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Modeling and Forecasting Energy Consumption in the Manufacturing Industry in South Asia

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ABSTRACT: The aim of this study is to model energy consumption and Manufacturing Value Added (MVA) in the industry level of five South Asian countries. Firstly, a cross-sectional model was developed by using R-statistical software to estimate the MVA with energy consumption being the independent variable. Secondly, a twenty years data series was analyzed to forecast volume of energy consumption in the manufacturing industry for five countries in a comparative manner. Thus, a prediction model was developed by using the time series forecasting system of the SAS statistical software and evaluated using Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percent Error (MAPE) with forecasts made up to year 2021. The forecasted energy consumption data might be used in the cross-sectional model to forecast MVA. Besides, based on the increasing trends in volume of energy, industry should prepare now for using efficient and clean energy in order to achieve an environment friendly and sustainable manufacturing industry.

Keywords: Energy Consumption; Manufacturing Value Added (MVA); Cross-sectional model; Time Series Model
JEL Classifications: C21; C22; Q47; L60

1. Introduction

The South Asian economy is growing rapidly. Along with the population growth, production of commodities is rising to serve public demand such as expanding the scope of manufacturing industry. Basic metals, non-metallic minerals, Textiles and Apparels, Food industry etc. are vastly contributing to the Manufacturing Value Added (MVA) of India, Bangladesh, Pakistan, Nepal and Sri Lanka (Zahan and Upadhyaya, 2012). The capital and energy intensive production process is consuming energy in high volumes. Electricity, natural gas, coal and oil are mostly used in the manufacturing industry for mass and quality production. Apparently, growth of industrial nations consider that energy input is the 4th most important production factor along with labor and capital (Imran and Siddiqui, 2010). A co-integration analysis was applied to the linear combinations of time series of production output, labor, and energy for some countries showing that production output is relatively much smaller for labor and much larger for energy (Kuemmel et al., 2008). With energy being an important production factor Manufacturing Value Added (MVA) is becoming a growing concern. MVA is the significant part of the Gross Domestic Product (GDP) which plays a significant role in national income and export earnings. In the next section energy and MVA are discussed in detail:

1.1. Energy

Energy; fuel and electricity, is an important factor in manufacturing industry. In economic statistics, inputs are disaggregated into two major groups, namely primary inputs (factors of production) comprising labor input and capital input; and intermediate inputs (materials and supplies, energy, industrial services, etc.). The change in productivity occurs as a result of the change in the efficiency of the use of all these inputs. Energy is one of the concerns as an intermediate input. Thus, change in energy input changes the total factor productivity. This is particularly important since modern production technology is energy intensive. Moreover, energy is a significant factor and key player in the production process, because it can directly be used to produce a final product (Stern, 2000).

1.2. Manufacturing Value Added (MVA)

Manufacturing Value Added (MVA) is a comprehensive measure of production that includes the cost of labor, consumption of capital (depreciation) and operating surplus. MVA is measured at basic prices so it is free of the variation caused by the ever changing rate of commodity taxes. This is measure of productivity indicates the level of industrial development achieved by a country as MVA is estimated as the total of value added of all manufacturing activities in the country (UNIDO, 2010).

However, this study is to depict the direction of the relationship of the production factor energy and the MVA using a linear regression model. Section two consists of a literature review and the motivation for this work, section three presents the methodology and data collection used, and section four is focused on empirical results and a final section with conclusion.

2. Literature Review and Motivation

There are wide ranges of studies in exploring the relation between energy consumption and economic growth for different geographical context (See Ozturk, 2010 for detailed literature survey). Imran and Siddiqui (2010) investigated the causal relationships between energy consumption and economic growth within a multivariate framework that includes capital stock and labor input for the panel of three SAARC countries (Bangladesh, India, and Pakistan). They found a co-integration relationship between energy consumption and economic growth. Using panel co-integration, Noor and Siddiqi (2010) also examined the causal link between energy use and economic growth for five South Asian countries. Similar aspects; energy consumption and economic growth are also analyzed by Binh (2011) for Vietnam, Adebola (2011) for Botswana (focused on Electricity consumption), Apergis and Danuletiu (2012) for Romania, Khan and Qayyum (2007) for South Asia, Chary and Bohara (2010) for three South Asian countries, Aqeel and Butt (2001), Mahmud (2000), Siddiqui (2010) for Pakistan as well as Lau et al., (2011) for Asian countries. A cross-sectional study is also conducted by Sahu and Narayanan (2011) to analyze the relationship between energy intensity and total factor productivity for the Indian manufacturing industry. It found energy intensity are negatively related to the total factor productivity what implies the need for fostering energy efficiency at firm level.

Belke et al. (2010, 2011) referred a table of studies dealing with energy consumption and growth which is worth presenting here. It shows the studies focused on production side often include capital stock and labor along with energy.

From Table 1, it is seen that, the energy and growth nexus of India, Pakistan and Sri Lanka are discussed in different papers. Analyses for different geographical region are also available to reveal the relationship between energy and growth.

There are several studies on energy and manufacturing GDP Forecasting. Paul (1998) used an ARIMA model of energy forecasting with minimum value of Standard Error (SE), Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Mean Absolute Percent Error (MAPE). Bhuiyan et al., (2008) conducted Manufacturing GDP forecast by developing ARIMA model for Bangladesh. A pre-selected ARIMA model was chosen on the basis of the criteria mentioned in Paul (1998) and forecasting is thereby derived. Khan et al., (2011) developed energy forecasting for Gas sector. They used a Linear and Exponential time series wizard (Long-range Energy alternative Planning software).

