Technological & institutional changes and the changing role of economic modeling and forecasting in the telecommunications industry

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Technological & institutional changes in the telcos industry

- Convergence
- Internet (VOIP), Wireless,….
- Broadband
- Change in regulatory regimes
- Deregulation
- Globalisation
- Competition

The changing role of economic modeling

- Modeling, forecasting and strategies
- Opportunities, threats and market behaviour
- Economic value and industry performance

Economic and financial models in the telecommunications

- Economic and financial models are important tools for
  - Telecommunications operators
  - Regulators
  - Government

Economic and financial models in the telecommunications

- Economic and financial models can be used to:
  - Value certain key economic and financial variables
  - Fix prices for telcos services according to economic and financial criteria
  - Compare and make a selection of the best alternatives that, if used properly, will increase the telcos productivity and technological lead
  - Forecast certain key economic and financial variables that will help to plan future economic activities
  - Help develop appropriate strategies
  - Improve efficiency and economic performance

What is economic and financial modeling

- Real-life phenomena are complex and difficult to understand
- Models are simplifications of real-life situations
- Models, because they are simpler, are used to
  - explain the past and
  - predict the future
- Because it is impossible to make predictions with a high degree of precision, probabilities are attached to the occurrence of future phenomena
- This makes predictions less accurate but not valueless

Economic models applied to telecommunications

- Economic models are used to explain the theory
- Telecommunication services obey the law of demand, i.e., an increase (decrease) in price will decrease (increase) the quantity demanded, ceteris paribus.
- Simple models based on the concept of utility (marginal) are quite powerful and capable to explaining the law of demand for telco services
- Few models dealing with the explanation of the law of demand are the:
  - Ordinal
  - Cardinal
  - Hedonic

Economic models applied to telecommunications

- The cost of telecommunication services is also affected by a number of factors, internal and external to the firm
- The production and the cost functions follow certain paths (the law of diminishing returns, i.e., the total production increases at a decreasing rate when an ever increasing number of a variable factor of production is combined with a fixed one (capital).

Economic models applied to telecommunications

- The modeling of the production and cost functions are important tools to estimate the costs and productivity of the telecommunications industry.
- Both, forecasted demand and costs can be used for planning and strategic decisions such as
  - Upgrading the infrastructure
  - Investment in new technologies
  - Investment in new products and services
  - Building excess capacity

Economic models used to forecast the future

- By the same token, economic models are used for forecasting purposes
- The demand for telecommunication services may vary in the future (increase/decrease or remain the same) and this is an important variable for
  - the government
  - the regulator and particularly
  - the firm

