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THE FORECASTED ACCURACY OF THE BIOENERGY MARKET IN THE EU-28 REGION

MOHD ALSALEH* AND ABDUL SAMAD ABDUL-RAHIM

Faculty of Economics and Management, Universiti Putra Malaysia, Serdang, Selangor, Malaysia..

**Corresponding author: moe_saleh222@hotmail.com*

Abstract: We developed and evaluated a new approach to investigate the accuracy of forecasted analysis findings of the bioenergy market in the European Union EU-28 between 2014 and 2020. This study tests the accuracy of forecasted analysis results by applying panel data analysis and using the ARIMA forecasting model. Testing the forecasted accuracy for the bio-energy market in the EU-28 zone resulted in an increase in the ratios of supply by 3.04 million tonnes of oil equivalent (Mtoe), demand by 13.83 Mtoe and import by 13.39 Mtoe of bio-energy output, which is logical for achieving objectives of the 2020 National Renewable Energy Action Plan (NREAP). However, export rates are predicted to reduce markedly in all EU28 countries by 26.87 Mtoe because of the significant efforts of the EU-28 states to increase local demand of bio-energy products. This study contributes to the literature by providing an accurate forecasted analysis of the status of the bio-energy markets in the EU-28 zone till the end of 2020 for decision makers and other energy politicians.

Keywords: Bioenergy forecasted, evaluation analysis, bio-energy market, EU-28 zone

Introduction

Bioenergy plays a major role in the green and friendly energy industry around the world and it contributes significantly to different energy sectors, such as in thermal energy, transport and the electricity industry. Bio-mass is the main input consumed in bio-energy output. It is derived from various sources like organic substance and bio-waste. According to Susaeta *et al.* (2012), the EU-28's evaluations of the bio-energy application scales are needed to meet the NREAP (National Renewable Energy Action Plan) goals by 31/12/2020 and reveal that local demand of bio-energy output may grow from 686. 1 thousand GWh (Gigawatt per hour) in 2005 to 1,570 thousand GWh by 2020, from a local consumption increments perspective. The major bio-energy sections that may contribute significantly in increasing consumption are the bio-electricity (from 116.300 thousand GWh to 232.600 thousand GWh) and bio-fuel (from 162.820 thousand GWh to 325.640 thousand GWh) sections. Improvements in the bio-electricity section between 2005 and 2020 are quite remarkable with forecasted growth as follows: 10,467 GWh in Belgium, 17,445 GWh in France, 48,846 GWh in Germany, 19,771 GWh in Italy, 16,282 GWh in Netherlands, 13,956 GWh in Poland and 25,586 GWh in the UK (Junginger *et al.,* 2011; Susaeta *et al.,* 2012). A previous paper pointed out that to fulfil the constant rise in bio-mass demand there was a consistent increase of the bio-mass imported from 2,778 GWh in 1990 to 41,667 GWh in 2006 (a total of 50 thousand GWh in 1990 to 10,556 thousand GWh in 2006) (Snieskiene & Cibinskiene, 2015).

This increase in demand led to an unstable status in the bio-energy market, which was reflected through the shortage of bio-mass supply (472 thousand GWh) used to fulfil the local consumption (1,027 GWh) for the term between 1990 through 2006. In addition, there were changes in the ratio of the bio-mass imported and increases in the bio-mass exported, which were 1,389 Gwh in 1990 and 19,444 GWh in 2006 (Snieskiene & Cibinskiene, 2015). According to an earlier paper by Bottcher *et* *al.* (2011) pertaining to the timberland market, input values and bio-wood have important influences on the market equilibrium in the supply equation. Furthermore, the local price variable can contribute significantly in the local market equation. The ratio of real exchange (EXR) is predicted to have significant impact on the import demand and export demand in the foreign markets (Bottcher *et al.,* 2011; Kanjilal & Ghosh, 2014). As a result, the high expense of bio-mass energy in the EU zone in comparison with other countries has negatively impacted the gross expense of bio-energy output and the attractiveness of bio-energy outputs in the power market (Whistance, 2012). The World Bioenergy Association (WBA) in 2014 has shown the European Union to be a zone with a very sophisticated bio-energy sector with the strong likelihood for further outgrowth. The bioenergy purchased from abroad using biomass and bio-waste sources is expected to meet 20 percent of the domestic energy demand of the European zone in 2030, with 85 percent of the bioenergy coming from the European zone and 15 percent originating from foreign and other external purchases. Sustainable energy sources would then meet 45 percent of EU's energy domestic demand by 2030.

