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Financial Stability of Energy Utilities in a Volatile Energy Market

Nirmalendunath Ghosh[1]

Abstract

Uncertainty in financial stability of the organization is expected due to unpredictable energy market on account of diversity in system environment .The paper aim to analyze financial stability of the electricity utility system in the long term and short term period due to the impact of economy, weather and political environment that may drive financial stability to instability or vice versa. And also to justify the role of technology diffusion as catalyst in restoring stability to corroborate the concept with reality by evaluating stability criteria with available data of different state electricity utilities. The analysis framed a mathematical expression linking market price of electricity and earnings per unit of electricity distributed to ascertain financial stability. Then the change in stability is derived by differentiating with different driving dimensions of economy, weather and policy issues. Finally evaluating the performance of the state utilities based on available data about their status justifying the concept involved in the analysis. There are changes in stability function from -ve uncertainty to +ve certainty because of the adaptation of technology in the system. Technology diffusion acts as catalyst to save the organization from instability that result in poor performance.

Keywords: Economic growth, Electricity utilities financial stability, Technology, Uncertainty

1. Introduction

Energy market in the country is depended on the availability of natural gas, oil and fossil fuel and the corresponding price of the resources. Oil and fossil fuel resource is quite comfortable while natural gas availability is not enough to meet the demand. Renewable energy is emerging as alternative resources though solar and wind power is not a dependable resource, because of unpredictable climate in a region. Financial achievement in energy utilities is linked with cost of the fuel .Now fossil fuel dominate 56% of electricity generation and states privileged with coal mines are able to save cost of transportation while the states located far away from coal pits faces the burden of transportation cost. Further, quality of fossil fuel determines extent of financial strain to generate electricity. Then economy of the country is responsible for financial stability of the electricity utilities. The growth in industry and agriculture will contribute to state gross domestic product as the SGDP increased, so the contribution of electricity sector to SGDP will increase if proper planning procedure is followed, then only the electricity utility will have financial stability keeping in view efficiency measures. Therefore, uncertainity in economic growth will cast a shadow of uncertainty in financial stability of electricity utilities; it has been perceived that technology innovation is always coming into play when such situation arises because of urge of innovation to counter the negativity in the growth trend. The development of computer, laser technology has brought a significant relief from uncertainty in functioning of

1. Ex-Superintending Engineer (Electrical), WBSEB, Kolkata

different activities that has reduced cost, improved productivity and manpower. There is always a trend of innovation in developed country to overcome any difficulties that has resulted in series of changes in industrial and agricultural resources, information technology has completely changed the working system that manages the present scenario to meet the challenges of uncertainty in future. The industrial growth is the basic need for sustaining financial stability of electricity utilities; because installed capacity of generating plant can be efficiently utilized to supply bulk power for base load, at the same time, the tariff is quite high to get best earnings per unit of electricity sold. There is a shortcoming in respect of agricultural load because of subsidy in tariff, that area of revenue earning creates a void in financial stability. Uncertainty in financial stability is also related to climate of the region. There is possibility of natural disaster that could bring havoc in electricity installation or the draught situation in a region can push a state to overdraw power to meet its high demand resulting in grid failures that may be a reason of financial losses. There may be uncertainty due to fall in demand for weather change when a part of installed capacity will remain out of network, all those developments on the system results in financial losses. Overall effect of these issues is perceived in dynamic change of financial stability. The policy issues at political level also have impact on future uncertainty, for example, this may be policy on revising selling price or assigning more importance on fossil fuel than renewable energy or technology implementation on specific issues in generation, transmission and distribution or the land acquisition issues for sub-station, transmission line that involve a large flow of power through grid. The study has discussed all these issues in subsequent sections in different scenario of uncertainty by assigning weightage in respect of resources, economy, climate and financial effect and policy decision based on present day scenario of the relative dimensions (Ebinger and Vergara, 2011).