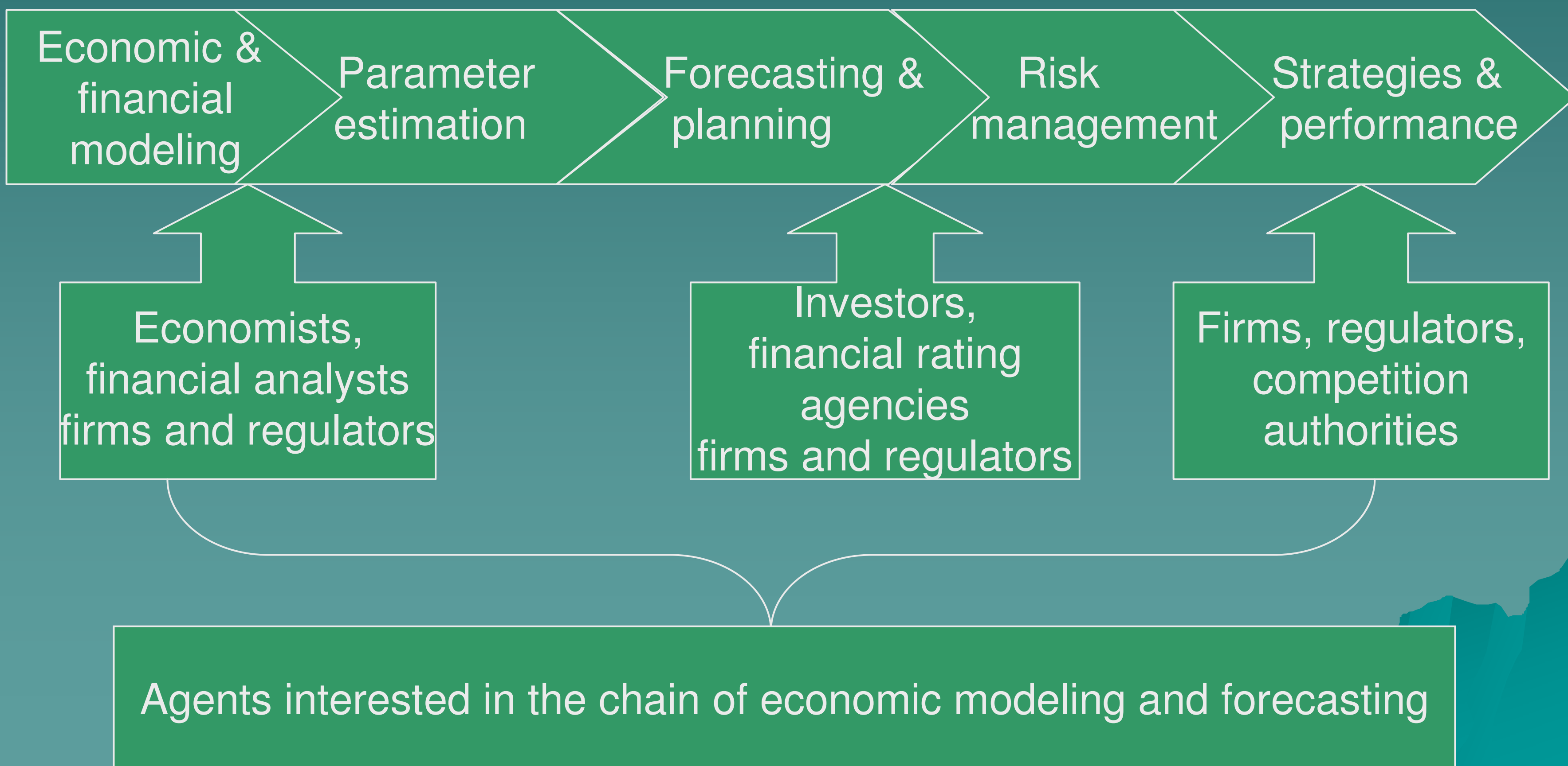
Economic models used in forecasting

- A variation (increase or decrease) in demand will affect
  - Prices
  - Costs
  - Profitability
  - Industry structure
  - Government policies
  - Firm strategies
- Forecasting the nature and size of these impacts are obviously quite important to all economic agents.

Economic forecasting and risk management

- Risk management is intimately associated with modeling and forecasting
- The estimates economists get from good forecasting models are used to develop strategies (marketing, investment, competition, risk, etc.)
- Risk management techniques reduce risk and therefore increase the firms' odds to have a higher profitability.

The economic, forecasting and risk management modeling chain



The change in interest and needs of economic modeling and forecasting

- The interest and needs in economic modeling and forecasting is changing constantly.
- This change in interest depends on:
  - changes in regulatory regimes
  - changes in technologies
  - changes in the level of competition in the industry
  - changes in priorities of public policies

The change in interest in economic modeling and forecasting

- *Changes in regulatory regimes:*
- The regulatory requirements are not the same in every regulatory regime.
- Therefore, the degree of sophistication in economic modeling varies.
- For instance, the change of regulation from RRR to PCs (price caps) have shifted interest in economic modeling (from precise estimations of cost of capital and tariff structures to estimations of productivity gains and simple rates of inflation).

The change in interest in economic modeling and forecasting

- *Changes in technologies:*
- The changes in technologies affect the cost structure of the firms and the demand for traditional and new telephone services
- For instance, the advent of fibre optics and Internet has changed dramatically the subadditivity of the cost function of incumbent monopolies.
- Economic modeling, by estimating the degree of cost subadditivity, was able to shed more light on whether the incumbents were still natural monopolies.