The problem with this scenario is that the EU states have realized that there is doubt regarding achieving the NREAP 2020 goals because of the instability of bioenergy production and consumption, large consumption of the bio-mass resources and the shortfall of the domestic bio-mass production. This causes doubt regarding enhancing the consumption of bio-energy. This will respond poorly by enhancing the cost of produced bio-mass. Thus, bio-energy output costs in the market European zone will increase and the bio-energy production will be losing its attractiveness as a source of energy to substitute for the conventional energy in the future (Schutter & Giljum, 2014). The primary questions are: Will the bio-energy market of EU28 be in a stable condition in the future? How accurate is the forecasted estimation results of the bio-energy market during the period between 2014 and 2020? Given these questions, the objective of the current study is to estimate the accuracy level of the forecasted analyses of the bio-energy market between 2014 and 2020. The significance of this study is to investigate the likelihood of the bioenergy supply meeting the large domestic bio-energy demand and to achieve the NREAP objectives by 2020. This paper validates the influence of bio-energy supply security to reduce the increased ratio of bio-energy importation in the EU-2 8 zone in first world and second world state markets. Furthermore, the significance of this study is to identify the ability of bio-energy sector to be an attractive sustainable energy sector compared with conventional fuel in energy markets by applying a complete estimation for the local and foreign bio-energy markets in the EU-28 zone. Lastly, decision makers will be able to assess the outcomes of increased investment in the bio-energy market.

Literature Review

As reviewed in Trømborg *et al.* (2013), the local production of bio-energy from bio-mass timberland sources in the Kingdom of Sweden was 16,282 GWh (gigawatt per hour), whereas consumption was evaluated to be nearly 19,771 GWh. Nearly 4,652 GWh were purchased from abroad to fulfil the shortage in the local market. As per a previous study by Trømborg *et al. (*2008), in the Kingdom of Finland the bio-mass production from timberland sources was approximately 3,838 GWh and the local consumption was evaluated to be nearly 1,360 GWh in 2007, showing a large production scale compared with the consumption scale and a large sell abroad ratio in comparison with the buy abroad scale, which is dissimilar in the Kingdom of Sweden. According to earlier research by Zhang and Zhuang (2011), in the Kingdom of Norway the extract ratio of bio-mass from timberland resources pertaining to the bio-energy production is smaller than the yearly outgrowth ratio. This has a negative effect on bio-mass costs and the production of an attractive bio-energy output in the energy market. Nybakk and Lunnan (2013) described that the economic improvement of the bio-mass market by applying incorrect tools in the European market would the negatively affected by reducing bio-energy output between 10% and 12.5%. This would increase the extract volume of biomass required for bioenergy output from timberland resources by 6% to 9%, thereby raising the needed bio-mass for bio-energy productions from timberland resources by 30% to 60% and enhancing bio-mass purchases in the European zone from abroad by 6% to 9%. Moiseyev *et al.* (2013) as well as Nybakk and Lunnan (2013) found that many bio-mass inputs have gone thorough unstable pricing changes, which leads to additional expenses because of the transfer of expenses from the producer to the buyer. Nonetheless, cost instability of the bio-mass production remains attractive compared to cost instability of fuel productions because of the improvement of the bio-mass market (Moiseyev *et al.,* 2013).