2. Resources and Financial Uncertainty - Innovation Criteria

The availability of resources for electricity generation is an issue of uncertainty for electricity utilities. Fossil fuel fired generation plant is dominating 55% of total electricity production in utilities across the country While hydro electricity resource shares 25% of total electricity generation. Natural gas is used to some extent in western region of the country. The major issue of uncertainty in hydro power generation is impact of climate on water availability in the region. The adverse climate will affect the water flow in the rivers that will pose a problem in generating power affecting revenue earnings. Fossil fuel fired generating units will be affected by climate change due to change in ambient temperature, pressure and humidity that has impact on generation cycle efficiency and water requirement, obviously that will affect both cost of supply and availability of target output. In case of renewable energy, grid interactive energy system is now in operation across the country that is susceptible to impact of climate change. Solar power, wind power and biomass generated power are all dependent on climate effect. Temperature increase will affect natural gas based generating plants for reduction in heat rate and power output. This shortcoming in power generation will affect both revenue and the cost of supply. These dimensions can be related in a mathematical form

If Sf is financial stability of the organization and R is resource, then

$$Sf \propto R$$

or $$Sf = \varphi.[R], \quad 0.1 < \varphi < 1 \qquad — \qquad — \qquad — \qquad (1)$$

Where is uncertainty factor that depend on economy, climate and policy decision, Again, Cost of supply of electricity (I) is a variable that need to be managed by forecasting the demand,

available fuel resources and available plant capacity, if cost of supply increases, the financial stability will be uncertain, whereas decline of cost of supply is an indicator of better status of stability. This status depends on information sharing between the stakeholders of utilities. Thus the mathematical relation can be re-stated as

$$Sf = \varphi .[R/I] \quad — \quad — \quad — \quad — \quad (2)$$

3. Economy and Financial Stability

Sustainable financial stability in electricity utility depends on the economy of the state. Economy of the state is related to growth of industrial sector and agricultural productivity. There is uncertainty in the growth of economic resources due to recession or affected by policy decision on tax and duties or effect of long term planning that involve forecast of long term growth of industrial sector commensurate with investment possibilities and agricultural production with capital investment under favorable climate. Electricity utilities similarly develop long term planning proposal of capacity addition to meet the expected demand commensurate with growth of economy in the projected year. If there is mis-match between growth in industrial sector and the growth of capacity addition, then there will be uncertainty in evacuating power from the generating sources, either there need be shut down of units or the excess power need be dispatched to other areas through grid, if there exist such possibilities. Dependance on renewable energy is also uncertain that need periodical monitoring of expected dispatch of generated power from wind turbine. The wind power generation is mentioned here because there is substantial growth of grid interactive wind power generation in the country. Economy of the country is interrelated with climate of the region. Economic growth is commensurate with monsoon activity across the country. So, uncertainty in demand of electricity is expected with rise and fall of economy. Therefore, financial stability of the system depends on effective planning with technological input in relation with economy and climate of the state.

This concept has been translated in mathematical form as follows

$$Sf = \varphi . [I(q-ql)/Cs] \quad — \quad — \quad — \quad (3)$$

Where, Cs is cost of supply, I is earning of utilities, Q-Ql is the electricity supplied, Ql is loss and is proportionality constant termed as uncertainty.

First of all the correlation between economy in terms of State gross Domestic product (SGDP)

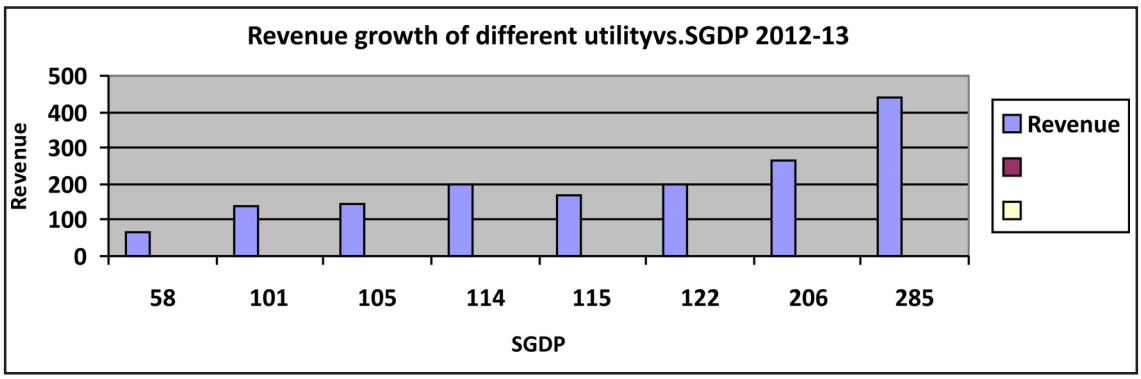

Figure 1: Correlation between SGDP and Revenue Growth
Source of data: [PFC &data.gov.in]