In the above studies energy consumption is evaluated in relation with GDP and/or economic growth. The relation between energy consumption and MVA forecasting has received little attention in the literature. This study investigates the core relation between energy consumption in the manufacturing industry and manufacturing value added (MVA) and forecasting the MVA based on the theoretical energy consumption. The overall presentation of the analysis is maintained in a comparative way so that readers realize easily the difference among the consumption and production structures of the manufacturing industry.

Table 1. Overview of selected studies

Study	Method	Countries	Result
Kraft and Kraft (1978)	Bivar. Sims Causality	USA	Growth →Energy
Yu and Choi (1985)	Bivar.Granger test	South Korea Philippines	Growth →Energy Energy →Growth
Erol and Yu (1987)	Bivar.Granger test	USA	Energy ~Growth
Yu and Jin (1992)	Bivar. Granger test	USA	Energy ~Growth
Masih and Masih (1996)	Trivar. VECM	Malaysia, Singapore & Philippines India Indonesia Pakistan	Energy ~Growth Energy →Growth Growth →Energy Energy ↔ Growth
Glasure and Lee (1998)	Bivar. VECM	South Korea & Singapore	Energy ↔ Growth
Masih and Masih (1998)	Trivar. VECM	Sri Lanka & Thailand	Energy →Growth
Asafu-Adjaye (2000)	Trivar. VECM	India & Indonesia Thailand & Philippines	Energy →Growth Energy ↔ Growth
Hondroyiannis et al. (2002)	Trivar. VECM	Greece	Energy ↔ Growth
Soytas and Sari (2003)	Bivar. VECM	Argentina South Korea Turkey Indonesia & Poland Canada, USA & UK	Energy ↔ Growth Growth →Energy Energy →Growth Energy ↔ Growth Energy ↔ Growth
Fatai et al. (2004)	Bivar. Toda and Yamamoto (1995)	Indonesia & India Thailand & Philippines	Energy→Growth Energy ↔ Growth
Oh and Lee (2004b)	Trivar. VECM	South Korea	Energy ↔ Growth
Wolde-Rufael (2004)	Bivar. Toda and Yamamoto (1995)	Shanghai	Energy →Growth
Lee (2005)	Trivar. Panel VECM	18 developing nations	Energy →Growth
Al-Iriani (2006)	Bivar. Panel VECM	Gulf Cooperation C.	Growth→Energy
Lee and Chang (2008)	Mulitv. Panel VECM	16 Asian countries	Energy →Growth
Lee et al. (2008)	Trivar. Panel VECM	22 OECD countries	Energy ↔ Growth
Narayan and Smyth (2008)	Multiv. Panel VECM	G7 countries	Energy →Growth
Apergis and Payne (2009a)	Multiv. Panel VECM	11 countries of the Commonwealth of Independent States	Energy ↔ Growth
Apergis and Payne (2009b)	Multiv. Panel VECM	6 Central American countries	Energy →Growth
Ozturk et al. (2010)	Pedroni panel cointegration	51 Low and middle income countries	-Growth→Energy for low income countries -Energy ↔ Growth for middle income countries
Lee and Lee (2010)	Multiv. Panel VECM	25 OECD countries	Energy ↔ Growth
Kaplan et al. (2011)	Multiv. Granger test	Turkey	Energy ↔ Growth

Notes: X _ Y means variable X Granger-causes variable Y.
Source: Belke et al. RUHR Economic Paper, June 2010.

3. Data and Methodology

The data used was taken from IEA and UNIDO databases. The twenty years time series (from 1990 to 2009) of energy consumption (kilo tonne oil equivalent; ktoe) and MVA (in thousands US$) in the manufacturing industry for five South Asian countries (Bangladesh, India, Nepal, Pakistan and Sri Lanka) are taken to measure the cross sectional model. The forecasting is causal based on the assumption that energy consumption impacts MVA. Then the same energy data is used to conduct the time series analysis.

Firstly, using the R statistical software, cross-sectional relation between energy consumption and MVA being the dependent variable is analyzed. A simple linear regression model is conducted where there is a value of x (energy volume) with corresponding value of y (MVA).

The second analysis is based on a time series analysis of energy consumption. To forecast the energy consumption till 2021 Time Series Forecasting System of the statistical software SAS is used. The software fits the models automatically with the selection criteria being Mean Square Error, Root Mean Square Error, Mean Absolute Error, Mean Absolute Percent Error and R-Squared. Three different models resulted from five different energy volume series. The models are described below:

3.1) Linear Trend

This time series illustrates how simple linear regression can be used to forecast a time series with a linear trend. The methods of simple linear regression are used to develop such a linear trend line. The fact is clear that in forecasting the independent variable is time. Thus, for estimating the linear trend in a time series, the following estimated regression equation is used:

$$T_t=b_0+b_1t \qquad (1)$$

Where

T_t=linear trend forecast in period t
b_0= intercept of the linear trend line
b_1=slope of the linear trend line
t=time period

3.2) Linear (Holt) Exponential Smoothing

Charles Holt developed a version of exponential smoothing (Anderson et al., 2011) that can be used to forecast a time series. The special matter of Holt's is to use two smoothing constant α and β to 'smooth out' the randomness or irregular fluctuation in a time series and three equations.

$$L_t=\alpha Y+(1-\alpha)(L_{t-1}+b_{t-1}) \qquad (2)$$
$$b_t=\beta(L_t-L_{t-1})+(1-\beta)b_{t-1} \qquad (3)$$
$$F_{t+k}=L_t+b_tk \qquad (4)$$