The change in interest in economic modeling and forecasting

- *Changes in technologies (cont'd):*
- At that time, this information was of great interest to regulators
- Nowadays, this information is of lesser interest because, in many segments of the industry, competition is the rule of the game.
- Nonetheless, modeling telcos' production function may be still of great interest to CEOs for helping them to take decisions concerning the capacity of the firm to compete in the market place.

The change in interest in economic modeling and forecasting

- *Changes in the level of competition in the industry:*
- As the level of competition in the industry increases, the need for sophisticated economic modeling decreases
- Simply, firms have neither the time nor the resources for developing and estimating sophisticated economic models.

The change in interest in economic modeling and forecasting

- *<u>Changes in the level of competition in the industry (cont'd):</u>*
- However, modeling and forecasting demand for traditional and new services and new technologies (broadband, for instance) are still a major priority for many telcos, particularly in a competitive environment
- Theories such first- and second-mover advantages and strategies that follow the exploitation of these advantages are used by many major telcos to develop strategies in a competitive environment (game theory).

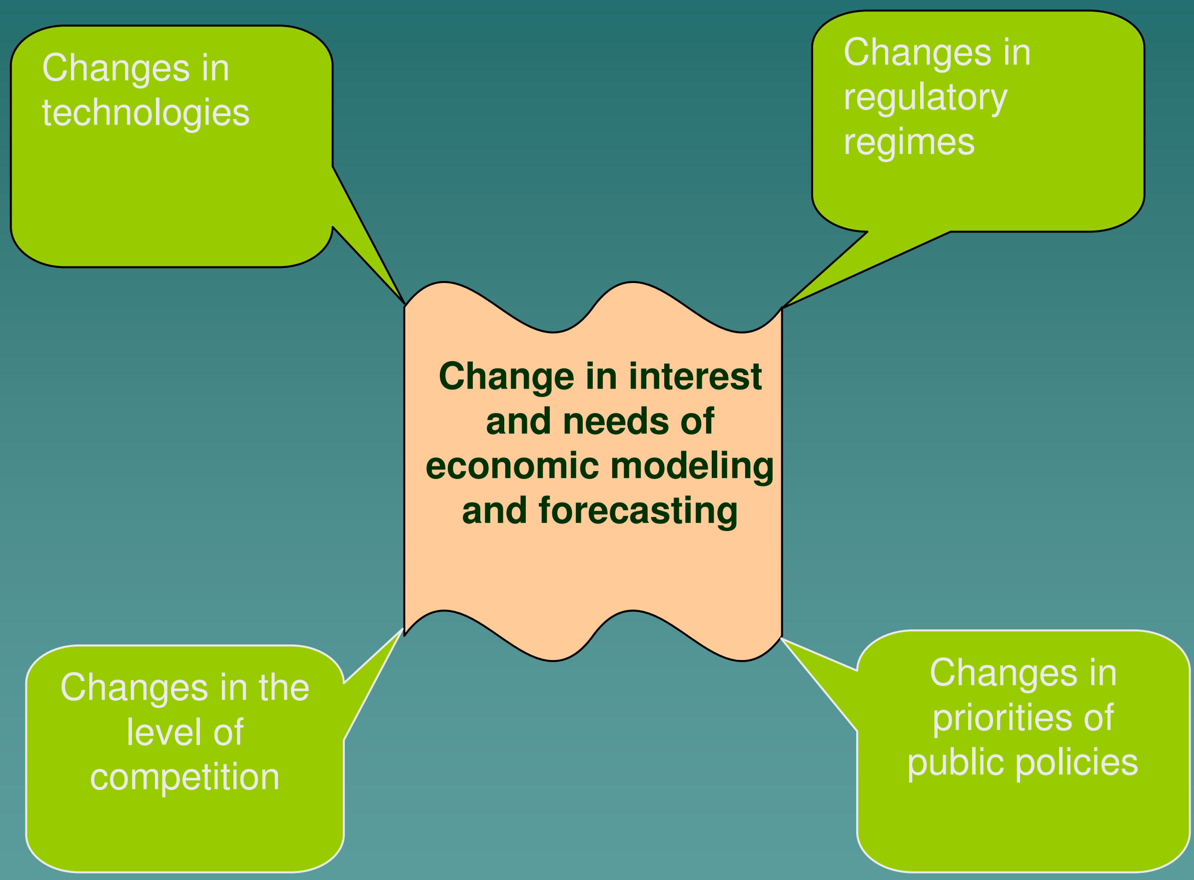
The change in interest in economic modeling and forecasting

- *Changes in priorities of public policies:*
- As the priorities of public policies change so does the requirement for economic modeling
- For instance, the government may want to increase the deployment of broadband technology in the country.