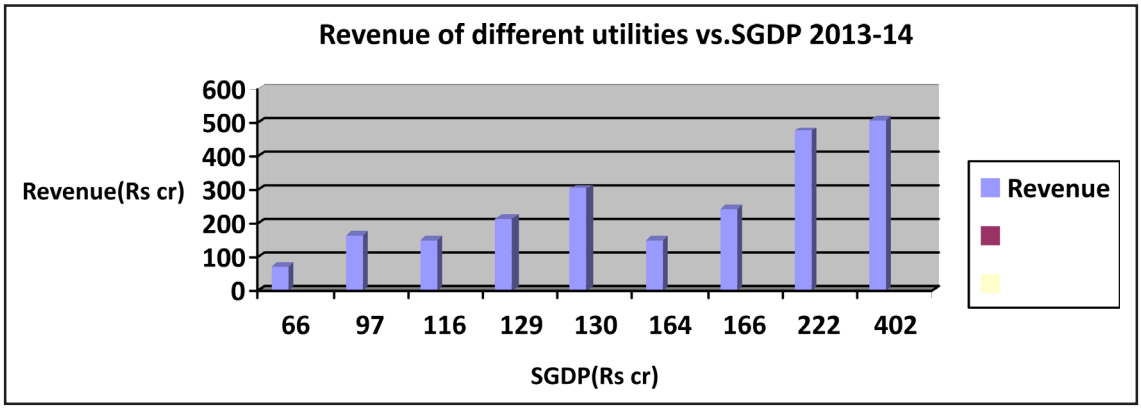

Figure 2: Correlation between SGDP and Revenue Growth for 2013-14
Source of data: [2] & [3]

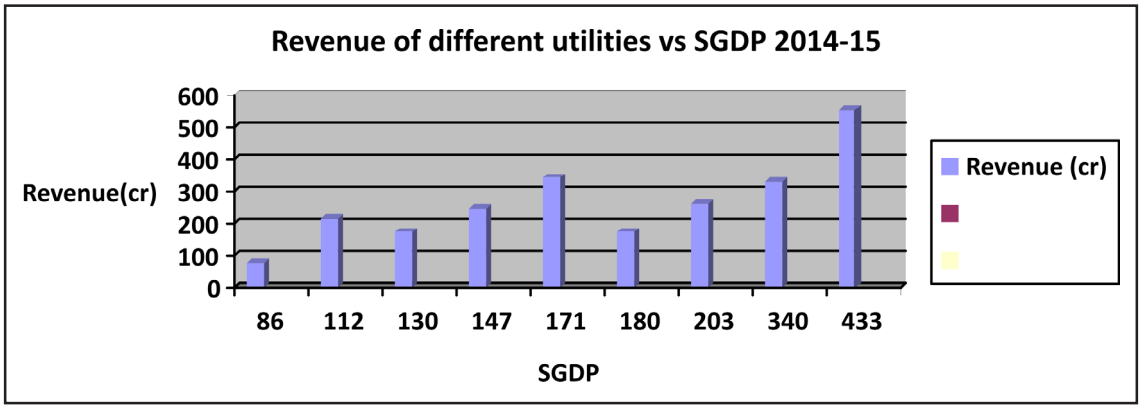

Figure 3 Correlation between SGDP and Revenue Growth 2014-15
Source of data: [PFC &data.gov.in]

and the revenue earned by the utilities is analyzed in the following Figures 1, 2 and 3.

The Figures 1, 2 and 3 visualizes the variation of State Gross Domestic Product with revenue earning of state utilities in Tamilnadu, Maharashtra, Karnataka, MP, Maharashtra, Rajasthan, West Bengal and Orissa covering all major utilities with different load and installed plant capacity, but one thing is important to note that revenue variation with SGDP is linearly correlated. Therefore the concept that the revenue growth is dependent on state economic growth has been justified. This verification of the concept also justifies the concept that uncertainties associated with economic growth due to recession, inflation will also affect revenue, thus affecting financial stability of the system. So far, the study has focused on analysis of the system stability pertaining to climate and economy effect criteria, next discussion involves on policy issues

4. Policy Issues and Uncertainties

There is state electricity regulatory commission which looks into tariff, performance that act in between state and the utilities. The state utility is under state government, therefore each of the utilities have their own norms and regulation in operation of the system. Therefore, the

decision on the issues of tariff and technology deployment will vary that will affect the financial stability, but common perception that emerge out of all discussion highlight dependence of financial stability on economic growth of the state. The most important issue is tariff revision commensurate with escalation of fuel cost and cost of operation. The application of this concept is actually depending on policy issues. In many cases, the decision to assign more importance on renewable energy resources with non-renewable energy sources remains unresolved. Therefore uncertainty in financial stability is expected due to policy issues.