Where

L_t =estimate of the level of the time series in period t
b_t =estimate of the slope of the time series in period t
α=smoothing constant for the level of the time series
β= smoothing constant for the slope of the time series
F_{t+k}=forecast for k periods ahead
k=the of period ahead to be forecast

3.3) Damped Trend Exponential Smoothing

A damping parameter (φ) is added in Holt's formula to give more control over trend extrapolation (Taylor, 2003). The result is a method stationary in first differences, rather than second differences as in the Holt method (Gardner & McKenzie, 2010a).The damped trend exponential smoothing expressions are as follows

$$L_t=\alpha Y_t+(1-\alpha)(L_{t-1}+\varphi T_{t-1}) \qquad (5)$$
$$b_t=\beta(L_t-L_{t-1})+(1-\beta)\varphi b_{t-1} \qquad (6)$$
$$F_{t+k} - L_t + \sum_{i-1}^{k} \varphi^i b_t \qquad (7)$$

Gardner & McKenzie (1985b) explained that the method is identical to the standard Holt method presented in expressions (4-6) if φ=1. The trend is damped if 0<φ<1.

3.4) Residual Analysis

The regression model indicates that the assumption of energy consumption to be a linear function of MVA plus and error term ε. The expectation of this error term is zero. The value are independent and has a normal distribution. In this study, to determine the assumptions of error term to be appropriate residual plots such as Residual verses Fitted value, Quantiles (Q-Q), Scale locations and Leverage are discussed for the cross-sectional linear model. Moreover, normalized residual plots are analyzed for the time-series model.

4. Empirical Results

Different results are obtained by conducting data analyses. The key issues are presented here. The first model is the cross-sectional linear model.

4.1 Cross-Sectional model of Energy Consumption

Energy is taken as the independent variable. The aim is to see the impact of one unit (volume in ktoe) change of energy to MVA.

Descriptive statistics are presented in Table 2. The mean volume of energy consumption in the manufacturing industry for five countries is presented with other parameters. India holds the maximum volume whereas Nepal holds the lowest volume based on its size of manufacturing industry. The parameters and estimate of the linear model of energy and MVA is shown in Table 3.

Table 2. Summary Statistics for Energy Consumption

Country	Sample Size	Min	Max	1^{st} Quantile	Mean	3^{rd} Quantile
Bangladesh	20	753	4872	1298	2109	2622
India	20	69627	134611	75649	91167	97617
Nepal	20	99	427	152	250	342
Pakistan	20	7933	18989	10261	12523	15609
Sri Lanka	20	688	2126	916	1434	1906

Table 3. Cross-Sectional model parameters

Country	Parameter	Estimate	Standard Error	t-value	Probability	Multiple R-squared	Adjusted R-squared
Bangladesh	b_0 b_1	2.202e+06 2.459e+03	2.257e+05 9.373e+01	9.753 26.237	1.31e-08 8.50e-16	0.9745	0.9731
India	b_0 b_1	-5.623e+07 1.376e+03	6.760e+06 7.273e+01	-8.319 18.922	1.4e-07 2.5e-13	0.9521	0.9495
Nepal	b_0 b_1	224208.1 791.3	30879.7 112.9	7.261 7.010	9.48e-07 1.53e-06	0.7319	0.717
Pakistan	b_0 b_1	-3.790e+06 1.251e+03	8.305e+05 6.393e+01	-4.564 19.561	0.000241 1.41e-13	0.9551	0.9526
Sri Lanka	b_0 b_1	491466.21 1215.71	143671.78 94.08	3.421 12.923	0.00305 1.52e-10	0.9027	0.8973

The R^2 showed us very good linear model except that for Nepal. This coefficient of determination shows a good fit of in predicting the MVA in relation with the energy.

Cross-Sectional Model Residual Analysis

The assumption being the variance of the error term is same for all values and the assumed model is an adequate representation of the relationship between energy and MVA; to determine whether it is appropriate to fit the model into the data set. It is found that the points are randomly scattered about the x-axis for all five countries; with no obvious pattern in the residual plot. This indicates that the data varies randomly about the line of best fit, so the linear model is appropriate for the data. The assumption of normality of the error term is also satisfied because the normal probability plots (Q-Q plot) follow linear trend. No observation is detected to be considered as potential outlier with absolute value larger than 3.

The leverage detected 3 influential observations fall in 50th percentile. All are for the year 2009 for Bangladesh, India and Pakistan. The observations of Bangladesh and Pakistan can be ignored according to Cook's Distance: if $D^1_i < 1$, the observation can be ignored (Anderson et al., 2011). Only

[1] D_i=Cook's distance measure for observation i; here observation of the year 2009.

one more observation that is for India; D>1. So, removing that observation the programming is run again. The parameter coefficient is not found that unstable as well as the MVA estimate seems reasonable. So, in conclusion, the data fits the model perfectly.