Matzenberger *et al.* (2015) analysed the growth of the main variables of the bio-energy foreign market in Europe. The paper presented fast outgrowth in the bio-energy commerce but was limited with some restrictions pertaining to bio-energy outputs. Research by Lamers *et al.* (2011) employed a systematic approach using unique techniques related to market segmentation to evaluate the consumption of the bio-energy market in the UK. A previous article reported that regulations upgrading local bio-energy outputs had important impact on the growth of the foreign bio-energy market (Makridakis *et al.,* 1998). Furthermore, the foreign bio-energy outputs market is led by production and consumption. The local consumption in the EU was shaped by supporting regulations that increased the local market value of bio-energy outputs. Magar *et al.* (2010) reported that local bio-energy consumption has enhanced importantly and is predicted and future forecasts. These amends will enhance both bio-energy foreign market inflows and modality. One study by Hargrave and Katos (2013) investigated the variables of integrating bio-energy market contribution by using various attractive analyses for bio-energy market share using variables across input kinds, reproducer categories and location condition. In reference to one study by Hubert (2004) which analysed the economic functionality of the bio-energy market in Argentina, the paper assessed the availability of bio-energy resources by taking into consideration various outlines by 2030. The variables of the bio-energy market have been defined as the accessible resources for bio-energy productions, supply chain, venture and attraction. Based on research by Schwarzbauer and Stern (2009), input price has a significant role in the economic growth of the bio-energy sector, which has important impacts on the local prices in the bio-energy market. In addition, climate change regulation has an important role in upgrading bio-energy outputs in the energy market. Accordingly, early scholars like Schwarzbauer and Stern (2009) and Snieskiene and Cibinskiene (2015) investigated the part of environmental variables and regulation in the competitiveness among the bio-energy and power markets.

Various studies carried out by researchers like Kristofel *et al.* (2014) and Hargrave and Katos (2013) applied regression analysis for a time series of not less than 14 years. An earlier study by Kristofel *et al.* (2014) applied specific scale datasets to estimate the minimal regulation and economic factors of forestry destruction in Brazil. The research evaluated annual panel data regression in that zone from 2002-2009, a term of more than seven years. The results showed that forestry destruction is increasing with economic activities and is also influenced by economic motivations, which were measured through differences in bio-agricultural products and bio-wood prices. Moreover, it was pointed out that increasing fulfilment of the climate change regulations significantly influenced reducing forestry destruction ratios in Brazil. Similarly, Wang *et al.* (2011) and Zhang and Zhuang (2011) estimated the influence of the workforce on economic outgrowth in the Republic of China through a panel regression. That study analysed a dataset for 31 territories between 1997 and 2006, a period of ten years.

In this part, we review papers that have applied the market approach to define the economic factors of the local and foreign markets. One important study by Bottcher *et al.* (2011) applied the market approach to analyse the pellets market in Malaysia. The research used an experimental estimation to the market and utility to assess economic impacts of sustainable timberland business growth (Bottcher *et al.,* 2011). Previously, an interesting paper developed and applied a structural equilibrium approach for the bio-mass domestic market in the USA (Whistance, 2012). An accuracy estimation focusing on supply response illustrated that the findings are totally sensible to supply flexibility. The study by Galik (2015) analysed local market model for bio-wood outputs in the USA timberland applying a simultaneous equation model. Moreover, domestic price elasticity was analysed and regressed in comparison with the price elasticity of other research.

Dam *et al.* (2009) investigated the possible impact of bioenergy growth on the timberland bio-mass market. The study took into consideration the following factors: important domestic market variables influences, available volume of bio-mass from timberland resources and the bad influence of the economic crisis on bio-mass domestic market variables. Based on the analysis of the geographical impacts and the variables, both modifications on economic outgrowth, timberland output supply demand and technological directions, the study conducted by Wang *et al.* (2014) employed a semi equilibrium market approach to the timberland industry worldwide. With reference to the bioenergy forecasted approach estimation used, this study evaluated the accuracy level of the forecasted analysis of the bio-energy market approach in the European zone. This is in contrast with other papers, which are limited to either local or foreign bio-energy market models and include studies such as those of Matzenberger *et al.* (2015); Lamers *et al.* (2011); Jablonski *et al.* (2008); and Schwarzbauer and Stern (2009). Matzenberger *et al.* (2015) applied a primary data analysis to investigate the chances and limits to the foreign bioenergy commerce in the European states for 2009. One significant research by Lamers *et al.* (2011) analysed the available consumption for bio-energy in the thermal industry in the UK by taking into consideration market segment regression, not to highlight the forecasted estimation for the bio-energy local and foreign market models. Thus, this study investigates the accuracy levels of the bioenergy forecasted analysis. The European states planned for a co-integrated agenda related to the NREAP aims. The NREAP objectives promote the EU's environmental regulations to a higher standard and forecast the contribution and role of each EU state (Geheeb, 2007). Thus, this paper investigates the accuracy level of the forecasted approach related to the bioenergy market from 2014 to 2020 to find out whether the EU-28 states can meet the NREAP objectives by 2020.

