identified VAR Conclusions About Money *International Finance Discussion Papers* Number 610 April 1998

Fengwei, W., Yiyong, L., Qicai, C., Yunqi, Z.A., & Shijian, Z. (2016). <22 Study on methods for improving LMD end effect by Gaussian Process based on the particle swarm optimization algorithm. *International Conference on Mechanics, Materials, and Structural Engineering (ICMMSE 2016)*, 414-455.

Ferguson, J. (1980). pp. 143–179, Variable duration models for speech. In *Proc. of the Symposium on the applications of hidden Markov models to text and speech, JD Ferguson, Ed. Princeton: IDA-CRD*..

Figlewski, S (1997) Forecasting Volatility. Financial Markets, Institutions, and Instruments, 6, 1-88, 1997.

Fiorentini, G., Sentana, E., and Calzolari, G. Maximum likelihood estimation and inference in multivariate conditionally heteroscedastic dynamic regression models with Student t innovations. Journal of Business and Economic Statistics, 21(4):532–546, 2003

Fiorentino, M., Gioia, a., Iacobellis, V., & Manfreda, S. (2006). Analysis on floodgeneration processes by means of a continuous simulation model. *Advances in Geosciences*, 7(August 2016), 231-236. http://doi.org/10.5194/adgeo-7-231-2016

Fox, E. B., Sudderth, E. B., Jordan, M. I., & Willsky, A. S. (2008). An HDP-HMM for systems with state persistence. In *Proceedings of the 25th international conference on Machine learning* (pp. 312-319).Francq C, Zakoïan J-M. 2010. GARCH Models: Structure, Statistical Inference, and Financial Applications. Chichester, UK: Wiley.

Franz, J., & Röben, F. (2020, September). Market Response for Real-Time Energy Balancing: Simulation using Field Test Data. In *2020 17th International Conference on the European Energy Market (EEM)* (pp. 1-5). IEEE.

Frezza, M., Bianchi, S., & Pianese, A. (2021). Forecasting Value-at-Risk in turbulent stock markets via the local regularity of the price process. *Computational Management Science*, 1-34.

Frénay, B., de Lannoy, G., & Verleysen, M. (2011). Label noise-tolerant hidden Markov models for segmentation: application to ECGs. In *Joint European Conference on Machine Learning and Knowledge Discovery in Databases* (pp. 455-470). Springer, Berlin, Heidelberg..

Fulvio Corsi, Stefan Mittnik, Christian Pigorsch & Uta Pigorsch (2008) The Volatility of Realized Volatility, *Econometric Reviews* 27:1-3, 46-78 http://dx.doi.org/10.1080/07474930701853616

Fulvio, J. M., Singh, M., & Maloney, L. T. (2005). Combining achromatic and chromatic cues to transparency. *Journal of Vision*, *5*(8), 566-566.

Fulvio Corsi & Roberto Renò (2012) Discrete-Time Volatility Forecasting With Persistent leverage Effect and the Link With Continuous-Time Volatility Modeling, Journal of Business & Economic Statistics, 30:3, 368-380, DOI: 10.1080/07350015.2012.663261

Gales, M. J. (2000). Cluster adaptive training of hidden Markov models. *IEEE transactions on speech and audio processing*, *8*(4), 417-428.Gasparrini, A., Armstrong, B., & Kenward, M. G. (2010). Distributed lag non-linear models. *Statistics in medicine*, *29*(21), 2224-2234.

Gasparrini, A., Armstrong, B., & Kenward, M. G. (2010). Distributed lag non-linear models. Statistics in medicine, 29(21), 2224-2234.

Gelgi, F., & Davulcu, H. (2007). Baum-welch style em approach on simple bayesian models forweb data annotation. In *IEEE/WIC/ACM International Conference on Web Intelligence (WI'07)* (pp. 736-742). IEEE..

Girardin, E., Joyeux, R., & Shi, S. (2018). Stock Market Bubble Migration: From Shanghai to Hong Kong. Uncertainty, Expectations, and Asset Price Dynamics, 173–192. doi:10.1007/978-3-319-98714-9_8

Goebel, R., Roebroeck, A., Kim, D. S., & Formisano, E. (2003). Investigating directed cortical interactions in time-resolved fMRI data using vector autoregressive modeling and Granger causality mapping. *Magnetic resonance imaging*, *21*(10), 1251-1261.Gonzalez-Rivera G. 1998. Smooth transition GARCH models. Studies in Nonlinear Dynamics and Econometrics 3: 61–78.

Gorodnichenko Yuriy and Alan J. Auerbach (2012) Fiscal Multipliers in Recession and Expansion Published by University of Chicago Press Vol 11 No 1 ISBN: 0-226-01844-X, 978-0-226-01844-7

Granger C. W. J. Investigating causal relations by econometric models and cross-spectral methods Econometrica Vol. 37, No. 3 (Aug. 1969), Published By: The Econometric Society https://doi.org/10.2307/1912791 https://www.jstor.org/stable/1912791

Grek, Å. (2014). Forecasting accuracy for ARCH models and GARCH (1, 1) family: Which model does best capture the volatility of the Swedish stock market?..

Gupta, R., Olson, E., and Wohar, M.E., (2017). Forecasting Key US Macroeconomic Variables with a Factor-Augmented Qual VAR. Journal of Forecasting.

Gupta, Aditya, and Dhingra Bhuwan. 2012. Stock market prediction using Hidden Markov models. Paper presented at Proceedings of the Student Conference on Engg and Systems (SCES), Allahabad, Uttar Pradesh, India, March 16–18, pp. 1–4.

Halkos, G. E., & Tsirivis, A. S. (2019). Effective energy commodity risk management: Econometric modeling of price volatility. *Economic Analysis and Policy*, *63*, 234-250.

Hamilton, J.D. Time series analysis. Princeton University Press, 1994.

Hamilton, J. D. (1983). Oil and the macroeconomy since World War II, Journal of Political Economy, 91, 228–248.

Hamilton, J. D. (2008). Oil and the macroeconomy. In New Palgrave Dictionary of Economics, 2nd edition, edited by Steven Durlauf and Lawrence Blume, Palgrave McMillan Ltd.

Hamilton, J. D. (2009). Causes and consequences of the oil shock of 2007-08, Brookings Papers on Economic Activity, Spring, 215–259.

Hamilton, J. D. (2011). Historical oil shocks. National Bureau of Economic Research, Working Paper No. w16790.