4.2 Time Series model of Energy consumption

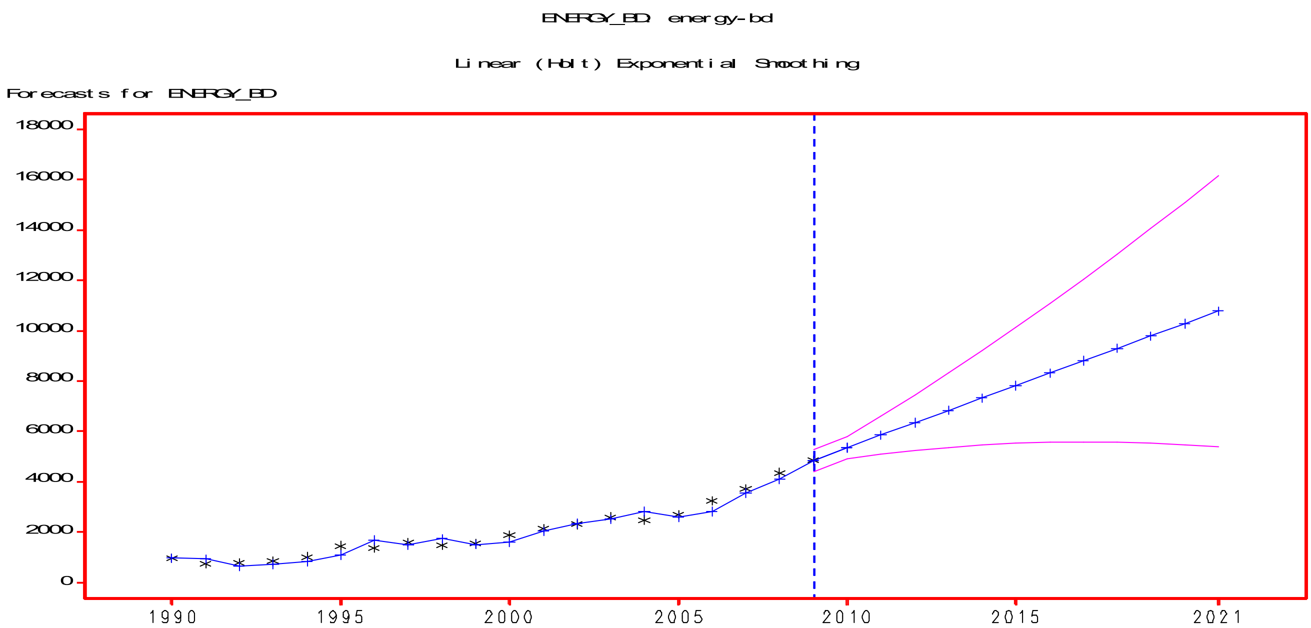
In the second phase of the analysis time series model was conducted based on twenty years energy consumption data. The automatic model forecasting system results those models for five different series. For Holt Exponential Smoothing there are two and for Damped Exponential Smoothing, three parameters.

Table 4. Time Series Energy Forecasting Model for Bangladesh

<table>
<tr><td>Energy / Bangladesh</td><td colspan="5">Model Label: Linear(holt) Exponential Smoothing</td></tr>
<tr><td></td><td></td><td>Estimate</td><td>Standard Error</td><td>T</td><td>Prob>|T|</td></tr>
<tr><td>Model Parameter</td><td>LEVEL Smoothing Weight</td><td>0.99900</td><td>0.1733</td><td>5.7632</td><td><.0001</td></tr>
<tr><td></td><td>TREND Smoothing Weight</td><td>0.40518</td><td>0.2011</td><td>2.0145</td><td>0.0592</td></tr>
<tr><td></td><td>Residual Variance (sigma squared)</td><td>51001</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Smoothed Level</td><td>4872</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Smoothed Trend</td><td>92.65700</td><td></td><td></td><td></td></tr>
<tr><td>Statistics of fit</td><td>MSE</td><td colspan="3">Mean Square Error</td><td>45901.3</td></tr>
<tr><td></td><td>RMSE</td><td colspan="3">Root Mean Square Error</td><td>214.24579</td></tr>
<tr><td></td><td>MAPE</td><td colspan="3">Mean Absolute Percent Error</td><td>10.68541</td></tr>
<tr><td></td><td>MAE</td><td colspan="3">Mean Absolute Error</td><td>176.36734</td></tr>
<tr><td></td><td>RSQUARE</td><td colspan="3">R-Squared</td><td>0.966</td></tr>
<tr><td></td><td>AJDRSQ</td><td colspan="3">Adjusted R-Squared</td><td>0.964</td></tr>
<tr><td></td><td>AIC</td><td colspan="3">Akaike Information Criterion</td><td>218.68496</td></tr>
<tr><td></td><td>SBC</td><td colspan="3">Schwarz Bayesian Information Criterion</td><td>220.67642</td></tr>
</table>

Table 4 presents the time series model for energy consumption for the manufacturing industry in Bangladesh. The t-value at 5% confidence level is significant from that of the estimate.

Figure 1. Energy Consumption Forecasting Graph for Bangladesh



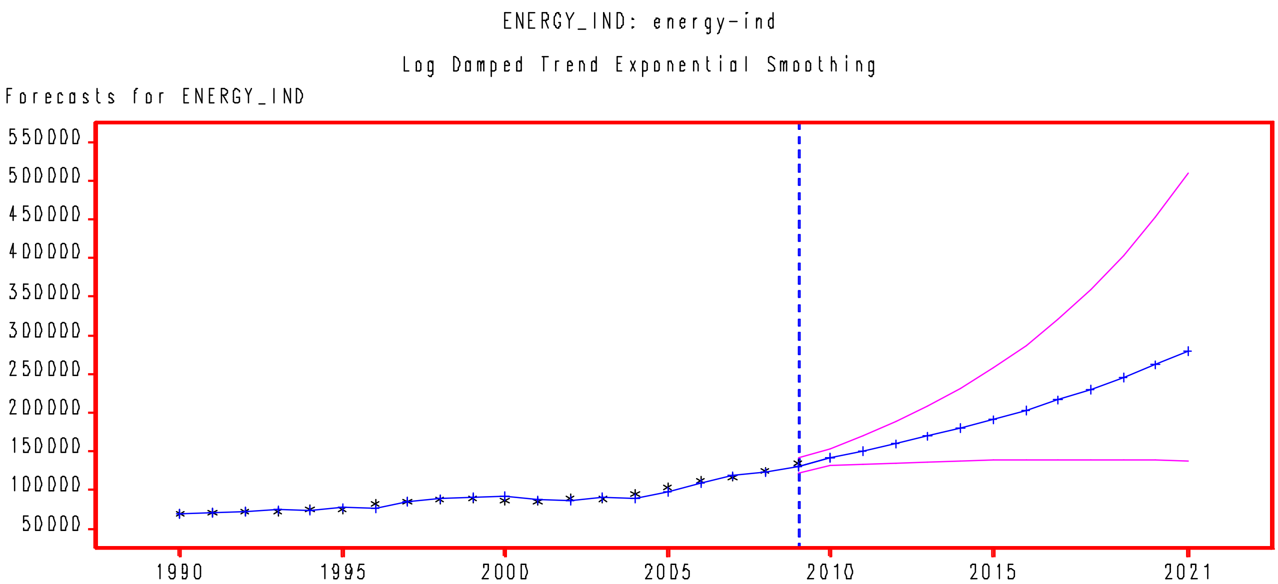
For the energy consumption of Bangladesh the linear Holt Exponential Smoothing is obtained. Hence, the value is as usual based on the parameters shown in the box of Statistics of fit of SAS programming. A forecasting graph is also shown in figure 1 to see the obvious trend of rising energy consumption.