Based on the reviewed studies above, no study has thus far implemented forecasted analysis for the bioenergy market in EU-28 Region. Moreover, no studies have tested the accuracy of the applied forecasted analysis of the bioenergy market in EU-28 Region for the period between 2014 and 2020. Thus, this study bridges the gap of previous studies by testing the accuracy of forecasted analysis of the bioenergy market in the EU-28 Region. This study will complete and emphasize the results of forecasted analysis of bioenergy market through applying various testing methods, which will provide solid results to support the forecasted analysis findings. However, based on the availability of the data, our analysis can only cover the years 1990–2013. Thus, this study tests the forecasted analysis for the bioenergy market for the period between 2014 and 2020 in order to discover if the EU28 region can achieve the set NREAP targets by 2020.

Materials and Methods

Box-Jenkins Analysis refers to a systematic method of identifying, fitting, checking and using the Auto-regressive Integrated Moving Average (ARIMA) model. The method is appropriate for a time series of medium to long length. In this section we present the Box-Jenkins method, concentrating on the ARIMA model as summarised from the landmark book on time series analysis (i.e. Box and Jenkins, 1976). Based on previous research by Thomas and Maurice (2015) to forecast the domestic and international markets model in a future period, the study identified the status of the domestic and international markets in the future period of the forecast. The implemented process of locating the domestic and international markets in the future is straightforward. The study calculated the forecasted results of all the external determinants of the market model equations and then substituted these findings into the evaluated market model equilibrium. As already mentioned in Equation 1, forecasted values of exogenous variables can be acquired by using Panel Data Simultaneous Equation Model techniques to generate predicted values of the exogenous explanatory variables. In order to locate the bioenergy market model in Equation 2 for a future period (t+1), the study forecasted all exogenous variables for that period. In Equation 3, the forecasted future bioenergy market supply for (t+1) framed as follows:

$$Q_{i,t+1} = \widehat{a}_i + \widehat{b}\,P_{i,t+1} + \widehat{c}\,M_{i,t+1} + \widehat{d}\,PR_{i,t+1} \quad (1)$$

$$= (\widehat{a}_i + \widehat{c}\,M_{i,t+1} + \widehat{d}\,PR_{i,t+1}) + \widehat{b}\,P_{i,t+1} \quad (2)$$

$$= \widehat{e}_{i,t+1} + \widehat{b}\,P_{i,t+1} \quad (3)$$

Then the forecasted future bioenergy market demand for (t+1) framed in Equation 4, Equation 5 and Equation 6 as the following:

$$Qi,t+1 = \widehat{e} + \widehat{f}\,Pi,t+1 + \widehat{g}\,PIi,t+1 \quad (4)$$

$$= (\widehat{e} + \widehat{g}\,PIi,t+1) + \widehat{f}\,Pi,t+1 \quad (5)$$

$$= \widehat{e}\,i,t+1 + \widehat{f}\,Pi,t+1 \quad (6)$$

In Equation 4, Q refers to the quantity, PI stands for domestic price, M points to the income, PR price of goods related to the consumption, P to input price, i refers to country and t stands for year. ARIMA (autoregressive integrated moving average model) or Box-Jenkins approaches were completely framed in 1976 (Pankratz, 2009). In Equation 7, the economical and statistical formula for an ARIMA approach may be framed as the following:

$$Yt = \sum_{i=1}^{p} \varphi iYt\text{-}i + \varepsilon t + \sum_{i=1}^{q} \theta i \quad \varepsilon t\text{-}I \quad (7)$$

There are a few underlying key essentials in ARIMA modelling, such as stationarity, invertibility and parsimony. Stationarity means that the mean, variance and covariance of the series remain constant over time. This can be achieved by logarithmic transformation and by differencing either integrated to the order one I (1) or two I (2). Box and Jenkins believed that parsimonious models produce higher forecast compared to an over-parameterised approach with further coefficients that could impact the levels of independency. The ability to invert is additionally implied and is the main need in the ARIMA approach in which the weighted factor should show an approximate autoregressive procedure or be denoted by a finite order moving average. The three stages in ARIMA modelling as advocated by Box and Jenkins are (a) identification; (b) estimation; and (c) diagnostic checking (Asteriou & Hall, 2015). The data of dependent variables: supply, demand, import and export, were extracted mainly from the World Bank Database and Eurostat Database in Mtoe (Millions of tonne oil equivalent) and Gwh (Giga-watt per hour) as units measurement.