Hammoudeh, S., Sari, R., Ewing, B.T. (2008), Relationships among strategic commodities and with financial variable A new look. Contemporary Economic Policy, 27(2), 251-264.

Hamilton, James D. 1989. A New Approach to the Economic Analysis of Nonstationary Time Series and Business Cycle. Econometrica 57: 357–84.

Han, Q., Meng, F., Hu, T., & Chu, F. (2017). Non-parametric hybrid models for wind speed forecasting. *Energy Conversion and Management, 148,* 554-568. http://doi.org/10.1016/j.enconman.2017.06.021

Han, T., Peng, Q., Zhu, Z., Shen, Y., Huang, H., & Abid, N. N. (2020). A pattern representation of stock time series based on DTW. *Physica A: Statistical Mechanics and its Applications*, *550*, 124161.Hannan, Edward J., and Barry G. Quinn. 1979. The determination of the order of an autoregression. Journal of the Royal Statistical Society. Series B (Methodological) 41: 190–95.

Hansson, B., & Hordahl, P. (1998). Testing the conditional CAPM using multivariate GARCH-M. *Applied Financial Economics*, *8*(4), 377-388.

Hassan, B. (2015). The Role of Value Added Tax (VAT) in the Economic Growth of PAKISTAN. *Journal of Economics and Sustainable Development, 6*(3), 174-185.

Haug S, Czado C. 2007. An exponential continuous-time GARCH process. Journal of Applied Probability 44: 960–976.

Herbert, W. E. (2018). Tax Reforms and Nigeria's Economic Stability. *International Journal of Applied Economics, Finance, and Accounting, 3*(2), 74-87. doi:10.33094/8.2018.32.74.87

Higgins, M. L. & Bera, A. (1992) "A class of Nonlinear ARCH Models". International Economic Review, 33 (1): 137 -158

Hormann, S., Horv ¨ ath, L. and Reeder, R. (2013). A functional version of the ARCH model. ´ Econometric Theory 29, 267–288.

Hsu, L. C., & Wang, C. H. (2009). Forecasting integrated circuit output using multivariate grey model and grey relational analysis. *Expert systems with applications*, *36*(2), 1403-1409..

Hsu, D. S. M. Kakade, and T. Zhang, "A spectral algorithm for learning hidden Markov models," Journal of Computer and System Sciences, vol. 78, no. 5, pp. 1460–1480, 2012.

Hwang SY, Yoon JE. 2018. Volatility for high-frequency time series toward fGARCH (1,1) as a functional model. Quantitative Bio-Science 37: 73–79.

Hyvärinen A, J. Karhunen, E. Oja (2001) independent component analysis John Wiley& Sons, New York (2001)

Ifere., Eugene Okoi, E.A., & Omini, E. E. (2014). Tax-Innovation-Administration-and-Revenue-Generation-in-Nigeria-Case-of-Cross-River-State. *International Science Index, Economics and Management Engineering, 8*(5).

Iqelan, B. M. (2015). Time Series Modeling of Monthly Temperature Data of Jerusalem / Palestine. *MATEMATIKA***,** 31(2), 159-176.

Jadhav, S., He, H.A., & Jenkins, K. (2017). Applications_of_Data_Mining_Techniques_in_Finance_Industry-. *International Journal of Soft Computing and Artificial Intelligence, 4*(1), 79-96.

Jeantheau, T. (1998). Strong consistency of estimators for multivariate ARCH models. *Econometric theory*, *14*(1), 70-86.

Jebran, K., Chen, S., Ullah, I. and Mirza, S.S. (2017), "Does volatility spillover among stock markets varies from normal to turbulent periods? Evidence from emerging markets of Asia", The Journal of Finance and Data Science, Vol. 3 Nos 1/4, pp. 20-30.

Jian, W., Guangdong, W., Qing, Z.A., & Mi, L. (2014). Spatial Variation of Regional Sustainable Development and its Relationship to the Allocation of Science and Technology Resources. *Sustainability, 6*(9), 6400-6417. doi:10.3390/su6096400

Jiang Kaifeng, David P. Lepak, Jia Hu, Judith C. Baer (2012) How does human resource management influence organizational outcomes? A meta-analytic investigation of mediating mechanisms. Academy of Management Journal 2012, Vol. 55, No. 6, 1264–1294. http://dx.doi.org/10.5465/amj.2011.0088

Jigar, P., Sahil, S., Priyank, T.A., & Kotecha, L. (2015). Predicting stock and stock price index movement using Trend Deterministic Data Preparation and machine learning techniques. *Expert Systems with Applications*, *42*(1), 259-268. doi:10.1016/j.eswa.2014.07.040

Joao F. Gomes Leonid Kogan and Motohiro Yogo (2007) Durability Of Output And Expected Stock Returns *Working Paper* 12986 http://www.nber.org/papers/w12986

Johnson, M. T. (2005). Capacity and complexity of HMM duration modeling techniques. *IEEE signal processing letters*, *12*(5), 407-410.Juselius, K. (2007). *Cointegration Analysis o f Climate Change : An Exposit**on.***

Kalliovirta L, Meitz M, Saikkonen P (2012) A Gaussian mixture autoregressive model for univariate time series. HECER Discussion Paper 352 1795–0562.

Kang, W., Ratti, R.A., Yoon, K.H., (Forthcoming). Time-Varying Effect of Oil Market Shocks on the Stock Market, Journal of Banking and Finance.

Kayode, S. A., & Kadiri, K. O. (2019). Boosting of Internally Generated Revenue (IGR) of Nigeria through Enforcement of Adequate Tax Payment by Cooperate

Citizens and Organizations. *Journal of Economics, Management, and Trade*, 1-9. doi:10.9734/jemt/2019/v23i530141

Kelkay, B. D. & and G/Yohannes, E. (2014) "The Application of Garch Family Models to Some Agricultural Crop Products in Amhara National Regional State". Journal of Economics and Sustainable Development, 5: 24-35.

Khan, S. A. R., Yu, Z., Belhadi, A., & Mardani, A. (2020). Investigating the effects of renewable energy on international trade and environmental quality. *Journal of Environmental Management, 272*, 111089.

Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market, American Economic Review, 99(3), 1053-1069.

Kilian, L., Park, C. (2009). The impact of oil price shocks on our stock market, International Economic Review, 50(4), 1267-1287.

Kilian, L., Vigfusson, R. J. (2011). Nonlinearities in the oil price-output relationship, Macroeconomic Dynamics, 15(S3), 337-363.

Kilian, L., Vigfusson, R. J. (2013). Do oil prices help forecast our real GDP? The role of nonlinearities and asymmetries, Journal of Business & Economic Statistics, 31(1), 78-93.