Table 5. Time Series Forecasting Model of energy consumption for India

Energy / India	Model Label: Log Damped Trend Exponential Smoothing				
		Estimate	Standard Error	T	Prob>|T|
Model Parameter	LEVEL Smoothing Weight	0.99900	0.1822	5.4835	<.0001
	TREND Smoothing Weight	0.24228	0.1711	1.4162	0.1748
	DAMPING Smoothing Weight	0.99900	0.0571	17.5045	<.0001
	Residual Variance (sigma squared)	0.00152	--	--	--
	Smoothed Level	11.81012			
	Smoothed Trend	0.05685			
Statistics of fit	MSE	Mean Square Error	10649200		
	RMSE	Root Mean Square Error	3263.3		
	MAPE	Mean Absolute Percent Error	2.74794		
	MAE	Mean Absolute Error	2543.5		
	RSQUARE	R-Squared	0.967		
	AJDRSQ	Adjusted R-Squared	0.964		
	AIC	Akaike Information Criterion	329.61991		
	SBC	Schwarz Bayesian Information Criterion	332.60710		

The forecasting system analysis results in Log Damped Exponential Smoothing for the energy consumption data series of Indian manufacturing industry. The results are presented in Table 5. It has three parameters with significant differences with the critical values at 5% level. The forecasting trend graph in figure 2 is upward sloping for the next twelve years.

Figure 2. Energy Consumption Forecasting Graph for India



The model is a simple trend model presented in Table 6. The coefficient of determination (R^2) got a massive difference in developing the model. The data distribution is unusual as one sees in the first part of the forecasting graph. Hence, the forecasting value of energy consumption in the manufacturing industry in Nepal is also a crisscross one shown in figure 3.

Table 6. Time Series Forecasting Model of energy consumption for Nepal

Energy / Nepal	Best Fit Model Label: Linear Trend				
		Estimate	Standard Error	T	Prob>|T|
Model Parameter	Intercept Linear Trend Residual Variance (sigma squared)	84.93684 15.76316 4260	30.3177 2.5309 -	2.8016 6.2283 -	0.0118 <.0001
Statistics of fit	MSE Mean Square Error 3833.6 RMSE Root Mean Square Error 61.91593 MAPE Mean Absolute Percent Error 19.19480 MAE Mean Absolute Error 47.40737 RSQUARE R-Squared 0.683 AJDRSQ Adjusted R-Squared 0.665 AIC Akaike Information Criterion 169.03110 SBC Schwarz Bayesian Information Criterion 171.02256				