Results and Discussion

The Augmented Dickey Fuller Test (ADF) is a unit root test for stationarity. Unit roots can cause unpredictable results in a study time series analysis. The null hypothesis for this test is that there is a unit root. The alternate hypothesis differs slightly according to which equation the study is using. The basic alternate is that the time series is stationary (or trend-stationary). The main purpose is to consider some of the operational aspects of the ADF test and especially the question of how many autoregressive lags are needed when the latter may be a mixed ARIMA process. Thus, the results are reported to determine the lag structure and whether the ADF test consistently rejects the null and alternative hypotheses when it is true. At the identification stage, a mathematical inspector identified as the Augmented Dickie Fuller (ADF) inspection is applied to ensure that the transformed series has achieved stationarity. The series of the four studies models are labelled as intercept and intercept and trend at the first different series. The results of the ADF test for the four models studied are presented in Table 1. After being transformed to the first different scale, the ADF test result showed that the series of the four models achieved a stationary state. The results are considered stationary when the t stats value exceeds the 5% critical value.

In Figure 1, the bio-energy output forecast supply of 0.435 Million GWh and import of 0.731 Million GWh for the EU-28 countries and by end of 2006 was evaluated to provide approximately 1.167 Million GWh overall. The bio-energy utilising forecast demand of 0.669 Million GWh and export but 0.628 Million GWh by the end of 2006 was estimated to be about 1.298 Million GWh overall in EU-28 countries. The finding showed a shortfall in the bioenergy market by (-0.131) Million GWh in 2006. The bioenergy output forecast supply of 0.660 Million GWh and import of 0.912 Million GWh in the EU-28 countries by the end of 2020 was foreseen to provide approximately 1.572 Million GWh overall (Figure 1). On the other hand, the bioenergy use forecast demand of 1.114 Million GWh and export of 0.436 Million GWh and by the end of 2020 demand is expected to be about 1.551 Million GWh overall. The finding indicates that there will be a surplus of 0.021 Million GWh in the bio-energy market in the EU-28 region. The findings show that the bioenergy market in the EU-28 has moved from having a lack of (–0.131) Million GWh to attaining a surplus scale of 0.021 Million GWh by the end of 2020 (Alsaleh *et al.,* 2017).

We visualised the applied data set and created dummy variables for the structural break by adding unusual values 1 or 0. This will give our study a series of a single variable, to be placed into the independent side of the applied empirical market models. Table 2 shows the result if the residuals have white noise characteristics. To avoid a spurious forecast, residuals must not be related and the addition of dummy variables is a proper exercise to apply a multiple breakpoints inspection to eliminate structural breaks. Moreover, as a breakpoint to keep a significant prediction by finding minimum 14 actual observed data, 2002 and 2003 were the identified breakpoint test years for the multiple breakpoints tests. The results were the multiple breakpoints test for the four identified models (Supply, Demand, Import and Export) which indicated that there was no evidence pointing to a breakpoint for the selected investigation year because the p-value is higher than the 0.05 importance scale, as shown in Table 2.

The correlogram is a useful tool for examining the degree of autocorrelation. This examines the correlations between residuals at times t and t-1, t-2, etc. If no autocorrelation

Table 1: Panel Augmented Dickie Fuller (ADF) test results

Variable	ADF	
	Intercept	**Intercept and Trend**
Supply	-4.380*** (0.003)	-4.326** (0.014)
Demand	-4.337*** (0.003)	-4.292** (0.015)
Import	-4.351*** (0.003)	-4.310** (0.015)
Export	-4.316** (0.015)	-6.557*** (0.000)

Notes: ***Significant at 1%, **significant at 5%, *significant at 10%; values in parentheses are *p* values.