Kim, B.H., Kim, H. and Lee, B.S. (2015), "Spillover Effects of the US financial crisis on financial markets in emerging Asian countries", International Review of Economics and Finance, Vol. 39, pp. 192-210

Kissling, W. D., Dormann, C. F., Groeneveld, J., Hickler, T., Kühn, I., McInerny, G. J., ... & O'Hara, R. B. (2012). Towards novel approaches to modeling biotic interactions in multispecies assemblages at large spatial extents. *Journal of Biogeography*, *39*(12), 2163-2178.

Kithure., M. E., Waititu., A.A., & Wanjoya., A. (2019). Modeling and Forecasting Volatility of Value Added Tax Revenue in Kenya. *Science Journal of Applied Mathematics and Statistics, 7*(1), 1-7. doi:10.11648/j.sjams.20190701.11

Kobayashi, K., & Inaba, M. (2006). Business cycle accounting for the Japanese economy. *Japan and the World Economy*, *18*(4), 418-440.

Kogan, S., Levin, D., Routledge, B. R., Sagi, J. S., & Smith, N. A. (2009, June). Predicting risk from financial reports with regression. In *Proceedings of Human Language Technologies: The 2009 Annual Conference of the North*

American Chapter of the Association for Computational Linguistics (pp. 272-280).

Koop, G., Pesaran, M. H., & Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of econometrics*, *74*(1), 119-147.

Kopelman Naama M, Jonathan Mayzel, Mattias Jakobsson, Noah A Rosenberg§, Itay Mayrose (2015) Program for Identifying Clustering Modes and Packaging Population Structure Inferences Across K doi: 10.1111/1755-0998.12387

Kristjanpoller R., W., & Michell V., K. (2018). A stock market risk forecasting model through integration of switching regime, ANFIS, and GARCH techniques. Applied Soft Computing, 67, 106–116. doi:10.1016/j.asoc.2018.02.055

Kumar, M. (2013), "Returns and volatility spillover between stock prices and exchange rates: empirical evidence from IBSA countries", International Journal of Emerging Markets, Vol. 8 No. 2, pp. 108-128.

Kundu, A. T. Hines, J. Phillips, B. D. Huyck, and L. C. Van Guilder, "Arabic handwriting recognition using variable duration HMM," in *Proceedings of the 9th International Conference on Document Analysis and Recognition (ICDAR '07)*, vol. 2, pp.644–648, IEEE, Washington, DC, USA, September 2007.

Lamoureux, Christopher G., and William D. Lastrapes. 1990. "Persistence in Variance, Structural Change, and the GARCH Model." American Statistical Association 1990. Journal of Business & Economic Studies, April 1990, Vol. 8, No. 2.

Lamoureux, C. (1990) Persistence in Variance, Structural Change, and the GARCH Model. J. Bus Econ. Statist., 8:2, 225-234, 1990.

Lanne, M. and P. Saikkonen (2007), "A multivariate generalized orthogonal factor GARCH model" Journal of Business & Economic Statistics, 25, 61–75.

Laurila, K."Noise robust speech recognition with state duration constraints," in *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP '97)*, vol. 2, pp. 871–874, IEEE Computer Society, Munich, Germany, April 1997.

Leal, S. J., & Napoletano, M. (2019). Market stability vs. market resilience: Regulatory policies experiments in an agent-based model with low-and high-frequency trading. *Journal of Economic Behavior & Organization*, *157*, 15-41.

Lee, J.C., Johnson, W.O., Zellner, A. ŽEds., Modelling and Prediction Honouring Seymour Geisser. Springer, New York, pp. 402422.

Lee, S. L. Li, and J. Ni, “Online degradation assessment and adaptive fault detection using modified hidden Markov model,” *Journal of Manufacturing Science and Engineering*, vol. 132, no.2, Article ID 021010, 11 pages, 2010.

Leuz, W.A., & Wysocki, P. (2016). The economics of disclosure and financial reporting regulation Evidence and suggestions for future research. *Law Working Paper N° 306/2016*, 1-143.

Lewis, C. D. (1982). Industrial and business forecasting methods: A practical guide to exponential smoothing and curve fitting. Butterworth-Heinemann.

Li, Y. and Giles, D.E. (2015), “Modelling volatility spillover effects between developed stock markets and Asian emerging stock markets”, International Journal of Finance and Economics, Vol. 20 No. 2, pp. 155-177.

Ling, S., & McAleer, M. (2003). Asymptotic theory for a vector ARMA-GARCH model. *Econometric theory*, *19*(2), 280-310.

Liu, L., Ma, F., and Wang, Y. (2015). Forecasting excess stock returns with crude oil market data, Energy Economics 48, 316-324.

Lu, L., Chong, Z., Junbing, H. a., & Yu, H. (2018). The Impact of Financial Development on Energy Demand: Evidence from China. *Emerging Markets Finance and Trade*, *54*(2), 269-287. doi:10.1080/1540496x.2017.1358609

Lu, X., & Dong, Z. (2016). Dynamic Correlations between Real Estate Prices and international Speculative Capital Flows: An Empirical Study Based on DCCMGARCH Method. *Procedia Computer Science*, 91(Itqm), 422-431. http://doi.org/10.1016/j.procs.2016.07.114

Lutkepohl, (1991) Introduction To Multiple Time Series Analysis, Springer Verlag, Berlin (1991)

Lutkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis***.** Springer.

MacDonald, R., Sogiakas, V. and Tsopanakis, A. (2018), “Volatility co-movements and spillover effects within the eurozone economies: a multivariate GARCH approach using the financial stress index”, Journal of International Financial Markets, Institutions, and Money, Vol. 52, pp. 17-36.

Malakhov, V. S., & Simon, M. E. (2018). Labour Migration Policy in Russia: Considerations on Governmentality. *International migration*, *56*(3), 61-72.

Malhotra, N., & Gupta, S. (2019). volatility spillovers and correlation between cryptocurrencies and asian equity market. International Journal of Economics and Financial Issues, 9(6), 208–215. doi:10.32479/ijefi.8624

MaJose, R.V. (2010). “Volatility Models with Leverage Effect”. A Doctoral Thesis. Universidad Carlos III De Madrid

Manasseh, C. O., Chukwu, N. O., Abada, F. C., Ogbuabor, J. E., Lawal, A. I., & Alio, F. C. (2019). Interactions between stock prices and exchange rates: An application of multivariate VAR-GARCH model. *Cogent Economics & Finance*, *7*(1), 1681573.