Figure 3. Energy Consumption Forecasting Graph for Nepal

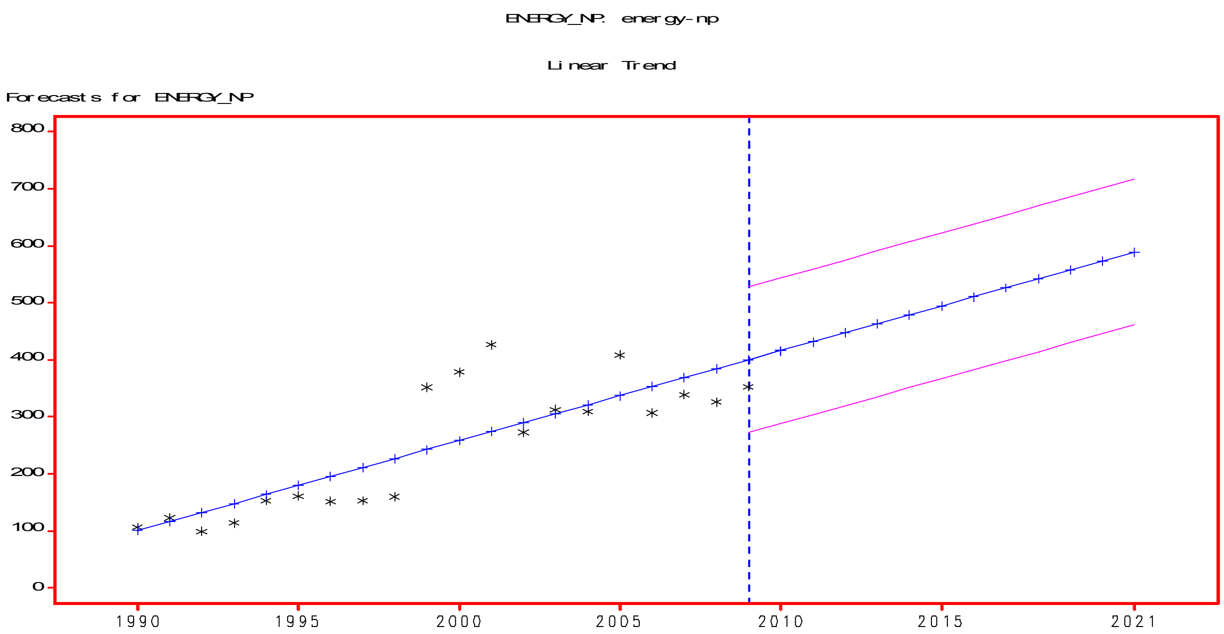
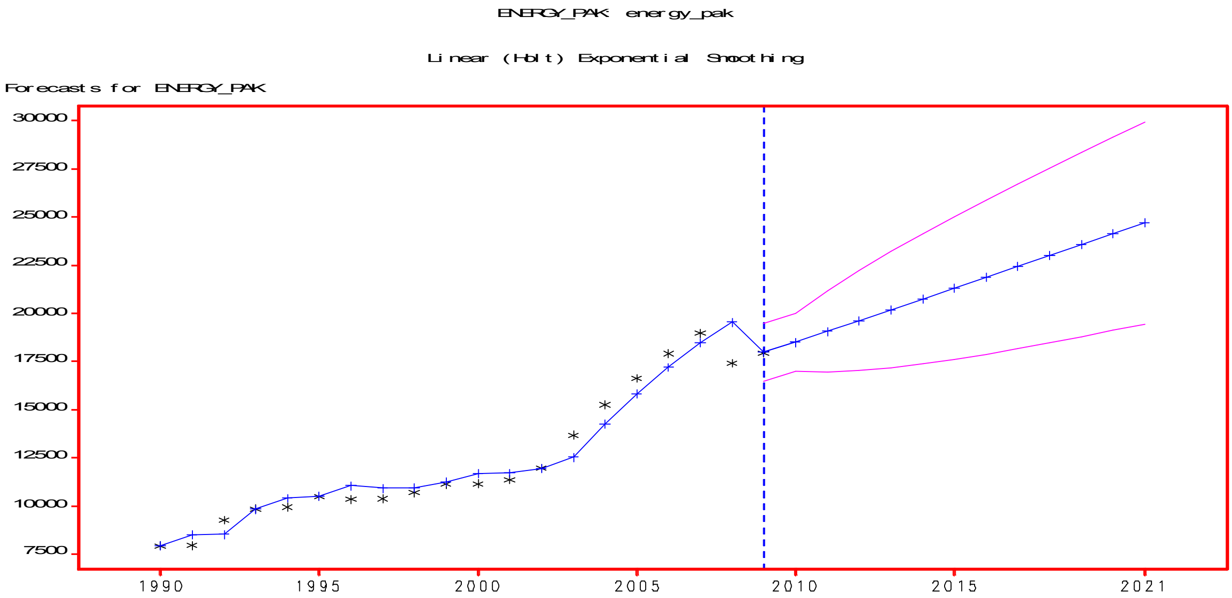


Table 7. Time Series Forecasting Model of energy consumption for Pakistan

Energy / Pakistan	Best Fit Model Label: Linear(holt) Exponential Smoothing				
		Estimate	Standard Error	T	Prob>|T|
Model Parameter	LEVEL Smoothing Weight TREND Smoothing Weight Residual Variance (sigma squared) Smoothed Level Smoothed Trend	0.99900 0.00100 590598 17944 562.95402	0.1674 0.0545 -	5.9674 0.0184 -	<.0001 0.9856 -
Statistics of fit	MSE Mean Square Error 531537.9 RMSE Root Mean Square Error 729.06645 MAPE Mean Absolute Percent Error 4.10767 MAE Mean Absolute Error 533.35340 RSQUARE R-Squared 0.955 AJDRSQ Adjusted R-Squared 0.953 AIC Akaike Information Criterion 267.67060 SBC Schwarz Bayesian Information Criterion 269.66206				