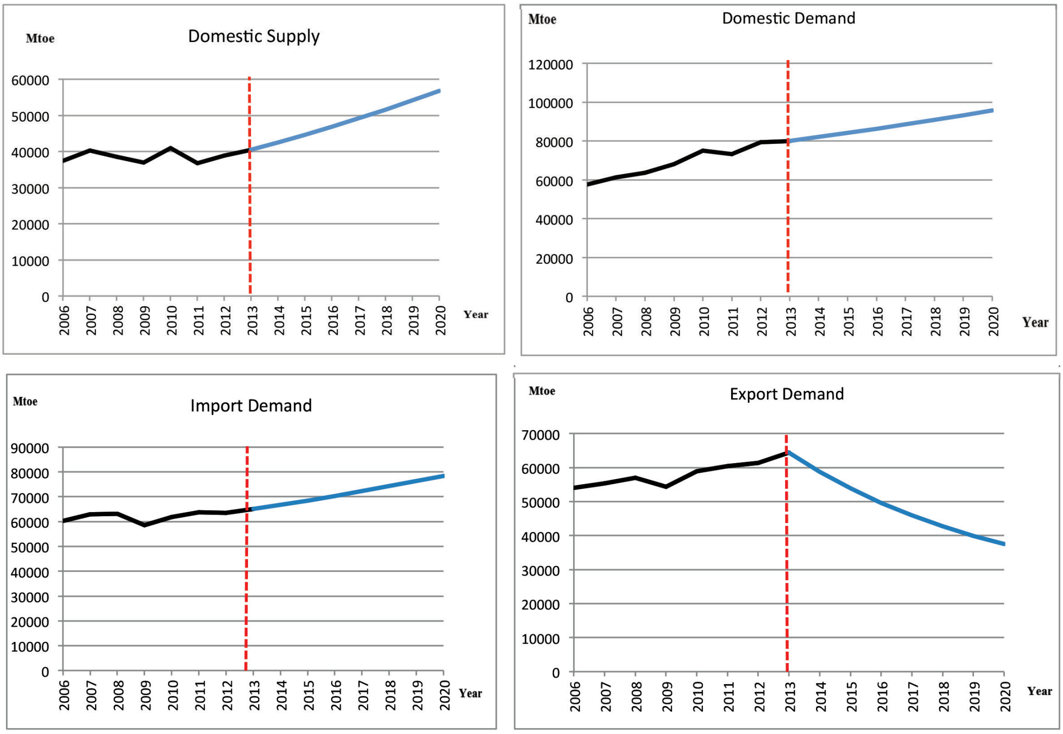

Figure 1: Forecasting Results of Domestic and International Bioenergy Markets in the EU28 Region from 2014-2020

Note: The black line referred to available data; the vertical line referred to the threshold between historical data and forecasted data.

Table 2: Multiple breakpoints test results

Model	Supply	Demand	Import	Export
F-statistic	4.041	7.661	13.892	9.864
p-value	8.58	8.58	10.13	10.13

exists, then these should be 0, or at least they have no pattern. Prediction degree of autoregressive and moving average can be seen from the correlogram plot of auto-correlation function (ACF) and partial auto-correlation function (PACF). In Figure 2, the applied ACF (Auto Correlation Function) and the PACF (Partial Auto Correlation Function) for all three models (EU28 zone, first world and second world states) resulted in no indictors of relationship since all the indices were within the acceptable fault levels.