Man Shan, K. M., Andy, A. C. C.A., & Joseph, M. (2015). A review of prognostic techniques for non-stationary and non-linear rotating systems. *Mechanical Systems and Signal Processing, 62-63*, 1-20. doi:10.1016/j.ymssp.2015.02.016

Mattila, R., Rojas, C. R., & Wahlberg, B. (2015). Evaluation of spectral learning for the identification of hidden Markov models. *IFAC-PapersOnLine*, *48*(28), 897-902. Rong, K., & Bailis, P. (2017). ASAP: prioritizing attention via time series smoothing. *arXiv preprint arXiv:1703.00983*.

Mazin, A.M.A., Abdulnasser, H.J., Manuchehr, I. (2010), An empirical investigation of the informational efficiency of the GCC equity markets: Evidence from the bootstrap simulation. International Review of Financial Analysis, 19(1), 47-54.

McDonald, K., Bosshard, P., & Brewer, N. (2009). Exporting dams: China's hydropower industry goes global. *Journal of environmental management*, *90*, S294-S302.

McFarlin Daniel S, Franz Franchetti, Markus P¨uschel, and Jos´e M.F. Moura (2009) High-Performance Synthetic Aperture Radar Image Formation On Commodity Multicore Architectures

McNeil, A. J., & Frey, R. (2000). Estimation of tail-related risk measures for heteroscedastic financial time series: an extreme value approach. *Journal of empirical finance*, *7*(3-4), 271-300.

Mensi, W., Beljid, M., Boubaker, A., & Managi, S. (2013). Correlations andvolatility spillovers across commodity and stock markets: Linking energies, food, and gold. *Economic Modelling*, *32*, 15-22. http://doi.org/10.1016/j.econmod.2013.01.023

Mercy, C., & Kihoro, J. (2015). Application of Vector Autoregressive (VAR) Process in Modelling Reshaped Seasonal Univariate Time Series. *Science Journal of Applied Mathematics and Statistics*, *3*(3), 124-135.

Medjaher, K. D. A. Tobon-Mejia, and N. Zerhouni, "Remaining useful life estimation of critical components with application to bearings," *IEEE Transactions on Reliability*, vol. 61, no. 2, pp. 292–302, 2012.

Mei, q., Liu, y. & jing, x. (2011). Forecast the GDP of shanghai based on the multi-factors VAR model. Journal of the Hubei University of Technology, 26(3).

Meinusch, A., and Tillmann, P. (Forthcoming). The macroeconomic impact of unconventional monetary policy shocks. Journal of Macroeconomics.

Militello, G. M., Bloise, A., Gaggero, L., Lanzafame, G., & Punturo, R. (2019). Multi-analytical approach for asbestos minerals and their non-asbestiform analogues: Inferences from host rock textural constraints. *Fibers*, *7*(5), 42.

Mishra, P.K., Das, J.R., Mishra, S.K. (2005), Gold price volatility and stock market returns in India. American Journal of Scientific Research, 9, 47-55.

Mohammadi, H. and Tan, Y. (2015), "Return and volatility spillovers across equity markets in mainland China, Hong Kong, and the United States", Econometrics, Vol. 3 No. 2, pp. 215-232.

Modarres, R., & Ouarda, T. B. M. J. (2014). A generalized conditional heteroscedastic model for temperature downscaling. Climate Dynamics, 43(9-10), 2629-2649. http://doi.org/10.1007/s00382-014-2076-x

Moon, G.H. and Yu, W.C. (2010), "Volatility spillovers between the US and China stock markets: structural break test with symmetric and asymmetric GARCH approach", Global Economic Review, Vol. 39 No. 2, pp. 129-149.

Morema, K., & Bonga-Bonga, L. (2020). The impact of oil and gold price fluctuations on the South African equity market: Volatility spillovers and fiscal policy implications. *Resources Policy*, *68*, 101740.

Mountford Andrew and Harald Uhlig (2002) What are the effects of fiscal policy shocks? ISSN 0924-7815

Münnix, M. C., Shimada, T., Schäfer, R., Leyvraz, F., Seligman, T. H., Guhr, T., & Stanley, H. E. (2012). Identifying states of a financial market. *Scientific reports*, *2*(1), 1-6.

Murphy, K. P. "Hidden semi-Markov models (hsmms)," Tech. Rep., University of British Columbia, 2002, http://www.cs.ubc.ca/~murphy.

Musa, P. O., & Ajionde, O. (2018). The implication of Nigeria National Security Challenges on Nigeria's Foreign Policy. *Studies in Social Science and Humanities, 5 (1): 1, 9.*

Naimy, V. Y., & Hayek, M. R. (2018). Modeling and predicting the Bitcoin volatility using GARCH models. *International Journal of Mathematical Modelling and Numerical Optimisation, 8(3), 197.* doi:10.1504/ijmmno.2018.088994

Nam K, Pyun CS, Arize AC. 2002. Asymmetric mean-reversion and contrarian profits: ANST-GARCH approach. Journal of Empirical Finance 9: 563–588.

Narayan, P. K., Gupta, R. (2015). Has oil price predicted stock returns for over a century? Energy Economics, 48, 18-23.

Nath Mukherjee, K., & Mishra, R. K. (2010). Stock market integration and volatility spillover: India and its major Asian counterparts. *Research in International Business and Finance*, *24*(2), 235-251.

Nelson, D. (1990). Stationarity and Persistence in the GARCH(1,1) Model. *Econometric Theory, 6*(3), 318-334. doi:10.1017/S0266466600005296

Nelson, D. (1991). "Conditional Heteroskedasticity in Asset Returns A new approach", Econometrica, 59(2): 394-419.

Ngerebo, T. A.A., & Masa, A. (2012). Appraisal of the tax system in Nigeria a case study of value-added tax. *https://www.researchgate.net/publication/280291533*, *1*(6), 338-344.

Nishimura, Y. and Men, M. (2010), "The paradox of China's international stock market co-movement: evidence from volatility spillover effects between China and G5 stock markets", Journal of Chinese Economic and Foreign Trade Studies, Vol. 3 No. 3, pp. 235-253

Norrulashikin, S. M. Fadhilah B.Y., Ibrahim L.K., (2015). An Investigation Towards The Suitability Of Vector Autoregressive Approach On Modeling Meteorological Data. Modern Applied Science, 9(11), 89. doi:10.5539/mas.v9n11p89

Norrulashikin S.M, Fadhilah B.Y., Ibrahim L.K., (2018) Performance Evaluation of a New Hybrid Multivariate Meteorological Model Analysis: A Simulation Study Malaysian Journal of Industrial and Applied Mathematics; 2018 - matematika. UTM.my https://doi.org/10.11113/matematika.v34.n1.1026

Nyberg, H. (2011). Forecasting the direction of the US stock market with dynamic binary probit models, International Journal of Forecasting, 27(2), 561-578.