Figure 4. Energy Consumption Forecasting Graph for Pakistan



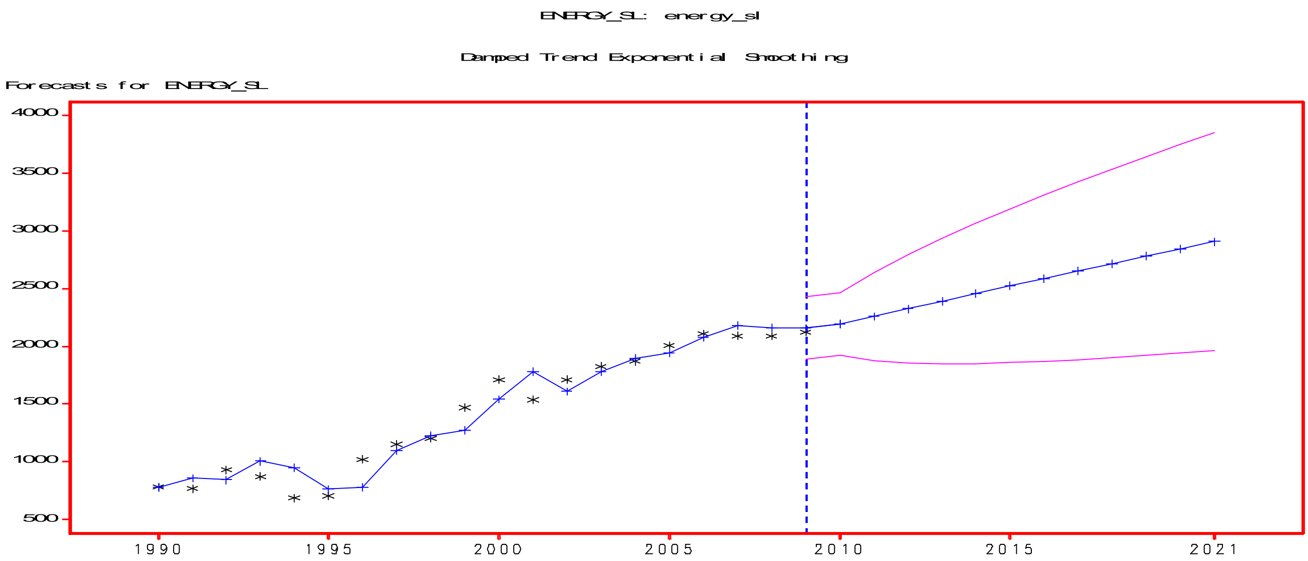
The analysis of the energy consumption time series of the manufacturing industry of Pakistan results in Linear (Holt) Exponential Smoothing as best fit model. The critical value differs from the computed value of two parameters at 5% significance level. The results are presented in Table 7. Also, the smooth distribution of series value has a forecasting graph with an upward slope shown in figure 4.

Table 8. Time Series Forecasting Model of energy consumption for Sri Lanka

Energy / Sri Lanka	Best Fit Model Label: Damped Trend Exponential Smoothing				
		Estimate	Standard Error	T	Prob>|T|
Model Parameter	LEVEL Smoothing Weight	0.99857	0.1805	5.5313	<.0001
	TREND Smoothing Weight	0.00100	0.1181	0.008469	0.9933
	DAMPING Smoothing Weight	0.99396	0.0170	58.3425	<.0001
	Residual Variance (sigma squared)	19196	-	-	-
	Smoothed Level				
	Smoothed Trend	2126			
		67.93159			
Statistics of fit	MSE Mean Square Error	16316.7			
	RMSE Root Mean Square Error	127.73683			
	MAPE Mean Absolute Percent Error	8.77101			
	MAE Mean Absolute Error	101.08406			
	RSQUARE R-Squared	0.940			
	AJDRSQ Adjusted R-Squared	0.933			
	AIC Akaike Information Criterion	199.99889			
	SBC Schwarz Bayesian Information Criterion	202.98608			

Table 8 presented the time series analysis of the energy consumption in the manufacturing industry in Sri Lanka has had the best fit model as Damped Trend Exponential Smoothing. This is a good model as the R^2 is close to one. On the other hand, there is a significant difference between t-value and computed parameters. The forecasting graph in figure 5 shows a rising trend of energy consumption.

Figure 5. Energy Consumption Forecasting Graph for Sri Lanka



To validate the model, the residual analysis was also performed. Standardized residual plot (a random variable is standardized by subtracting its mean and dividing the results by its standard deviation) is analyzed to see whether 95% of the standardized residuals are between -2 and +2. The range would assure us about the question of assuming the residuals (ε) having normal distribution. There is no observation detected as outliers in the Normalized Residual plot. So, the model fits the data set perfectly.

4.3 Prediction of Energy Consumption

Based on the time series model of five countries, now the estimated energy consumption in the manufacturing industry for coming twelve years is presented in table 9 below. The forecasting shows us an apparent growth of consumption of energy. The forecast value shows that in twelve years, Bangladesh and India are going to consume twice the volume of energy that it used in 2010. On the other hand, the growth of manufacturing energy consumption is fairly steady in Pakistan and in Sri Lanka. Though Nepal is not consuming that volume in relation with India, consumption is rising slowly.

Table 9. Prediction of energy consumption (in ktoe) for five countries

Country	Bangladesh	India	Nepal	Pakistan	Sri Lanka
2010	5365	142582	415	18507	2194
2011	5857	151082	431	19070	2261
2012	6350	160161	447	19633	2327
2013	6843	169875	463	20196	2394
2014	7335	180290	479	20759	2460
2015	7828	191479	494	21322	2525
2016	8321	203524	510	21885	2590
2017	8813	216518	526	22448	2655
2018	9306	230565	542	23011	2719
2019	9799	245782	557	23574	2783
2020	10291	262304	573	24137	2847
2021	10784	280279	589	24699	2910

5. Conclusion

Energy consumption in the manufacturing industry affects the MVA. Based on this assumption a linear model was conducted for energy consumption and estimated the MVA first in a cross-sectional regression analysis. In the second phase time series analysis was done for the energy consumption in the manufacturing industry for five South Asian countries. Forecasting of energy consumption is made for the coming twelve years; from 2010 to 2021. Nonetheless, by using the cross-sectional linear model, one can easily use the estimated energy volume to forecast the MVA.

The model shows that energy consumption is mounting. Considering the starting point and measuring the growth of energy consumption between the year 1990 and 2021, one finds a huge increase; Bangladesh by 11 times, India by 4 times, Nepal by 5 times, Pakistan by 3.5 times and Sri Lanka by 3.75 times. Nevertheless, India would alone consume almost 7 times the amount of energy that the other four countries should altogether consume as forecasted for the year 2021.

Environment matters. Green-house gas increases. Along, sustainable industry is demanded for sustainable wealth creation. Specific targets for sustainable development policy are recommended to reduce carbon emissions for manufacturing industry (Zahan et al., 2012). So, energy consumption should be efficient; as clean as possible. Based on the predicted energy consumption in manufacturing industry in South Asia, preparation is necessary for the energy supply, system and substitute where policy matters.