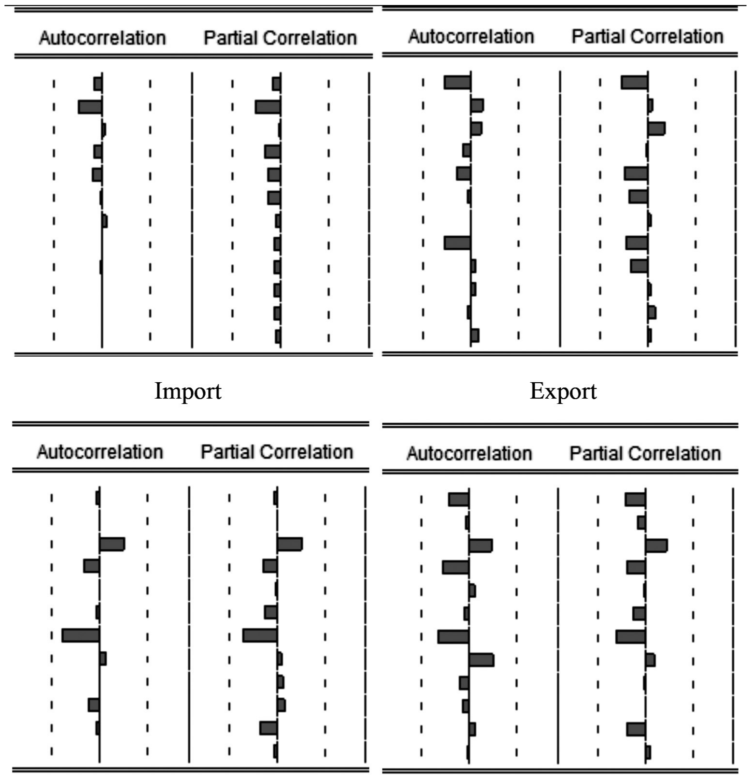

Figure 2: Residual correlograms function for the models test results

It is important to evaluate forecast accuracy using genuine forecasts, that is, it is invalid to look at how well a model fits the historical data**.** The accuracy of forecasts can only be determined by considering how well a model performs on new data that were not used when fitting the model. When choosing a model, it is common to use a portion of the available data for fitting and use the rest of the data for testing the model. Then the testing data can be used to measure how well the model is likely to forecast new data. Table 3 shows that measures are used to isolate the more reasonable and reliable forecast model. When investigating these statistical results on various models, the model with the lowest values for RMSE/MAE (Root Mean Square Error/Mean Absolute Error) gives the most precise predictions. RMSE relies on a quadratic loss method. It therefore investigates high prediction errors and is more complicated than the MAE approach. Table 3 shows that the import model followed by the export model are more reliable forecasts out of the four market models because they result in lower RMSE; 2.01 and 2.20 and MAE; 1.42 and 1.54, respectively. The Mean Absolute Parentage Error (MAPE) is often reported in % (scale-free) terms. The supply model result of 859.77 shows a better predictive performance measured by a reduction of the MAPE of forecasts - as compared to the other three models' model. TIC (Theil's Inequality Coefficient) have the value among [0,1]. An accurate forecasted analysis would result either TIC=0 or RMSE=0. This refers to that TIC of import and export models shows lower rates in comparison with the other rates of the models 0.11 and 0.2, respectively.

The forecasted analysis can foresee one of these properly but not the rest. However, Table 3 provides a BP (bias proportion) and VP (variance proportion), which are related to the accuracy of the forecasted analysis of the mean and variance, respectively, of the series in the forecast term.

Small bias and variance proportions in the import model 0.01 and 0.04 point to higher accuracy in forecasting of the mean and variance, respectively, compared to the other models. The covariance proportion captures the remaining unsystematic forecast error. This proportion will be large relative to the bias and variance proportions if the forecasts of the mean and variance are accurate (the bias, variance and covariance proportions sum to unity). 1% of the total forecast error (TFE) is due to high accuracy in forecasting the mean of the forward premium (bias proportion). About 4% of the TFE is due to low accuracy in forecasting the variance of the forward premium (variance proportion). The remaining 95% is due to unsystematic forecast error (covariance proportion). This suggests, that relatively speaking, a major ratio of the TFE is of the low accuracy level in forecasting the mean of the forward premium.

SMAPE (Symmetric Mean Absolute Percent Error) is an accuracy scale based on percentage errors and an alternative to MAPE (Mean Absolute Percent Error) when there are zero or near-zero demands for items. SMAPE self-limits to an error ratio of 200%, lowering the impact of these low quantum items. Implement the SMAPE whose values are between 0 and 200%. Items with low quantum are problematic because they would otherwise have infinitely high error ratios that bias the total error ratio. SMAPE can be computed through the forecast minus actuals divided by the sum of forecasts and actuals. In Table 3, the SMAPE indicator represents the high value, after which all error values will be ignored.

This study tests comparatively the accuracy of results from a research carried out Alsaleh *et al.* (2017) and the findings confirmed the results of the local supply tendency for the EU-28 zone in regard to bio-energy consumption during the period between 2006 and 2020. Consistent with the outcome of the earlier study by Alsaleh *et al.* (2017), this study presents the time trend of domestic demand for bio-energy for the term between 2006 and 2020. From the beginning of 2006, local demand for bio-energy increased significantly through 2014 and it is predicted to continue the rate of increase until at least 2020 in the EU-28 region. Importantly, this study emphasised, with a high accuracy level, the output of prior study by Alsaleh *et al.* (2017), where bio-energy imports demand increased from the volume of 731.8 thousand GWh in 2007 to 756.6 thousand GWh in 2013 and is forecasted to increase to 912.3 thousand GWh by 2020 in the EU28 region. A previous study by Alsaleh *et al.* (2017) stated that EU-28 zone export demands have increased from the volume of 628.3 thousand GWh in 2006 to 748.8 thousand GWh in 2013 and is predicted to decrease sharply to 436.3 thousand GWh in 2020, which is consistent with the finding of this study. Furthermore, consistent with the previous