The change in interest in economic modeling and forecasting

- *Changes in priorities of public policies (cont'd):*
- Economic modeling can help to identify the benefits and costs of such a policy and evaluate the impact on social welfare.
- Likewise, telcos may want to deploy the broadband technology. Depending on cost and competition, they may decide to do it sooner or later.
- Economic modeling can help to identify the optimal time path of such deployment and evaluate the impact on company's profitability.

Change in interest and needs of economic modeling and forecasting



Main economic and forecasting models

- No model can claim to be the best in estimating and predicting key economic variables in *all* situations
- Nonetheless, some economic models are better than others in estimating and predicting key economic variables in *some* situations

Static and dynamic economic and forecasting models in the telcos

- The telecommunications industry is undergoing important new technological and market developments in the mobile segment of the market.
- These dynamic changes have had as an effect to change dramatically the structure and behaviour of the industry.
- Despite these dynamic changes, the *static models* are still useful.
- Thus, both the ***static*** and **dynamic models** are well suited in estimating and forecasting some key economic variables.

Forecasting in telecommunications industry

Why forecasting

- Uncertainty
- Improve the efficiency of the decision-making process
- To predict where one will be in the future
- To control company operations
  - Financial planning
  - Investment in infrastructure
  - Purchase of materials
  - Manpower requirements
  - Setting production and inventory levels
  - Determining sales targets
  - Deciding on advertising expenditures

Forecasting Methods

- Subjective methods
- Model-based methods
- Econometric methods
- The Delphi method
- Extrapolation methods
- Input-output method

Forecasting Methods

- Subjective methods
  - informal way to process information.
- Subjective methods are based on
  - guesses
  - experience and
  - intuition

Forecasting Methods

- Model-based methods:
  - It is a formal way to process information.
- Two type of models:
  - Causal models
  - Non-causal models

Forecasting Methods

- Causal models – explain how the values of variables are determined
- Non-causal models - provide prediction but no emphasis is given on understanding the behaviour of the variables (time-series models)
- Examples of non-causal models:
  - Trend extrapolation
  - Decomposition analysis
  - Box-Jenkins univariate time series model.

Forecasting using the Delphi method

- It is a non-causal method of obtaining information for predicting the future level of
  - Sales of a new product or service
  - Sales of a new technology
  - Growth of a new technology (broadband, for instance) over the next five years
- Information is obtained through a questionnaire addressed to a number of experts in a series of forecasting rounds
- The Delphi method is most appropriate for:
  - longer term forecasting where past data may be misleading
  - qualitative forecasting such as predicting what technological changes will occur and when.

Forecasting using extrapolation methods

- It is a non-causal method based on the idea that past patterns in the data will be repeated in the future
- There are basically three main extrapolation techniques:
  - Simple extrapolation
  - General extrapolation models based on trends
  - Decomposition analysis
  - Smoothing methods
- For these methods, the time profile of the observations is quite important, so that time-series rather than cross-section data are relevant.

Forecasting using the simple extrapolation method

- This is the naïve, "no-change" model
- According to this model, the forecast value of sales for wireless services *Y* for period *t* is the same value of sales in period *t-1*.
  - $Y_t = Y_{t-1}$
- The probabilistic nature of time series is taken into account by adding a random or stochastic term u_t to the equation
  - $Y_t = Y_{t-1} + u_t$
- This equation can be written as $Y_t - Y_{t-1} = u_t$ so that the change in Y is random (*random walk model*).