Nyberg, H. (2013). A Qualitative Response VAR Model: An Application to Joint Dynamics of U.S. Interest Rates and Business Cycle. HECER Discussion Papers No. 369.

Oates, W. E. (1966). <Budget Balance And Equilibrium Income A Comment On The Efficacy Of Fiscal And Monetary Policy In An Open Economy.pdf>. *The Journal of Finance, 21*(3), 489-498.

Ofurum, C. N., Amaefule, L. I., Okonya, B. E.A., & Amaefule. (2018). Impact of E-TaxationOn Nigeria's Revenue and Economic Growth A Pre-Post Analysis. *International Journal of Finance and Accounting, 7*(2), 19-26. doi:10.5923/j.ijfa.20180702.01

Okoye, P. V. C.A., & Ezejiofor, R. (2014). The impact of e-taxation on revenue generation in Enugu, Nigeria. *International Journal of Advanced Research, 2*(2), 449-458.

Pagan, A. R., G. W. Schwert," Alternative Models for Conditional Stock Volatility. J. Econometrics, 45, 267-290, 1990.

Palm et al (1996) Correlation of drug absorption with molecular surface properties / Journal of Pharmaceutical Sciences Vol. 85, No. 1, January 1996

Pantelidis, T., & Pittis, N. (2009). Estimation and forecasting in first-order vector autoregressions with near-to-unit roots and conditional heteroscedasticity. *Journal of Forecasting*, *28*(7), 612-630.

Park, B. U., Simar, L., & Zelenyuk, V. (2017). Nonparametric estimation of dynamic discrete choice models for time series data. *Computational Statistics & Data Analysis*, *108*, 97-120.

Pesaran, H. M., (1997). The Role of Economic Theory in Modeling the long-run. Economic Journal, 107, 178- 191.

Pérez-Rodríguez, J. V., & Santana-Gallego, M. (2020). Modeling tourism receipts and associated risks, using long-range dependence models. *Tourism Economics*, *26*(1), 70-96.

Perotti Roberto Pero and Kontopoulos (2002) Fragmented fiscal policy Journal of Public Economics 86 (2002) 191–222 www.elsevier.com/locate/econbase

Philip, M. O.A., & Olalekan, A. (2017). Mono Cultured Economy and National Development The Nigerian Explanation. *International Journal of Innovative Development & Policy Studies, 5*(3), 26-33.

Pincak, R., & Kanjamapornkul, K. (2018). GARCH(1,1) Model of the Financial Market with the Minkowski Metric. Zeitschrift Für Naturforschung A, 73(8), 669–684. doi:10.1515/zna-2018-0199

Pineda, L. E., & Willems, P. (2015). Multisite downscaling of seasonal predictions to daily rainfall characteristics over Pacific-Andean River Basins in Ecuador and,Peru using a non-homogeneous hidden Markov model. ***Journal of Hydrometeorology, 17,*** 481-498. http://doi.org/10.1175/JHM-D-15-0040.!

Polzehl, Jörg; Spokoiny, Vladimir (2006): Varying coefficient GARCH versus local constant volatility modeling: comparison of the predictive power, SFB 649 Discussion Paper, No. 2006,033, Humboldt University of Berlin, Collaborative Research Center 649 - Economic Risk, Berlin

Poornima, B. G. (2016). *Risk Assessment in Equity, Forex and Derivative Markets-an Empirical Study in Indian Context* (Doctoral dissertation, Goa University).

Pradeepkumar Dadabada and Vadlamani Ravi (2017) Forecasting Financial Time Series Volatility using Particle Swarm Optimization trained Quantile Regression Neural Network S1568-4946(17)30186-2 http://dx.doi.org/doi:10.1016/j.asoc.2017.04.014

Qarout, Y., Raykov, Y., & Little, M. (2020). Probabilistic Modelling for Unsupervised Analysis of Human Behaviour in Smart Cities. Sensors, 20(3), 784. doi:10.3390/s20030784

Rabiner, L., & Juang, B. H. (1986). An introduction to hidden Markov models. *IEEEASSP Magazine*, (January), 4-15.

Rabiner, L. R. (1989). A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition. *Proceedings o f IEEE,* 77(2), 267-295.

Ragnarsson, F. J. (2011). Comparison of Value at Risk Estimates from GARCH Models. *A Master of Science Thesis*.

Rahmawati, Honggowati, S.A., & Supriyono, E. (2014). The effect of corporate social responsibility on financial performance with real manipulation as a moderating variable. *International Journal of Management, Economics and Social Sciences, 3*(7), 59-78.

Ramey, V. A.A., & Zubairy, S. (2018). Government spending multipliers in good times and bad evidence from US historical data. *NBER WORKING PAPER SERIES.*

Ramey, V.A. and M. Shapiro, 1998. Costly capital reallocation and the effects of government spending. Carnegie-Rochester Conference Series on Public Policy 48, 145-194.

Rapach, D. E., Weber, C. E. (2004). Financial Variables and the Simulated Out-of-Sample Forecastability of US Output Growth since 1985: An Encompassing Approach, Economic Inquiry, 42(4), 717-738.

Rice Gregory, Tony Wirjanto and Yuqian Zhao (2020) Tests for Conditional Heteroscedasticity of Functional Data Journal of Time Series Analysis. Time Ser. Anal. 41: 733–758 (2020)

Rosselló, J., Becken, S., & Santana-Gallego, M. (2020). The effects of natural disasters on international tourism: A global analysis. *Tourism Management, 79*, 104080.

Rossi, E. (2004) "Lecture notes on GARCH models". University of Pavia, March.

Ruey S. Tsay, (2014) An introduction to the analysis of financial data with R. John Wiley & Sons, 2014.

Ruibin, G., Indranil, B.A., & Xi, C. (2015). Prediction of financial distress: An empirical study of listed Chinese companies using data mining. *European Journal of Operational Research, 241*(1), 236-247. doi:10.1016/j.ejor.2014.08.016

Rupande, L., Muguto, H. T., Muzindutsi, P.-F., & Yang, Z. (2019). Investor sentiment and stock return volatility: Evidence from the Johannesburg Stock Exchange. *Cogent Economics & Finance, 7*(1). doi:10.1080/23322039.2019.1600233

Ryden, T., Terasvirta, T. & Asbrink, S. (1998), 'Stylized facts of daily return series and the hidden markov model', Journal of Applied Econometrics 13(3), 217–244.