Table 3: Testing forecasted results

Test	Supply	Demand	Import	Export
Root Mean Square Error (RMSE)	3.42	3.87	2.01	2.20
Mean Absolute Error (MAE)	2.95	3.43	1.42	1.54
Mean Absolute Parentage Error (MAPE)	859.77	5249.45	3249.80	1244.92
Theil's Inequality Coefficient (TIC)	0.22	0.22	0.11	0.12
Bias Proportion (BP)	0.01	0.01	0.01	0.01
Variance Proportion (VP)	0.20	0.20	0.04	0.05
Covariance Proportion (CP)	0.79	0.79	0.95	0.94
Theil's U 2 Coefficient (TU2C)	63.08	388.35	215.66	79.26
Symmetric Mean Absolute Parentage Error (SMAPE)	84.26	89.12	71.12	69.21

study by Alsaleh *et al.* (2017), the findings of this study present the time scheme supply of bioenergy in first world states during the period between 2006 through 2020. The known tendency of bio-energy supply is foreseeable to enhance importantly during the period 2014-2020, compared to the one in 2007.

Moreover, the time scheme focused on local demand of first world states for bio-energy during the period between 2006 through 2020. In 2006, local demand for bio-energy increased largely to attain a high level in 2014 and it is expected to keep increasing until 2020. Moreover, bioenergy import trends increased during the period between 2007 and 2013 and are predicted to increase largely by 2020 in first world states. Based on previous research by Alsaleh *et al.* (2017), developed countries export trends have increased primary during the period 2006 and 2013 and are expected to decline significantly in 2020 is consistent with the results of this study. In developing countries, the results of this study confirm the finding of an earlier study by Alsaleh *et al.* (2017) where bioenergy import tendency increased significantly from 79 thousand GWh in 2007 to 98.7 thousand GWh in 2013 and which are expected to increase slowly to 10.2 GWh by 2020. However, in second states, export tendency was enhanced largely from 109.2 thousand GWh in 2007 to 173.2 thousand GWh in 2013 and they are predicted to decline largely to 142.11 thousand GWh by 2020, consistent with our findings. In 2006, the forecasted tendency of bio-energy supply increased slightly until the end of 2013 and this is expected to increase largely by 2020 (Alsaleh *et al.,* 2017). Our findings assured earlier research done by Alsaleh *et al.,* (2017) where in 2006, local demand for bioenergy had partially inclined and it was predicted to increase further by 2014 and continue to rise by 2020.

Conclusion

The EU28 region forecasted model for the bioenergy market showed an increase in the ratios of supply, demand and the import of bio-energy products, which is logical for achieving the 2020 NREAP objectives. However, export rates are predicted to decrease markedly in all market models, referring to the significant efforts of the EU-28 states to enhance local demand of bio-energy products by 20 percent aligned with the NREAPs. According to the evaluation of the forecasted accuracy applied for second world states, there is a gap in the bio-energy supply that can lead to the high expense of bio-energy supplies. There is a shortage in political aspiration for bio-energy supply of the EU zone regimes and current bio-energy supply in world second states of EU (Scowcroft & Nies, 2011). The most noticeable elaboration for this situation is that the expense of bio-energy supply is to increase sharply in world first states of EU due to the shortage of advanced materials. Regardless, it could be that energy producers have in common with other energy applications that have lower cost and higher revenue.

These results suggest caution about energy markets and how markets' mechanism is fundamental to bio-energy regulation. Anyhow, the EU-28 zone states could use high efficiency approaches to decrease the gross generation expense of the bio-energy factory. Moreover, the EU-28 states could generate more attractive bio-energy products in the energy markets like having adequate utilisation for the bio-energy stock by a second production stock for bio-energy. They could also improve the technical efficiency applications over time and implement a capital co-integration method among bio-energy and other energy sections to decrease the input expense and apply advanced methods. Other activities could include managing workshop and conference sessions to develop workforce capabilities that can meet the demand of a high technical efficiency in the bio-energy sector. Thus, these actions would push the bio-energy market in the EU-28 zone further and lead to an attractive output in the energy market in comparison with other types of energy outputs.

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