5. Innovation Solution to Uncertainty

If the system experience deficiency in productivity, quality of production and financial attainments, then financial stability of the system is affected. The major issue for consideration is to analyze the performance of sub systems and then integrating the values to decide how to improve function without impairing existing operational structure. As discussed in previous section, revenue earnings per unit of energy distributed is varying with SGDP, technology is new idea or a software or hardware which can transform resources to increase productivity with higher efficiency in congruence with growth in SGDP. It has been observed in the previous section that revenue earning of electricity utilities is linearly correlated with SGDP. Moreover, the system is exposed to uncertain characteristics of economy and climate when there is lack of knowledge about future stages of development in those dynamic entities. But advanced technology now has changed the scenario dramatically by long term forecasting of climate and trend of economy in the country. Technology diffusion in generation of power and efficiency improvement in distribution system will counter negative effects of climate change. Computerization and implementation of information and communication technology in financial work, transmission and distribution system has dramatically changed the performance in west Bengal, Maharashtra, Karnataka and Andhra Pradesh state electricity utilities. There is perceptible string of operation in the function of different sub systems that need integrated action of technology adaptation to achieve financial stability. Keeping in view this logic of Sustainable Financial turnaround and revival of Discom, UDAY (Ujwal Discom assurance yojna) has been implemented which is adopting technology based operational strategies. Around 16 states have joined in this yojna. Most of the states have achieved improvement in financial achievements except some states like UP. Technology transfer to electricity utilities is possible through different channels of import of software and hardware together with collaboration of institution for skill and knowledge improvement. We can consider these issues as utilities policy decision to adopt as resources. Knowledge base in the utilities need be enhanced with increasing communication and technology based operational process (demelt west, 2012)

6. Discussion

Now the analysis is focused on explaining the financial stability in the light of mathematical relation, some assumptions are

1. The contribution of electricity sector to state gross domestic product has been considered as growth of electricity sector.
2. The losses of electricity due to transmission and distribution has been included in the electricity utilization.
3. Uncertainty factor has been assumed as direct variation with change in economy, weather and policy decision, the proper weightage was assigned to the factor according to the present status of these dimensions in respective state. The logic behind this concept rest on present scenario of state if analyzed with available information of future, and then

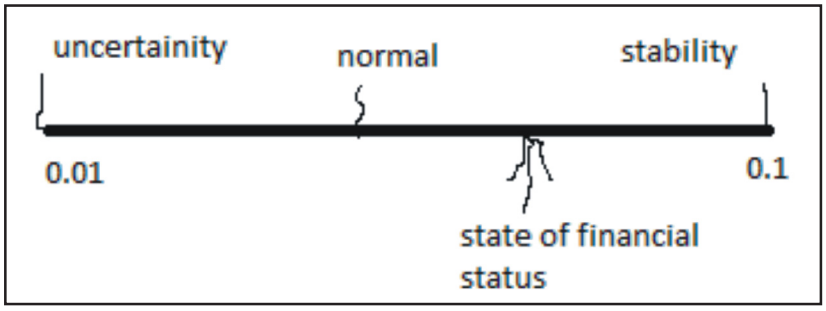

Figure 4: Block Diagram of Stability Criteria in Uncertain Situation

experiencing the challenge of uncertainty in future may be minimized.

The financial stability equation in (1) is further expanded as

Financial stability = ratio of cost of supply and earning per unit of electricity sold

$$Sf = \varphi * [R*(Q-Ql) / Cs] \quad — \quad — \quad — \quad — \quad (4)$$

Table 1: Uncertainty Factor and Corresponding Dimensions

Dimension	Low	Normal	Extreme
Economy	0.2	0.5	0.9
Climate	0.2	0.5	0.9
Policy /regulation	0.2	0.5	0.9

Uncertainty factor has been assumed as in the following table

Uncertainty factor is then determined by permutation and combination of different values assigned to the variables. For example, the economy may be extremely good and climate may be poor with good policy decision effect, then uncertainty factor is multiplication of weight age values [0.9*0.2*0.9 =0.16].