Sadorsky, P. (2014). Modeling volatility and conditional correlations between socially responsible investments, gold and oil. ***Economic Modelling, 38,*** 609618. http://doi.org/10.1016/j.econmod.2014.02.013

Sandrine Jacob Leal and Mauro Napoletano (2019) Market stability vs. market resilience Regulatory policies experiments in an agent-based model with low- and high-frequency *Journal of Economic Behavior & Organization* 157 (2019) 15–41

Sari, R., Hammoudeh, S., Soytas, U. (2010), Dynamics of oil price, precious metal prices, and exchange rate. Energy Economics, 32, 351-362.

Schwarz, Gideon. 1978. Estimating the Dimension of A Model. The annals of statistics 6: 461–64.

Schwert C. William (1990) Stock Volatility and the Crash of 87 NBER working paper series r No. 2954

Seifert M (2010) Extensions of Hidden Markov Models for the analysis of DNA microarray data. Ph.D. Thesis, Martin Luther University Halle. Available: http://nbn-resolving.de/urn:nbn:de:gbv:3:4-4110.

Seifert M, Cortijo S, Colome-Tatche M, Johannes F, Roudier F, et al. (2012) MeDIP-HMM: genome-wide identification of distinct DNA methylation states from high-density tiling arrays. Bioinformatics 28: 2930–2939.

Sen, D., Günay, M. E., & Tunç, K. M. (2019). Forecasting annual natural gas consumption using socio-economic indicators for making future policies. *Energy*, *173*, 1106-1118.

Serletis Apostolos, Olga Efimova (2014) Energy markets volatility modeling using GARCH Energy Economics journal homepage: www.elsevier.com/locate/eneco

Shahnazarian, H., Solberger, N.A., & Spanberg, E. (2017). Forecasting and analyzing corporate tax revenues in Sweden using bayesian var models. *Finnish Economic Papers, 28*(1), 1-25.

Shashanka, M, 2011 "A fast algorithm for discrete hmm training using observed transitions," in Proceedings of the IEEE International Conference on Acoustics, Speech and Signal Processing, Prague, Czech Republic, May 2011.

Shao, Z., Chao, F., Yang, S.-L., & Zhou, K.-L. (2016). A review of the decomposition methodology for extracting and identifying the fluctuation characteristics in electricity demand forecasting. Renewable and Sustainable Energy Reviews. http://doi.org/10.1016/j.rser.2016.10.056

Shephard Neil (1996) Statistical aspects of ARCH and stochastic volatility

Sims, C. A. (1980). Sims macroeconomics and reality. *Econometrica*, *48*(1), 1-48.

Singh Mandeep and Raman Maini (2020) Missing Data Analysis for Electric Load Prediction with Whole Record Missing Advances in Mathematics: Scientific Journal 9 (2020), no.6, 4015–4023 ISSN: 1857-8365 (printed); 1857-8438 (electronic) https://doi.org/10.37418/amsj.9.6.82

Siu TK, Ching WK, Fung E (2005) Extracting information from spot interest rates and credit ratings using double higher-order hidden Markov models. Computational Economics 26: 251–284.

Smyth, P, "Clustering sequences with hidden Markov models," in Advances in Neural Information Processing Systems, pp. 648– 654, MIT Press, 1997.

Sobri, S., Koohi-Kamali, S., Rahim, N.A., 2018. Solar photovoltaic generation forecasting methods: A review. Energy Convers. Manage. 156, 459–497. http://dx.doi.org/10. 1016/j.enconman.2017.11.019.

Sokolnikov, A. U. (2013). *THz identification for defence and security purposes: identifying materials, substances, and items*. World Scientific.

Soytas, U., Sari, R., Hammoudeh, S., Hacihasanoglu, E. (2009), World oil prices, precious metal prices, and the macroeconomy in Turkey. energy policy, 37, 5557-5566.

Srinivasan, S., Pauwels, K., Silva-Risso, J., & Hanssens, D. M. (2009). Product innovations, advertising, and stock returns. *Journal of Marketing*, *73*(1), 24-43.

Stock, J. H., Watson, M. W. (2003). Forecasting Output and Inflation: The Role of Asset Prices, Journal of Economic Literature, 41, 788-829.

Stoker, G. (2016). Public Value Management. *The American Review of Public Administration, 36*(1), 41-57. doi:10.1177/0275074005282583

Streimikiene, D., Ahmed, R. R., Vveinhardt, J., Ghauri, S. P.A., & Zahid, S. (2018). Forecasting tax revenues using time series techniques a case of Pakistan. *Economic Research-Ekonomska Istraživanja, 31*(1), 722–754. doi:10.1080/1331677X.2018.1442236

Sun Hao and Yu Bo Nesting Symmetric and Asymmetric GARCH Models

Symitsi, E., & Chalvatzis, K. J. (2018). Return, volatility, and shock spillovers of Bitcoin with energy and technology companies. Economics Letters, 170 127–130. doi:10.1016/j.econlet.2018.06.012

Urrutia J. – Mercado J. –Quite J.A. (2015): Mathematical Model for Estimating Income Tax Revenues in the Philippines through Regression Analysis Using Matrices, European Academic Research, May 2015, Vol. III, Issue 2,

Tang, S., Selvanathan, E. A., & Selvanathan, S. (2008). Foreign direct investment, domestic investment and economic growth in China: A time series analysis. *World Economy*, *31*(10), 1292-1309.

Tang, L., Heping, P.A., & Yiyong, Y. (2018). K-Nearest Neighbor Regression with Principal Component Analysis for Financial Time Series Prediction. 127-131. doi:10.1145/3194452.3194467

Taylor, S. (1986) Modelling Financial Time Series, Wiley, Chichester.

Taylor, M. P. (1995). The economics of exchange rates. *Journal of Economic literature*, *33*(1), 13-47.

Terwijn, B. "On the learnability of hidden Markov models," in ICGI 2002, vol. 2484 of LNAI, pp. 261–268, Springer, Berlin, Germany, 2002Hwang SY, Basawa IV. 2004. Stationarity and moment structure for Box-Cox transformed threshold GARCH (1,1) processes. Statistics & Probability Letters 68: 209–220.