Forecasting using the simple extrapolation method

- The random or stochastic term u_t is a *white noise or classical error* and has the classical properties:
  - $E(u_t) = 0$ (mean zero)
  - $E(u^2_t) = \sigma^2$ (a constant variance)
  - $E(u_t u_s) = 0$ for $t \neq s$ (uncorrelated with other values of u)
- The advantage of this model is that the only information needed to make a forecast for the next period is the current value of the variable.
- It is a *univariate model* in that data on other variables are ignored.

Forecasting using the general extrapolation model (trend analysis)

- There are many general extrapolation models.
- They are based on trends defined as the "general movement of a series in a particular direction".
- For instance, the demand for cell phones is growing as customers become more acquainted with the product, through advertising and experiencing the product.
- Because these factors are difficult to measure precisely, they can be represented by *time-trend* variable *t*, which increase by one with each successive observation.
- In *trend extrapolation,* the type of trend observed in cells phones sales is determined and this is projected into the future.

Forecasting using the general extrapolation model (trend analysis)

- The trend may be linear or nonlinear and can be measured
  - by a regression method or
  - by forming a moving average of a series
- For a series of observations Y_1, Y_2, Y_3, Y_4, Y_5 ,...... a linear trend can be estimated from the regression model
  - $Y_t = \alpha + \beta t + u_t$
  - where α and β are the intercept and slope terms respectively.
- The estimate β gives the average absolute increase in Y per unit of time.
- This corresponds to an arithmetic series, where there is a constant change each period.

Forecasting using the general extrapolation model (trend analysis)

- In telecommunications, there are better models to forecast
- For instance, the growth of cell phones can be expressed
  - either as geometric or compound growth at a rate of ρ per unit of time
    - $Y_t = A\,(1+\rho)^t 10^u$ transformed to
    - $\log Y_t = \log A + t \log(1+\rho) + u$
  - or in some cases as exponential or continuous growth at a rate of λ per unit of time:
    - $Y_t = A\,e^{\lambda t} + u$ transformed to
    - $\ln Y_t = \ln A + \lambda t + u$

Forecasting using the general extrapolation model (trend analysis)

- Alternative, the characteristics of a *varying trend* may be captured by a simple moving average model
- For example, given Y_1, Y_2, Y_3,….Y_n, a fifth order moving average forecast for period n+1 is obtained from
  - $Y_{n+1} = (Y_n + Y_{n-1} + Y_{n-2} + Y_{n-3} + Y_{n-4})/5$
- This is a simple univariate model where a variable is explained purely in terms of its own past values.

Forecasting using decomposition analysis

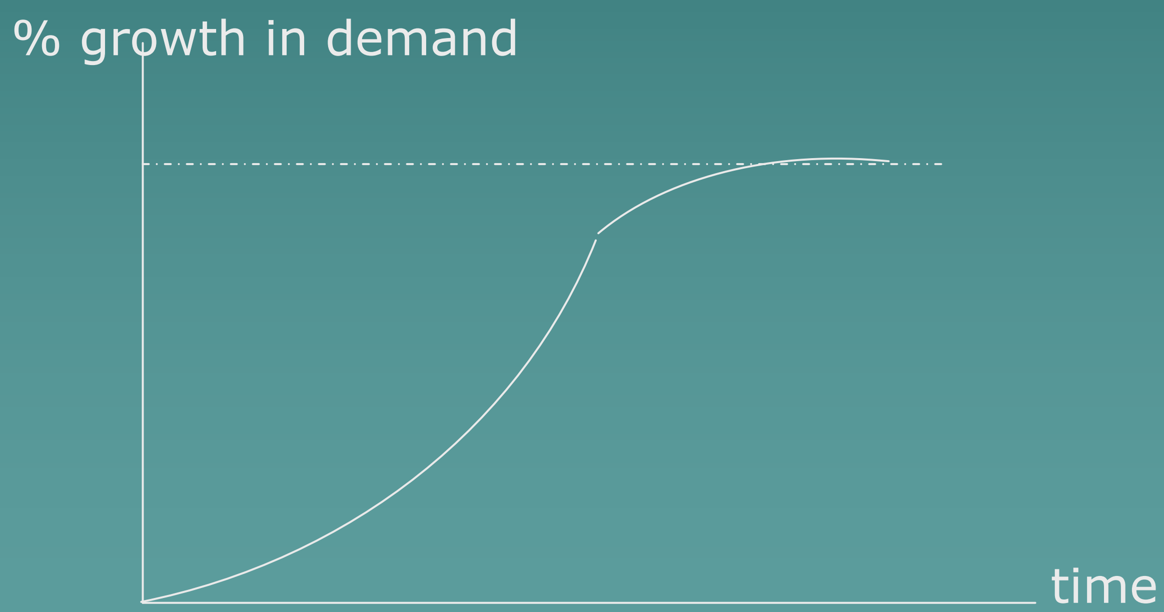
- This model is based on the assumption that a series of data can be split into four components:
  - a trend term
  - a cyclical term
  - a seasonal factor and
  - an irregular or residual element
- The relationship among these components may be
  - additive or
  - multiplicative
- The assumption of this model is that each of these components can be identified from past data and then be projected into the future.