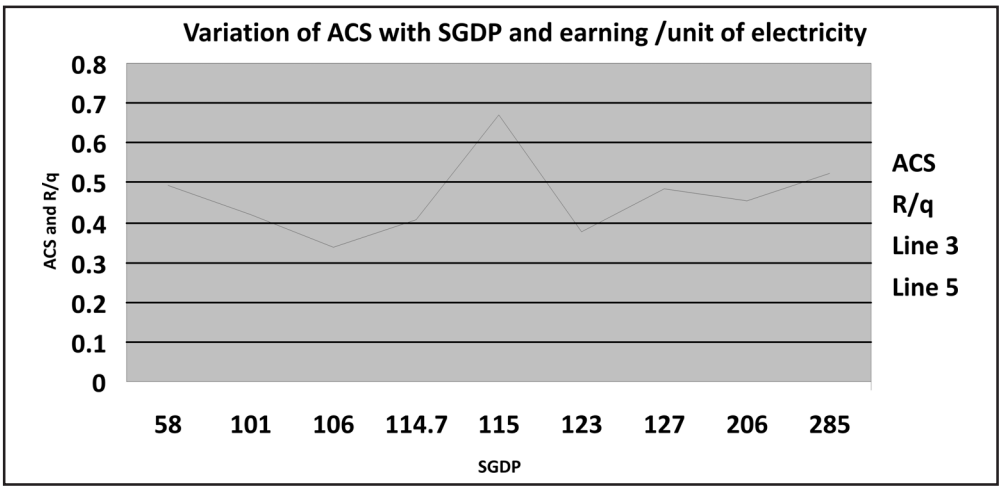

Figure 5: Variation of ACS with SGDP and Earning /Unit of Electricity

Then the real data of the utilities has been substituted in the equation and the corresponding graph has been plotted.

In determining uncertainty factor, weightage is assumed for each state based on existing economy, climate at state and policy of the utilities

Option I: economy 0.7; climate 0.9: policy 0.9

Option II uncertainty factor based on average economy (0.5), average weather 0.5 good policy 0.9

Table 2: Stability Index Computation

State	Stability index	Option	Uncertainty factor	Average cost of supply	Revenue earning / unit of energy supply
WB	0.07	I	0.58	4.92	0.669
Rajasthan	0.035	II	0.40	3.80	0.339
UP	0.031	II	0.40	4.75	0.375
Karnataka	0.054	I	0.58	4.30	0.405
Tamilnadu	0.043	I	0.58	6.42	0.485
Orissa	0.018	III	0.14	3.70	0.491
Maharashtra	0.063	I	0.58	4.8	0.524
MP	0.037	II	0.4	4.5	0.421
Gujarat	0.064	I	0.58	4.07	0.454

Source own design

Financial stability in order of ranking is as follows.

Table 3: Financial Stability Index of States in Order of Rank

1	2	3	4	5	6	7	8
West Bengal	Gujrat	Maharashtra	Karnataka	Tamilnadu	MP	UP	Orissa

Option III uncertainty factor based on low economy (0.2), good weather good policy

After substituting real values corresponding to ACS and R/Q, the stability is computed as

The improvement in financial stability can be achieved by diffusion of technology in MP, UP and Orissa state.

7. Conclusion

The study begins with the objective to find the relation between different dimensions and variables involved in achieving financial stability of electricity utilities, for this purpose, the analysis focused on impact of resources, economy and climate and policy issues at different state utilities. Then the correlation between the variables has been justified by graphical analysis, it has been

observed that SGDP is linearly varying with revenue earning per unit of electricity distributed by the utilities, climate has impact on stability criteria so also the policy issues .The mathematical expression has been derived for financial stability index to explain the relationship between uncertainty expected due to economy, climate, policy issues and financial attainments comprising of average cost of supply and revenue per unit of electricity supply. Financial stability index is then evaluated by substituting available data of financial attainments of the states as well as assessment of uncertainty factor based on present time status of economy, climate and management policy issues. The study also implies necessity of controlling dynamic stability index that changes from +ve certainty to – ve uncertainty by technology diffusion in the system. The logic behind impact of technology on financial attainments of the utilities has been explained substantiating with evidence of specific states utilities in innovation solution to uncertainty section that corroborate the findings of evaluated financial stability index of corresponding states in discussion section. The study finally identified the status of financial stability index of the states where technology diffusion is required to achieve +ve certainty in financial attainments. The study suggest financial stability criteria is an issue to know the deficiency in the electricity utility in relation to environmental characteristics that can be rectified by appropriate technology adaptation at proper time and right stages. In other words, Financial stability index evaluation for state electricity utilities will be considered as a step to know whether the operational strategy is in right direction, higher the index value, better is financial stability; whereas lower the index value, higher is vulnerability to instability that need analysis of system performance to find out deficiency for improvement by adaptation of technology based operation.

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