Tillman, P. (2015). Estimating the effects of macroprudential policy shocks: A Qual VAR approach, Economics Letters 15, 1-4.

Tillman, P. (2019). Unconventional monetary policy shocks and the response of emerging markets. Journal of International Money and Finance.

Tiwari, A. K., Trabelsi, N., Alqahtani, F., & Raheem, I. D. (2020). Systemic risk spillovers between crude oil and stock index returns of G7 economies: Conditional value-at-risk and marginal expected shortfall approach. *Energy Economics*, *86*, 104646.

Tobon-Mejia, D. A., Medjaher, K., Zerhouni, N., & Tripot, G. (2010, August). A mixture of gaussians hidden markov model for failure diagnostic and prognostic. In *2010 IEEE International Conference on Automation Science and Engineering* (pp. 338-343). IEEE..

Tobon-Mejia, D. A. K. Medjaher, N. Zerhouni, and G. Tripot, "Estimation of the remaining useful life by using wavelet packet decomposition and HMMs," in *Proceedings of the IEEE Aerospace Conference (AERO '11)*, pp. 1–10, IEEE Computer Society, AIAA, Big Sky, Mont, USA, March 2011.

Tobon-Mejia, D. A., Medjaher, K., Zerhouni, N., & Tripot, G. (2012). A data-driven failure prognostics method based on mixture of Gaussians hidden Markov models. *IEEE Transactions on reliability*, *61*(2), 491-503.Tsay, R. S. (2005) Analysis of financial time series, 2nd Edition. New Jersey: John Wiley & Sons.

Tse, Y. K., & Tsui, A. K. C. (2002). A multivariate generalized autoregressive conditional heteroscedasticity model with time-varying correlations. *Journal of Business & Economic Statistics*, *20*(3), 351-362.

Turasie, A. A., & Coelho, C. A. S. (2016). Cointegration modeling for empirical South American seasonal temperature forecasts. *International Journal of Climatology***,** 36(14), 4523-4533. http://doi.org/10.1002/joc.4649

Umar, M. A., Derashid, C.A., & Ibrahim, I. (2017). Challenges of tax revenue generation in developing countries: Adopting the carrot and stick approach. *IOSR Journal Of Humanities And Social Science, 22*(1), 30-34. doi:10.9790/0837-2201013034

Umar Muhammad, Syed Kumail Abbas Rizvi b, Bushra Naqvi (2020) Dance with the devil? The nexus of the fourth industrial revolution, technological financial products and volatility spillovers in global financial system *Technological Forecasting & Social Change,* https://doi.org/10.1016/j.techfore.2020.120450

Urrutia, J. D., Mingo, F. L. T.A., & Balmaceda, C. N. M. (2015). Forecasting income tax revenue of the Philippines using autoregressive integrated moving average (Arima) modeling: a time series analysis. *American research thoughts ISSN: 2392 – 876X, 1*(9), 1937-1992. doi:10.6084/m9.figshare.1469539

Vallejos, S., Umek, P., Stoycheva, T., Annanouch, F., Llobet, E., Correig, X., ... & Blackman, C. (2013). Single-step deposition of Au-and Pt-nanoparticle-functionalized tungsten oxide nanoneedles synthesized via aerosol-assisted CVD and used for fabrication of selective gas microsensor arrays. *Advanced Functional Materials*, *23*(10), 1313-1322.

Van Der Weide Roy. (2002) GO-GARCH: A Multivariate Generalized Orthogonal GARCH Model Journal of Applied Econometrics J. Appl. Econ. 17: 549–564 (2002)

Vilenkin, N. Y. (1968). Special functions and the theory of group representations. Providence: American mathematical society. *Providence: American mathematical society*.

Vrontos, I. D., P. Dellaportas and D. N. Politis (2003), "A full-factor multivariate GARCH model", Econometrics Journal, 6, 312–334.

Walsh, D., & Tsou, G. (1998). Forecasting index volatility: Sampling interval and non-trading effects. Applied Financial Economics, 8(5), pp. 477-485

Wang, P., & Wang, P. (2010). Price and volatility spillovers between the Greater China Markets and the developed markets of US and Japan. *Global Finance Journal*, *21*(3), 304-317.Wang Ruiping, Huimin Guo, Larry S. Davis, and Qionghai Dai (2012) Covariance Discriminative Learning: A Natural and Efficient Approach to Image Set Classification 978-1-4673-1228-8/12/$31.00 ©2012 IEEE Xplore

Wang, Y., Xu, C., Zhang, S., Yang, L., Wang, Z., Zhu, Y., & Yuan, J. (2019). Development and evaluation of a deep learning approach for modeling seasonality and trends in hand-foot-mouth disease incidence in mainland China. *Scientific reports*, *9*(1), 1-15.

Wang, N. S.-D. Sun, Z.-Q. Cai, S. Zhang, and C. Saygin, "A hidden semi-Markov model with duration-dependent state transition probabilities for prognostics," *Mathematical Problems in Engineering*, vol. 2014,Article ID 632702, 10 pages, 2014.

Wei, Y., Wei, Q., Wang, S., & Lai, K. K. (2018). A hybrid approach for studying the lead-lag relationships between China's onshore and offshore exchange rates considering the impact of extreme events. *Journal of Systems Science and Complexity*, *31*(3), 734-749.

Wen, M., Li, P., Zhang, L., & Chen, Y. (2019). Stock market trend prediction using high-order information of time series. *Ieee Access*, *7*, 28299-28308.William, M. Q.A., & Yili, H. (2013). Reliability Meets Big Data: Opportunities and Challenges. *Quality Engineering*, *26*(1), 102-116. doi:10.1080/08982112.2014.846119

Wong, Chun Shan, and Wai Keung Li. 2000. On a Mixture Autoregressive Model. Journal of the Royal Statistical Society, Series B 62: 95–115.

Wooldridge Michael (2012) Does Game Theory Work 1541-1672/12/$31.00 © 2012 IEEE Intelligent systems Published by the IEEE Computer Society

Xavier, J., Patnaik, S. K., & Panda, R. C. (2021). Process Modeling, Identification Methods, and Control Schemes for Nonlinear Physical Systems–A Comprehensive Review. *ChemBioEng Reviews*.

Xiao Han Cai (2008). Time series analysis of air pollution co in California south coast area, with seasonal ARIMA model and VAR model. University of California, Los Angeles.