Forecasting using the logistic and Gompertz models

- Growth curves are used to forecast demand for goods and services
- The basic assumption is that the growth curve is S-shaped with various saturation levels
- According to these models, the growth in demand is simply a function of time and causal variables such as prices and advertising have no direct effect.

The S-shaped growth curve

- A S-shaped growth curve with a saturation level of 90% is indicated in the diagram:



Forecasting using the logistic and Gompertz models

- The most common growth curves used to forecast demand in the telecommunications industry are:
  - the logistic and
  - the Gompertz models

Forecasting telecommunication services using the logistic model

- The logistic model takes the form:

$$X_t = \frac{\alpha}{1+\beta\exp(\gamma - t)}$$

  - where α α, β, γ > 0 and
  - α is the saturation level
  - X is the cumulative telcos sales
  - t is time and
  - exp is exponential

Forecasting telecommunication services using the logistic model

- If α is known, this equation can be transformed to:

$$\log\left[\frac{X_t}{\alpha - X_t}\right]_t = -\log\beta + \gamma t$$

- Given time-series data on X, the remaining parameters, β and γ, can be estimated.

Forecasting telecommunication services using the Gompertz models

- The Gompertz model takes the form:

$$X_t = \alpha \exp(-\beta(\exp(-\gamma t)))$$

  - where α α, β, γ > 0 and
  - α is the saturation level
  - X is the cumulative telcos sales
  - t is time and
  - exp is exponential

Forecasting telecommunication services using the logistic model

- If α is known, this equation can be transformed to:

$$\log\left[\log\frac{\alpha_t}{X_t}\right]_t = \log\beta - \gamma t$$

- Given time-series data on X, the remaining parameters, β and γ, can be estimated.

CONCLUSIONS (1)

- This paper examined the empirical evidence and compared economic and forecasting models used in the telcos industry.
- The goal was to identify models that can be useful for predicting demand and investment in infrastructure in the telcos industry as regulations, competitive conditions and government priorities vary, and to warn against models that should not be used.

CONCLUSIONS (2)

- In general, one should weigh costs and benefits of each model.
- Some static or naïve models used in the telecommunications industry are appealing because of their simplicity and easiness in getting some results.
- Unfortunately, they cannot capture the dynamic aspects of the industry.
- Dynamic models are more sophisticated theoretically but difficult to apply in practice.
- Nonetheless, structured methods are superior than the unstructured ones.
- Depending on data availability, the use of quantitative and econometric modeling, extrapolation techniques, rule-based forecasting, and causal methods are far better than simple intuition or unstructured estimates.

CONCLUSIONS (3)

- If data are not easily available, methods that structure judgement such as surveys of intentions and expectations and simulations are quite useful.
- Forecasting economic models should also incorporate the knowledge of the telcos managers and engineers.
- These models, such as Delphi improve accuracy of predictions and industry performance.

CONCLUSIONS (4)

- The majority of telcos use a small number of economic and forecasting models.
- The guidelines given in this paper, if followed, will improve the effective use of modeling and forecasting technique sin the telcos industry.
- Thus, there are opportunities for the telcos industry to improve their efficiency by adopting the modeling and forecasting techniques presented in this paper, especially in during a period of rapid changes in the regulatory, technological and competitive environment.