References

Adebola, S.S. (2011), *Electricity Consumption and Economic Growth: Trivariate investigation in Botswana with Capital Formation*. International Journal of Energy Economics and Policy, 1(2), 32-46.

Apergis, N., Danuletiu, D. (2012), *Energy Consumption and Growth in Romania: Evidence from a Panel Error Correction Model.* International Journal of Energy Economics and Policy 2(4), 348-356.

Anderson, D., Sweeny, D., Williams, T. (2011*), Statistics for Business and Economics*. Ohio: South-Western, CENGAGE Learning.

Aqeel, A., Butt, M.S. (2001), *The Relationship between Energy Consumption and Economic Growth in Pakistan*. Asia-Pacific Development Journal 8(2), 101-110.

Belke, A,. Dreger, C., Haan, F., (2010), *Energy Consumption and Economic Growth New Insights into the Cointegration Relationship*. RUHR Economic Papers 190.

Belke, A., Dobnic, R., Dreger, C. (2011), *Energy consumption and economic growth: New insights into the cointegration relationship*.Energy Economics 33, 782-789.

Bhuiyan, M.N.A. Ahmed, K.S., Jahan, R. (2008), *Study on Modeling and Forecasting of the GDP of Manufacturing Industries in Bangladesh*. Chiang Mai University Journal of Social Science and Humanities 2(2), 143-157.

Binh, P.T. (2011), Energy *Consumption and Economic Growth in Vietnam: Threshold Cointegration and Causality Analysis.* International Journal of Energy Economics and Policy 1(1), 1-17.

Bohara, A.K., Charry, R.S. (2010), *Energy consumption in Bangladesh, India, and Pakistan: cointegration analysis.* The Journal of Developing Areas 44(1), 41-50.

Gardner, E.S., Jr., McKenzie, E. (2010a), *Damped Trend Exponential Smoothing: A modeling viewpoint.* International Journal of Forecasting, 26(4), 661-665.

Gardner, E.S., Jr., McKenzie, E. (1985b), *Forecasting trends in time series*. Management Science 31, 1169-1176.

Imran, K., Siddiqui, M.M. (2010), *Energy Consumption and Economic Growth: A Case Study of Three SAARC Countries*. European Journal of Social Sciences 16(2), 206-213.

Kaplan, M., Ozturk, I., Kalyoncu, H. (2011), *Energy Consumption and Economic Growth in Turkey: Cointegration and Causality Analysis*. Romanian Journal for Economic Forecasting, 2011(2), 31-41.

Khan, A.M., Qayyum, A. (2007), *Dynamic Modelling of Energy and Growth in South Asia*. The Pakistan Development Review 46(4), 481-498.

Khan, S. Islam, A., Khan, H.I. (2011), *Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software*. Global Journal of Research in Engineering 11(1-1), 14-20.

Kuemmel, R., Stresin, R., Lindenberger, D. (2008), *Co-integration of output, capital, labor and energy*. The European Physical Journal B, 66(2), 279-287.

Lau, E., Chye, X-H., Choong, C-K. (2011), *Energy-Growth Causality: Asian Countries Revisited.* International Journal of Energy Economics and Policy 1(4), 140-149.

Mahmud, S.F. (2000), *The Energy Demand in the Manufacturing Sector of Pakistan: Some Further Results*. Energy Economics 22(6), 641-648.

Noor, S., Siddiqi, M.W. (2010), *Energy Consumption and Economic Growth in South Asian Countries: A Co-integrated Panel Analysis*. International Journal of Human and Social Sciences 5(14), 921-926.

Ozturk, I. (2010), *A Literature Survey on Energy-Growth Nexus*. Energy Policy, 38(1), 340-349.

Ozturk, I., Aslan, A., Kalyoncu, H. (2010), Energy consumption and economic growth relationship: evidence from panel data for low and middle income countries. Energy Policy, 38, 4422-4428.

Ozturk, I., Aslan, A. (2011), Are fluctuations in energy consumption per capita transitory? Evidence from Turkey. Energy Exploration & Exploitation, 29(2), 161-68.

Paul, J.C. (1998), *Modeling and Forecasting the energy consumption in Bangladesh*, PhD thesis, Department of Mathematics, University of North Bengal, West Bengal, India.

Sahu, S.K., Narayanan, K. (2011), *Total Factor Productivity and Energy Intensity in Indian Manufacturing : A Cross-Sectional Study*. International Journal of Energy Economics and Policy 1(2), 47-58.

Siddiqui, R. (2004), *Energy and Economic Growth in Pakistan*. The Pakistan Development Review 43(2), 175-200.

Stern, D.I. (2000), A *multivariate cointegration analysis of the role of energy in the US macro economy*. Energy Economics 22(2), 267-283.

Taylor, J. (2003), *Exponential Smoothing with a Damped Multiplicative Trend.* International Journal of Forecasting 19, 715-725.

UNIDO. (2010), *Industrial Statistics: Guidelines and Strategy*. United Nations Industrial Development Organization, Vienna, Austria.

Zahan, M., Sarker, T., Corradetti, R. (2012), *Policy and Projects: Reduction of Carbon Emissions in the manufacturing industry in South Asia*, Study as a part of PhD thesis, University of Turin. Forthcoming in *Journal of Economics and Sustainable Development*.

Zahan, M., Upadhyaya, S. (2012), *Energy Efficiency Indicators for the manufacturing industry in South Asia,* Working Paper done in UNIDO, Vienna, Austria as a part of PhD Thesis, April.