Xuan Vinh, V. and Ellis, C. (2018), "International financial integration: stock return linkage and volatility transmission between Vietnam and other advanced countries", Emerging Markets Review, Vol. 36, pp. 19-27, doi: doi.org/10.1016/j.ememar.2018.03.007

Yang, D., Dong, Z., Reindl, T., Jirutitijaroen, P., & Walsh, W. M. (2014). Solar irradiance forecasting using spatio-temporal empirical kriging and vector

autoregressive models with parameter shrinkage. ***Solar Energy, 103,*** 550-562.http://doi .org/10.1016/j. solener.2014.01.024

Yarushev, S. A., Ярушев, С. А., Averkin, A. N.A., & Averkin, A. N. (2016). Review of studies on time series forecasting based on hybrid methods, neural networks, and multiple regression. *Международный журнал "Программные продукты и системы", 31*, 75-82. doi:10.15827/0236-235x.113.075-082

Yilmaz, K. (2010), "Return and volatility spillovers among the east Asian equity markets", Journal of Asian Economics, Vol. 21 No. 3, pp. 304-313.

Ying Rex, Ruining He, Kaifeng Chen, Pong Eksombatchai, William L. Hamilton, and Jure Leskovec. (2018) Graph convolutional neural networks for web-scale recommender systems. In KDD, 2018.

Ying, T., Wang, K., Liu, X., Wen, J., & Goh, E. (2020). Rethinking game consumption in tourism: a case of the 2019 novel coronavirus pneumonia outbreak in China. Tourism Recreation Research, 1-6. doi:10.1080/02508281.2020.1743048

Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in quantitative methods for psychology*, *9*(2), 79-94.

Yoon Jinsung, James Jordon and Mihaela van der Schaar (2018) Gain: Missing data imputation using generative adversarial nets Proceedings of the 35 the International Conference on Machine Learning, Stockholm, Sweden, PMLR 80, 2018.

Yu, L., Zhou, L., Tan, L., Jiang, H.A., & Wang, Y. (2014). 5d a new hybrid model with seasonal auto-regressive integrated moving average (ARIMA) and nonlinear autoregressive neural network (NARNN) in forecasting. *PLOS ONE | www.plosone.org*, *9*(6), 1-9.

Yu, S.-Z. "Hidden semi-Markov models," *Artificial Intelligence*, vol. 174, no. 2, pp. 215–243, 2010.

Yu, S.-Z. and H. Kobayashi, "An efficient forward-backward algorithm for an explicit-duration hidden Markov model," *IEEE Signal Processing Letters,* vol. 10, no. 1, pp. 11–14, 2003.

Yu, S.-Z. and H. Kobayashi, "Practical implementation of an efficient forward-backward algorithm for an explicit-duration hidden Markov model," *IEEE Transactions on Signal Processing*, vol. 54, no. 5, pp. 1947–1951, 2006.

Zarei, A. R., & Moghimi, M. M. (2017). Environmental assessment of semi-humid and humid regions based on modeling and forecasting o f changes in monthly temperature. ***International Journal o f Environmental Science and Technology.*** http://doi.org/10.1007/s13762-017-1600-z

Zhang, C., Zhou, J., Li, C., Fu, W., & Peng, T. (2017). A compound structure of ELM based on feature selection and parameter optimization using hybrid backtracking search algorithm for wind speed forecasting. Energy Conversionand Management, *143*, 360-376. http://doi.org/10.1016/j.enconman.2017.04.007

Zhang Qiang, Rui Luoy, Yaodong Yang, Yuanyuan Liu (2018) Benchmarking Deep Sequential Models on Volatility Predictions for Financial Time Series *32nd Conference on Neural Information Processing Systems* (NIPS 2018), Montreal, Canada

Zhou, X., Zhang, W. and Zhang, J. (2012), "Volatility spillovers between the Chinese and world equity markets", Pacific-Basin Finance Journal, Vol. 20 No. 2, pp. 247-270

Zhuang, X.-F., & Chan, L.-W. (2004). Volatility Forecasts in Financial Time Series with HMM-GARCH Models. Intelligent Data Engineering and Automated Learning – IDEAL 2004, 807–812. doi:10.1007/978-3-540-28651-6_120

Zhu Fumin, Wei Quan, Zunxin Zheng, And Shaohua Wan (2018) A Bayesian Learning Method for Financial Time-Series Analysis IEEE access Digital Object Identifier 10.1109/ACCESS.2018.2853998

Zhu, B., Ye, S., He, K., Chevallier, J., & Xie, R. (2019). Measuring the risk of European carbon market: An empirical mode decomposition-based value at risk approach. *Annals of Operations Research*, *281*(1), 373-395.

Živkov, D., Manić, S., & Đurašković, J. (2020). Short and long-term volatility transmission from oil to agricultural commodities–The robust quantile regression approach. *Borsa Istanbul Review*, *20*, S11-S25.

Zivot, e. And J.wang (2006). Modeling Financial Time series with Splus, 2nd Edition. Springer, p.p. 385-386.

Zucchini W, Mac Donald IL (2009) Hidden Markov Models for Time Series. Chapman & Hall.

Zukarnain, Z., & Shamsuddin, S. (2012). Empirical Evidence on the Relationship between Stock Market Volatility and Macroeconomic Volatility in Malaysia. Journal of Business Studies Quarterly, 4(2), 61-71.

LIST OF PUBLICATIONS

1. Baba Gimba Alhassan, Fadhilah Binti Yusof, Siti Mariam Norrulashikin (2020) Assimilation of Principal Component Analysis and Wavelet with Kernel Support Vector Regression for Medium-Term Financial Time Series Forecasting International Journal of Management and Humanities (IJMH) ISSN: 2394-0913, Volume-4 Issue-7, March 2020 DOI: 10.35940/ijmh. G0667.034720

2. Baba Gimba Alhassan, Fadhilah Binti Yusof, Siti Mariam Norrulashikin (2020) DOI: 10.5373/JARDCS/V12SP7/20202110 Jour of Adv Research in Dynamical & Control Systems, Vol. 12, 07-Special Issue, 2020 ISSN 1943-023X 29 Received: 04 May 2020/Accepted: 05 June 2020 DOI: 10.5373/JARDCS/V12SP7/20202110

3. Baba Gimba Alhassan, Fadhilah Binti Yusof, Siti Mariam Norrulashikin, Ibrahim Lawal Kane (2020) “Dynamics of Heteroscedasticity Modelling and Forecasting of Tax Revenue in a Developing Economy: A Review” International Journal of Management and Humanities (IJMH) ISSN: 2394 – 0913, Volume-5 Issue-3, November 2020 DOI:10.35940/ijmh.C1161.115320